Jobs and Matches: Quits, Replacement Hiring, and Vacancy Chains

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Job Openings

Key variable for aggregate labor market behavior.

Data
- Drives the job finding rate of unemployed workers,
- And thereby employment fluctuations.

Theory Diamond-Mortensen-Pissarides (DMP) search model.
- Job openings = creation of **new** jobs.
- Driven solely by "fundamentals" in costs and benefits of hiring: productivity, discount factor, wages, separations, ...

This Paper

I Establish/point out three empirical facts:

1. Job: ~ 60% of job openings aim to fill **old** jobs vacated by **quits**.
2. Establishment: 1 quit ⇒ ~ 1 new hire.
3. Aggregate: Hires tightly track quits.

II Extend textbook DMP model to accommodate old jobs and quit-replacement hiring.

+ Sunk job creation cost ⇒ Vacant positions are valuable.
+ On-the-job search ⇒ Job-to-job quits drive vacancy repostings.

⇒ Two types of jobs:

new	standard DMP entry
old	vacated by quits and reposted

III Quantitatively study aggregate implications:

- Vacancy chains & "multipliers".
- Business cycles amplification.

Road Map

Mechanism

Empirical Evidence

Model

Quantitative Analysis

Business Cycle Implications

Two-Period DMP

- New hires:

$$\underbrace{h}_{\text{hires}} = \underbrace{q(\theta)}_{\text{job filling rate}} \times \underbrace{v}_{\text{job openings}}$$

- Zero-profit condition for vacancy posting:

$$\underbrace{\kappa}_{\text{flow cost}} = \underbrace{q(\theta)\beta(y-w)}_{\text{returns to hiring}},$$

  where market tightness $\theta \coloneqq \frac{\text{Job Openings}}{\text{Unemployed Searchers}}$.
- Equilibrium θ through:
  - Congestion in labor market: $q'(\theta) < 0$.
  - Wage bargaining: $w_y,\ w_\theta > 0$.
- A model solely of **new** job creation:
  - Linear production function (CRS).
  - No sunk investments.

This Paper: Old vs New Jobs

New jobs: pay one-time fixed cost of job creation $k(n)$ (Fujita and Ramey (2007)):

$$\kappa + k(n) = q(\theta)\beta(y - w)$$

Old jobs: costs are sunk and vacancies have **strictly positive** equilibrium value:

$$\kappa < q(\theta)\beta(y - w)$$

⇒ Old jobs are **reposted**.

⇒ Quits trigger **replacement hiring**.

⇒ Quits can act as a (proximate) driver of total job openings in "**vacancy chain**".

Conventional View of Quits in DMP

Add on-the-job-search to the baseline model:

$$\theta = \frac{\text{Job Openings}}{\text{Total Searchers}} = \frac{\text{Job Openings}}{\text{Unemployed} + \text{On-the-job Searchers}}$$

$$\kappa = q(\theta)\beta\Big[(y - w) + (1 - \text{P(Quit)}) \cdot \beta(y - w)\Big]$$

- Two market-level effects of quits:
  - ☺ Labor supply channel: $q(\theta) \uparrow$
  - ☹ Match duration channel: $[1 - \text{Prob(Quit)}] \downarrow$
- But: jobs vacated by quits are **not** reposted!
  - ... zero value of vacancy, old or new.
  - Match resolution and job destruction similar events.

Road Map

What is a Job Opening?

Job Openings and Labor Turnover Survey (JOLTS) definition:

[...] all positions that are open (not filled) on the last business day of the month. A job is "open" only if it meets **all three** of the following conditions:

1. A specific **position exists** and there is **work available** for that position.
2. The **job could start within 30 days**.
3. There is **active recruiting** for workers from outside the establishment.

⇒ Notion of **sunk** cost!

Empirical Evidence

Four levels of evidence:

1. Vacancy survey
2. Establishment level worker flows
3. Local labor markets
4. Aggregate comovements

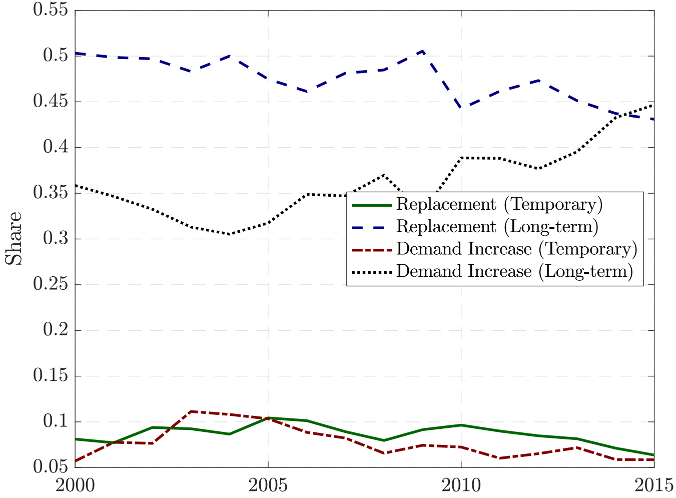
Vacancy Level Evidence

- German IAB Vacancy Survey.
- Annual, 2000-2015, ~ 75,000 establishments per year.
- Detailed questions on the last filled opening in the past 12 months.

"Why did you post this particular job opening?"

Replacement Hiring		Demand Increase	
Temporary	Long-term	Temporary	Long-term
8.7%	47.4%	7.7%	36.2%
56.1%		43.9%	

Composition of Job Openings



~ 50% – 60% of job openings to replace workers.

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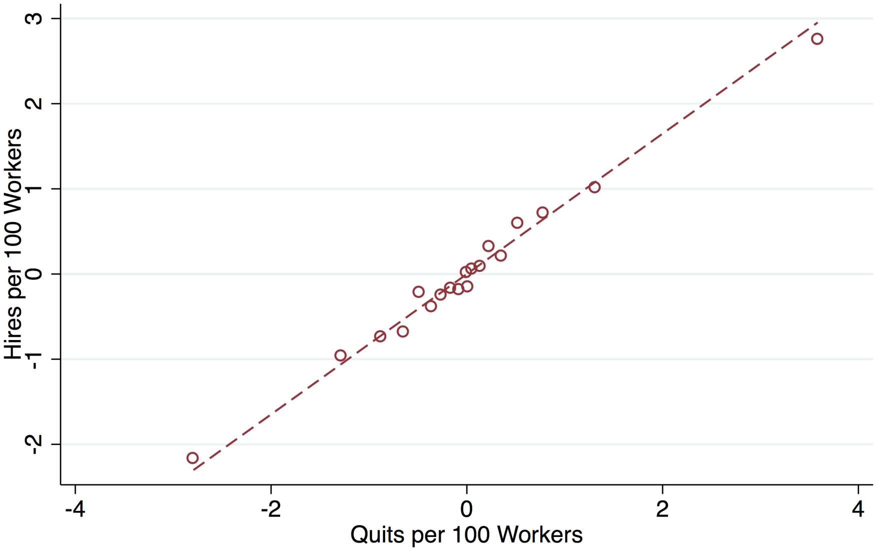
Establishment-Level Evidence

Run regression at the establishment level:

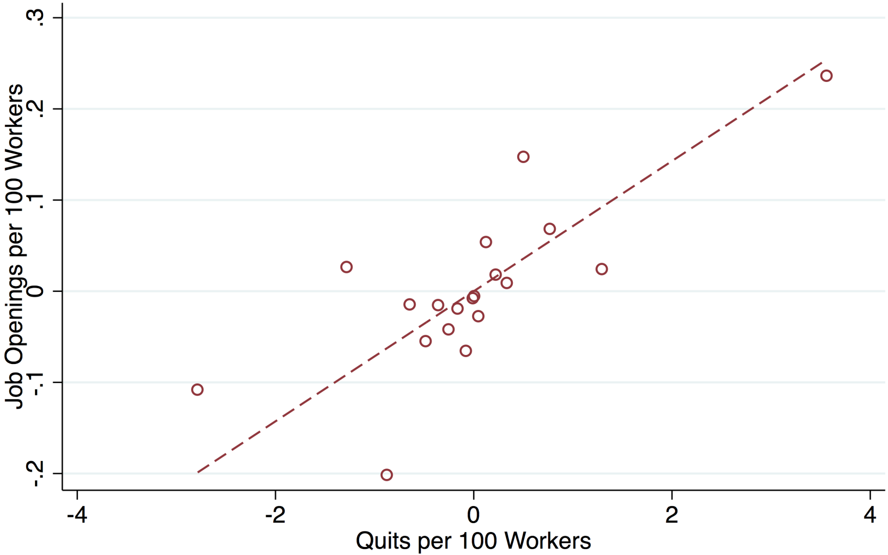
$$\frac{\text{Hires}_{e,t}}{\text{Emp}_{e,t-1}} = \beta_0 + \beta_1 \frac{\text{Quits}_{e,t}}{\text{Emp}_{e,t-1}} + \gamma X_{e,t} + \alpha_e + \alpha_t + \varepsilon_{e,t}$$

Source: IAB Establishment Survey ("annual German JOLTS").

Establishment-Level Quits and Hires



Establishment-Level Quits and Job Openings



Establishment Level Regressions

A. Dependent Variable: $\frac{\text{New Hires}_{et}}{\text{Emp.}_{et-1}}$

	All			Positive Quits		
	(1)	(2)	(3)	(1)	(2)	(3)
$\frac{\text{Quits}_{et}}{\text{Emp.}_{et-1}}$	.736	.727	.733	.824	.817	.821
	(.067)	(.068)	(.068)	(.086)	(.086)	(.085)
Establishment FE	✓	✓	✓	✓	✓	✓
Year FE	✓			✓		
Year x Industry FE		✓			✓	
Year x State FE			✓			✓
N	24509	24509	24509	18015	18015	18015
R^2	.64	.64	.64	.66	.67	.67

B. Dependent Variable: $\frac{\text{Job Openings}_{et}}{\text{Emp.}_{et-1}}$

	All			Positive Quits		
	(1)	(2)	(3)	(1)	(2)	(3)
$\frac{\text{Quits}_{et}}{\text{Emp.}_{et-1}}$	.048	.046	.047	.071	.069	.068
	(.026)	(.027)	(.026)	(.035)	(.035)	(.035)
Establishment FE	✓	✓	✓	✓	✓	✓
Year FE	✓			✓		
Year x Industry FE		✓			✓	
Year x State FE			✓			✓
N	23209	23209	23209	16964	16964	16964
R^2	.37	.37	.37	.35	.36	.35

Event Study

Dependent Variable: $\frac{\text{New Hires}_{et}}{\text{Emp.}_{et-1}}$

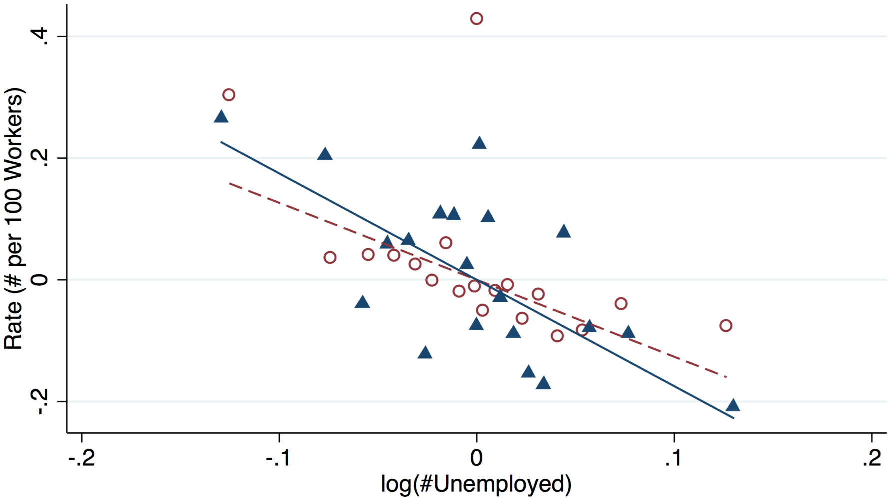
	All				Positive Quits			
Lead/Lag	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
−3				−.060 (.067)				−.115 (.074)
−2			.016 (.096)	−.008 (.086)			.060 (.158)	−.123 (.132)
−1		.051 (.057)	.064 (.098)	.078 (.091)		.011 (.089)	.010 (.150)	−.005 (.129)
0	.736 (.067)	.753 (.068)	.815 (.095)	.818 (.127)	.824 (.086)	.928 (.097)	1.03 (.140)	.903 (.164)
+1		.050 (.069)	.079 (.086)	.192 (.104)		0.030 (.102)	.044 (.136)	.070 (.129)
+2			.086 (.085)	−.055 (.088)			−.001 (.122)	−.258 (.122)
+3				.161 (.139)				.037 (.226)
Establishment FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
N	24509	11414	5732	2832	18015	6433	2912	1385
R^2	.64	.67	.63	.65	.66	.64	.62	.73

Empirical Evidence

Four levels of evidence:

1. Vacancy survey
2. Establishment level worker flows
3. Local labor markets
4. Aggregate comovements

Local-Labor-Market-Level Quits and Hires



Local-Labor-Market-Level Quits and Job Openings

Empirical Evidence

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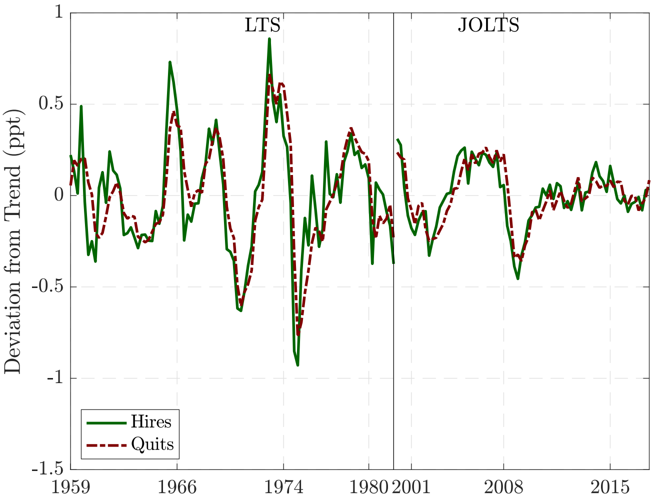
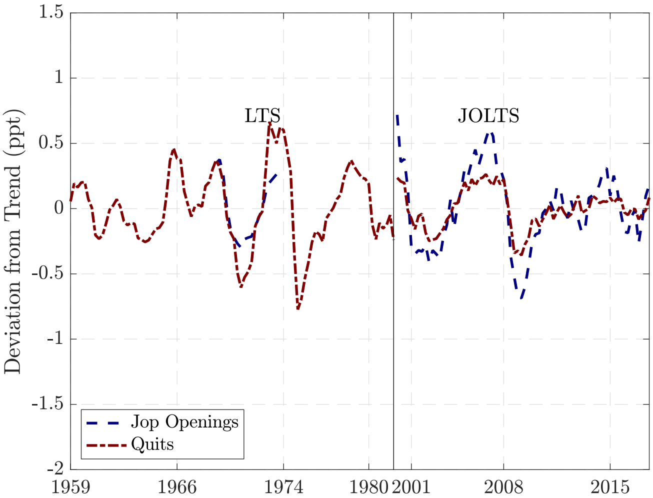
Quits and Hires (Quarterly Rate per 100 Workers)



Quits and Job Openings (Quarterly Rate per 100 Workers)



Summary of Empirical Evidence

Old rather than **new** jobs behind job openings:

- **Vacancy** level: ~ 60% of job openings to replace quitting workers.

Suggests quit-replacement hiring:

- **Establishment** level: 1 quit $\propto$ 0.7-0.8 new hires.
- **Aggregate** level: Strongly procyclical quits, hires and vacancies.

Interpretation:

✓ Quit-replacement hiring: concentrated in **same firm**/job!

X Standard view: market level.

Road Map

Mechanism

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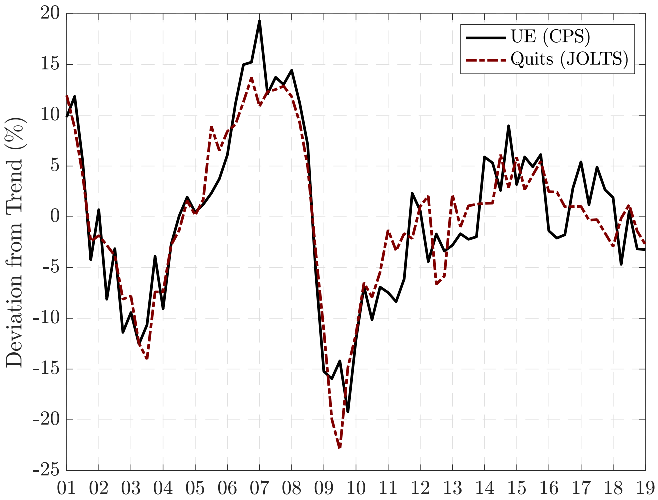
Business Cycle Implications

Environment

- Equilibrium search model — TEXTBOOK DMP
  - \+ fixed cost of vacancy creation
  - \+ on-the-job search.
- Random search under CRS matching function.
  - On-the-job search with relative efficiency λ.
- Different types of exogenous shocks:
  - σ: match **separation**
    - Firm can repost vacated job with probability γ.
  - δ: job **destruction**
    - Permanent destruction $\Rightarrow$ No reposting.

Quits and On the Job Search: Pr(Quit) = $\lambda f(\theta)$



Worker Problem

Unemployed:

$$U(\mathbf{s}) = b + \beta\Big[(1-\delta)(1-\sigma)f(\theta)\mathbb{E}[W(\mathbf{s}')] + (1-(1-\delta)(1-\sigma)f(\theta))\mathbb{E}[U(\mathbf{s}')]\Big]$$

Employed:

$$W(\mathbf{s}) = w(\mathbf{s}) + \beta(\delta + (1-\delta)\sigma)\mathbb{E}[U(\mathbf{s}')] + \beta(1-\delta)(1-\sigma)\underbrace{[\overbrace{\lambda f(\theta)}^{\text{EE Quit}} + (1-\lambda f(\theta))]}_{=1}\mathbb{E}[W(\mathbf{s}')]$$

Unemployment LoM:

$$u_t = \underbrace{\Big(1-(1-\delta)(1-\sigma)f(\theta_{t-1})\Big)u_{t-1}}_{\text{stay unemployed}} + \underbrace{\delta(1-u_{t-1})}_{\text{EU: job destruction}} + \underbrace{(1-\delta)\sigma(1-u_{t-1})}_{\text{EU: match separation}}$$

Firm Problem

Vacant job:

$$V(\mathbf{s}) = -\kappa + \beta(1-\delta)\Big[q(\theta)(1-\sigma)\mathbb{E}[J(\mathbf{s}')] + (1-q(\theta)(1-\sigma))\mathbb{E}[V(\mathbf{s}')]\Big]$$

Filled job:

$$J(\mathbf{s}) = y - w(\mathbf{s}) + \beta(1-\delta)\Big[\gamma(\sigma + (1-\sigma)\lambda f(\theta))\mathbb{E}[V(\mathbf{s}')] + (1-\sigma)(1-\lambda f(\theta))\mathbb{E}[J(\mathbf{s}')]\Big]$$

New job creation:

$$N(\mathbf{s}) = -k(n) + V(\mathbf{s})$$

Free Entry implies $N(\mathbf{s}) = 0$:

$$V(\mathbf{s}) = k(n)$$

Vacancy Dynamics

In equilibrium vacancies have positive value.

⇒ Firms will repost positions.

⇒ Vacancies become predetermined (not jump variable anymore!).

$$v_t = \underbrace{n_t}_{\text{new}} + (1-\delta)\Bigg(\underbrace{(1-(1-\sigma)q(\theta_{t-1}))v_{t-1}}_{\text{unfilled}}$$

$$+ \gamma \Big(\overbrace{\underbrace{(1-\sigma)\lambda f(\theta_{t-1})e_{t-1}}_{\text{reposted: EE}} + \underbrace{\sigma e_{t-1}}_{\text{reposted: EU}}}^{\text{Inflow of ``old jobs''}} \Big) \Bigg)$$

Stationary Equilibrium

Set of worker and firm value functions, wage function and new job creation such that:

- $W(\mathbf{s}), U(\mathbf{s}), J(\mathbf{s}), V(\mathbf{s})$ satisfy worker and firm Bellman Equations.
- Wage function $w(\mathbf{s})$ solves the Nash Bargaining problem.
- Unemployment u and vacancies v satisfy the LoMs induced by Bellman Equations.
- New job creation n solves firm free-entry condition.

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Calibration

Set model period to a month.

Matching function: $M(S,V) = \mu S^{\eta} V^{1-\eta}$, where $S = u + \lambda e$.

A. PREDETERMINED		
Discount factor	β	0.9967
Worker bargaining share	ϕ	0.5
Elasticity of matching function	η	0.5
Unemployment benefit	b	0.9
Reposting rate	γ	1
Vacancy creation cost	k_1	0.1
	k_2	1
B. ESTIMATED		
Relative efficiency of OJS	λ	0.0556
Scale of matching function	μ	0.6542
Job destruction	δ	0.0222
Match separation	σ	0.0051
Vacancy posting cost	κ	0.1611

Targets and Model Fit

Target	Data	Model	Source
Unemployment rate	0.057	0.057	CPS - Shimer (2005)
Job-to-job rate	0.025	0.025	CPS - Fujita and Nakajima (2016)
Unemployed job finding rate	0.45	0.45	CPS - Shimer (2005)
Reposted vacancy share	0.56	0.56	IAB German Job Vacancy Survey
Job filling rate	0.9	0.9	Fujita and Ramey (2007)

Micro Vacancy Chains

Chain: Expected count of vacancies "generated" by one vacancy.

Define $\Upsilon \coloneqq \frac{u}{u+\lambda(1-u)}$.

1. Special case: $\delta = 0, \gamma = 1$:

$$\mathbb{E}[C] = \sum_{c=1}^{\infty} c(1-\Upsilon)^{c-1}\Upsilon = \frac{1}{\Upsilon} = \frac{u+\lambda(1-u)}{u}$$

$$u \uparrow \Rightarrow \mathbb{E}[C] \downarrow$$

$$\lambda \uparrow \Rightarrow \mathbb{E}[C] \uparrow$$

2. **Gross** vacancy chain: $\delta > 0, \gamma < 1$:

$$\mathbb{E}[C] = \frac{\delta + (1-\delta)q(\Upsilon + \gamma(1-\Upsilon))}{1-(1-\delta)(1-q\Upsilon)} \approx 1.88$$

Tractable, DMP, equilibrium version of vacancy chain in Akerlof, Rose and Yellen (1988)!

Towards Aggregate Equilibrium Effects...

$$v_t = n_t + \underbrace{(1-\delta)\bigg((1-(1-\sigma)q(\theta_{t-1}))v_{t-1} + \gamma\Big((1-\sigma)\lambda f(\theta_{t-1})e_{t-1} + \sigma e_{t-1}\Big)\bigg)}_{\tilde{v}_t\text{: inherited vacancies}} \boxed{+\varepsilon_s^{\tilde{v}}}$$

Aggregate effects of vacancy chain depend on "crowd-out" from new job creation:

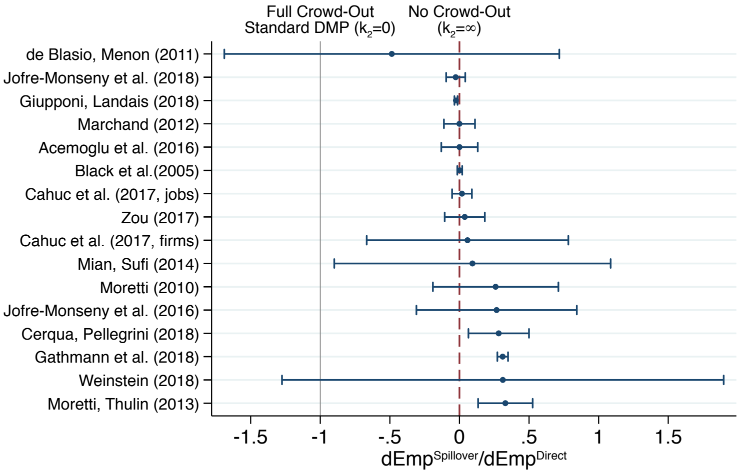
$$\frac{dn}{d\tilde{v}} \in [-1, 0]$$

3. **Net** vacancy chain:

$$\mathbb{E}[C^{\text{net}}] = \frac{\delta + (1-\delta)q(\Upsilon + \gamma(1-\Upsilon)(1+\frac{dn}{d\tilde{v}}))}{1-(1-\delta)(1-q\Upsilon)}$$

Full crowd-out: $\frac{dn}{d\tilde{v}} = -1 \Rightarrow \mathbb{E}[C^{\text{net}}] = 1$

Empirical (Short-run) Crowd-Out



Job Creation Costs: $k(n) = k_1 + k_2 \frac{(n-\bar{n})}{\bar{n}}$

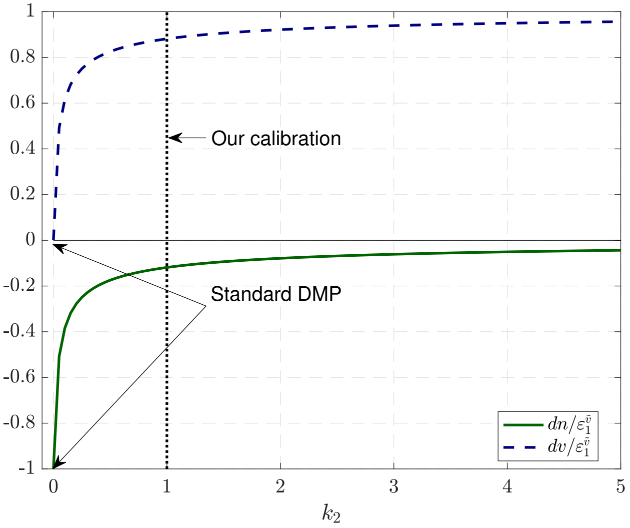
Free-entry condition under:

1. No creation cost $(k_1 = 0,\ k_2 = 0)$:
$$0 = V$$

2. Fixed marginal cost $(k_1 > 0,\ k_2 = 0)$:
$$k_1 = V$$

3. Linear marginal cost $(k_1 > 0,\ k_2 > 0)$:
$$k_1 + k_2 \frac{(n - \bar{n})}{\bar{n}} = V$$

Net Effects of Reposting

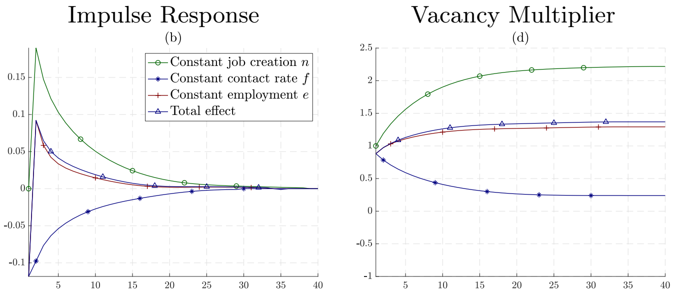


Equilibrium Vacancy "Multiplier"

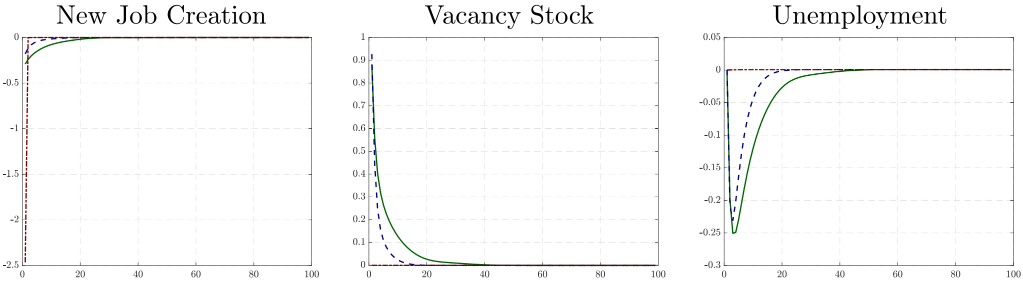
$$v_t = \underline{n_t} + (1-\delta)\Bigg((1-(1-\sigma)q(\theta_{t-1}))v_{t-1} + \gamma\Big((1-\sigma)\lambda f(\theta_{t-1})e_{t-1} + \sigma e_{t-1}\Big)\Bigg) \boxed{+\varepsilon_s^{\tilde{v}}}$$

... in response to one-time transitory shock to vacancy stock:

$$M(h) := \frac{\sum_{s=1}^{h} dv_s}{\varepsilon_1^{\tilde{v}}}$$



Other Outcomes



Roadmap

Experiments

- One-time, unanticipated aggregate shock to
  - labor productivity y
  - on-the-job search intensity λ
  - matching efficiency μ.
- Compare IRFs of three economies.

GREEN: Vacancy reposting — full equilibrium dynamics.

BLUE : No incremental reposting — keep repostings at SS.

RED : Full crowd-out — new and old jobs are perfect substitutes.

$$v_t = \underbrace{n_t}_{\text{new}} + (1-\delta)\Bigg(\underbrace{(1-(1-\sigma)q(\theta_{t-1}))v_{t-1}}_{\text{unfilled}} + \overbrace{\gamma\Big(\underbrace{(1-\sigma)\lambda f(\theta_{ss})e_{ss}}_{\text{reposted: EE}} + \underbrace{\sigma e_{ss}}_{\text{reposted: EU}}\Big)}^{\text{Inflow of "old jobs"}}\Bigg)$$

Cyclical Amplification:
Aggregate Productivity Shock

Does the Vacancy Chain Amplify Business Cycles?

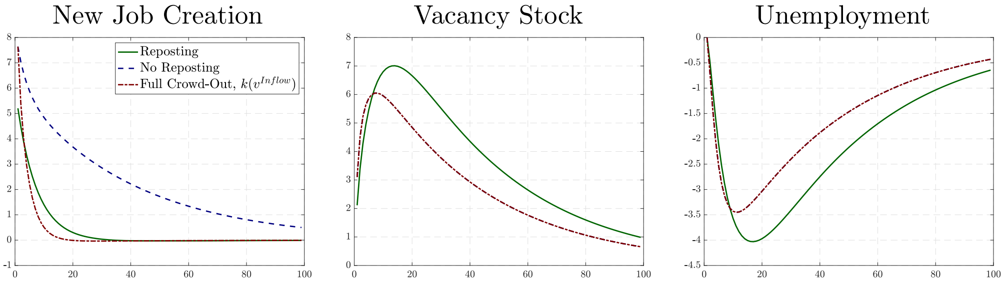
Mechanism in model:

$y \uparrow \Rightarrow$ Returns to hiring$\uparrow \Rightarrow n \uparrow \Rightarrow v, \theta \uparrow$

$\Rightarrow$ Job finding rate, Quits$\uparrow \overset{k_2>0}{\Rightarrow} v \uparrow$

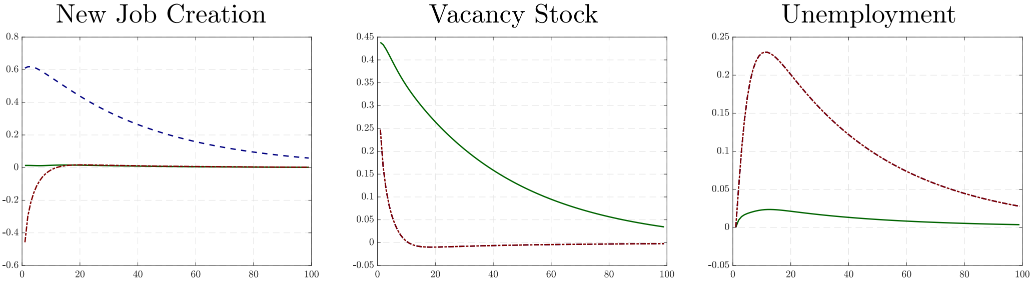
Total vacancies increase by more than in model without reposting!

Aggregate Productivity Shock

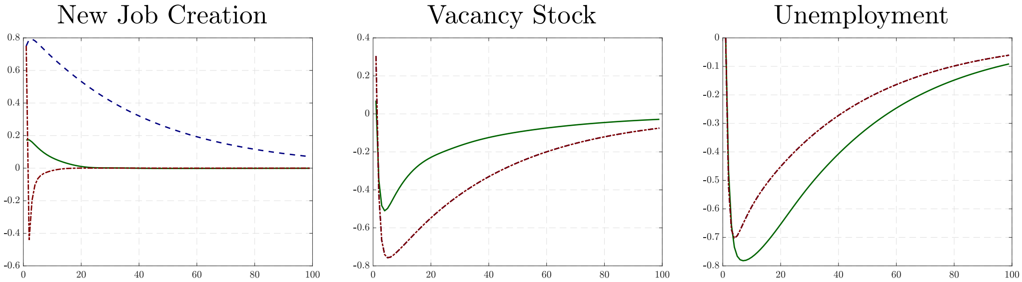


Other Shocks

OJS Intensity Shock



Matching Efficiency Shock



Conclusion

- Tension:
  - DMP model: all job openings are for new jobs.
  - Data: ~ 60% of job openings are for old jobs, vacated by a quit.
- Fix: sunk vacancy creation cost for new jobs generates quit-replacement hiring.
- Rich notion of vacancy chain and vacancy multiplier.
- Aggregate effects depend on crowd-out between new and old jobs.
  - Evidence suggests very limited short-run crowd-out.
- One implication: procyclicality of quits may be a key (proximate) contributor to fluctuations in job openings.