Aggregate Recruiting Intensity

Alessandro Gavazza
London School of Economics

Simon Mongey
New York University

Gianluca Violante
New York University

NBER Summer Institute EFMPL - July 18, 2016

Introduction

What is aggregate recruiting intensity?

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

Aggregate match efficiency

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

Introduction

What is aggregate recruiting intensity?

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

Aggregate match efficiency

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

Why study aggregate recruiting intensity?

- 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
- Macro data
  - Large and persistent decline in A_t in '08 recession
  - Existing studies focus on mismatch, composition, job-search effort

Introduction

Questions

1. What fraction of 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"*

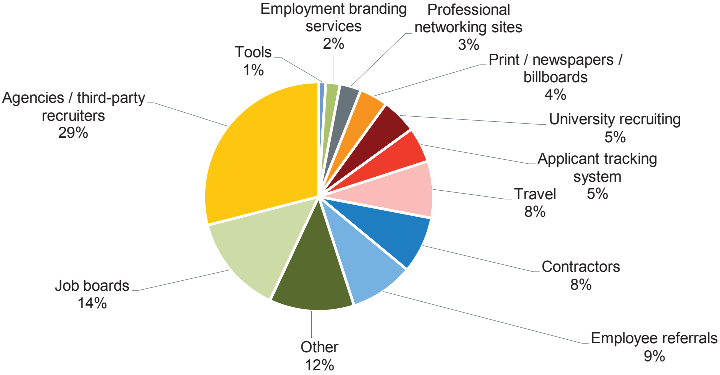
Firm-level hiring technology

$$\text{Random-matching model} \quad h_{it} = q_t v_{it}$$
$$\text{+ recruiting effort} \quad h_{it} = q_t e_{it} v_{it}$$

- 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

$$\downarrow h_{it} = \bar{q}_t \downarrow e_{it} \downarrow v_{it}$$

- Shift in growth rate distribution

∗ Moderated by selection

  - Better entrants and hiring firms

2. Slackness effect

$$\bar{h}_{it} = \uparrow q_t \downarrow e_{it} \downarrow v_{it}$$

- 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

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

- Fire or hire

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

Value functions - Firing

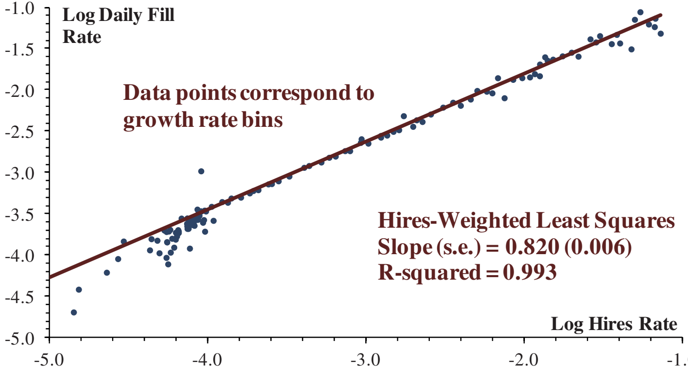
$$
\begin{aligned}
\mathbb{V}^f(n,a,z) &= \max_{n' \leq n, k, d} \quad d + \beta \int_{\mathcal{Z}} \mathbb{V}(n',a',z')\Gamma(z,dz') \\
& s.t. \\
d + a' &= \left(zn'^{\nu}k^{1-\nu}\right)^{\sigma} + (1+r)a - \omega n' - (r+\delta)k - \chi \\
k &\leq \varphi a \\
d &\geq 0
\end{aligned}
$$

Value functions - Hiring

$$\begin{aligned}
\mathbb{V}^h(n,a,z) &= \max_{v>0,e>0,k,d} d + \beta \int_{\mathcal{Z}} \mathbb{V}(n',a',z')\Gamma(z,dz') \\
&\quad s.t. \\
d + a' &= \left(zn'^{\nu}k^{1-\nu}\right)^{\sigma} + (1+r)a - \omega n' - (r+\delta)k - \chi - C(e,v,n) \\
n' - n &= q(\theta^*)ev \\
k &\leq \varphi a \\
d &\geq 0
\end{aligned}$$

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

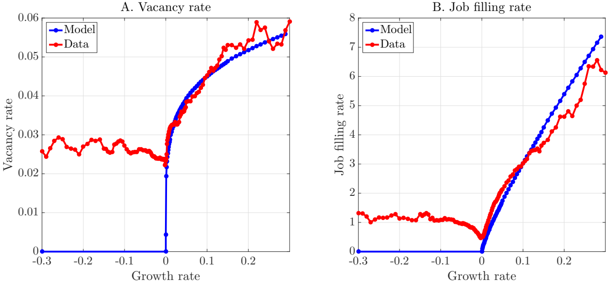
Cost function

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

First-order conditions give the DFH specification

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

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

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

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

- 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.	$\bar{\Phi}$	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 $z_0 \sim Exp(\bar{z}_0^{-1})$	$\bar{z}_0$	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 $\geq$ 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

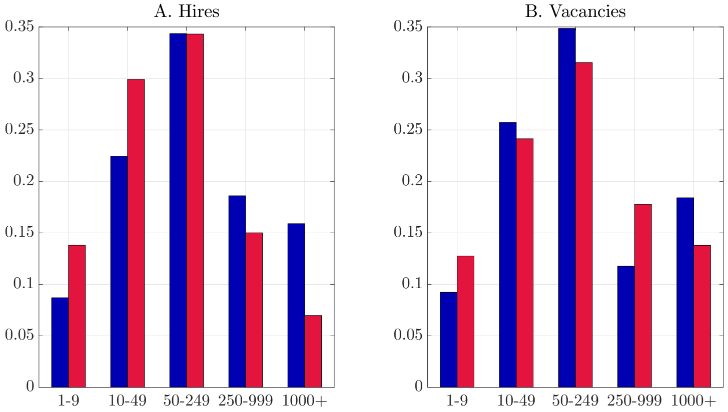
Non-targeted moments

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.*

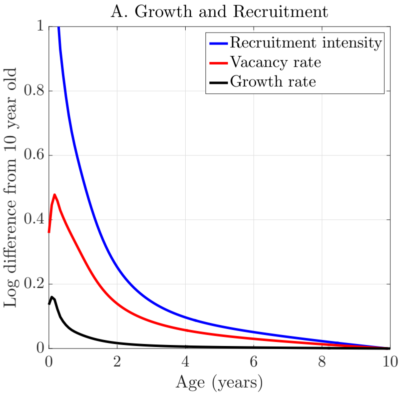
▸ Fig. Average firm lifecycle (i) size, (ii) job creation, (iii) fraction constrained, (iv) leverage

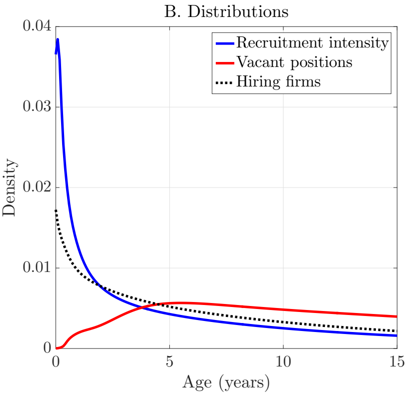
Hire and vacancy shares by size class



Model, Data - JOLTS 2002-2007

Vacancy and recruitment intensity by age





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

Transition dynamics experiments

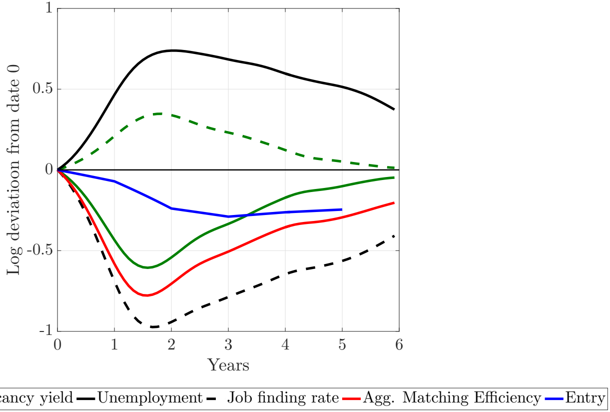
Transition dynamics experiments

Trace transitional dynamics of the economy in response to:

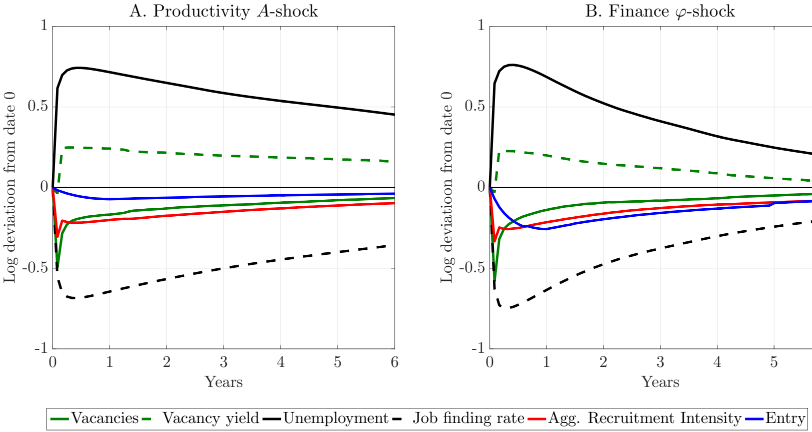
- Tightening of financial constraint $\downarrow \varphi$
- Decline in aggregate productivity $\downarrow Z$
- Size of shocks to match 10% decline in output (Fernald, 2015)
- Geometric decay with half-life of six years

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

US data 2008:01 - 2013:12



Transition dynamics - Model



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

Decomposing aggregate recruiting intensity

Aggregate recruiting intensity

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

Decomposing aggregate recruiting intensity

Aggregate recruiting intensity

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

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

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

1. Slackness effect

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

Decomposing aggregate recruiting intensity

Aggregate recruiting intensity

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

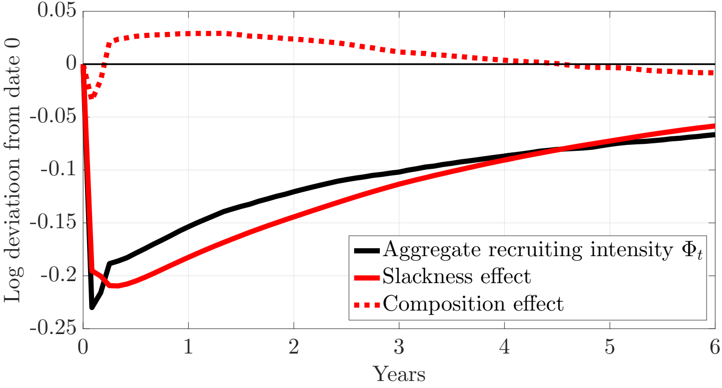
Substituting in the policy function for effort $e_{i,t}$

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

2. Composition effect

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

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

$\downarrow$ **PE** Composition effect under shock to φ_t, keeping θ^* fixed

$\uparrow$ **GE** Composition effect under θ_t^*, keeping φ fixed

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

$\downarrow$ **PE** Composition effect under shock to φ_t, keeping θ^* fixed

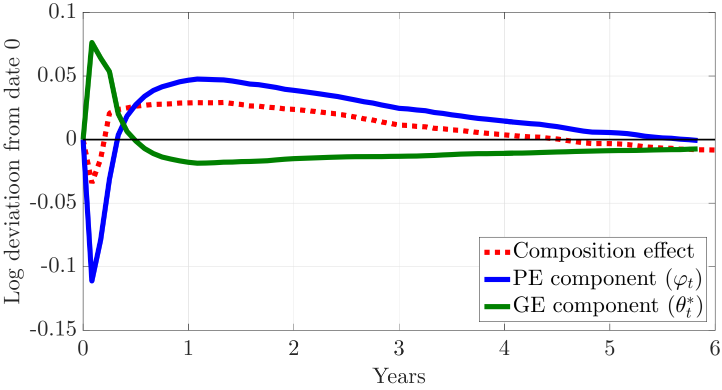
$\uparrow$ **GE** Composition effect under θ_t^*, keeping φ fixed

2. Both moderated by selection

$\uparrow$ **PE** More productive entrants and hiring firms

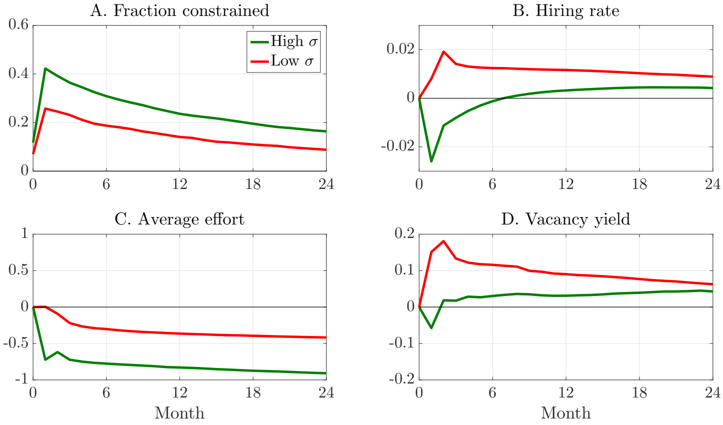
$\downarrow$ **GE** Less productive entrants and hiring firms

Why is the composition effect zero?

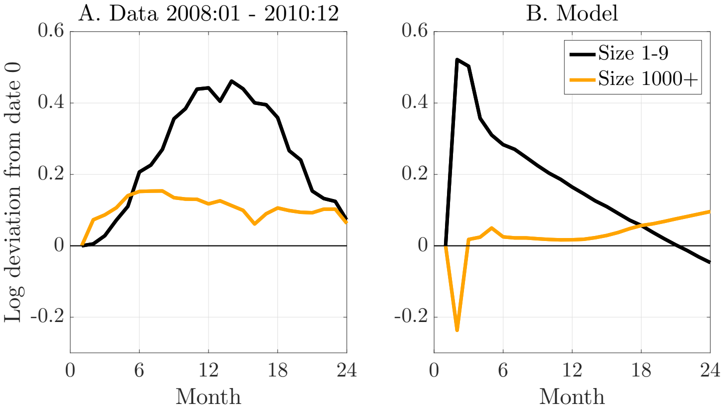


- At impact large negative **PE** component, offset by **GE** effect
- Followed by offsetting selection effects

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

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

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

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

"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"

1. Relation to Kaas Kircher (2015)

KK model

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

"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"

Our model

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

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

1. Relation to Kaas Kircher (2015)

KK model

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

"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"

Our model

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

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

2. Approximate index of aggregate recruiting intensity

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

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

2. Approximate index of aggregate recruiting intensity

Return to model based decomposition

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

GMV

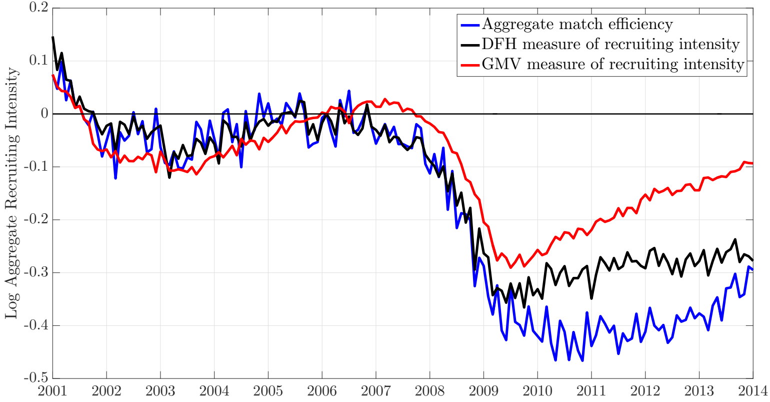
(a) Model tells us that the composition effect is approximately zero

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

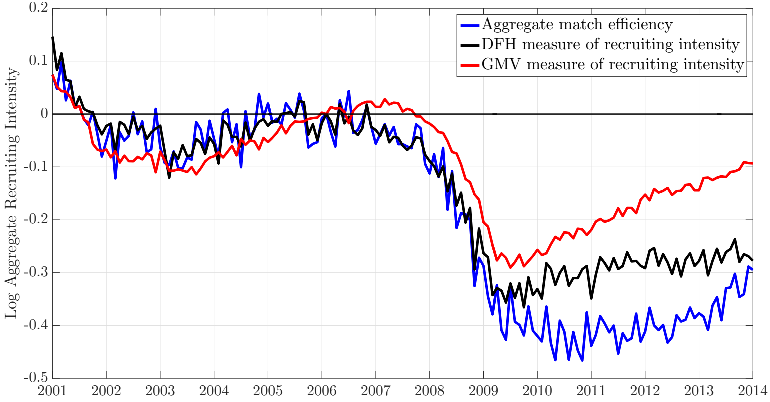
(b) Take elasticity of θ_t^* to θ_t from transition dynamics

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

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 $\uparrow \Phi_t$

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 $\uparrow \Phi_t$

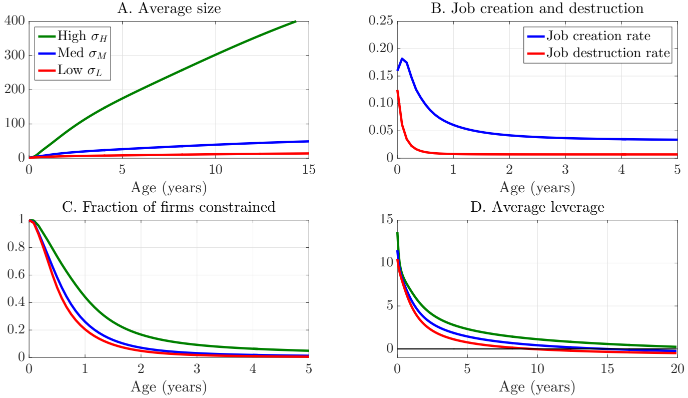
2. Search-effort subsidy to workers

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

- 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 $\downarrow \Phi_t$

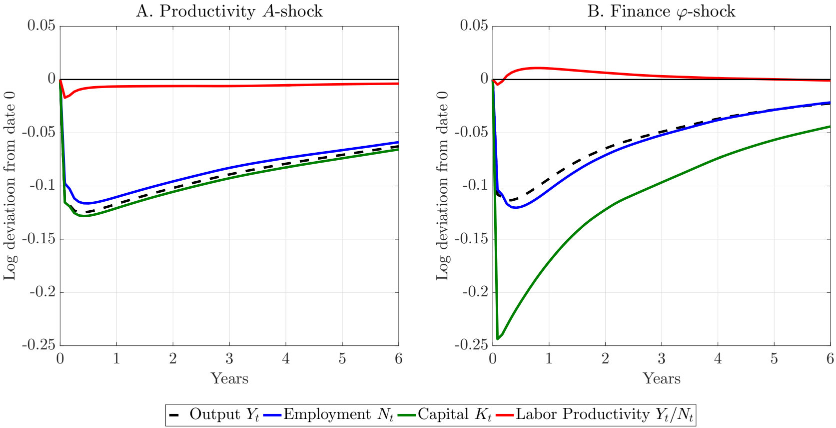
THANK YOU!

Average life cycle of firms in the model



Back - Non-targetted moments

Transition dynamics - Macro



▸ Back - Transition dynamics - Labor