

Aggregate Recruiting Intensity

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Introduction

What is aggregate recruiting intensity?

The component of A_t accounted for by firms' effort to fill vacancies

$$H_t = A_t V_t^\alpha U_t^{1-\alpha}$$

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Why study aggregate recruiting intensity?

- **Macro data**
 - ▶ Large and persistent decline in A_t in '08 recession
 - ▶ Existing studies focus on mismatch, composition, job-search effort
- **Micro data (Davis-Faberman-Haltiwanger, 2013)**
 - ▶ Firms fill vacancies at different rates, depending on how fast they grow
 - ▶ Distribution of firm growth rates important for match efficiency

Introduction

Questions

1. How much of the decline in A_t is accounted for by Φ_t ?
2. How do macro shocks transmit to aggregate recruiting intensity Φ_t ?

Model

- Equilibrium random matching model with firm dynamics
Cooper-Haltiwanger-Willis (2007), Elsby-Michaels (2013), Acemoglu-Hawkins (2014)
- + Choice of recruiting intensity per vacancy
- + Entry and exit
- + Financial frictions

Approach

1. Examine transition dynamics to financial & productivity shocks
2. Decomposition of Φ_t and cross-section of firms along the transition

Firm-level hiring technology

Random-matching model $h_{it} = q_t v_{it}$

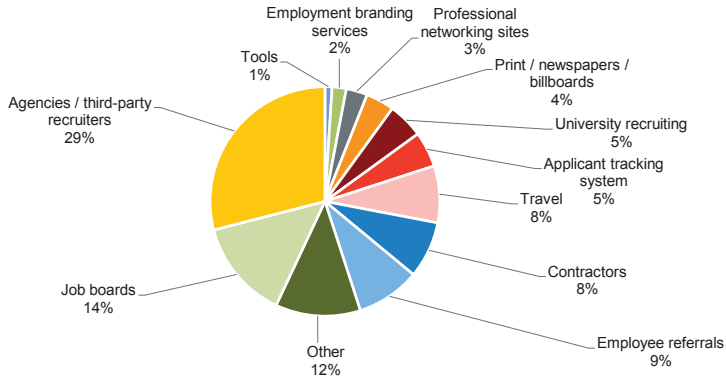
- JOLTS vacancies - v_{it}
 - BLS: *“Specific position that exists...for start within 30-days...active recruiting from outside the establishment”*

Firm-level hiring technology

$$\begin{aligned} \text{Random-matching model} \quad h_{it} &= q_t v_{it} \\ + \text{recruiting intensity} \quad h_{it} &= q_t e_{it} v_{it} \end{aligned}$$

- **JOLTS vacancies** - v_{it}
 - BLS: *“Specific position that exists...for start within 30-days...active recruiting from outside the establishment”*
- **Recruitment intensity** - e_{it}
 1. Shifts the filling rate of an open position
 2. Costly on a per vacancy basis
 - An outcome of expenditures on recruiting activities

Recruiting costs



Bersin and Associates, *Talent Acquisition Factbook* (2011)

- Average hiring cost at 100+ employee firms **\$3,479**

Aggregate recruiting intensity

- Aggregation

$$H_t = q_t \int e_{it} v_{it} d\lambda_t^h = q_t V_t^*$$

- Aggregate matching function

$$H_t = V_t^{*\alpha} U_t^{1-\alpha} = \Phi_t V_t^\alpha U_t^{1-\alpha}$$

- Aggregate recruiting intensity

$$\Phi_t = \left[\int e_{it} \left(\frac{v_{it}}{V_t} \right) d\lambda_t^h \right]^\alpha$$

Macro shocks and aggregate recruiting intensity

1. Composition effect

$$\downarrow h_{it} = q_t \downarrow e_{it} \downarrow v_{it}$$

- Shift in growth rate distribution

2. Slackness effect

$$h_{it} = \uparrow q_t \downarrow e_{it} \downarrow v_{it}$$

- Firms substitute away from costly hiring measures

Value functions

Value functions

Firms are heterogeneous in n , a , z and age

Let $\mathbb{V}(n, a, z)$ be the present discounted value of dividends

- Exit exogenously or endogenously

$$\mathbb{V}(n, a, z) = \zeta a + (1 - \zeta) \max \left\{ a, \mathbb{V}^i(n, a, z) \right\}$$

- Fire or hire

$$\mathbb{V}^i(n, a, z) = \max \left\{ \mathbb{V}^f(n, a, z), \mathbb{V}^h(n, a, z) \right\}$$

Value functions - Firing

$$\begin{aligned}\mathbb{V}^f(n, a, z) &= \max_{n' \leq n, k, d} d + \beta \int_{\mathcal{Z}} \mathbb{V}(n', a', z') \Gamma(z, dz') \\ &\text{s.t.} \\ d + a' &= \left(zn'^{\nu} k^{1-\nu} \right)^{\sigma} + (1+r)a - \omega n' - (r + \delta)k - \chi \\ k &\leq \varphi a \\ d &\geq 0\end{aligned}$$

Value functions - Hiring

$$\mathbb{V}^h(n, a, z) = \max_{v>0, e>0, k, d} d + \beta \int_{\mathcal{Z}} \mathbb{V}(n', a', z') \Gamma(z, dz')$$

s.t.

$$d + a' = \left(z n'^{\nu} k^{1-\nu} \right)^{\sigma} + (1+r)a - \omega n' - (r+\delta)k - \chi - C(e, v, n)$$

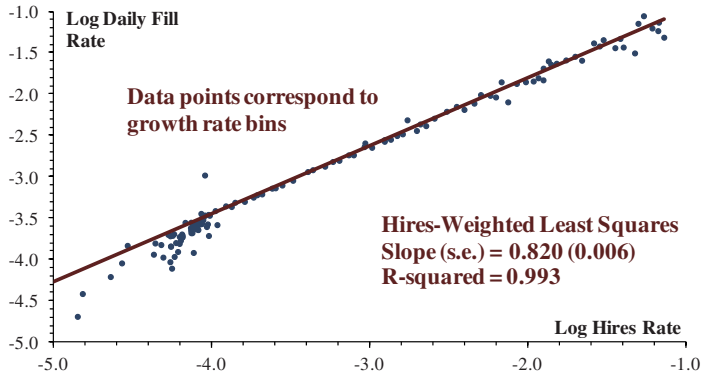
$$n' - n = q(\theta^*) e v$$

$$k \leq \varphi a$$

$$d \geq 0$$

Reverse engineer $C(e, v, n)$ to match micro-evidence

Log-linear relation between the **vacancy-yield** and **hiring rate**



Davis, Faberman and Haltiwanger (2013)

Reverse engineer $C(e, v, n)$ to match micro-evidence

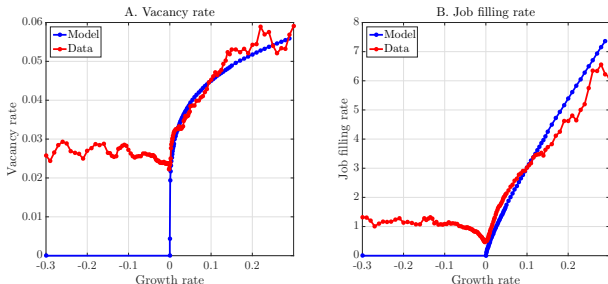
Cost function

$$C(e, v, n) = \left[\frac{\kappa_1}{\gamma_1} e^{\gamma_1} + \frac{\kappa_2}{\gamma_2 + 1} \left(\frac{v}{n} \right)^{\gamma_2} \right] v, \quad \gamma_1 \geq 1, \gamma_2 \geq 0$$

First-order conditions give the **DFH specification**

$$\log \left(\frac{h_{i,t}}{v_{i,t}} \right) = \Omega(\theta_t^*) + \frac{\gamma_2}{\gamma_1 + \gamma_2} \log \left(\frac{h_{i,t}}{n_{i,t}} \right)$$

Optimal job filling and vacancy rates



$$\frac{v}{n} = \text{const.} \cdot q(\theta^*)^{-\frac{\gamma_1}{\gamma_1+\gamma_2}} \cdot \left(\frac{n' - n}{n}\right)^{\frac{\gamma_1}{\gamma_1+\gamma_2}} = 0.18$$

$$e = \text{const.} \cdot q(\theta^*)^{-\frac{\gamma_2}{\gamma_1+\gamma_2}} \cdot \left(\frac{n' - n}{n}\right)^{\frac{\gamma_2}{\gamma_1+\gamma_2}} = 0.82$$

Value functions - Entry

- **Initial wealth** Household allocates a_0 to λ_0 potential entrants
- **Productivity** Potential entrants draw $z \sim \Gamma_0(z)$
- **Entry** Choice to become incumbent and pay χ_0 start-up costs

$$\mathbb{V}^e(a_0, z) = \max \left\{ a_0, \mathbb{V}^i(n_0, a_0 - \chi_0, z) \right\}$$

Selection at entry based only on productivity z

Given z , growth determined by financial constraints and hiring costs

Equilibrium

- **Aggregate state** $S_t = (\lambda_t, U_t, Z_t, \varphi_t)$

1. Measure of firms evolves via decision rules and z process
2. Labor market flows are equalized at $\theta_t^* = V_t^* / U_t$

$$U_{t+1}^{flows} = U_t - H(\theta_t^*, S_t) + F(\theta_t^*, S_t) - \lambda_{e,t} n_0$$

$$U_{t+1}^{demand} = \bar{L} - \int n'(n, a, z, \theta_t^*, S_t) d\lambda_t$$

3. Hires are given by the matching function $H_t = \Phi V_t^{*\alpha} U_t^{1-\alpha}$

- **Stationary equilibrium** Measure is stationary, and $S = (\lambda, U)$

Parameter values set externally

Parameter		Value	Target
Discount factor (monthly)	β	0.9967	Ann. risk-free rate = 4%
Mass of potential entrants	λ_0	0.02	Meas. of incumbents = 1
Size of labor force	\bar{L}	24.6	Average firm size = 23
Elasticity of matching function wrt V_t	α	0.5	JOLTS

Add to the model

- Heterogeneity in returns to scale $\sigma \in \{\sigma_L, \sigma_M, \sigma_H\}$

Calibration strategy

1. Worker flows and labor share
2. Distribution of firm size, growth rates
3. Micro-evidence on job-filling and vacancy-posting
4. Entry and exit
5. Young firms' and aggregate leverage

Parameter values estimated internally

Parameter		Value	Target	Model	Data
Flow of home production	ω	1.000	Monthly separ. rate	0.033	0.030
Scaling of match. funct.	Φ	0.208	Monthly job finding rate	0.411	0.400
Prod. weight on labor	ν	0.804	Labor share	0.627	0.640
Midpoint DRS in prod.	σ_M	0.800	Employment share n : 0-49	0.294	0.306
High-Low spread in DRS	$\Delta\sigma$	0.094	Employment share n : 500+	0.430	0.470
Mass - Low DRS	μ_L	0.826	Firm share n : 0-49	0.955	0.956
Mass - High DRS	μ_H	0.032	Firm share n : 500+	0.004	0.004
Persistence of z shocks	ρ_z	0.992	Std. dev ann emp growth	0.440	0.420
Std. dev. of z shocks	θ_z	0.052	Mean Q1 emp / Mean Q4 emp	75.161	76.000
Mean $z_0 \sim \text{Exp}(z_0^{-1})$	\bar{z}_0	0.390	$\Delta \log z$: Young vs. Mature	-0.246	-0.353
Cost elasticity wrt e	γ_1	1.114	Elasticity of vac yield wrt g	0.814	0.820
Cost elasticity wrt v	γ_2	4.599	Ratio vac yield: <50/>50	1.136	1.440
Cost shifter wrt e	κ_1	0.101	Hiring cost (100+) / wage	0.935	0.927
Cost shifter wrt v	κ_2	5.000	Vacancy share $n < 50$	0.350	0.370
Exogenous exit probability	ζ	0.006	Survive ≥ 5 years	0.497	0.500
Entry cost	χ_0	9.354	Annual entry rate	0.099	0.110
Operating cost	χ	0.035	Fraction of JD by exit	0.210	0.340
Initial wealth	a_0	10.000	One year old Debt to Output	1.394	1.250
Collateral constraint	φ	10.210	Aggregate debt-to-assets	0.276	0.330

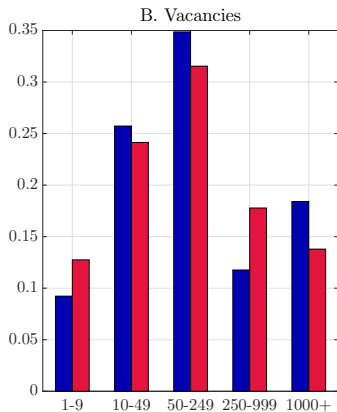
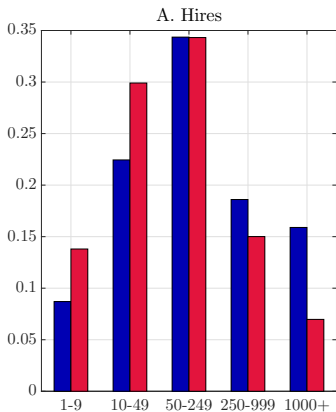
Non-targeted moments

Moment	Model	Data	Source
Aggregate dividend / profits	0.411	0.400	NIPA
¹ Aggregate capital / output	1.100	1.370	Flow of funds
² Employment share: $growth \in [-2.00, -0.20]$	0.070	0.076	Davis et al (2010)
Employment share: $growth \in (-0.20, -0.20]$	0.828	0.848	Davis et al (2010)
Employment share: $growth \in (0.20, 2.00]$	0.102	0.076	Davis et al (2010)
Employment share: $Age \leq 1$	0.013	0.020	BDS
Employment share: $Age \in (1, 10)$	0.309	0.230	BDS
Employment share: $Age \geq 10$	0.678	0.750	BDS

Note (1.) Capital measured from Flow of Funds B.103 non-financial business corporations: real-estate plus equipment (2.) Firm growth rates are annual.

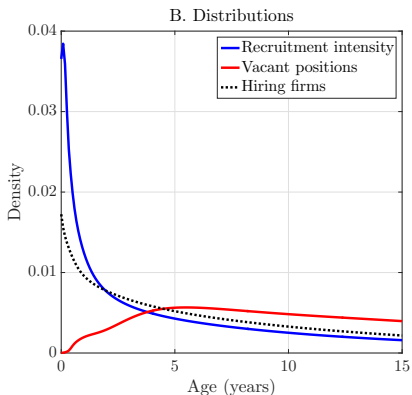
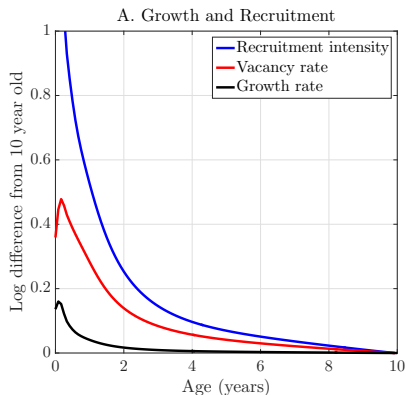
► Fig. Average firm lifecycle (i) size, (ii) job creation, (iii) fraction constrained, (iv) leverage

Hire and vacancy shares by size class



Model, Data - JOLTS 2002-2007

Vacancy and recruitment intensity by age



$$\downarrow \left(\frac{n' - n}{n} \right) = q(\theta^*) \times \left(\downarrow e \right) \times \left(\downarrow \frac{v}{n} \right)$$

Transition dynamics experiments

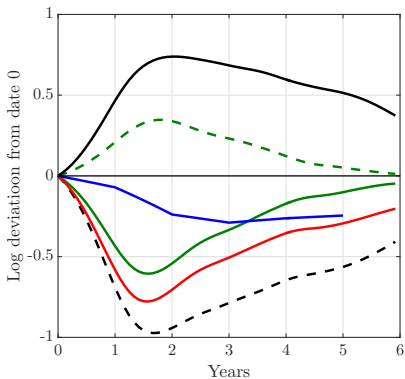
Transition dynamics experiments

Trace **transitional dynamics** of the economy in response to:

- Tightening of financial constraint $\downarrow \varphi$
- Decline in aggregate productivity $\downarrow Z$
- Size of shocks to match 10% decline in output (Fernald, 2015)
- Geometric decay with half-life of six years

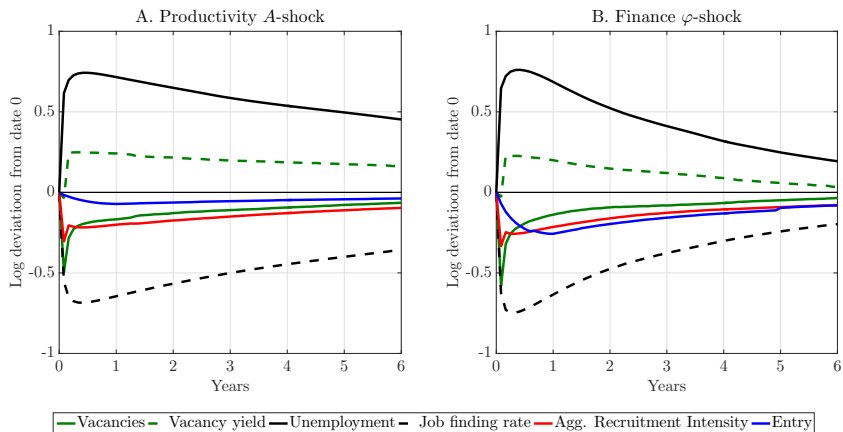
Shocks: (i) 4% drop in Z , (ii) 75% drop in φ

US data 2008:01 - 2013:12



— Vacancies — Vacancy yield — Unemployment - - Job finding rate — Agg. Matching Efficiency — Entry

Transition dynamics - Model



► Fig. Macro variables (i) output, (ii) capital, (iii) labor productivity

Decomposing aggregate recruiting intensity

Aggregate recruiting intensity

$$\Phi_t = \left(\frac{V_t^*}{V_t} \right)^\alpha = \left[\int e_{i,t} \left(\frac{v_{i,t}}{V_t} \right) d\lambda_t^h \right]^\alpha$$

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Substituting in the policy function for effort $e_{i,t}$

$$\Delta \log \Phi_t = \underbrace{-\alpha \frac{\gamma_2}{\gamma_1 + \gamma_2} \Delta \log q(\theta_t^*)}_{1. \text{ Slackness effect}} + \underbrace{\alpha \Delta \log \left[\int g_{i,t}^{\frac{\gamma_2}{\gamma_1 + \gamma_2}} \left(\frac{v_{i,t}}{V_t} \right) d\lambda_t^h \right]}_{2. \text{ Composition effect}}$$

1. Slackness effect

$$\bar{g} = \uparrow q(\theta^*) \times \left(\downarrow e \right) \times \left(\downarrow \frac{v}{n} \right)$$

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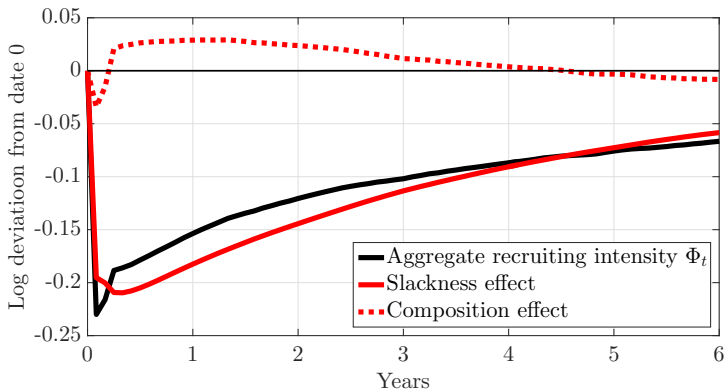
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2. Composition effect

$$\downarrow g = q(\theta^*) \times \left(\downarrow e \right) \times \left(\downarrow \frac{v}{n} \right)$$

Decomposing aggregate recruiting intensity



- **Slackness effect** dominates
- **Composition effect** roughly zero

Why is the composition effect zero?

Composition effect

$$\Delta\Phi_t^{Comp} = \alpha\Delta \log \left[\int g_{i,t}^{\frac{\gamma_2}{\gamma_1+\gamma_2}} \left(\frac{v_{i,t}}{V_t} \right) d\lambda_t^h \right]$$

1. Two off-setting forces of the shock

↓ **PE** Composition effect under shock to φ_t , keeping θ^* fixed

↑ **GE** Composition effect under θ_t^* , keeping φ fixed

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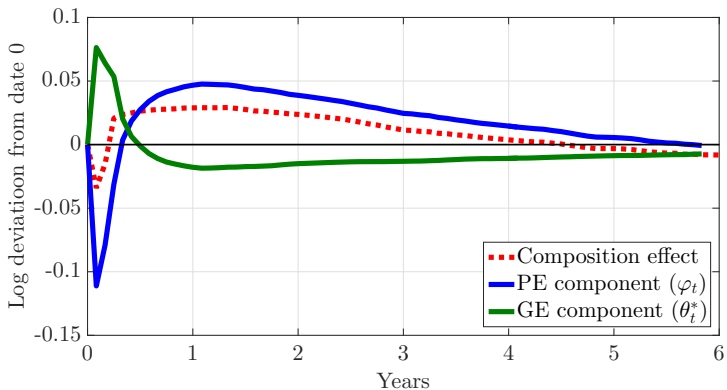
↑ **GE** Composition effect under θ_t^* , keeping φ fixed

2. Both moderated by selection

↑ **PE** More productive entrants and hiring firms

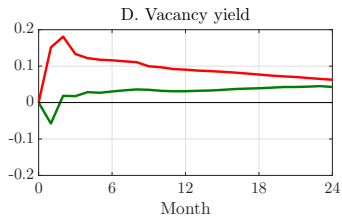
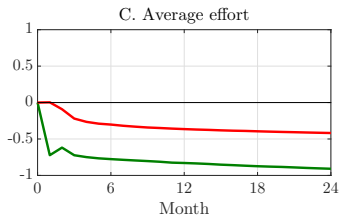
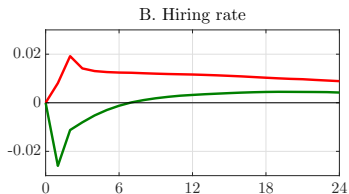
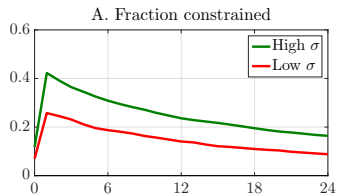
↓ **GE** Less productive entrants and hiring firms

Why is the composition effect zero?

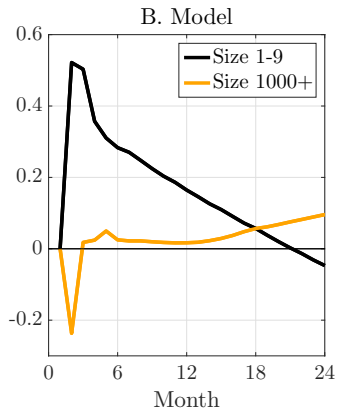
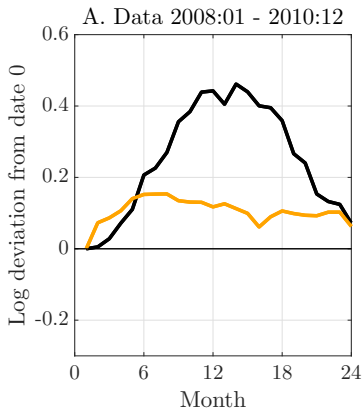


- At impact large negative **PE** component, offset by **GE** effect
- Followed by offsetting selection effects

Hiring by returns to scale parameter (σ)



Vacancy yields by firm size



Taking stock and going forward

Answers

1. Recruiting intensity explains **approx. 1/3** of decline in match eff.
- 2a. Dominant effect: **Slack markets reduce need for costly recruiting**
- 2b. Strong selection effects limit role of compositional changes
- 2c. Slackness and composition explain vacancy yields by size

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Extensions

1. Relationship to Kaas & Kircher (2015)
2. Construct an easy-to-measure index of aggregate recruiting intensity
3. How would Φ_t respond to hiring / job-search subsidies?

1. Relation to Kaas Kircher (2015)

KK model

$$\Phi_t^{KK} = \int \frac{q(\theta_{mt})}{\bar{q}(\theta_t)} \frac{v_{mt}}{\bar{V}_t} dm$$

*“The reason why [recruiting intensity] is **pro-cyclical** in our model is that q is concave, and the cross-sectional dispersion in θ_{mt} is counter-cyclical”*

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Our model

$$\Delta \log \Phi_t = \underbrace{-\alpha \frac{\gamma_2}{\gamma_1 + \gamma_2} \Delta \log q(\theta_t^*)}_{1. \text{ Slackness effect}} + \underbrace{\alpha \Delta \log \left[\int g_{it}^{\frac{\gamma_2}{\gamma_1 + \gamma_2}} \left(\frac{v_{it}}{V_t} \right) d\lambda_t^h \right]}_{2. \text{ Composition effect}}$$

Dispersion effect is present

1. $\frac{\gamma_2}{\gamma_1 + \gamma_2} < 1$
2. φ_t shock delivers 45% increase in SD of g_{it} , as in data

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Quantitatively, this effect is small

1. $\frac{\gamma_2}{\gamma_1 + \gamma_2} = 0.82 \approx 1$
2. Strong offsetting selection

2. Approximate index of aggregate recruiting intensity

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DFH provide an easy-to-compute index of aggregate recruiting intensity

$$\log \Phi_t = \log(H_t/V_t) - \log q_t$$

$$\frac{d \log \Phi_t}{d \log(H_t/N_t)} = \frac{d \log(H_t/V_t)}{d \log(H_t/N_t)} - \frac{d \log q_t}{d \log(H_t/N_t)}$$

- (a) Use firm-level elasticity for first term, $\xi = 0.82$
- (b) Assume second term is zero

$$\frac{d \log \Phi_t}{d \log(H_t/N_t)} \approx \xi$$

$$d \log \Phi_t^{DFH} = \xi \times d \log(H_t/N_t)$$

2. Approximate index of aggregate recruiting intensity

Return to model based decomposition

$$\log \Phi_t = \underbrace{-\alpha \frac{\gamma_2}{\gamma_1 + \gamma_2} \log q(\theta_t^*)}_{\text{Substitution effect}} + \underbrace{\alpha \log \left[\int g_{i,t}^{\frac{\gamma_2}{\gamma_1 + \gamma_2}} \left(\frac{v_{i,t}}{V_t} \right) d\lambda_t^h \right]}_{\text{Composition effect}}$$

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GMV

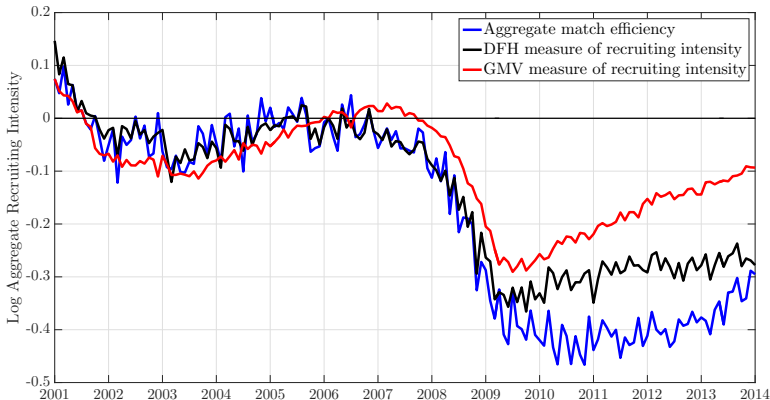
(a) Model tells us that the composition effect is approximately zero

$$d \log \Phi_t^{GMV} = \alpha \frac{\gamma_2}{\gamma_1 + \gamma_2} \times (1 - \alpha) \times d \log \theta_t^*$$

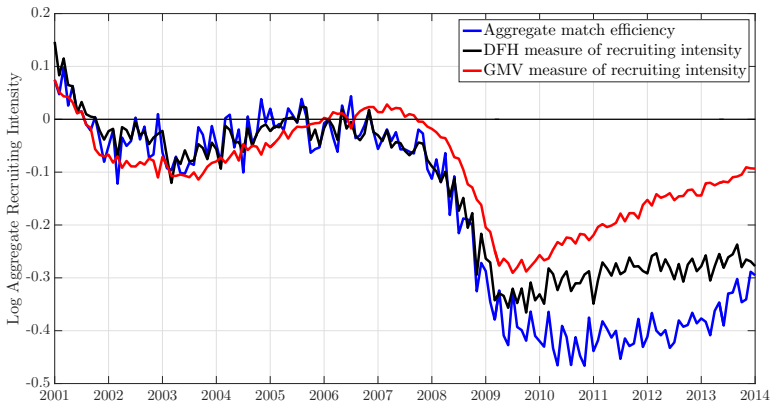
(b) Take elasticity of θ_t^* to θ_t from transition dynamics

$$d \log \Phi_t^{GMV} = \alpha \frac{\gamma_2}{\gamma_1 + \gamma_2} \times (1 - \alpha) \times \underbrace{\varepsilon_{\theta^*, \theta}}_{\approx 1.45} d \log \theta_t$$

2. Approximate index of aggregate recruiting intensity



2. Approximate index of aggregate recruiting intensity



- **DFH proxy** Persistently low Φ_t explains persistently low A_t
- **Our proxy** Persistence due to other sources

3. Subsidies and aggregate recruiting intensity

1. Hiring subsidy paid to firms

- e.g. *Hiring Incentives to Restore Employment Act, 2010*
- Increases hiring
- Increase in hiring achieved by $\uparrow e_t$
- Increase in aggregate recruiting intensity $\uparrow \Phi_t$

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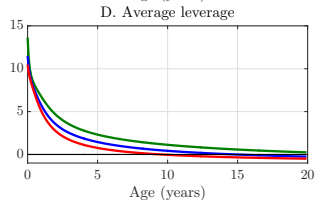
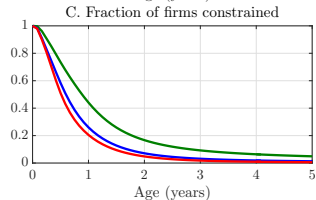
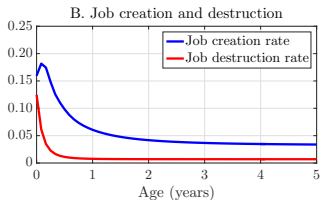
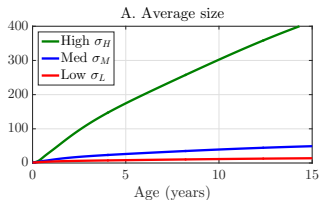
2. Search-effort subsidy to workers

$$H_t = V_t^{*\alpha} S_t^{1-\alpha}, \quad S_t = s_t U_t, \quad H_t = \left(\Phi_t s_t^{1-\alpha} \right) V_t^\alpha U_t^{1-\alpha}$$

- Increases unemployed search intensity $\uparrow s_t$
- Increases labor market slackness $\uparrow q_t$
- For constant hiring-rates $\downarrow e_t$
- Reduction in aggregate recruiting intensity $\downarrow \Phi_t$

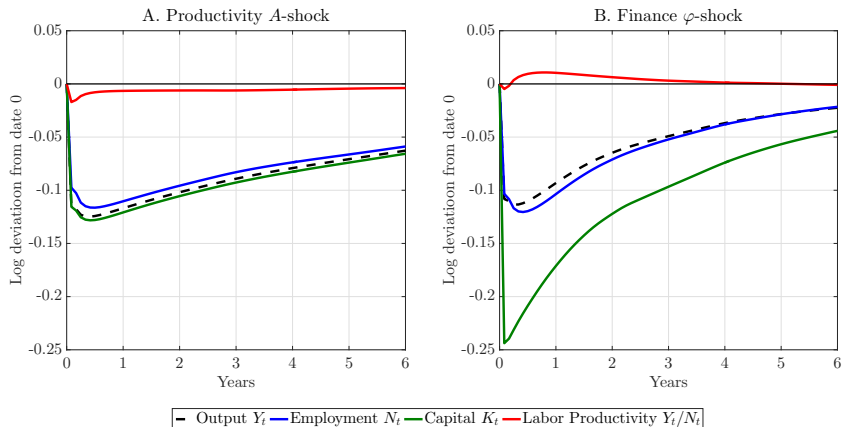
THANK YOU!

Average life cycle of firms in the model



▶ Back - Non-targetted moments

Transition dynamics - Macro



▶ Back - Transition dynamics - Labor