Job Polarization, Skill Mismatch, and the Great Recession

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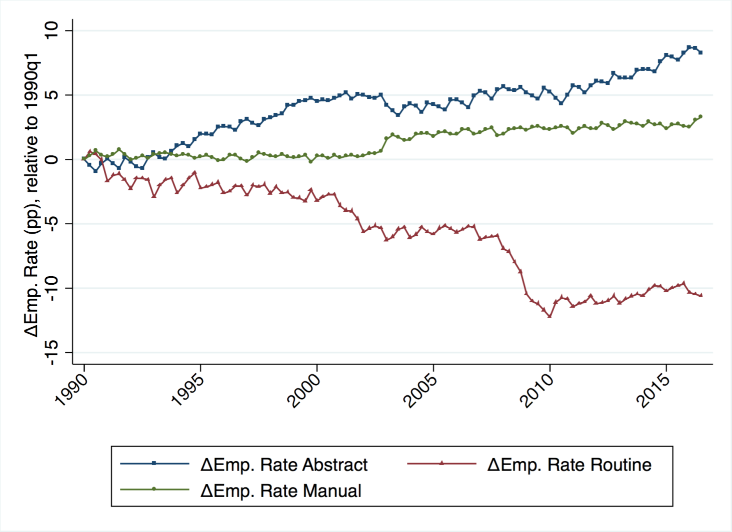
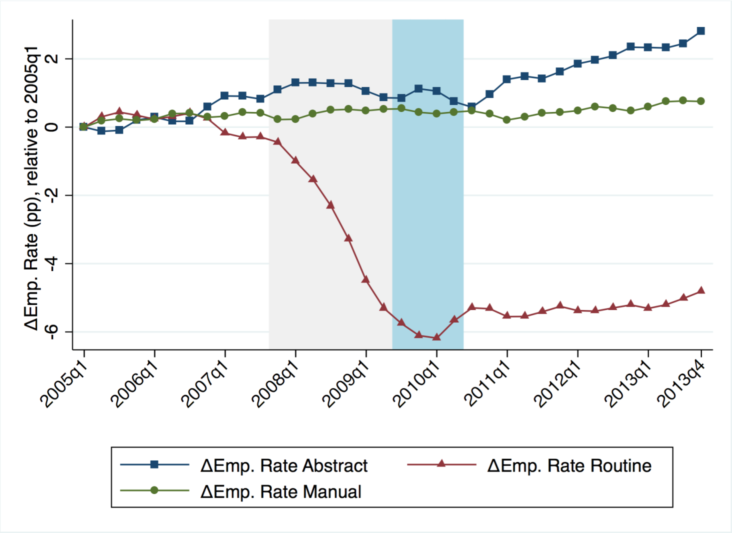
ECB/CEPR Labour Market Workshop

Job Polarization



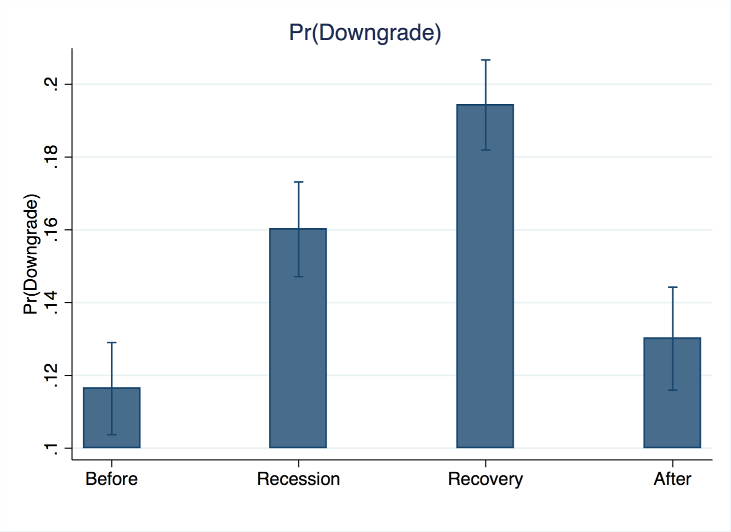
▸ More

Job Polarization & the Great Recession



▸ Unemp.

Vertical Downgrade & the Great Recession



▸ Details ▸ High-Skilled vs. Low-Skilled

This Paper

- **This paper** is the first to show that
  - the **decline of routine employment**
  - the change in **skill-demand** across jobs

  explain together
  - deterioration of **skills-to-job match quality** → *"Skill Mismatch"*
  - longer **unemployment spells**
  - sluggish **labor mobility**

Theoretical Mechanism

- A **model** with endogenous **mapping of skills to jobs**
  - **skill-heterogeneous workers**
  - job-specific **technologies** and **endogenous skill-requirements**
  - skill-dependent **job opportunities** and **multiple jobs search**

- **Asymmetric technology shocks** and **labor market frictions** affect
  - workers' **job opportunities and mobility**
  - the process of **sorting** skills with jobs

$\downarrow$

Skills-to-Job Mismatch

- **Routine Biased Technical Change** drives Job Polarization

Structural Estimation

- Estimation to **match only employment dynamics** between 2005 and 2015
- The model accounts well for the **reallocation patterns** of
  - **high-skilled workers**
  - **low-skilled workers**
- The **aggregate predictions** of the model are also **true within local-labor markets**

Main Results

1. job polarization accounts for the rise in skill mismatch
2. skill mismatch dynamics differ across workers when the market polarizes
3. higher skills attenuate the wage loss from mismatch
4. changes in skill-demand across jobs and frictions explain 38% of the shift-out of the Beveridge Curve

Policy Relevance

- **Inefficiency** in labor factor allocations due to frictions
  - longer unemployment spells for the low-skilled
  - welfare loss due to job polarization
- The **central planner**
  - reduces low-skilled unemployment
  - attenuates job-polarization
  - reduces skill mismatch by $1/3$

Outline

1. **THE MODEL**

- Technologies and Jobs
- Workers and Job-Search
- Equilibria

2. **QUANTITATIVE ASSESSMENT**

- Estimation to match occupational dynamics between 2005 and 2015
- Comparison of the implied allocation patterns of HS and LS with the data
- Model implications for welfare, matching efficiency and wages

The Model

RBTC and Temporary Shocks

- Assume abstract and manual technology to follow this

$$z_{a,t} = \bar{z}_a + \sigma_a \epsilon_t \quad ; \quad z_{m,t} = \bar{z}_m + \sigma_m \epsilon_t$$

- Assume routine technology to follow this

$$z_{r,t} = \begin{cases} z_{r,0}(1 + g_{z_r})^t + \sigma_r \epsilon_t & \text{for } t \in [0, T] \\ z_{r,T} + \sigma_r \epsilon_t & \text{for } t > T \end{cases}$$

- The technological shock ϵ follows an AR(1) process:

$$\epsilon_{t+1} = \rho \epsilon_t + \nu_{t+1}$$

and ν being a random shock out of a standard-normal distribution.

- σ_j governs the the job-specific intensity of the shock (similar to Lilien '82)

Production and Skill Requirements

- Workers differ in their skill-level x
- Technology z_j and skills x are mixed as follows:

$$y(x;z_a) = z_a x^{\lambda_a} \;\; ; \;\; y(x;z_r) = z_r x^{\lambda_r} \;\; ; \;\; y(x;z_m) = z_m$$

- The value of production is

$$J(x;z_j) = y(x;z_j) - w(x;z_j) + \beta \mathbb{E}\Big\{ s_j'(x)(1-\delta)J(x;z_j') + [1 - s_j'(x)(1-\delta)]V(z_j') \Big\}$$

with

$$s_j'(x) = s(x, e_j') = Pr(x \geq e_j')$$

- Firms choose the minimum requirement e_j to ensure a non-negative J:

$$J(e_j;z_j) = 0$$

- **Countercyclical Skill Requirements:** if $z_j \downarrow \Rightarrow e_j \uparrow$

Vacancy Posting

- Firms posts vacancies v_j for $j = \{a, r, m\}$ following this rule

$$V(z_j) = -c_j + \beta \mathbb{E}\Big\{p(\theta_j)J(x, z_j') + [1 - p(\theta_j)]V(z_j')\Big\}$$

with

$$p(\theta_j) = \psi_j \theta_j^{-\alpha}$$

and

$$\theta_j = \frac{v_j}{u_j} = \frac{\textit{n. of vacancies for market } j}{\textit{n. of qualified unemp. workers for market } j}$$

- **Free entry condition:** $V(z_j) = 0$, $\forall t$

Employment Opportunities and Unemployment

- Skills x are drown from a $U_{[0,1]}$ pdf

- For given e_a and e_r, a worker with skill x knows his job-opportunity set $\Omega(x) = \{j : e_j \leq x\}$
- The value of unemployment is

$$U(x; \boldsymbol{z}) = b + \beta \mathbb{E}\Big\{ \sum_{j \in \Omega(x)} q(\theta_j) N(x; z_j') + \Big[1 - \sum_{j \in \Omega(x)} q(\theta_j)\Big] U(x; \boldsymbol{z}') \Big\}$$

with $\boldsymbol{z} = [z_a, z_r, z_m]$, a vector of all technologies currently available in the job-opportunity set

Employment Value and Dynamics

- The value of employment is

$$N(x;z_j) = w(x;z_j) + \beta\mathbb{E}\Big\{s_j'(x)[(1-\delta)N(x;z_j') + \delta U(x;\boldsymbol{z'})] + [1-s_j'(x)]U(x;\boldsymbol{z'})\Big\}$$

- The dynamic for the stock of employment in job j is

$$n_j' = s_j(1-\delta)n_j + u_j q(\theta_j)$$

- For an increase in requirements in j, the factor $s_j(1-\delta)$ falls such that it
  - amplifies job destruction dynamics
  - exposes also highly-ranked worker to displacement (differently from Mortensen and Pissarides '94)
  - increases individual employment uncertainty (as in Ravn and Sterk '15...but here endogenously)

Wage Equation

- Under Nash Bargaining:

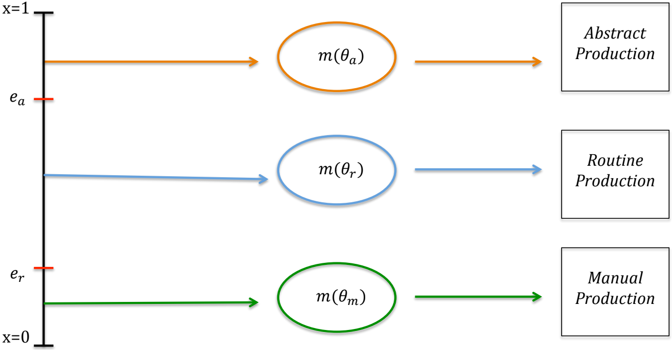
$$w(x; z_j) = (1-\eta)b + \eta y(x; z_j) + \eta \Big\{ \sum_{j \in \Omega(x)} c_j \theta_j \Big\}$$

with the value of the out-side option that varies over time and across workers due to:

- changes in θ_j
- changes in $|\Omega(x)|$
- changes in both θ_j and $|\Omega(x)|$

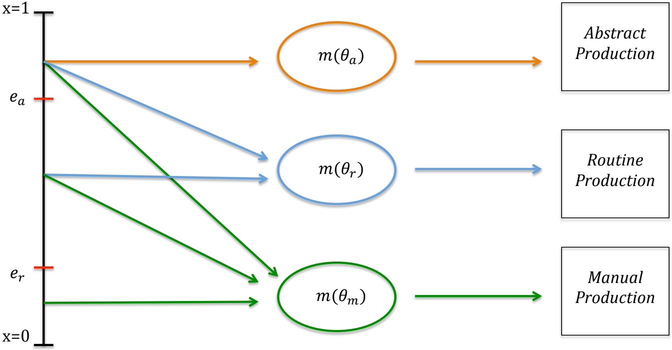
Two Alternative Equilibria

Skill-Separating Equilibrium: <u>**PAM of Skills and Technology**</u>



Two Alternative Equilibria

Skill-Pooling Equilibrium: <u>Skill Mismatch</u>



Skill-Pooling Equilibrium

Definition

Contingent to technology, a skill-pooling equilibrium is a vector $\{\theta_j, n_j, w(x, z_j), e_j, u_j\}_{t=0}^{\infty}$ for any $j = \{a, r, m\}$ and $x \in [0, 1]$ satisfying simultaneously the job creation condition, the minimum requirement condition, the wage equation, employment and unemployment dynamics.

Existence Condition

A skill-pooling equilibrium exists in the routine submarket iff the surplus from the match $S(x, z_r) \geq 0$ for all $x \in [e_a, 1]$; a skill-pooling equilibrium exists in the manual submarket iff $S(x, z_m) \geq 0$ for all $x \in [e_r, 1]$.

Quantitative Assessment

Bringing the Model to the Data

- Use CPS classification of educational attainments as a sufficient statistics for the distribution of skills

- Define two major skill groups (ILO)

    - **High Skilled (HS):** bachelor, master, phd
    - **Low Skilled (LS):** 11th Grade, high-school diploma, 2 years of college, vocational degree

- Build (quarterly) series for HS and LS employment in each occupation (only full time, non-self employed workers; codes for farming, fishing, forestry and military occupations excluded)

- **GOAL: estimate the model to match occupational employment dynamics from 2005 to 2015 and check reallocation patterns for HS and LS workers**

Structural Estimation via SMM

- **Preset Parameters:** β, b, δ, η, α, $z_{r,0}$, g_{LS} Appendix

- **Two Step Estimation**

  - **1st Step**: characterize the economy at an initial point (2005q1)

    - use $n_{a,2005}$, $n_{r,2005}$, $n_{m,2005}$, $Share^{HS}_{a,2005}$, $Share^{HS}_{r,2005}$, $Share^{HS}_{m,2005}$, $Share^{HS}_{u,2005}$, $\frac{w^{HS}_{r,2005}}{w^{HS}_{a,2005}}$, $\frac{w^{HS}_{m,2005}}{w^{HS}_{a,2005}}$, $\frac{w^{LS}_{r,2005}}{w^{LS}_{a,2005}}$, $\frac{w^{LS}_{m,2005}}{w^{LS}_{a,2005}}$

    - back-up z_a, z_m, c_j, ψ_j, λ_a, λ_r, γ Appendix

  - **2nd Step**: let the economy move on the RBTC trend and shock it to generate the dynamics observed from the Great Recession (2005q1 to 2015q4)

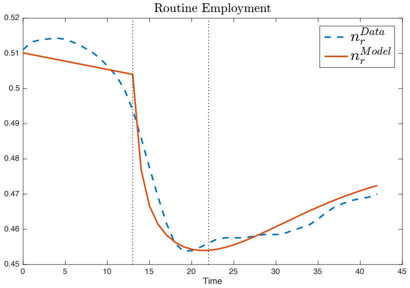
    - use long-run g_{n_r}, $\Delta n_{a,GR}$, $\Delta n_{r,GR}$, $\Delta n_{m,GR}$, $Corr(u_t, u_{t-1})$ Appendix

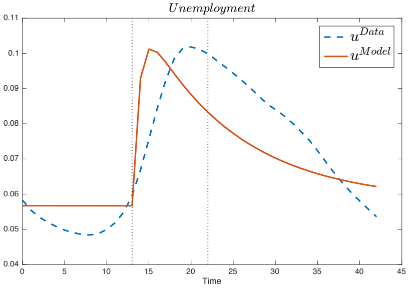
    - back-up g_{z_r}, σ_j, ρ

Parameter	Description	Value
Technology		
z_a	Tech. in abstract jobs	1.09
z_m	Tech. in manual jobs	0.68
Labor Market		
c_a	Vacancy posting cost in abstract	0.02
c_r	Vacancy posting cost in routine	0.04
c_m	Vacancy posting cost in manual	0.05
ψ_a	Matching efficiency in abstract	0.79
ψ_r	Matching efficiency in routine	0.68
ψ_m	Matching efficiency in manual	0.46
Skills		
λ_a	Return to skills in abstract	1.02
λ_r	Return to skills in routine	0.49
γ	Lowest skill for HS workers	0.71
Dynamics		
g_r	Growth of routine tech.	-9.81×10^{-5}
σ_a	Std. for tech. shock in a	0.040
σ_r	Std. for tech. shock in r	0.051
σ_m	Std. for tech. shock in m	0.017
ρ	Persistency of the shock	0.91

▸ Loss Function ▸ Moments (model vs. data) ▸ Skill Returns (data) ▸ Skill-Pooling Existence

Job Polarization and Jobless Recovery

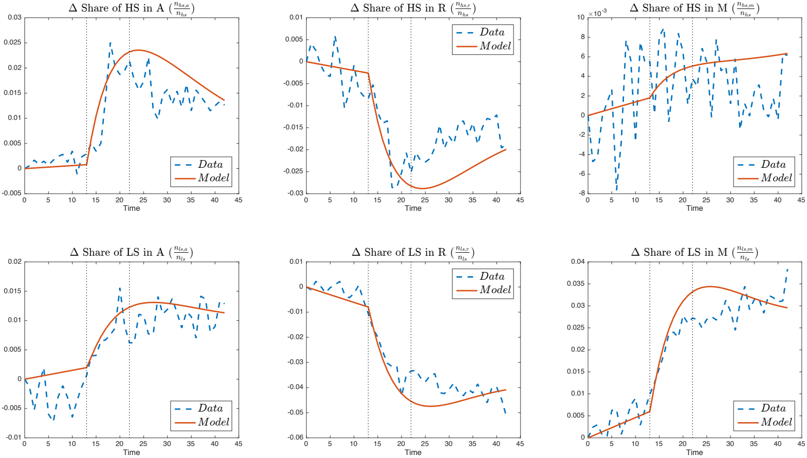




- The model generates too high unemployment in the long-run. Why?
  Rise in non-participation rate after the Great Recession

▸ Change σ (employment) ▸ Change g_{r_Z}

Employment Dynamics by Skill Group



- Temporary reversal in emp. shares for HS workers
- Permanent change in emp. shares for LS workers

▸ Change σ (sorting) ▸ *Data* (state-level) ▸ $E \longrightarrow U$ (aggregate) ▸ Other Dynamics

Employment Mismatch

Social Planner

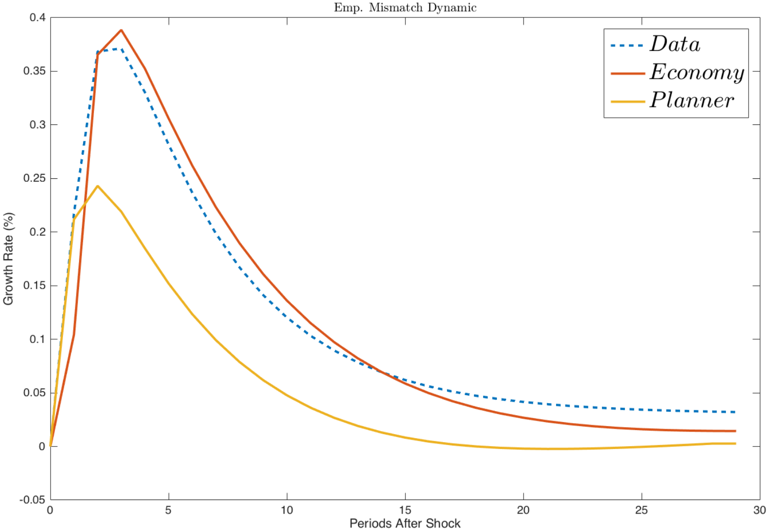
Following Bhattacharya and Bunzel '03, assume a social planner maximizes total expected output and total value of "leisure" at the net vacancy costs:

$$\max_{\theta_j, e_j, n'_j} \quad \mathbb{E}\sum_{t=0}^{\infty}\beta^t\{\tilde{y}_a n_a + \tilde{y}_r n_r + y_m n_m + b(1 - n_a - n_r - n_m) - \sum_j c_j\theta_j u_j\}$$

$$\text{s.t.} \quad n'_j = s(1-\delta)n_j + u_j q(\theta_j)$$

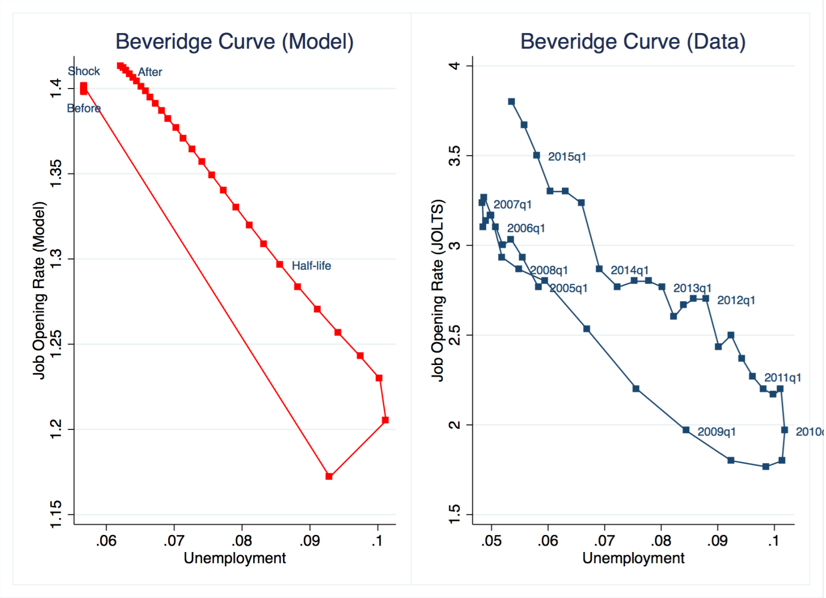
$$\tilde{y}_j = \int_{e_j}^{1} y(x; z_j)U_{[x\geq e_j]}dx \quad \Rightarrow \text{average output in } j$$

Employment Mismatch



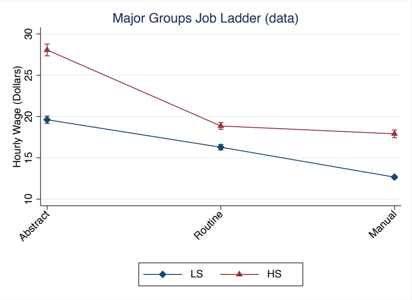
▸ Polarization (Planner) ▸ On ψ

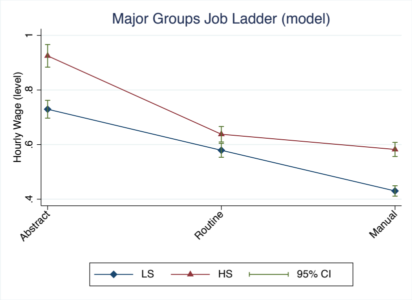
The Shift of the Beveridge Curve



Planner   Frictions vs. Shocks

The Wage Ladder





Wage loss is bounded for HS workers when moving down the ladder

Conclusion

- The change in the occupational structure and in skill-demand across jobs explain the rise in skill mismatch:
  - mismatch dynamics differ across skill-groups
  - the wage-loss from mismatch is bounded for high-skilled
- Job polarization is associated with specific reallocation patterns
- A central planner reduces skill mismatch and the process of polarization
- Changes in skill-demand across jobs and frictions explain the deterioration of aggregate matching efficiency

APPENDIX

Job Polarization

- Since the 80s, **routine employment** is falling along with wages
- Jobs grouped by task (Acemoglu and Autor '11) :
  - **abstract:** Management, Professionals, and Related jobs
  - **routine:** Production and Clerical jobs
  - **manual:** Food prep and service, personal/child care, recreation and hospitality jobs
- Job Polarization is driven by:
  - **Routine Biased Technical Change (RBTC):** robotics, IT innovations, etc.
  - **International Trade**: imports of "routine" products (e.g. cloths from China), offshoring, etc.

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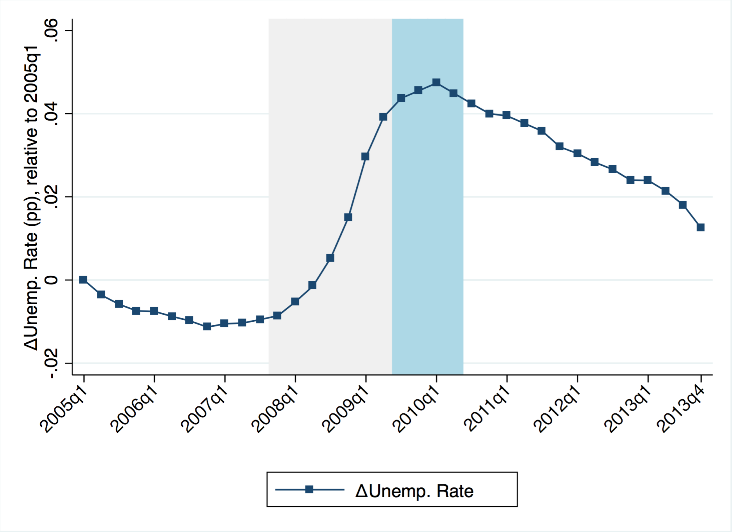
Unemployment



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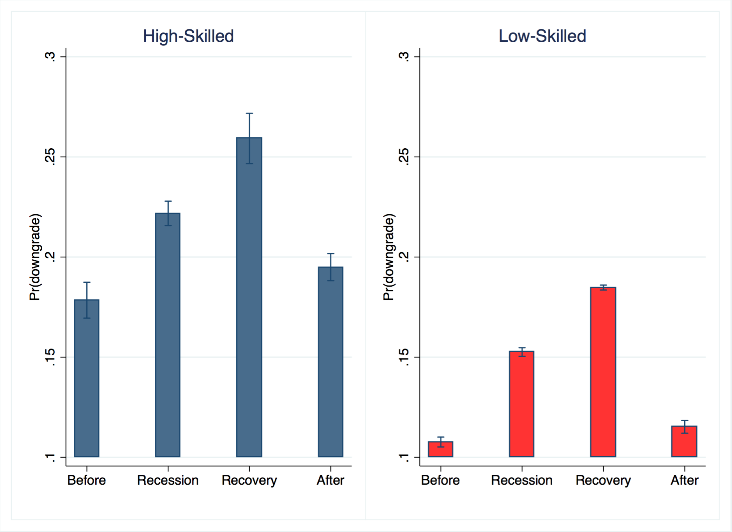
Vertical Downgrade & the Great Recession



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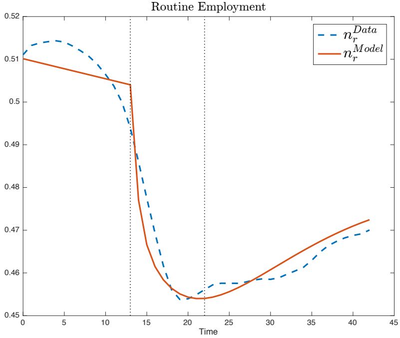
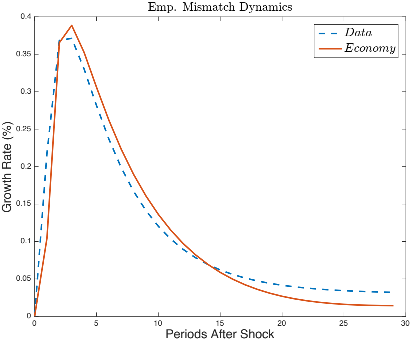
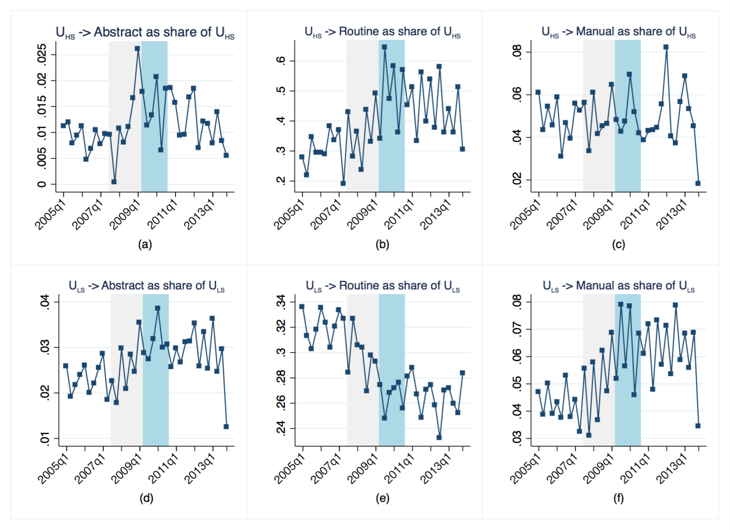
Polarization and Mismatch





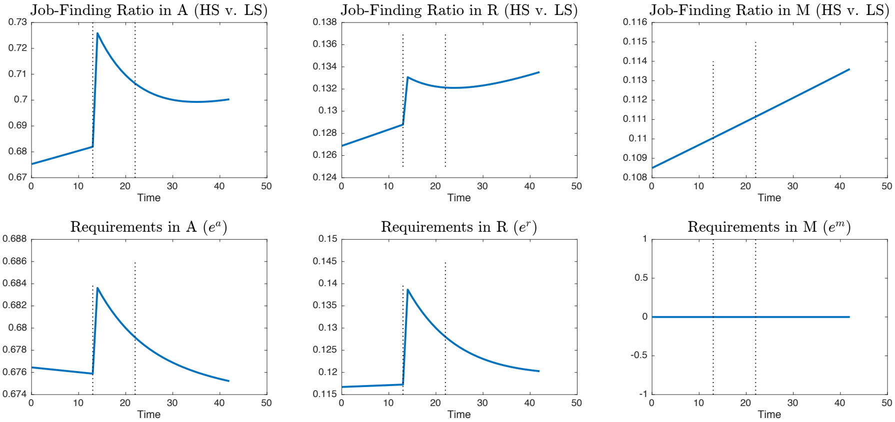
▸ Back

Flows from Unemp. to Emp.



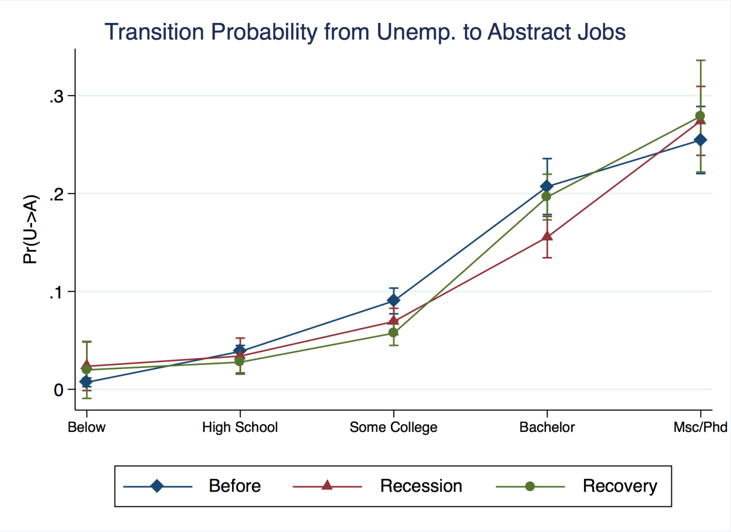
Model

Job-Finding and Skill-Requirements

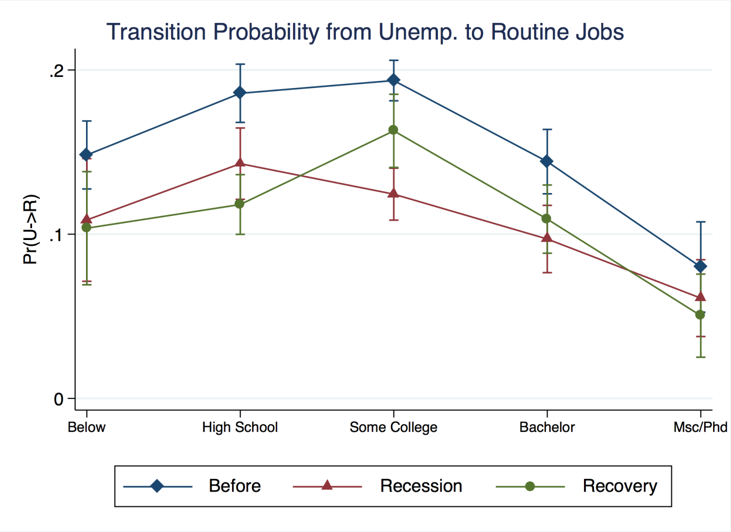


Up-skilling (data) *Model*

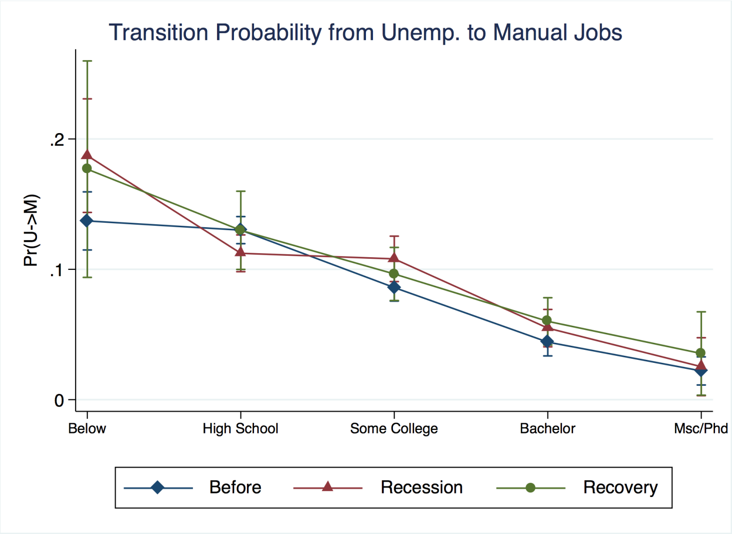
From Unemployment to Abstract Jobs



From Unemployment to Routine Jobs



From Unemployment to Manual Jobs



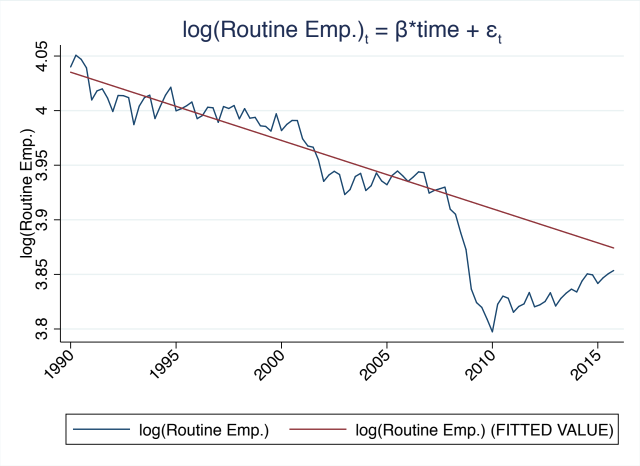
Back Model

Returns to Education over the Cycle

Back

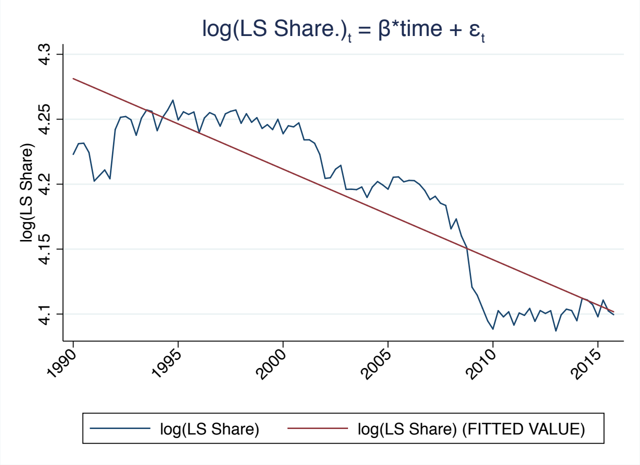
Structural Estimation

The long-run decline in routine employment ▸ Back

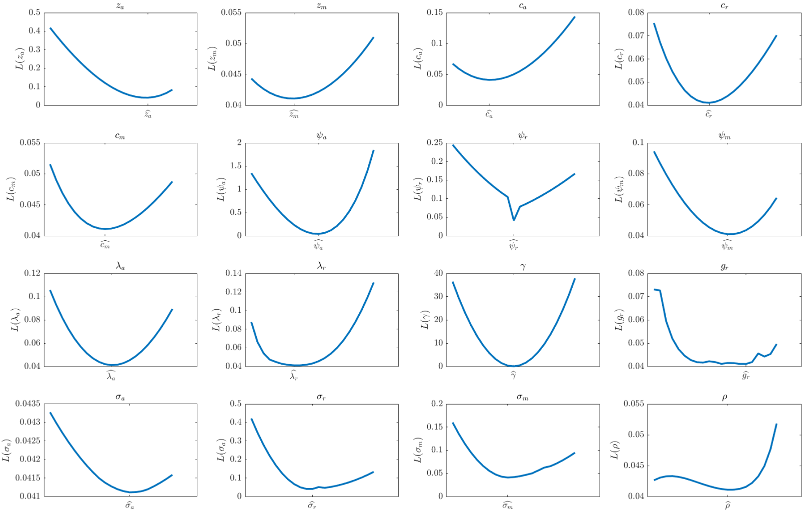


Structural Estimation

- γ is the skill level in the interval $[0,1]$ that splits the skill distribution in two subgroups: high-skilled ($\forall x \geq \gamma$), low-skilled ($\forall x < \gamma$)
- The share of low-skilled population decline at a rate $g_{LS} = -0.1\%$. Back



Structural Estimation



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Job-specific Surplus over time

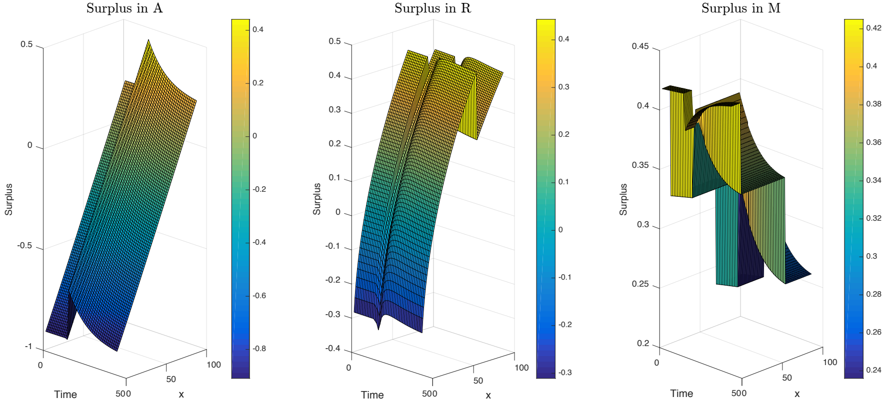

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Table: Preset Parameters

Parameter	Description	Value
β	Discount factor (quarterly)	0.95
b	Value of leisure	0.40
δ	Separation rate	0.10
η	Employer bargaining power	0.50
α	Matching elasticity	0.50
g_{LS}	Growth of LS pop. Share	-1.1×10^{-3}
$z_{r,0}$	Technology in routine jobs	1

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Table: Targeted moments and model moments

Moment	Data	Model
n_a in 2005	0.285	0.286
n_r in 2005	0.512	0.510
n_m in 2005	0.152	0.153
HS Share of n_a in 2005	0.660	0.675
HS Share of n_r in 2005	0.154	0.152
HS Share of n_m in 2005	0.102	0.105
HS Share of u in 2005	0.12	0.11
$\frac{w_{r,HS}}{w_{a,HS}}$ in 2005	0.683	0.689
$\frac{w_{m,HS}}{w_{a,HS}}$ in 2005	0.572	0.590
$\frac{w_{r,LS}}{w_{a,LS}}$ in 2005	0.810	0.795
$\frac{w_{m,LS}}{w_{a,LS}}$ in 2005	0.603	0.590
n_r long-run growth rate	-1.5×10^{-3}	-1.6×10^{-3}
$\%\Delta n_a$ during GR	-0.68%	-0.67%
$\%\Delta n_r$ during GR	-4.00%	-4.01%
$\%\Delta n_m$ during GR	-0.24%	-0.22%
$Corr(u_t, u_{t-1})$ during GR	0.900	0.899

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Vertical Downgrade over the Cycle

- **Say your company shuts down. What is your next job going to be over the cycle?**
- Use Displaced Worker Supplement (DWS) to identify workers that had been fired for "exogenous" reasons (plant closing, abolished jobs,...)
- For worker i consider:

$$Pr(\text{Downgrade}_i \neq 0 | X_i) = \Phi(\delta_s' \beta + X_i' \gamma)$$

where

- δ_s is a vector of mutually exclusive dummy variables for state-specific expansion, recession and recovery periods
- X controls for sex, age, education, experience, marital status, number of children.

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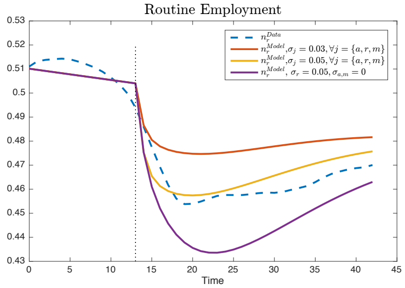
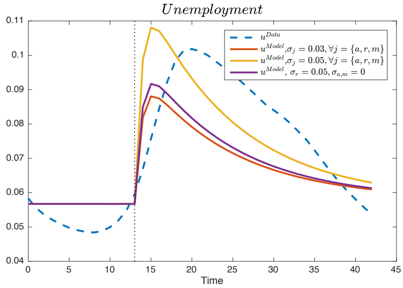
The role of σ





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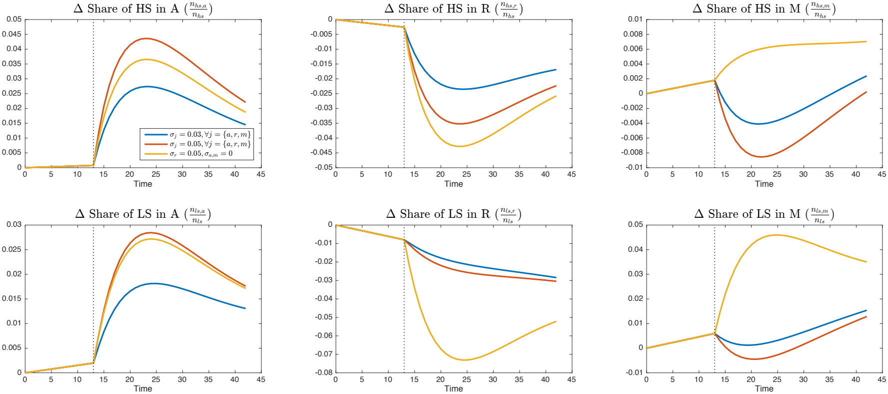
The role of σ



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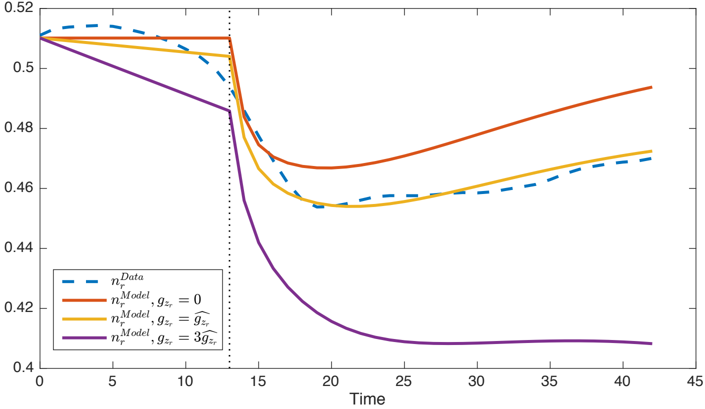
The role of g_{z_r}



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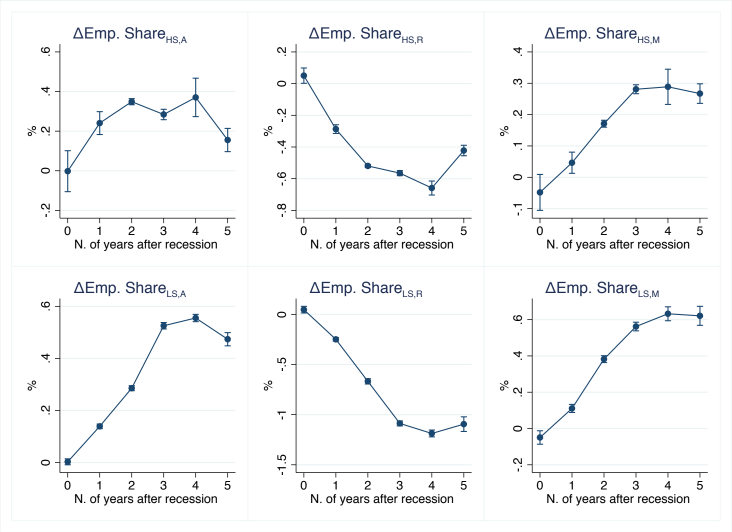
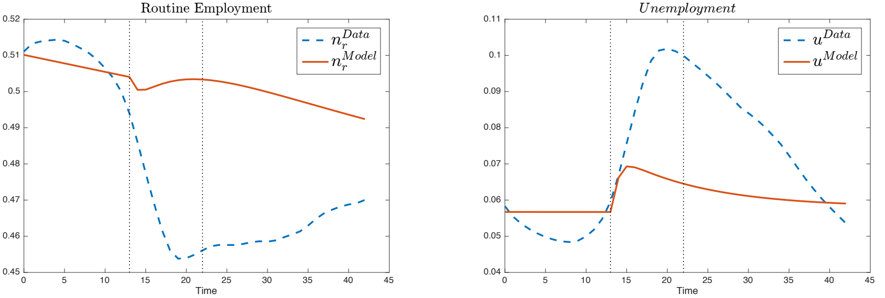
Employment Dynamics across States' Cycles

$$\Delta \text{Emp. Share}_{s,t} = \beta year_s + X'_{s,t}\gamma + \epsilon_{s,t}$$



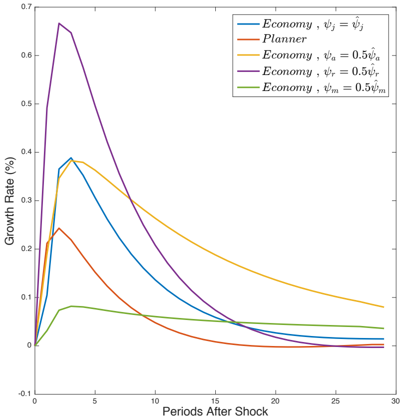
▸ Model

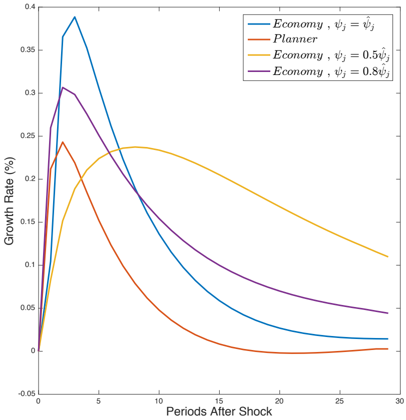
Job Polarization (Planner)



▸ Emp. Mismatch ▸ Policy Relevance

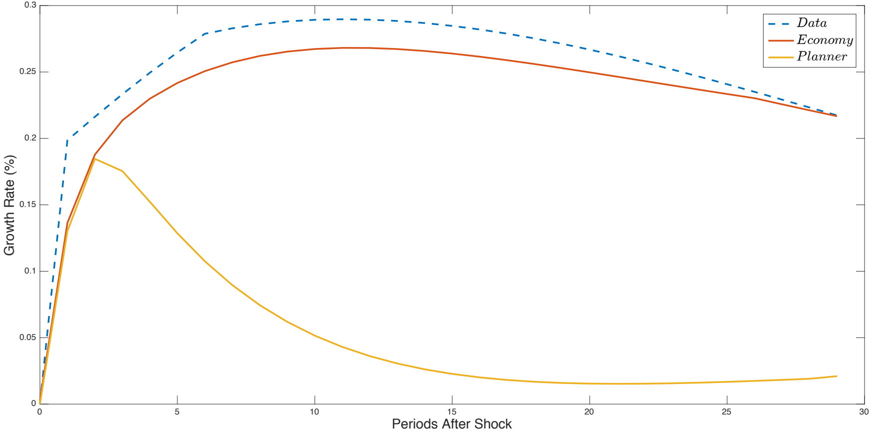
The role of ψ and the Social Planner





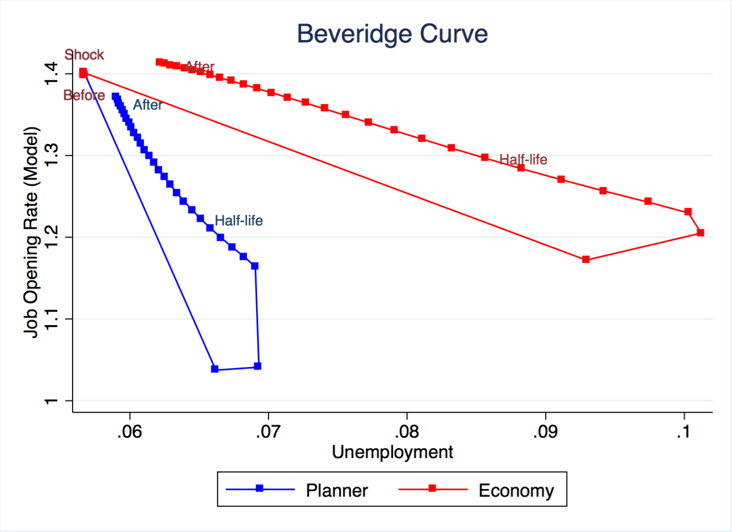
▸ Emp. Mismatch

HS Emp. Mismatch



Emp. Mismatch

The Beveridge Curve: Planner vs. Economy



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Frictions vs. Shocks

	Search Frictions	Shock Asymmetry
Up-Skilling		✓
Shift-out BC	✓	
Job Polarization		✓
LS Mismatch	✓+	✓
HS Mismatch	✓	✓+

Back

Related Literature

1. **Job Polarization and Technical Change**
    - over the cycle: Jaimovich and Siu '13, Foote and Ryan '15, Restrepo '15
    - in the long-run: Acemoglu and Autor '11, Autor '07, Autor and Dorn '13
2. **Skill Mismatch and Inefficiency in Labor Allocation**
    - cyclical reallocation of skills and efficiency: McLaughlin and Bils '01, Altiwanger et al. '15, Carillo-Tudela and Visschers '13
    - vertical displacement and wage loss: Huckfeldt '16, Krolikowsky '17, Jarosch '14
    - fall in aggregate matching efficiency: Sahin et al. '14, Barnichon and Figure '11
2. **Skill-pooling and Up-skilling**
    - skill-pooling and requirements: Albrecht and Vroman '02
    - counter-cyclical skill requirements: Modestino et al. 15

Validation of the Skill-Pooling Equilibrium

Under Nash Bargaining, the value of production is a share of the surplus

$$J(x; z_j) = (1 - \eta)S(x; z_j)$$

Under the estimated parameters, the condition for existence of a skill-pooling equilibrium holds. ▸ OverTime ▸ Back