Unemployment Cycles

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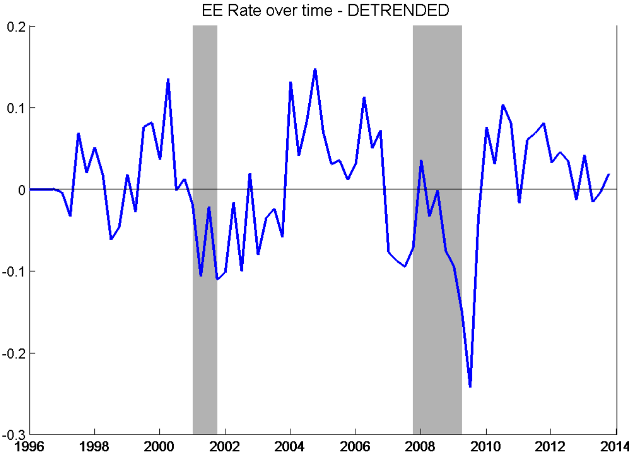
This Paper

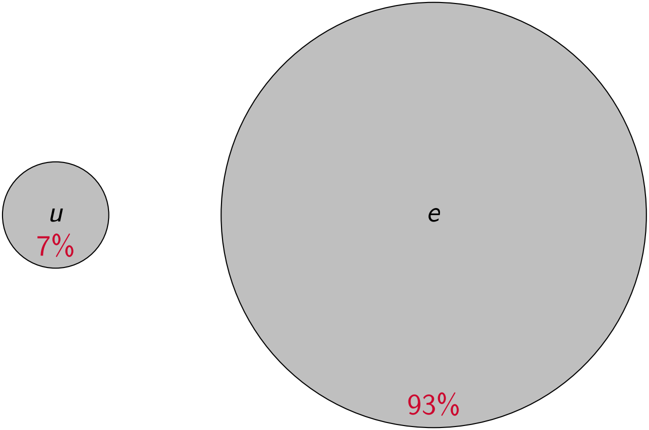
- Theory of cycles, solely driven by the labor market
- Labor market by itself can generate cyclical outcomes
    1. Mechanism: search behavior of the employed
    2. We illustrate theory with a Quantitative Exercise

Search Behavior of the Employed



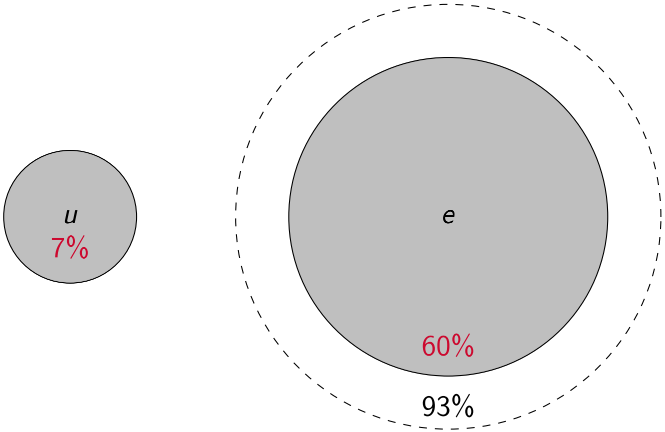
Composition Externality

Labor Force (on average)



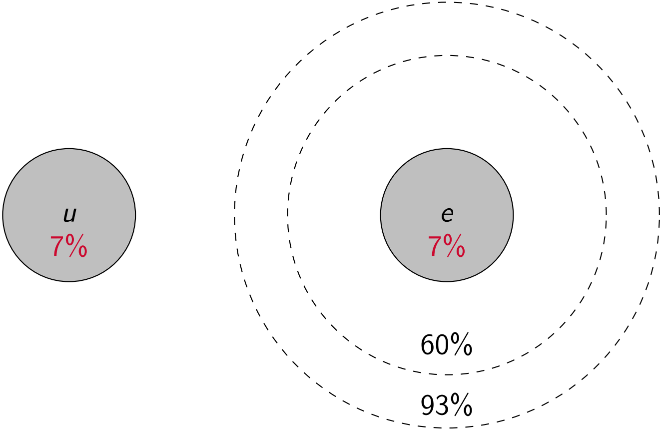
Composition Externality

Searchers



Composition Externality

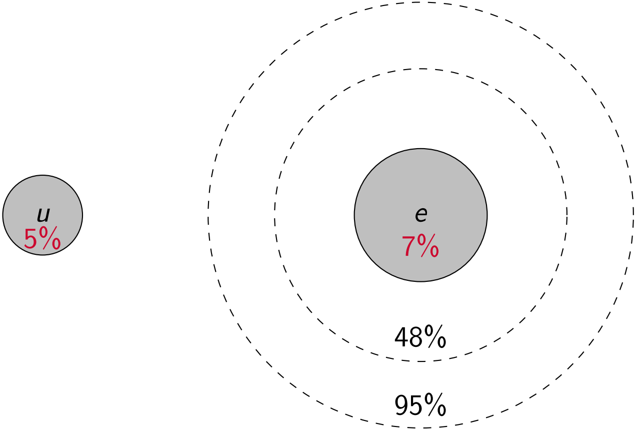
Effective Searchers



→ *on average* 50% $\simeq \frac{7}{7+7}$ of jobs are filled by employed

Composition Externality

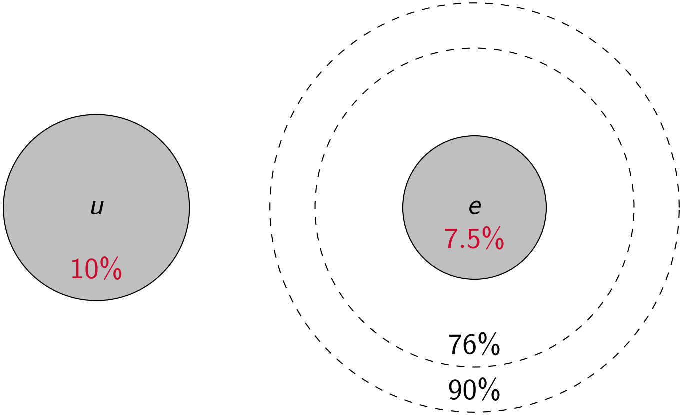
Boom



→ *Boom:* 62% $\simeq \frac{7}{7+5}$ of jobs are filled by employed

Composition Externality

Recession



→ *Recession:* 42% $\simeq \frac{7.5}{7.5+10}$ of jobs are filled by employed

The Mechanism

- Pro-cyclical on-the-job search (OJS) intensity of employed

  $\Rightarrow$ Multiple equilibria

- Strategic complementarity betw. search effort and vac. posting due to:

  1. Composition externality + job quality: newly created jobs by employed are more productive and more prevalent in Boom: 42% (R) $\rightarrow$ 62% (B)
  2. Duration: average job duration shorter in Boom

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Boom: OJS intensity $\uparrow \Rightarrow$ composition $\succ$ duration $\Rightarrow$ profits $\uparrow$
$\Rightarrow v \uparrow \Rightarrow$ matching prob $\succ$ search cost $\Rightarrow$ OJS intensity $\uparrow$

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Boom: OJS intensity $\uparrow$ $\Rightarrow$ composition $\succ$ duration $\Rightarrow$ profits $\uparrow$
$\Rightarrow$ $v \uparrow$ $\Rightarrow$ matching prob $\succ$ search cost $\Rightarrow$ OJS intensity $\uparrow$

Recession: OJS intensity $\downarrow$ $\Rightarrow$ composition $\prec$ duration $\Rightarrow$ profits $\downarrow$
$\Rightarrow$ $v \downarrow$ $\Rightarrow$ matching prob $\prec$ search cost $\Rightarrow$ OJS intensity $\downarrow$

Implications

1. Large fluctuations in u, v, EE without shifts in fundamentals
2. Jobless recovery: OJS crowds out unemployed searchers during recovery
3. Outward shift Beveridge curve in recovery (no change match efficiency)

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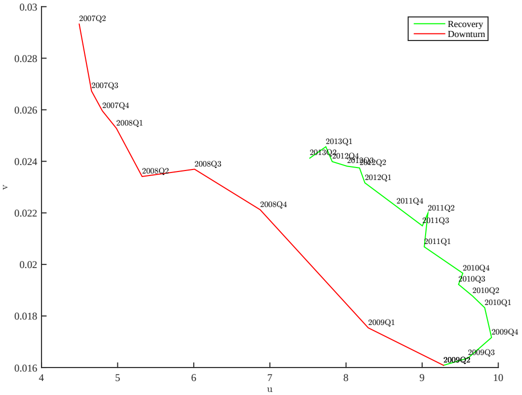

The Literature

- Multiple Equilibria in Search Markets:

  Increasing Returns: Diamond (1982)

  Selection: Burdett-Coles (1998)

  Demand External.: McAfee (1992), Kaplan-Menzio (2014), Schaal-Taschereau (2014)

  Decreasing Returns: Golosov-Menzio (2015)

  Marriage Market: Burdett-Imai-Wright (2004)

  Housing Market: Moen-Nenov (2014)

- Business Cycles and Search:

  Shimer (2005), Hall (2005), Hagedorn-Manovskii (2008)

The Model

The Model: Key Ingredients

1. On-the-job search
2. Job ladder (sorting)
3. Endogenous vacancy creation

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1. On-the-job search
2. Job ladder (sorting)
3. Endogenous vacancy creation

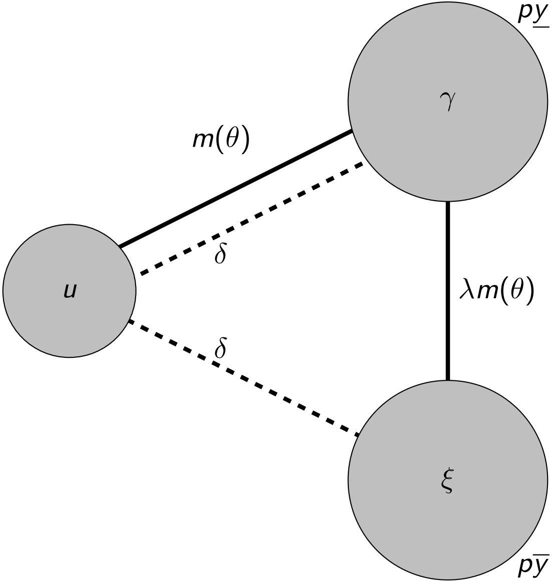
- Natural setup: random arrival diff. jobs $\Rightarrow$ selection + duration issue
- All action comes from OJS of those in low productivity job who transit to high productivity job

$\Rightarrow$ Focus on simple model: out of U, low prod. job; out of E high prod.

Agents, Actions, Payoffs + Wage Setting

- Workers: measure one; risk-neutral and homogenous
  - Employed (get w) or unemployed (get b)
  - Decision: Once on the job, *active* OJS at cost k?
  - Cost of search during unemployment (or passive OJS) normalized to zero
  - Objective: maximize discounted value of employment
- Firms: large number; ex-ante homogenous and risk-neutral
  - Decision: post a vacancy at cost c; free entry
  - Ex-post heterogeneity in their job productivity $y \in \{\underline{y}, \overline{y}\}$:
    $\underline{y}$ for UE match, $\overline{y}$ for EE match $\rightarrow$ Job ladder
  - Objective: maximize discounted sum of profits
- Wage setting: sequential auction; firms match outside offers

Labor Market



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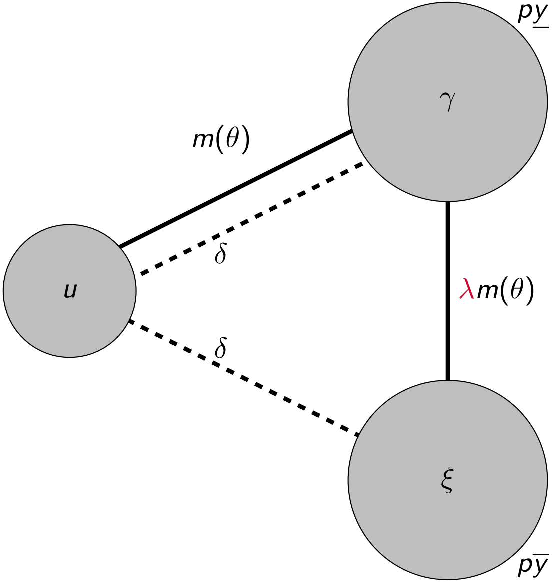
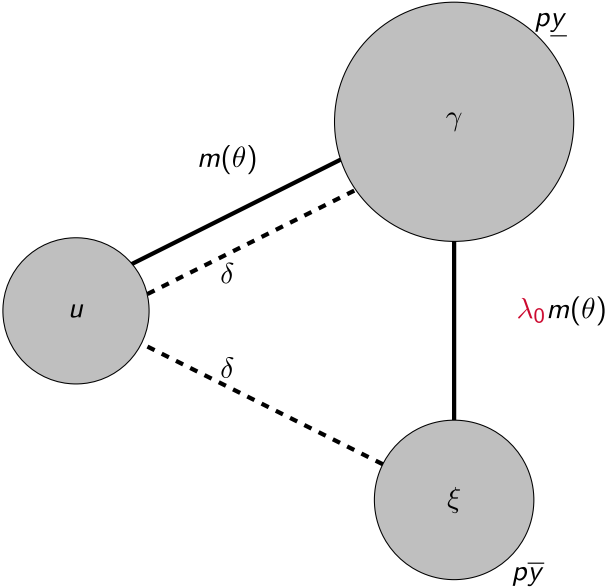
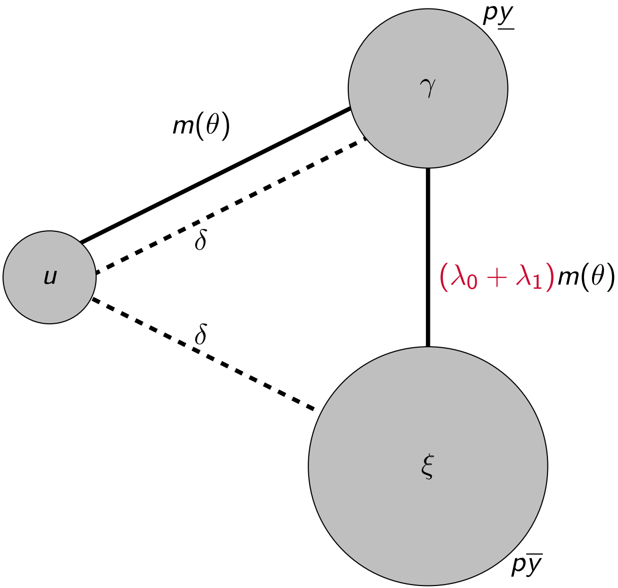


No Active OJS



Active OJS



$p\underline{y}$
γ
$m(\theta)$
δ
u
$(\lambda_0 + \lambda_1)m(\theta)$
δ
ξ
$p\overline{y}$

Firms

Bellman Equations

$$rV = -c + q(\theta(\Omega))\left[\frac{u}{s(\Omega)}\underline{J} + \frac{\lambda(\Omega)\gamma}{s(\Omega)}\overline{J} - V\right] + \dot{V}$$

$$r\underline{J} = p\underline{y} - \underline{w}(\Omega) - [\lambda(\Omega)m(\theta(\Omega)) + \delta](\underline{J} - V) + \dot{\underline{J}}$$

$$r\overline{J} = p\overline{y} - \overline{w}(\Omega) - \delta(\overline{J} - V) + \dot{\overline{J}}$$

where

- $\Omega \in [0, 1]$ all workers' search decision
- we suppress time indices
- $\theta(\Omega) = \frac{v}{s(\Omega)} = \frac{v}{u+\lambda(\Omega)\gamma}$
- $\underline{w}(\Omega), \overline{w}(\Omega)$ set by PVR bargaining

▸ Wages

Firms

Bellman Equations

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Workers

Bellman Equations

$$
\begin{aligned}
rU &= pb + m(\theta(\Omega))(\underline{E} - U) + \dot{U} \\
r\underline{E} &= \underline{w}(\Omega) - \omega pk + \lambda(\omega) m(\theta(\Omega))(\overline{E} - \underline{E}) - \delta(\underline{E} - U) + \dot{\underline{E}} \\
r\overline{E} &= \overline{w}(\Omega) - \delta(\overline{E} - U) + \dot{\overline{E}}
\end{aligned}
$$

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- $\omega \in [0, 1]$ individual worker's search decision

Workers

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where

- $\omega \in [0, 1]$ individual worker's search decision

Labor Market Dynamics

$$\begin{aligned}
\dot{\gamma} &= um(\theta(\Omega)) - \gamma[\delta + \lambda(\Omega)m(\theta(\Omega)] \\
\dot{\xi} &= \gamma\lambda(\Omega)m(\theta(\Omega)) - \xi\delta \\
1 &= u + \gamma + \xi
\end{aligned}$$

Equilibrium

Definition

An equilibrium is a path $\{U_t, \underline{E}_t, \overline{E}_t, V_t, \underline{J}_t, \overline{J}_t, \theta_t, \underline{w}_t, \overline{w}_t, u_t, \gamma_t, \xi_t, \omega_t, \Omega_t\}$ s.t. for all $t \geq 0$

1. $U_t, \underline{E}_t, \overline{E}_t, V_t, \underline{J}_t, \overline{J}_t$ satisfy the Bellman equations above;
2. Given Ω_t, $\omega_t = \Omega_t$ maximizes $\underline{E}_t$;
3. There is free entry: $V_t = 0$;
4. Wages: $\underline{w}_t$ such that $\underline{E}_t = U_t$ and $\overline{w}_t$ such that $\underline{J}_t = V_t$;
5. u_t, γ_t, ξ_t satisfy the laws of motion;
6. $\lim_{t\to\infty} \underline{J}_t$ is finite for initial conditions u_0, γ_0, ξ_0.

Multiple Steady State Equilibria: Existence

- Check one-shot deviations of workers in $\underline{y}$-jobs in interval dt
- Denote $\underline{E}(\omega|\Omega)$: value of $\underline{y}$ job when worker action is ω given Ω
  1. $\Omega = 1$: all workers active OJS $\Rightarrow$ profitable to stop active OJS $\omega = 0$?

$$\underline{E}(1|1) > \underline{E}(0|1) \quad \Longleftrightarrow \quad m^{-1}\left(\frac{k(r+\delta)}{\lambda_1(\underline{y}-b))}\right) < \theta(1).$$

  2. $\Omega = 0$: all workers no active OJS $\Rightarrow$ profitable active OJS $\omega = 1$?

$$\underline{E}(0|0) > \underline{E}(1|0) \quad \Longleftrightarrow \quad \theta(0) < m^{-1}\left(\frac{k(r+\delta)}{\lambda_1(\underline{y}-b))}\right).$$

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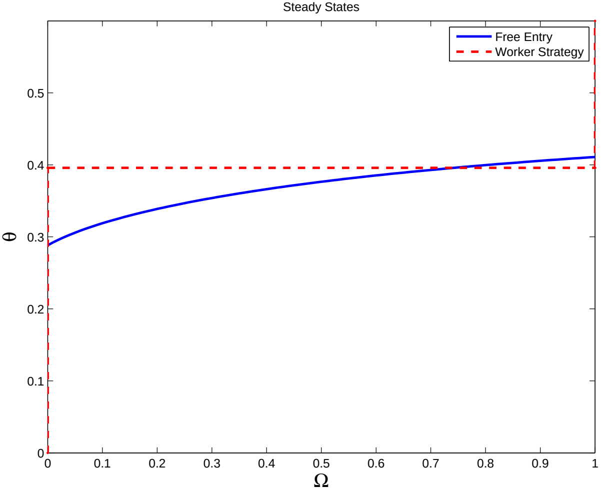
Lemma

There are multiple steady states if and only if

$$\theta(0) < m^{-1}\left(\frac{k(r+\delta)}{\lambda_1(\underline{y}-b)}\right) < \theta(1).$$

▸ Proof

Steady State Equilibria

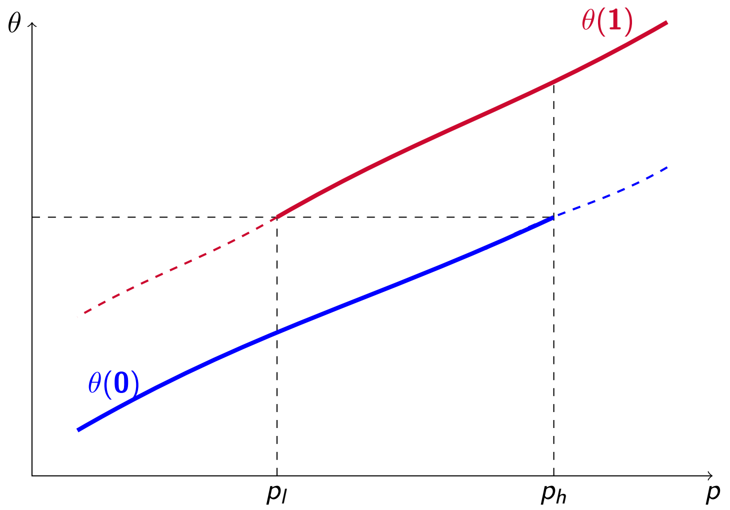


Multiple Steady States: Existence

Proposition

Let $m(\theta) = \phi \frac{\alpha\theta}{\alpha\theta+1}$. *Then there are multiple steady state equilibria if and only if* $p \in [p^l, p^u]$. *The set* $[p^l, p^u]$ *is non-empty for an open set of parameters.*

Multiplicity Bounds: p



Multiple Steady State Equilibria: Existence

Sufficient Sorting Needed for Active OJS

Proposition

Let $m(\theta) = \phi \frac{\alpha\theta}{\alpha\theta+1}$.

1. *If* $(\overline{y} - \underline{y} < \epsilon)$ *then there is a unique steady state with no active OJS;*
2. *If* $\overline{y}$ *is arbitrarily high (given* $\underline{y}$*), there is a unique steady state with active OJS;*
3. *For* $\overline{y} \in [\overline{y}^l, \overline{y}^u]$ *(given* $\underline{y}$*), there are multiple steady states.*

▸ Plot

Steady State Equilibria: Properties

Proposition

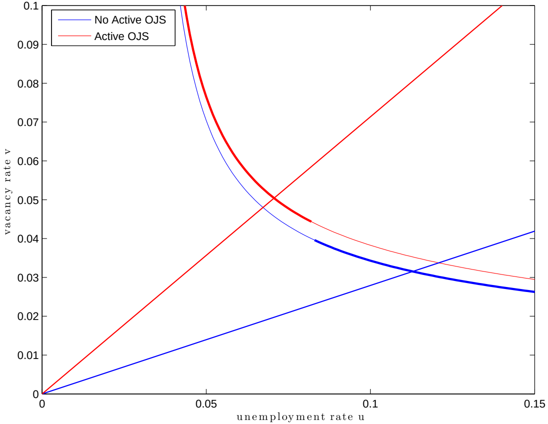
Assume there are multiple steady states. Then:

1. *unemployment is lower with active OJS:* $u(\mathbf{1}) < u(\mathbf{0})$;
2. *EE flows are higher with active OJS:* $EE(\mathbf{1}) > EE(\mathbf{0})$;

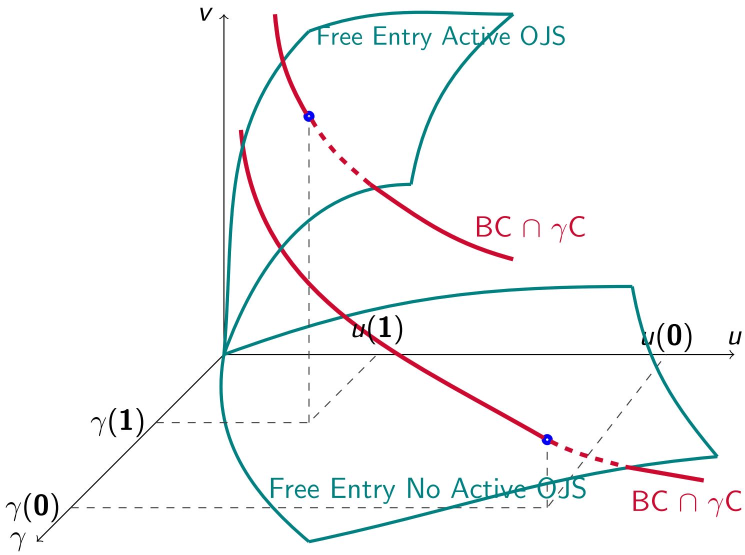
and under $m(\theta) = \phi\alpha\theta/(\alpha\theta + 1)$

3. *vacancies are higher with active OJS:* $v(\mathbf{1}) > v(\mathbf{0})$;
4. *conventional market tightness is higher with active OJS:* $\Theta(\mathbf{1}) > \Theta(\mathbf{0})$;
5. $BC(\mathbf{1})$ *is shifted outward relative to* $BC(\mathbf{0})$
6. $BC^s(\mathbf{1})$ *is shifted outward relative to* $BC^s(\mathbf{0})$
7. *Share of OJSearchers is higher with active OJS:* $\frac{\lambda(\mathbf{1})\gamma(\mathbf{1})}{s(\mathbf{1})} > \frac{\lambda(\mathbf{0})\gamma(\mathbf{0})}{s(\mathbf{0})}$.

Steady State Equilibria: Properties



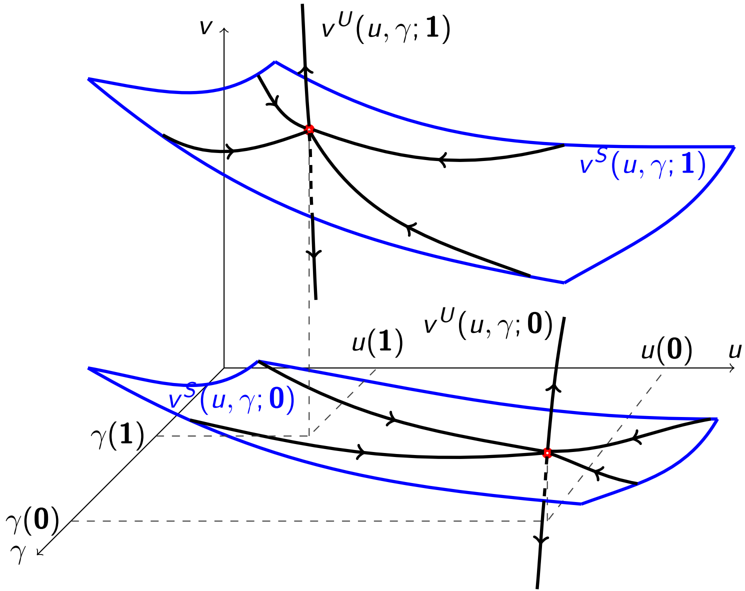
Steady State Equilibria: Properties



Dynamics

- Our model can be reduced to a dynamic system in $\mathbb{R}^3$:
  $\dot{u}(\Omega), \dot{\gamma}(\Omega), \dot{\theta}(\Omega)$ ▸ System
- Multiple SS equilibrium $\rightarrow$ multiple equil. paths in dynamic economy

Saddle-Path Stability



Validation and Quantitative Exercise

Validation and Quantitative Exercise

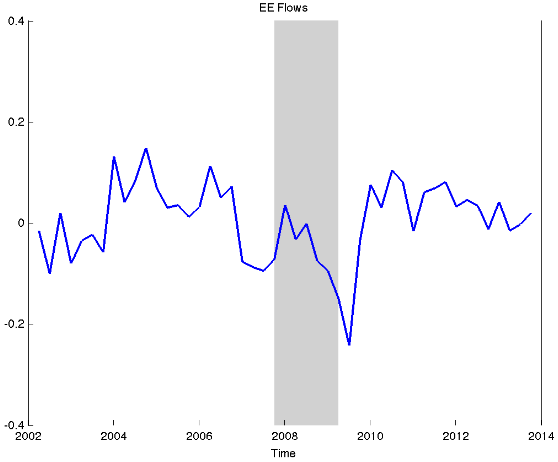
1. Direct evidence for mechanism: pro-cyclical search intensity
2. Quantitative exercise
    - Calibrate the model to US economy
    - Quantitative assessment:
        - Steady States: Labor Market Fluctuations and counterfactuals
        - Dynamics: Jobless recovery

The Data

- US quarterly data
- Main data source: Current Population Survey (CPS)
- Data on vacancies, unemployment, labor market transitions
- Vacancies: JOLTS (BLS) + online help-wanted ads
- Data spans 1996-2013 but main focus on Great Recession

1. Evidence on Pro-Cyclical Search Intensity

EE Flows (Detrended)



Decomposition of EE Flows: $EE = \lambda\gamma m(\theta)$

$$m(\theta) = \frac{UE}{u} \quad \text{and} \quad \lambda\gamma = \frac{EE \cdot u}{UE}$$

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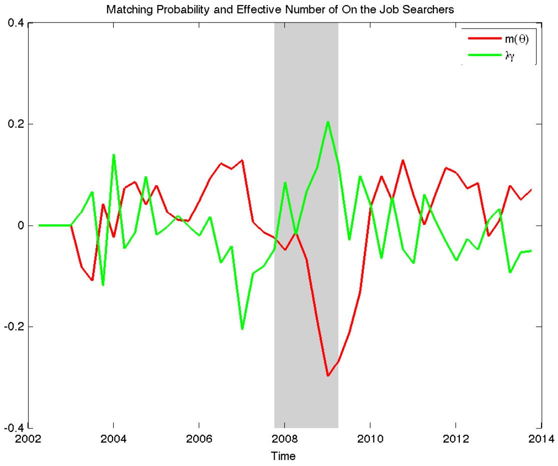
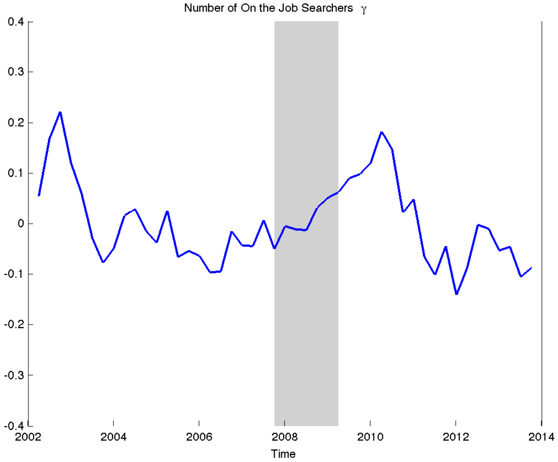


Decomposing $\lambda\gamma$

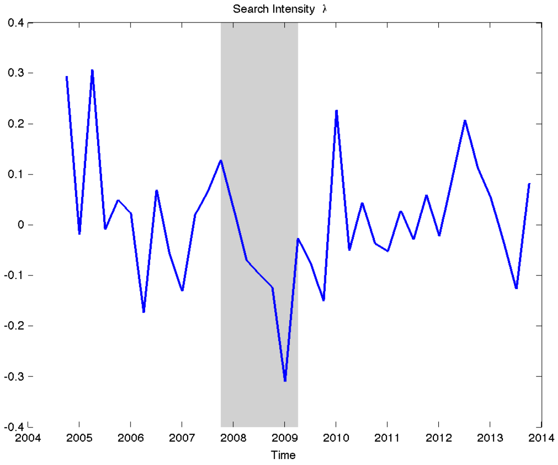
- Problem: No direct measure of search intensity λ
- Use CPS micro-data panel structure
- Check whether individuals was unemployed before current job or transited from another job
- Construct γ (employed after UE transition) and ξ (after EE transition)
- Then, search intensity is computed as: $\lambda = \frac{EE}{m(\theta)\gamma}$

Decomposition of EE Flows: γ



▸ ξ

Decomposition of EE Flows: $\lambda = \frac{EE}{m(\theta)\gamma}$



$\Rightarrow$ Pro-cyclical search intensity!

Back

2. Quantitative Exercise

Calibration

- Set parameters $(r, b, \delta, p, \underline{y})$ outside the model
- Calibrate $(\lambda_0, \lambda_1, \alpha, \phi, c, k, \overline{y})$ using GMM
- Target business cycle moments from the Great Recession
  - EE fluctuations (peak and trough)
  - $m(\theta)$-fluctuations (peak and trough)
  - wage differentials $\overline{w}/\underline{w}$ in *boom* (peak)
  - v, *u-levels* in *boom* (peak)
- Focus on 2 data points from last cycle with largest differences in EE

$\Rightarrow$ 2006Q3 *boom* $(\Omega = 1)$ and 2009Q3 *recession* $(\Omega = 0)$

Calibration

- We do *not* target unemployment and vacancy levels in the recession
- We do *not* restrict the estimates to fall into range of multiple SS (we get it)

Exogenously Set Parameters

Variable	Value		Notes
r	0.0113	discount factor	standard
$\underline{y}$	1	productivity first job	normalization
b	0.919	unemployment value	92% of $\underline{y}$; 58% of $\overline{y}$ (see below)
δ	0.05	job separation rate	average separation rate
p	1	productivity	normalization

Estimated Parameters

	Estimate	Parameter Description
λ_0	0.092	passive OJS intensity
λ_1	0.073	active OJS intensity
α	0.863	curvature matching function
ϕ	3.258	overall matching efficiency
c	9.404	vacancy posting cost
$\bar{y}$	1.577	high productivity
k	0.080	search cost

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$\Rightarrow$ Multiple Steady States Exist: $p \in [p^l, p^u] = [0.994, 1.026]$

Moments

Targeted

- **Model 1**: Benchmark model, multiple steady st., fixed productivity p

	Data	**Model**
$EE(\mathbf{1})$	0.066	0.035
$EE(\mathbf{0})$	0.036	0.022
$u(\mathbf{1})$	0.047	0.055
$v(\mathbf{1})$	0.029	0.039
$m(\theta(\mathbf{1}))$	0.852	0.853
$m(\theta(\mathbf{0}))$	0.511	0.513
$\frac{\overline{w}(\mathbf{1})}{\underline{w}(\mathbf{1})}$	1.230	1.230

Moments

Targeted

- **Model 1**: Benchmark model, multiple steady st., fixed productivity p

	Data	**Model**
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$m(\theta(\mathbf{0}))$	0.511	0.513
$\frac{\overline{w}(\mathbf{1})}{\underline{w}(\mathbf{1})}$	1.230	1.230

- Discrepancy between model and data: constant separation rate

Moments

Non-Targeted

	Data	**Model**
$u(\mathbf{0})$	0.096	0.089
$v(\mathbf{0})$	0.016	0.029
$\frac{\lambda(\mathbf{0})\gamma}{s(\mathbf{0})}$	0.423	0.327
$\frac{\lambda(\mathbf{1})\gamma}{s(\mathbf{1})}$	0.625	0.425

Labor Market Fluctuations

- Fluctuations between peak and trough of Great Recession
- $\Delta x = \frac{x(\mathbf{0})-x(\mathbf{1})}{x(\mathbf{1})}$

	Data	**Model 1**	**Model 2**
ΔEE	-0.46	-0.37	
$\Delta m(\theta)$	-0.40	-0.40	
Δv	-0.47	-0.28	
Δu	1.06	0.60	
$\Delta \theta$	-0.61	-0.47	
$\Delta \Theta$	-0.74	-0.55	
$\Delta \lambda\gamma/s$	-0.32	-0.23	

Labor Market Fluctuations

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- $\Delta x = \frac{x(\mathbf{0}) - x(\mathbf{1})}{x(\mathbf{1})}$

	Data	**Model 1**	**Model 2**
ΔEE	-0.46	-0.37	-0.05
$\Delta m(\theta)$	-0.40	-0.40	-0.15
Δv	-0.47	-0.28	-0.08
Δu	1.06	0.60	0.17
$\Delta \theta$	-0.61	-0.47	-0.20
$\Delta \Theta$	-0.74	-0.55	-0.22
$\Delta \lambda\gamma/s$	-0.32	-0.23	-0.02

Model 1: Multiple equilibria, fixed productivity $\Delta p = 0$.

Model 2: Active OJS equil., Δp: $+2\%$ deviation from trend in boom, -3% in recession.

Jobless Recovery and Crowding Out

I. A Simple Exercise

- Myopic agents: in recession ($\mathbf{\Omega} = 0$) change beliefs to boom ($\mathbf{\Omega} = 1$)
- Searchers: $s(\mathbf{0}) = u(\mathbf{0}) + \lambda_0 \gamma(\mathbf{0}) \quad \rightarrow \quad s^R = u(\mathbf{0}) + (\lambda_0 + \lambda_1)\gamma(\mathbf{0})$
- Fraction κ of u-hires:

$$\kappa(\mathbf{0}) = \frac{u(\mathbf{0})}{u(\mathbf{0}) + \lambda_0 \gamma(\mathbf{0})} = 0.67 \;\; \rightarrow \;\; \kappa^R = \frac{u(\mathbf{0})}{u(\mathbf{0}) + (\lambda_0 + \lambda_1)\gamma(\mathbf{0})} = 0.53$$

- Uncond. matching probability $\kappa(\mathbf{0}) m(\theta(\mathbf{0})) = 0.34 \rightarrow \kappa^R m(\theta^R) = 0.30$

Jobless Recovery and Crowding Out

I. A Simple Exercise

- Myopic agents: in recession ($\mathbf{\Omega} = 0$) change beliefs to boom ($\mathbf{\Omega} = 1$)
- Searchers: $s(\mathbf{0}) = u(\mathbf{0}) + \lambda_0 \gamma(\mathbf{0}) \quad \rightarrow \quad s^R = u(\mathbf{0}) + (\lambda_0 + \lambda_1)\gamma(\mathbf{0})$
- Fraction κ of u-hires:

$$\kappa(\mathbf{0}) = \frac{u(\mathbf{0})}{u(\mathbf{0}) + \lambda_0 \gamma(\mathbf{0})} = 0.67 \ \rightarrow \ \kappa^R = \frac{u(\mathbf{0})}{u(\mathbf{0}) + (\lambda_0 + \lambda_1)\gamma(\mathbf{0})} = 0.53$$

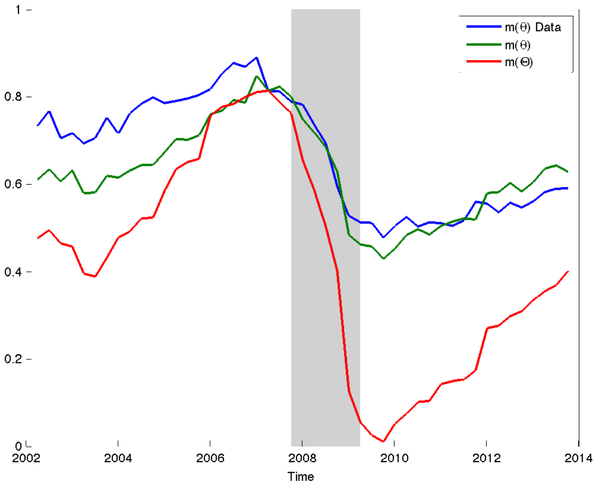
- Uncond. matching probability $\kappa(\mathbf{0}) m(\theta(\mathbf{0})) = 0.34 \rightarrow \kappa^R m(\theta^R) = 0.30$

$\Rightarrow$ Job-destructive Recovery

Jobless Recovery and Crowding Out

I. A Simple Exercise

- Effective matching probability $m(\theta)$ drops (but less so than $m(\Theta)$)



Jobless Recovery and Crowding Out

II. Productivity-Induced Dynamics

- Multiplicity selection criterion: history-dependent beliefs (Cooper 1994)
- Aggregate productivity p follows Markov process
- Agents are forward-looking
- Experiment: Economy has been in the recession for a while and positive shock $p \uparrow$ induces unique equilibrium with OJS

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- Limitations: saddle-path stability + linear approximation dynamic system

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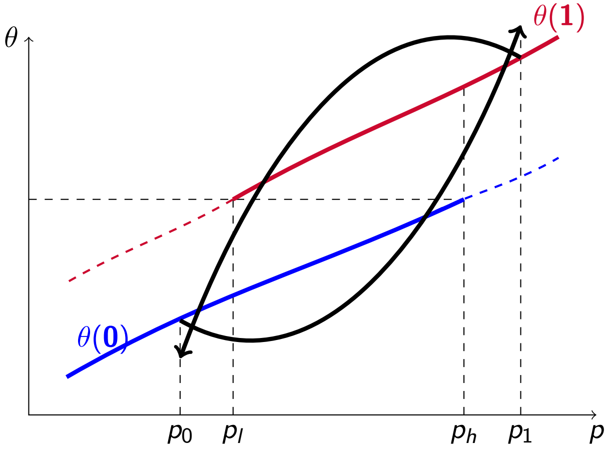
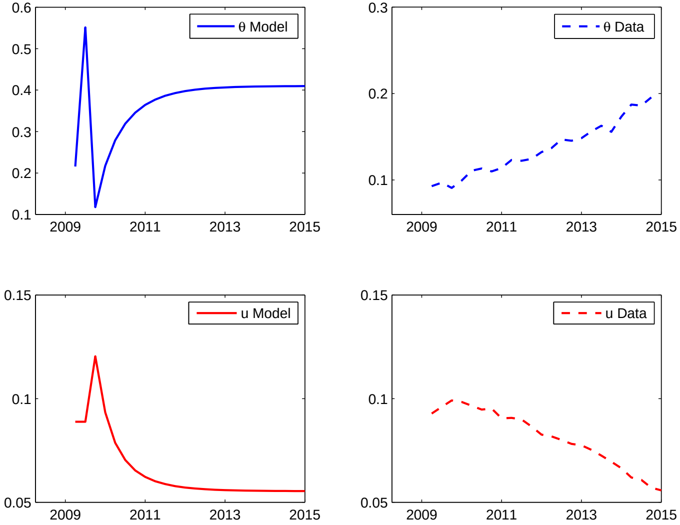
II. Productivity-Induced Dynamics



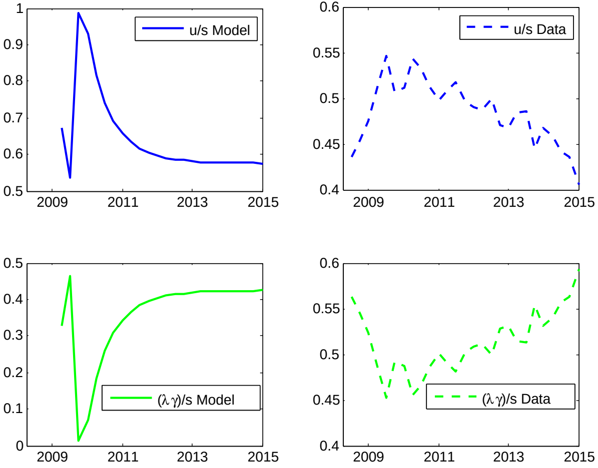
Jobless Recovery: Transition Paths

Market Tightness and Unemployment



Jobless Recovery: Transition Paths

Composition of New Jobs



Summary of Quantitative Results

- Fluctuations
  - Model generates sizable fluctuations v, u, EE without shift fundamentals
  - Small additional fluctuations from productivity change
- Jobless recovery
  - Unemployment initially grows during the recovery
  - Composition of u-jobs is initially higher in recovery

Conclusion

The labor market by itself can generate cycles

Unemployment Cycles

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Appendix

Wages

$$\underline{w}(\Omega) = pb\left(\frac{r+\lambda(\Omega)m(\theta(\Omega))+\delta}{r+\delta}\right) - \frac{\lambda(\Omega)m(\theta(\Omega))}{r+\delta}p\underline{y} + \Omega pk$$

$$\overline{w}(\Omega) = p\underline{y}$$

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Proof of Lemma 1

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1. No deviation when no one searches: $\underline{E}(0|\mathbf{0}) > \underline{E}(1|\mathbf{0})$.

$$\underline{E}(1|\mathbf{0}) = \frac{1}{1+rdt}\left[dt(\underline{w}(\mathbf{0}) - pk) + (1-\delta dt)dt\lambda(1)m(\theta(\mathbf{0}))\overline{E} + (1-\delta dt)(1 - dt\lambda(1)m(\theta(\right.$$

where $\overline{E} = \overline{E}(0|\mathbf{0})$.

$$\underline{E}(0|\mathbf{0})(1+rdt) > dt(\underline{w}(\mathbf{0}) - pk) + dt\lambda(1)(1-\delta dt)m(\theta(\mathbf{0}))\overline{E} + (1 - \delta dt - dt\lambda(1)m(\theta(\mathbf{0}))$$

Subtracting $\underline{E}(0|\mathbf{0})$ from both sides and dividing by dt and take the limit $dt \to 0$:

$$r\underline{E}(0|\mathbf{0}) > \underline{w}(\mathbf{0}) - pk + \lambda(1)m(\theta(\mathbf{0}))\overline{E} + (-\delta - \lambda(1)m(\theta(\mathbf{0})))\underline{E}(0|\mathbf{0}) + \delta U.$$

Substituting the equilibrium values for $\underline{E}(0|\mathbf{0}), \overline{E}, U$ and $\underline{w}(\mathbf{0})$ we get:

$$(\underline{y} - b)[\lambda(1) - \lambda(0)]m(\theta(\mathbf{0})) - k(r+\delta) < 0. \tag{1}$$

2. No deviation when all search: $\underline{E}(1|\mathbf{1}) > \underline{E}(0|\mathbf{1})$ (proceed similarly).

$$(\underline{y} - b)[\lambda(1) - \lambda(0)]m(\theta(\mathbf{1})) - k(r+\delta) > 0. \tag{2}$$

Putting (1) and (2) together gives the condition in the Lemma.

Multiple Equilibria: Dynamics

- Local stability around SS
- Our model can be reduced to a dynamic system in $\mathbb{R}^3$: $\dot{u}(\Omega), \dot{\gamma}(\Omega), \dot{\theta}(\Omega)$.

$$
\begin{aligned}
\dot{u}(\Omega) &= \delta(1-u) - um(\theta(\Omega)) \\
\dot{\gamma}(\Omega) &= um(\theta(\Omega)) - (\delta + \lambda(\Omega)m(\theta(\Omega)))\gamma \\
\dot{\theta}(\Omega) &= \frac{m(\theta(\Omega))u}{(1-\eta(\theta(\Omega)))(u+\lambda(\Omega)\gamma)} \quad \times \left[\frac{\lambda}{u}\left(-\frac{\theta(\Omega)c}{m(\theta(\Omega))} + \bar{J}\right)\left(-\dot{u}\frac{\lambda(\Omega)}{u} + \dot{\gamma}\right)\right. \\
&\quad \left. -(p\underline{y} - \underline{w}(\Omega)) + \left(\frac{c}{q(\theta(\Omega))}\frac{u+\lambda(\Omega)\gamma}{u} - \frac{\lambda(\Omega)\gamma}{u}\bar{J}\right)(r + \delta + \lambda(\Omega)m(\theta(\Omega)))\right]
\end{aligned}
$$

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Condition for Multiple Equilibria

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Necessary and sufficient condition for existence of multiple steady states

$$-\frac{2(\phi\lambda_0+2r)}{4\alpha(\phi\lambda_0+r)}+\overline{y}-\alpha^2 p\phi b+\frac{\sqrt{\alpha^2(-8cr^2(\phi\lambda_0+r)(2cr-\alpha p\phi(\overline{y}-b))+(cr2(\phi\lambda_0+2r)+\alpha p\phi(-(\overline{y}-b)(\phi\lambda_0+r)))^2)}}{4\alpha^2 cr(\phi\lambda_0+r)}$$

$$<\frac{kr}{\alpha\left(\phi\lambda_1(\underline{y}-b)-kr\right)}<-\frac{2(\phi(\lambda_0+\lambda_1)+2r)+kr}{4\alpha(\phi(\lambda_0+\lambda_1)+r)}+\overline{y}-\alpha^2 p\phi b \qquad \textbf{(ME)}$$

$$+\frac{\sqrt{\alpha^2(-8cr^2(\phi(\lambda_0+\lambda_1)+r)(2cr-\alpha p\phi(\overline{y}-b-k))+(cr2(\phi(\lambda_0+\lambda_1)+2r)+\alpha p\phi(kr-(\overline{y}-b)(\phi(\lambda_0+\lambda_1)+r)))^2)}}{4\alpha^2 cr(\phi(\lambda_0+\lambda_1)+r)}$$

Condition for Multiple Equilibria ▸ Back

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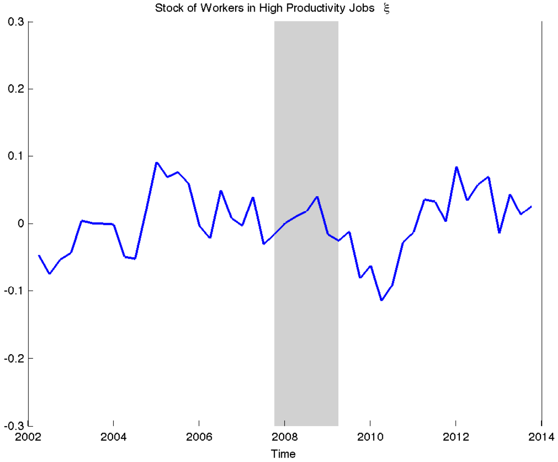
$$+\frac{\sqrt{\alpha^2(-8cr^2(\phi(\lambda_0+\lambda_1)+r)(2cr-\alpha p\phi(\overline{y}-b-k))+(cr2(\phi(\lambda_0+\lambda_1)+2r)+\alpha p\phi(kr-(\overline{y}-b)(\phi(\lambda_0+\lambda_1)+r)))^2)}}{4\alpha^2 cr(\phi(\lambda_0+\lambda_1)+r)}$$

Multiplicity bounds in terms of p:

$$p^l = \frac{2c\lambda_1 r(\underline{y}-b)[k(\lambda_0+\lambda_1)+\lambda_1(\underline{y}-b)]}{\alpha[\lambda_1\phi(\underline{y}-b)-kr][b^2\lambda_1+k(\lambda_0+\lambda_1)\overline{y}+\lambda_1(\overline{y}-k)\underline{y}-b(k\lambda_0+\lambda_1\overline{y}+\lambda_1\underline{y})]}$$

$$p^u = \frac{2c\lambda_1 r(\underline{y}-b)}{\alpha(\overline{y}-b)[\lambda_1\phi(\underline{y}-b)-kr]},$$

Decomposition of EE Flows: ξ



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Beveridge Curves

Steady state flow equations:

$$u = \frac{\delta}{\delta + m(\theta(\Omega))}$$

$$\gamma = \frac{\delta m(\theta(\Omega))}{[\delta + m(\theta(\Omega))][\delta + \lambda(\Omega) m(\theta(\Omega))]}.$$

Beveridge Curves BC and BC^s:

$$v = \frac{\delta u(1-u)[2\lambda(\Omega)(1-u)+u]}{\alpha[u(\delta+\phi)-\delta][\lambda(\Omega)(1-u)+u]} \quad (BC$$

$$v = -\frac{(\delta s(2\delta(-1+s)+\phi(\lambda(-2+s)+s-\sqrt{\lambda^2(-2+s)^2+s^2-2\lambda s^2}))}{-2\alpha\delta(\delta+2\lambda\phi)+2\alpha(\delta+\phi)(\delta+\lambda\phi)s} \quad (BC^s$$

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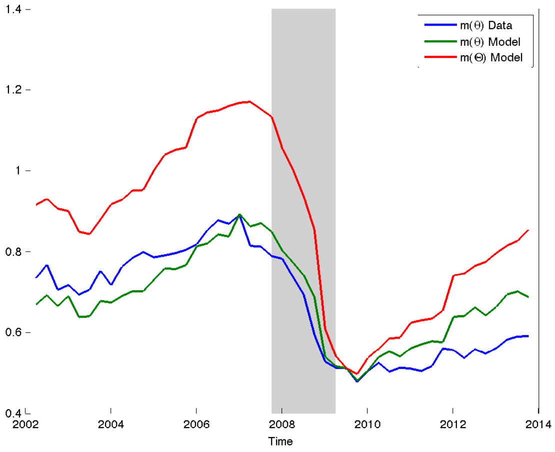
Jobless Recovery



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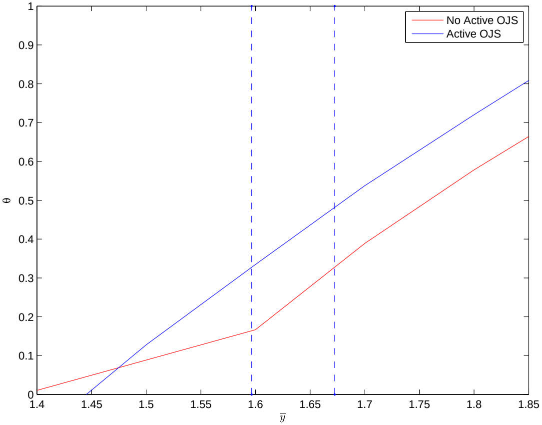
Multiplicity Bounds: $\overline{y}$ ($\underline{y} = 1$)



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Decomposition of EE Flows: $EE = \lambda\gamma m(\theta)$

$$m(\theta) = \frac{UE}{u} \quad \text{and} \quad \lambda\gamma = \frac{EE \cdot u}{UE}$$

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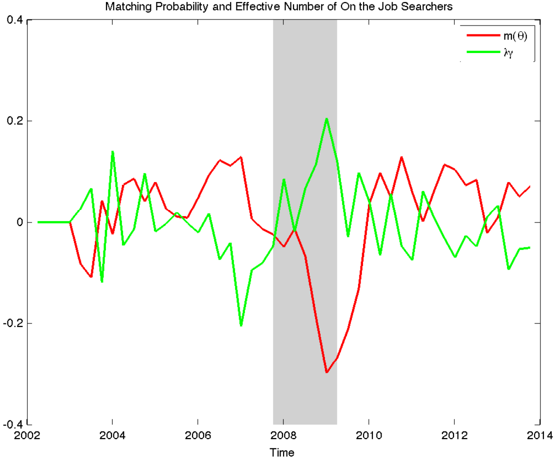
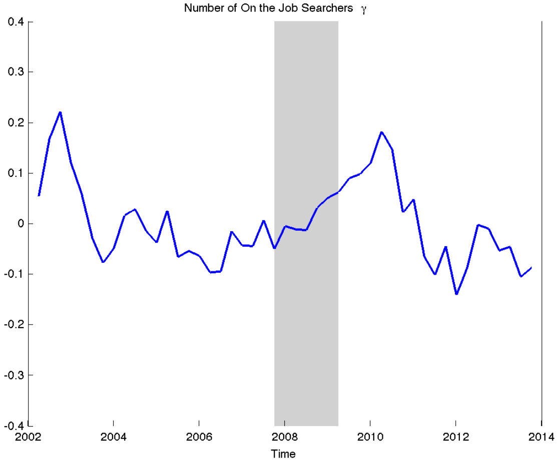


Decomposing $\lambda\gamma$

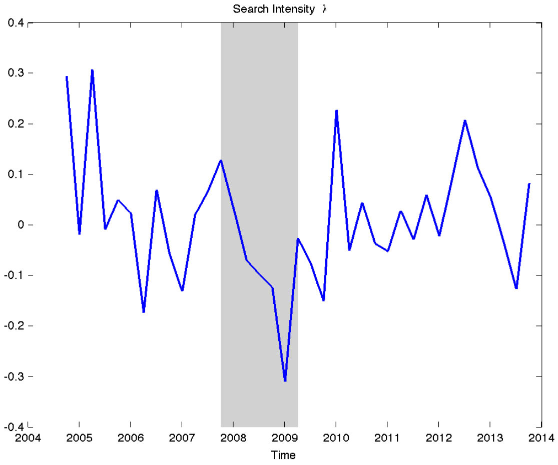
- Problem: No direct measure of search intensity λ
- Use CPS micro-data panel structure
- Check whether individuals was unemployed before current job or transited from another job
- Construct γ (employed after UE transition) and ξ (after EE transition)
- Then, search intensity is computed as: $\lambda = \frac{EE}{m(\theta)\gamma}$

Decomposition of EE Flows: γ



▸ ξ

Decomposition of EE Flows: $\lambda = \frac{EE}{m(\theta)\gamma}$



$\Rightarrow$ Pro-cyclical search intensity!

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