The Geography of Unemployment

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Princeton/Harvard

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Introduction

- **Unemployment** rate gaps between cities are large and persistent
  - 3 to 15 p.p. in France – similar in the US
- Welfare costs of unemployment magnified in high-unemp. labor markets
- Local governments spend billions every year to attract jobs
Introduction

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- Local governments spend billions every year to attract jobs

**Research questions**

- Why do large unemployment gaps persist across locations?
- What are the **welfare** implications for workers?
- What are the **general equilibrium** effects of **place-based policies**?
This paper

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   - Not due to differences in industry or worker composition
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   - **Policy implications**: optimal to subsidize employers where job loss is high
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   - Unemployment gaps **80% lower** with efficient employer location choices
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   ▶ Unemployment gaps **80% lower** with efficient employer location choices

4. Sizeable **general equilibrium** welfare gains from **place-based policies** (5%)
Descriptive evidence
Data: France

• Longitudinal matched employer-employee panel 1997-2007
  ▶ Worker, zipcode, plant, firm, industry, occupation, wages, spell start/end day
  ▶ 1 million workers representative of population
  ▶ Entire individual work histories

• Cities and skills
  ▶ City / local labor market = commuting zone
  ▶ Skill = combination of occupation and age

• Firm-level balance sheet data
Inflows and outflows from unemployment in space

- Large and persistent unemployment gaps across cities

- In a economy with cities $c$, no migration and constant labor force,

\[ u_{c,t+1} - u_{c,t} = s_{c,t}(1 - u_{c,t}) - f_{R,c,t}u_{c,t} \]

\[ \text{Job loss: inflow into unemployment} \]
\[ \text{Job finding: outflow out of unemployment} \]

- In steady-state,

\[ \log \frac{u_c}{1 - u_c} = \log s_c - \log f_{R,c} \]
Inflows and outflows from unemployment in space

- Large and persistent unemployment gaps across cities
  - Map
  - Persistence

- In a economy with cities \( c \), no migration and constant labor force,\\
  
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- Use to show
  1. Role of job loss vs. job finding
  2. Control for worker observables and unobservables
  3. Similar patterns in the US
Job loss explains unemployment gaps: France

Figure: Local job losing and finding rates against local unemployment-to-employment ratio. No controls.

(a) Job losing rate

![Graph showing local job losing and finding rates against local unemployment-to-employment ratio.](image-url)
Job loss explains unemployment gaps: France

**Figure:** Local job losing and finding rates against local unemployment-to-employment ratio. No controls.

(a) Job losing rate

(b) Job finding rate

Variance share of job losing rate = 86%
Employer heterogeneity drives spatial job loss gaps

Figure: Contribution of worker and job effects to local job losing rate. Worker and job (establishment-by-occupation) fixed effects Worker \( i \)-level.

\[
EU_{i,t} = \alpha C(i,t) + \beta J(i,t) + \gamma t + \epsilon_{i,t}
\]
Job loss explains unemployment gaps: US

Figure: Local job losing and finding rates against local unemployment-to-employment ratio. United States, no controls.

(a) Job losing rate

(b) Job finding rate

Variance share of job losing rate = 73%
Baseline model
Ingredients

• Many cities

• Frictional labor market in every city
  ▶ Job loss, job finding and unemployment

• Heterogeneous employers
  ▶ Differences in productivity \(\Rightarrow\) differences in job stability

• Location choice for employers
  ▶ Sorting \(\Rightarrow\) job loss gaps across cities

• Before quantification: add bells and whistles
Time and space

- Time and space are continuous

- **City sites** indexed by **productivity** $\ell$ with c.d.f. $F_\ell(\ell)$
  - For main mechanism only useful to **rank locations**
  - Can think of **arbitrarily small differences** in productivity $\ell$
  - Can think of **human capital differences** of local residents – endogenize later

- Unit **fixed supply of housing** in each location $\ell$
  - Equilibrium land rents $r(\ell)$
  - Paid to absentee landlords
Workers

- Unit mass of **homogeneous** infinitely-lived workers

- Preferences over consumption of final good $c_t$ and housing $h_t$

\[
\mathbb{E}_0 \left[ \int_0^\infty e^{-\rho t} \left( \frac{c_t}{1 - \omega} \right)^{1 - \omega} \left( \frac{h_t}{\omega} \right)^\omega dt \right]
\]

- Can be **unemployed** or **employed**

- **Freely mobile**
Local labor markets

• One labor market per city $\ell$

• Workers can only search where they live & while unemployed

• Random search in each market $\ell$: $\mathcal{M}(U(\ell), V(\ell)) = U(\ell)^\alpha V(\ell)^{1-\alpha}$

• Nash bargaining, with bargaining power $\beta$

• Home production / unemployment benefits $b(\ell) = b \cdot \ell$
  ▶ Captures parsimoniously a constant replacement rate as in the data
  ▶ Helps with analytical tractability
Employers

1. **Entry**
   - Pay an entry cost $c_e$ to enter
   - Learn quality $z$ (expected productivity)
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3. **Initial draw** Once matched with a worker,
   - Draw initial productivity $y_0$ from Pareto c.d.f $\mathcal{G}_0(y_0|z) = 1 - (Y/y_0)^{1/z}$
     - Higher quality $z$ means better initial draws

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   - Then produce $y_{t\ell}$ with one worker: employers $\Leftrightarrow$ firms $\Leftrightarrow$ jobs

Technological complementarity
$\Rightarrow$ Rank locations
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     - **Endogenous separations**
     - **Same process in all locations**
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   - Dynamic **optimal stopping problem** within each location

   ▶ Details
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   - Dynamic optimal stopping problem within each location
     - **Closed-form solution**

Details
- Solution
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   - Productivity shocks $d \log y_t = -\delta dt + \sigma dW_t$
   - Dynamic optimal stopping problem within each location
     - Closed-form solution
     - Delivers value $J(y, \ell)$ and endogenous separation threshold $\underline{y}(\ell)$
Location choice of heterogeneous employers

- **Employer** $z$ chooses location $\ell$ to maximize expected value at entry

\[
\max_\ell \frac{z}{1 - z} \log \ell + \frac{z}{1 - z} \log q(\theta(\ell)) - \log w(\ell)
\]

- **Technology**
- **Pooling Complementarity:** Opp. cost of time
- **Labor costs**

- $q(\theta(\ell)) = \theta(\ell)^{-\alpha}$: vacancy contact rate; $\theta(\ell) = \frac{V(\ell)}{U(\ell)}$

- $w(\ell) \propto y(\ell)$: reservation wage

- Productive emp. care more about filling vacancies and local productivity
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**Proposition**

*Suppose that \( \alpha \) and the supports of \( F_\ell, F_z \) are not too large. Then*

- **There exists** a **unique** steady-state equilibrium
- **It has** positive assortative matching: \( z(\ell) \) and \( w(\ell) \) are strictly increasing
- **When fixed productivity differences vanish** \( \ell \to 1 \), **locations differ ex-post**
From sorting to spatial unemployment differentials

- **Job losing rate** depends on
  - **Starting point**: expected productivity of new matches \( y_0 | z(\ell) \)
  - **End point**: separation cutoff \( y(\ell) \)
  - **Speed in between**: productivity depreciation \( \delta \)
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$\Rightarrow$ Solve for invariant distribution in closed form

$\Rightarrow$ Solution $\Rightarrow$ KFE
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### Proposition

**Job losing rates** $s(\ell)$, **finding rates** $f_R(\ell)$, and **unemployment rates** $u(\ell)$, are

$$s(\ell) = \frac{\delta}{z(\ell)}$$

$$f_R(\ell) = f(\theta(\ell)) \left( \frac{Y}{\underline{y}(\ell)} \right)^{1/z(\ell)}$$

$$u(\ell) = \frac{s(\ell)}{s(\ell) + f_R(\ell)}$$

for small $\beta$
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\[ \Rightarrow \text{Solution KFE} \]
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$\ominus$ for small $\beta$ $\oplus$
Productivity and job loss: balance-sheet data

- Labor productivity decreases with job losing rate
  - On average
  - In distribution (FOSD decline)
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Local labor market externalities

1. Standard **congestion** and **separation** externalities
   - Overall entry and separation efficient only if **Hosios condition** holds $\beta = \alpha$
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2. Labor market pooling externality
   ▶ Consider a firm $z \in (z_M, z_V)$ choosing between Marseille and Versailles
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**Proposition**

- *The decentralized equilibrium is in**efficient** for any $\alpha, \beta \in (0, 1]$*
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**Proposition**

- The decentralized equilibrium is inefficient for any $\alpha, \beta \in (0, 1]$
- Efficiency: need **place-based profit subsidies**, rising with **job loss rate**
Quantitative extensions
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- Fixed local productivities and amenities \((p, a)\)
- Local housing supply with elasticity \(\eta\)
- Housing in production with share \(\psi\)
- Migration frictions with migration elasticity \(1/\varepsilon\)
- Worker heterogeneity, learning and scarring effects of unemployment
- Convex vacancy cost
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Theory: previous results extend

- Employers sort along the composite index \(\ell(p, a) = p^{\omega + \varepsilon (1+\eta)} \cdot a^{-\psi}\)
- Complementarities with local human capital, decreasing in \(u(\ell)\)
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Estimation: recursive scheme to prove identification

- Run a sequence of regressions, without simulating the model
Results
Spatial unemployment differentials in equilibrium

**Figure:** Model solution in the decentralized equilibrium.

- **Job losing rate**
- **Job finding rate**
- **Unemployment rate**
Job loss drives spatial unemployment differentials

Table: Aggregate and local unemployment rates in the decentralized equilibrium.

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Re-estimated model.

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Pooling externality magnifies unemployment differentials five-fold.
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Pooling externality magnifies unemployment differentials five-fold
Policy counterfactuals
Place-based policies in the model and in the data

- Consider **quasi-optimal policy** that **corrects pooling externality**
  - **Profit subsidy** that **rises with job losing rate**
  - **Federally funded** with flat earnings tax (5% of GDP)
  - Economy not fully efficient unless Hosios condition holds

- Contrast with **French Enterprise Zones** – “Zones Franches Urbaines”
  - Rolled out in 1996 and subsequently expanded
  - **Targets high unemployment areas with large corporate tax breaks**
  - Consider a **budget-equivalent** profit subsidy in model (0.04% of GDP)
Local employment gains in France

Figure: Unemployment rate by commuting zone.
Before policy.
Local employment gains in France

Figure: Unemployment rate by commuting zone.
Under quasi-optimal policy.

Versailles: Corporate tax = 30%
Paris: Corporate tax = 30%
Marseille: Corporate tax = 0%
Stable jobs

9.8 - 15.4
8.1 - 9.8
7.2 - 8.1
6.9 - 7.2
6.5 - 6.9
6.0 - 6.5
5.2 - 6
4.5 - 5.2
3.4 - 4.5
Local employment gains in France

**Figure:** Unemployment rate by commuting zone. Under quasi-optimal policy.

Spatial unemployment gaps ↓ 5-fold

- Versailles: +1pp
  - Corporate tax = 30%
- Marseille: -5pp
  - Corporate tax = 0%

Stable jobs
Local employment gains in France

Figure: Unemployment rate by commuting zone. Under quasi-optimal policy.

Aggregate unemployment ↓ 0.5 p.p.

- Versailles: +1pp (Corporate tax = 30%)
- Paris
- Marseille: -5pp (Corporate tax = 0%)

Stable jobs
Local & aggregate gains from place-based policies

**Figure:** Local welfare gains from quasi-optimal and EZ policies given same preference for location. By population weighted unemployment rate quantiles.
Local & aggregate gains from place-based policies

Figure: Local welfare gains from quasi-optimal and EZ policies given same preference for location. By population weighted unemployment rate quantiles.
Local & aggregate gains from place-based policies

**Figure:** Local welfare gains from quasi-optimal and EZ policies given same preference for location. By population weighted unemployment rate quantiles.

**Welfare:**

+ 5.1%  

- 0.2%
Conclusion
Conclusion

- **Geography of unemployment** driven by job loss
  - Document relationship in French and US data
  - Propose a view emphasizing employer heterogeneity
  - Labor market frictions distort the location of employers

- Implications for **place-based policies**
  - Relocating high quality jobs towards low income locations beneficial
  - Sizeable employment and welfare gains

- Implications for Covid-19
  - Regional shocks magnified by pooling externality
  - Place-based policies key to help hard-hit areas
Thank You!
Appendix
Local unemployment rates in France

Figure: Unemployment rate in France by commuting zone. Men, aged 25-60. 1996-2007.
Life satisfaction is much lower for non-employed

**Figure:** Austin Glaeser Summers (2018): share of prime-aged men in the U.S. reporting low life satisfaction, employment status and Census region.

*Notes:* Share of prime-aged men in the continental 48 states reporting they are dissatisfied or very dissatisfied. Pooled 2005-2010 data from the Behavioral Risk Factor Surveillance System. Rates calculated using survey weights.
Unemployment risk and earnings across cities

- Accounting for worker $i$ in city $c$

$$\log \bar{y}_{i,c} = \log \bar{e}_{i,c} + \log \bar{w}_{i,c} + \log \varepsilon_{i,c}$$

  - Earnings
  - Fraction of time employed
  - Average daily wage
  - Covariance residual

- Aggregate at city level

$$\mathbb{E}_c[\log \bar{y}_{i,c}] = \mathbb{E}_c[\log \bar{e}_{i,c}] + \mathbb{E}_c[\log \bar{w}_{i,c}] + \mathbb{E}_c[\log \varepsilon_{i,c}]$$

- Variance decomposition of $\mathbb{E}_c[\log \bar{y}_{i,c}]$ across cities

  - $\mathbb{E}_c[\log \bar{e}_{i,c}]$ accounts for 11%
  - $\mathbb{E}_c[\log \bar{w}_{i,c}]$ accounts for 88%
Place-based policies target local unemployment

- Empowerment Zone program in the U.S.: $55 million in 2000
  "Its purpose [is] to create jobs in the most economically distressed areas."

- Free Urban Zones in France: €70 million in 2000
  *First eligibility criteria: high unemployment*

- Similar programs in the U.K., Sweden, Germany... (Kline Moretti 2013)
Free Urban Zones in the Paris area

Figure: Mayer, Maneyris and Py (2017): Free Urban Zones (“Zone Franches Urbaines”, 1997-2006) and unemployment rate in the Northern suburbs of Paris
Related literature

• **Inflows/outflows:** Shimer (2012, 2005), Fujita Ramey (2009)

• **Spatial unemployment:** Kline Moretti (2013), Blanchard Katz (1992), Topel (1984), Hall (1972)

• **Sorting in space:** Bilal Rossi-Hansberg (2018), Gaubert (2018), Davis Dingel (2018)

• **Quantitative geography:** Monte Redding Rossi-Hansberg (2018), Redding (2016)

• **Mismatch:** Sahin Song Topa Violante (2014), Shimer (2007)

• **Labor market distortions:** Hsieh Klenow (2009), Hopenhayn Rogerson (1993)

• **Place-based policies:** Slattery Zidar (2019), Fajgelbaum Gaubert (2018), Glaeser Gottlieb (2008)
Stylized facts
Unemployment in the data

- Observe only employment or non-employment in tax returns
- Use Labor Force Survey to adjust tax return data
  - Estimate transition probabilities between employment, unemployment, and non-participation
    - At 1D-occupation x city group x age group level
  - Infer participation margin in tax return data from estimated transitions
  - Akin to complementing PSID with CEX data
  - All results robust to using only the LFS data
    - Participation margin turns out unimportant across cities
- Skill defined as bin of worker’s average age + occ. wage premium
  - Details

Unemployment in LFS vs. DADS  Non-participation vs. unemployment  Back to main presentation
Unemployment in survey vs. administrative data

**Figure:** Unemployment rate in LFS against DADS. French commuting zones.

\[ \text{Dash: LFS} = 0.00 + 0.92 \ (0.06) \times \text{DADS} \ ; \ R^2 = 0.42 \]
Unemployment vs. non-participation in the LFS

**Figure:** Non-participation rate agains unemployment rate in French commuting zones. Bin-scatterplot, LFS.
Skill definition

- Run the following fixed effects regression:

\[
\log w_{it} = \alpha_{O(i,t)} + \alpha_{Y(t)} + \alpha_{C(i,t)} + \alpha_{A(i,t)} + \alpha_{F(i,t)} + \varepsilon_{it}
\]

for employed workers \( i \) in quarter \( t \)

- Define skill as average occupation and age premium

\[
\hat{S}_i = \frac{1}{N_{i,O}} \sum_{k=1}^{N_{i,O}} (\hat{\alpha}_{O(i,t)} + \hat{\alpha}_{A(i,t)})
\]

- Similar results when including
  
  - Worker fixed effects and include them in skill measure
    
    ★ Worker FEs noisy ⇒ attenuation bias when on right-hand-side
  
  - Industry fixed effects
Commuting zones

- Commuting zones defined by French statistical institute (INSEE)
- Geographic areas that partition the French territory
- Maximize the number of residents who work in their commuting zone
- In practice \(\approx 75\%\) of residents work in their commuting zone
  - Using residence and workplace zipcodes
Data: United States

- Restrict to white male household heads 30-52
- Define skill as education + age + occ. wage premium from Mincer regression
- Define a city / local labor market as a metropolitan area
- Consider 3 main groups of ~ 300 bins each
  - Cities
  - Industry
  - Skill
Unemployment rate in France by commuting zone

**Figure:** 1997-2007 averages, males aged 30-52.
Unemployment rate in France by commuting zone

**Figure:** 1997-2007 averages, males aged 30-52.
Unemployment rate in France by commuting zone

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Unemployment rate in France by commuting zone

**Figure**: 1997-2007 averages, males aged 30-52.

- Paris: 5%
- Marseille: 12%
Unemployment rate in France by commuting zone

**Figure:** 1997-2007 averages, males aged 30-52.


- Paris: 5%
- Versailles: 5%
- Marseille: 12%

Back to main presentation
City-level unemployment is highly persistent

**Figure:** 5-year change in city unemployment rate. Autocorrelation $= 0.86$
Residual city-level unemployment is even more persistent

**Figure:** 5-year change in city residual unemployment rate. Autocorrelation = 0.99.

\[
\Delta u_c = \text{cste} + \beta \Delta E_c + \nu_c, \quad \hat{u}_{c,1} = u_{c,0} + \hat{v}_c, \quad \Delta E_c = \sum_j \frac{E_{jc,0}}{E_{c,0}} \Delta E_j
\]
Job loss contribution to local unemployment: France & US

Figure: Variance decomposition of unemployment-to-employment ratio at city level.

- **Job losing**
  - France: 85%
  - United States: 70%

- **Job finding**
  - France: 15%
  - United States: 30%

- **Non-participation**
  - France: 5%
  - United States: 10%

- **Residual**
  - France: 5%
  - United States: 10%
Time aggregation

**Figure:** Variance decomposition of predicted log unemployed-to-employed ratio at city level.

[Graph showing variance decomposition with categories for job finding and job losing, differentiated by countries and data sources.]
Job loss explains most spatial unemployment differentials

**Figure:** Local job losing and finding rates against local unemployment-to-employment ratio. Fixed effects for 232 industries $J$ and 300 skill groups $S$. Worker $i$-level.

\[ Y_{i,t} = \alpha C(i,t) + \beta J(i,t) + \gamma S(i) + \varepsilon_{i,t} , \quad \text{for} \ Y \in \{ EU, UE, u \} \]
Spatial job losing rate differentials are not compositional

**Figure:** Variance decompositions of losing and finding rates into city, industry and skill contributions. France and United States.

(a) Job losing rate.  
(b) Job finding rate.
City residuals explain most of variation in job losing rates

**Figure:** Variance decomposition of job losing rate at city level.
Job-to-job mobility rate not associated with unemployment

**Figure:** Local job-to-job mobility rate against unemployment-to-employment ratios. France.

- 1 s.d. increase in $u \Rightarrow 0.08$ s.d. increase in $EE$
Temp contracts account for little of job loss differences

- Observe temp vs. regular contract in Labor Force Survey
- Temp contracts increase EU probability by 1.6 p.p. (double)
  - Unconditionally
  - Conditionally on age/occupation
- 4 p.p. more temp contracts in high-U quintile of cities vs. low-U quintile

⇒ Temp contracts account for about 10% of observed EU differences
  - Shift-share: temp contracts account for 0.06 p.p. EU differences
  - Top-bottom quintiles EU difference = 0.5 p.p

- But consistent with temp contracts as an outcome
  - Firm more likely to use temp contracts if knows that job will disappear soon
  - Reflect underlying productivity differences
Seasonality not main driver

**Figure:** Fraction of job loss per quarter against local unemployment rate.

- At most 6% of yearly job loss differences across cities are seasonal
Job loss from exit and continuing establishments

**Figure:** Job loss from surviving and exiting establishment. French commuting zones.

- Exit accounts for 11% of spatial differences in job loss
Job reallocation and job loss

**Figure:** Fraction of job loss per quarter against job reallocation. French commuting zones

- Spatial gaps in job reallocation account for 20% of spatial gaps in job loss
City job losing premia are strongest at early tenures

**Figure:** Job losing rate by job tenure, aggregate and by city. France.

Tenure (years)

- Economy-wide average
- 1st and 4th quartile of city-wide job losing rate

Back to France: no controls  ▶ Back to France: controls  ▶ Back to US
Unemployment more likely in low-wage and high-pop. cities

**Table**: Dependent variable: Unemployment dummy (100 p.p.).

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<th>All</th>
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Standard errors in parenthesis, clustered by city and 3-digit industry.

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. City population: by km2 (density).

Separation more likely in low-wage and high-pop. cities

**Table:** Dependent variable: Job losing or finding dummy (100 p.p.).

<table>
<thead>
<tr>
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<th>Job losing rate</th>
<th>Job finding rate</th>
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<td></td>
<td>(0.086)</td>
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<td>City Log Population Density</td>
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<td>Year-Quarter</td>
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<td>W.-$R^2$</td>
<td>0.000</td>
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</table>

Standard errors in parenthesis, clustered by city and 3-digit industry.

$\dagger$ $p < 0.10$, $^*$ $p < 0.05$, $^{**}$ $p < 0.01$, $^{***}$ $p < 0.001$. City population: by km2 (density).

Bargaining

• Wage determination not “split-the-pie”
  ▶ Marginal utility from $1 differs between firm and worker
  ▶ A priori unclear whether standard wage bargaining protocols still apply

Proposition

The wage resulting from the worker and the firm bargaining under alternating offers every instant is identical to the wage with identical marginal utilities.


• Valuation of wage relative to outside option determines outcome.
• Bargaining game still admits a simple solution with linear utility in wage.
Worker and employer values

- **Worker values**

\[
\rho U = b \ell r(\ell)^{-\omega} + f(\ell) \mathbb{E}_\ell \left[ \max \{ V^E(y_0, \ell) - U, 0 \} \right]
\]

\[
\rho V^E(y, \ell) = w^*(y, \ell) r(\ell)^{-\omega} + (L_y V^E)(y, \ell)
\]

where \( L_y V^E = (\sigma^2/2 - \delta)y \partial_y V^E + \sigma^2 y^2/2 \partial_{yy} V^E \)

- **Define**

\[
V(\ell) = r(\ell)^{\omega} f(\theta(\ell)) \mathbb{E}_\ell \left[ \max \{ V^E(y_0, \ell) - U, 0 \} \right]
\]

- **Employer value**

\[
\rho J(y, \ell) = y \ell - w^*(y, \ell) + (L_y J)(y, \ell) .
\]

- **Bargaining solution**

\[
w^*(y, \ell) = (1 - \beta)(b \ell + V(\ell)) + \beta y \ell
\]
Solving for the adjusted surplus

Proposition

The **adjusted surplus and the endogenous cutoff** are given by

\[
\begin{align*}
\rho_0 S(\ell, y) &= \rho \ell y(\ell) \cdot S \left( \frac{y}{y(\ell)} \right), \\
S(X) &= \frac{\tau X + X^{-\tau}}{1 + \tau} - 1
\end{align*}
\]

and

\[
\rho \frac{y(\ell)}{y_0} = b + V(\ell),
\]

where

\[
\tau = \frac{2\delta}{\sigma^2} \left\{ \sqrt{1 + \frac{2\rho\sigma^2}{\delta^2}} - 1 \right\}, \quad \rho_0 = \frac{1 + \tau}{\tau} \frac{\rho}{\rho + \delta - \sigma^2/2}.
\]

Then

\[
J = (1 - \beta) S
\]
Value of active employers and job loss

- Value of an active employer with productivity $y$ in location $\ell$

$$\rho J(y, \ell) = (1 - \beta) \cdot \left[ y\ell - \left( b\ell + V(\ell) \right) \right]$$

Employer share

Output − worker’s opportunity cost

$$+ \left( \frac{\sigma^2}{2} - \delta \right) y \frac{\partial J}{\partial y}(y, \ell) + \frac{\sigma^2}{2} \frac{\partial^2 J}{\partial y^2}(y, \ell)$$

Continuation value from productivity shocks

- Holds for productivity $y$ above endogenous job loss cutoff $y_{\ell}$, such that

$$0 = J(y_{\ell}, \ell)$$

Value matching

$$0 = \frac{\partial J}{\partial y}(y(\ell), \ell)$$

Smooth pasting

- Can be solved in closed form

Solution
Employer value

- The expected value of entry in location $\ell$ for employer $z$ is

$$\rho \bar{J}(z, \ell) = q(\theta(\ell))(1 - \beta) \int S(y_0, \ell) dG_0(y_0 | z)$$

where $S$ is the adjusted surplus from the match.

- Using the explicit solution for $S$,

$$\left(\bar{\rho} \bar{J}(z, \ell)\right)^{\frac{z}{1-z}} = \left(\ell q(\ell)\right)^{\frac{z}{1-z}} (\rho Y/y_0)^{\frac{1}{1-z}} \bar{S}(z)^{\frac{z}{1-z}} \sqrt{w(\ell)}$$

where $\bar{\rho} = \rho + \frac{\beta}{1-\beta} y_0$ and $\bar{S}(z) = \frac{z}{1-z} \frac{\tau z}{\tau z + 1}$. 
Location choice of workers

- Free mobility equalizes value of unemployed workers

\[
\frac{w(\ell)\ell}{r(\ell)\omega} \propto U
\]

- Reservation wages \(w(\ell)\) reflect
  - PDV of wages conditional on working \(\sim z(\ell)\)
  - Job finding rate \(f_R(\theta(\ell)) = f(\theta(\ell)) \times \left(\frac{Y}{y(\ell)}\right)^{1/z(\ell)}\)

- Housing \(r(\ell)\) allows for flat job finding rates + steep wages

- Flat job finding rate: **contact rate** vs. **success probability**
  - Versailles: few contacts but productive employers often offer viable jobs
  - Marseille: many contacts but unproductive employers often a dead end

Res: Reservation wage  Back to main presentation
Reservation wages, value of unemployment, free mobility

- Reservation wages satisfy
  \[
  w(\ell) = \frac{b\left((1 - \beta)\rho + \beta y_0\right)}{\rho - \beta \begin{cases} f_R(\ell) & \text{Job finding rate} \\ \bar{S}(z(\ell)) & \text{PDV wages} \end{cases}}
  \]

  Value of unemployment and value of search:
  \[
  \rho U(\ell) = \frac{b\ell}{r(\ell)\omega} + f(\theta(\ell)) \int \max\{V^E(y_0, \ell) - U, 0\} dG_0(y_0|z(\ell))
  \]

  Reservation wage and value of search: \( w(\ell) \propto y(\ell) \propto b + V(\ell) \)

- Free mobility
  \[
  U \equiv U(\ell) \propto \frac{w(\ell)\ell}{r(\ell)\omega} \quad \forall \ell
  \]
Equilibrium conditions

- Free entry: \( c_e = \int \bar{J}(z, \ell^*(z))dF_z(z) \)
  - \( \bar{J} \) is employers’ expected value at entry

- Free mobility: \( (\rho(1 - \beta) + \beta y_0)U = \max_{\ell} \frac{w(\ell) \cdot \ell}{r(\ell) \omega} \)

- Population adding up: \( 1 = \int L(\ell)dF_{\ell}(\ell) \)

- Land market clearing: \( r(\ell) = \omega L(\ell)(u(\ell) b \ell + (1 - u(\ell)) \bar{w}(\ell)) \)
  - \( \bar{w} \) is the average wage in location \( \ell \)

- Labor market clearing: \( \theta(\ell) = \frac{M_e \int 1\{\ell^*(z) \in [\ell, \ell + d\ell]\}dF_z(z)}{U(\ell)dF_{\ell}(\ell)} \)

- ▶ Back to main presentation
Global stability

- **Definition – Global stability**
  
  A steady-state assignment \((z, w)\) is globally stable if it arises when
  
  1. Starting from a random allocation of employers to locations
  2. Letting employers relocate according to a Poisson rate \(R \ll 1\)

**Proposition (Existence and uniqueness of assignment)**

*Given the mass of new employers \(M_e\) and the value of unemployment \(U\):*

- There exists a unique globally stable assignment \((z(\ell), w(\ell))\)
- \(z\) and \(w\) are increasing functions

- Relax assumption on supports: existence only
- Relax Pareto assumption: need \(\sigma\) large enough
Distribution of employment: KFE and job loss

- Fix a labor market $\ell$ and omit $\ell$ indices.
- The employment density $g$ solves the KFE:

$$0 = \frac{\partial}{\partial y} \left( (\delta - \sigma^2 / 2) yg(y) \right) + \frac{\partial^2}{\partial y^2} \left( \frac{\sigma^2 y^2}{2} g(y) \right) + n(\ell)g_0(y|z(\ell))$$

\[\text{Productivity shocks}\]

$$y > \underline{y}(\ell)$$

\[\text{New hires}\]

s.t.

$$g(y) = 0$$

\[\text{Brownian shocks}\]

$$\int_{\underline{y}}^{\infty} g(y) dy = 1$$

where $g_0(y|z) \propto \frac{dG_0(y|z)}{dy}$ is the density of new prod., $n(\ell)$ the local entry rate.

- The stationary separation rate is

$$\text{Separation rate} = \frac{\sigma^2 y(\ell)^2}{2} g'(\underline{y}(\ell))$$
Distribution of employment: solution

Proposition

The solution to the KFE in location $\ell$ is

$$g(y, \ell) = \frac{\kappa}{\kappa z(\ell) - 1} \left[ \left( \frac{y}{y(\ell)} \right)^{-\frac{1}{z(\ell)}} - \left( \frac{y}{y(\ell)} \right)^{-\kappa} \right]$$

for all $y \geq y(\ell)$, where $\kappa = \frac{2\delta}{\sigma^2}$. 
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

$\ell q(\ell)$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Increasing: Pooling and technological complementarities

$\frac{H(z(\ell))}{H(z(\ell))} \propto \frac{1}{1 - z(\ell)}$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Wages if employed

$\ell q(\ell)$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell)$

Wages if employed

Discounting

Ratio $H(z(\ell)) \propto \frac{1}{1 - z(\ell)}$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell) \propto$ separation threshold $y(\ell)$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

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Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell)$ $\propto$ separation threshold $y(\ell)$

Negative drift $\delta$

$\frac{H(z(\ell))}{1 - z(\ell)}$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

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Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

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Reservation wage $w(\ell) \propto$ separation threshold $y(\ell)$

Negative drift $\delta$

Ratio $H(z(\ell)) \propto 1 / (1 - z(\ell))$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

- Expected starting productivity $\sim z(\ell)$
- Reservation wage $w(\ell) \propto$ separation threshold $y(\ell)$
Spatial equilibrium with ex-ante identical locations

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Negative drift $\delta$

Ratio $H(z(\ell)) \propto 1 - z(\ell)$
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Expected starting productivity $\sim z(\ell)$

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$\frac{H(z(\ell))}{H(\ell)} \propto \frac{1}{1 - z(\ell)}$
Spatial equilibrium with ex-ante identical locations

Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell) \propto$ separation threshold $y(\ell)$

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Idiosyncratic productivity $y$

\[ \ell q(\ell) \]

\[ \text{Expected starting productivity} \sim z(\ell) \]

\[ \text{Reservation wage } w(\ell) \propto \text{separation threshold } y(\ell) \]
Spatial equilibrium with ex-ante identical locations

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Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell) \propto$ separation threshold $y(\ell)$

Ratio $H(z(\ell)) \propto \frac{1}{1 - z(\ell)}$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Positive shock $\sigma dW_t$

Reservation wage $w(\ell) \propto \text{separation threshold } y(\ell)$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell)$ $\propto$ separation threshold $y(\ell)$

Ratio $H(z(\ell))$ $\propto \frac{1}{1 - z(\ell)}$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell) \propto$ separation threshold $y(\ell)$

Negative drift $\delta$

Ratio $H(z(\ell)) \propto \frac{1}{1 - z(\ell)}$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell) \propto$ separation threshold $y(\ell)$
Spatial equilibrium with ex-ante identical locations

**Idiosyncratic productivity** $y$

- **Expected starting productivity** $\sim z(\ell)$
- **Reservation wage** $w(\ell) \propto$ separation threshold $y(\ell)$
- **Negative drift** $\delta$

Back
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell) \propto$ separation threshold $y(\ell)$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell) \propto \text{separation threshold } y(\ell)$

Negative shock $\sigma dW_t$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

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Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell) \propto$ separation threshold $y(\ell)$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

- Expected starting productivity $\sim z(\ell)$
- Reservation wage $w(\ell) \propto$ separation threshold $y(\ell)$
- Worker laid off

Ratio $H(z(\ell)) \propto \frac{1}{1 - z(\ell)}$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity $y$

Expected starting productivity $\sim z(\ell)$

Reservation wage $w(\ell) \propto$ separation threshold $y(\ell)$
Spatial equilibrium with ex-ante identical locations

Idiosyncratic productivity \( y \)

- **Expected starting productivity** \( y(\ell) H(z(\ell)) \)

- **Reservation wage** \( w(\ell) \propto \text{separation threshold } y(\ell) \)

- **Ratio** \( H(z(\ell)) \propto \frac{1}{1-z(\ell)} \)
State space for the planner’s problem

- Write the planner’s problem recursively with distribution as endogenous state
  - Build on Moll Nuño (2017)
  - General results require more restrictions on distribution space relative to paper
  - Results not directly applicable because of endogenous separations

- For distribution, define Hamiltonian over Sobolev-Strichartz space

\[ H^{1,2} \equiv \left\{ f : \text{for all } g \text{ among } f, \text{ its first } t, y, \ell\text{-weak derivatives,} \right. \]
\[ \text{and second } y, \ell\text{-weak derivatives,} \]
\[ \int_0^\infty e^{-\rho t} \left( \iint |g(t, y, \ell)|^2 dy d\ell \right) dt < \infty \left\} \right. \]

- Allows to use standard optimization results in Hilbert spaces.
Pooling externality and optimal place-based policies

Proposition (Externality and policy)

• Any decentralized equilibrium is inefficient for any $\alpha, \beta \in (0, 1]$.

Suppose that the supports of the distributions $F_\ell, F_z$ are not too large. Then

• The planning solution exists and is unique.

• Efficiency restored with
  
  ▶ Place-based profit subsidy, rising with rate of job loss
  
  ▶ Labor subsidy, rising with rate of job loss iff $\beta > \alpha$

• When search is directed, the decentralized equilibrium is efficient.

• Suppose $\beta = \alpha$. Then
  
  ▶ $z^{DE} < z^{SP}$
  
  ▶ $\frac{\partial \log w^{DE}}{\partial \log \ell} > \frac{\partial \log w^{SP}}{\partial \log \ell}$
Local labor productivity distributions across space

**Figure:** Labor productivity distribution in high-and low-job losing rate commuting zones. French firm-level balance sheet data.

(a) Cumulative function, means (all & entrants)

(b) Tail probabilities

Slope ratio \(= 1.35\)
Job losing ratio \(= 1.58\)
Local labor productivity distributions across space

Figure: Job loss probability by firm-level labor productivity centile. French firm-level balance sheet data.
Flat job finding rate: contact vs. success

- **Job finding rate** $f_R(\ell) = f(\theta(\ell)) \times \left( \frac{Y}{y(\ell)} \right)^{1/z(\ell)}$

  - Worker contact rate
  - Success prob. of contact

![Graph showing the relationship between log unemployment/employment and log job finding & contact rate.](image)

- Contact rate slope = 0.28
- Finding rate slope = -0.16

- Estimation of contact rate
- Back to job loss validation
Contact rate estimation

• LFS reports duration since last job offer
• Duration since last job offer identifies offer rate for workers $1/f$
• Unemployment duration is $1/f_R$

• **Assumption 1**: all contacts $\Rightarrow$ job offer (potentially rejected)
• Complication: available only for offers through ANPE

• **Assumption 2**
  ▶ Workers allowed to search for a job through ANPE and other means
  ▶ But contact-to-job probability is the same for ANPE jobs and other jobs
Local characteristics

- Cities now characterized by productivity–amenity pair \((p, a)\)
- Workers have flow utility function net of preference shocks

\[
u(c, h, a) = a \cdot \left( \frac{c}{1 - \omega} \right)^\omega \left( \frac{h}{\omega} \right)^\omega
\]
Local housing supply

- Fixed mass of perfectly competitive land developers produce local housing
- Use the final good as input with a DRS production function
- Results in a housing supply function
  \[ H(r) \propto r^\eta \]
- Owners receive profits from land developers
Migration

- At rate $\mu \in [0, +\infty]$, workers are given the opportunity to move.
- They receive a set of **preference shocks** for populated locations, $\{\varsigma_{p,a}\}_{p,a}$.
- The worker’s current location is treated symmetrically to other ones.
- Enter utility multiplicatively, Frechet with shape $1/\epsilon > 0$.
- Flow utility inclusive of preference shocks

$$ u(c, h, a, \varsigma) = \varsigma \cdot a \cdot \left(\frac{c}{1 - \omega}\right)^\omega \left(\frac{h}{\omega}\right)^\omega $$

- **I.I.D.** across locations and workers.
- **Nests free mobility** as $\epsilon \to 0$. 
Human capital and scarring effects of unemployment

- Workers differ in human capital $k$
  - Grows at rate $\lambda$ while employed
  - Depreciates at rate $\varphi$ while unemployed

- Workers exit labor force at rate $\Delta$
  - Replaced by single offspring
  - $\tilde{k}_0 = k_0 e^{-\lambda t} \sim F_{\tilde{k}}(\tilde{k}_0)$

Assumptions for tractability

- Assumption 1: variance in $F_{\tilde{k}}$ is small
- Assumption 2: firms cannot observe $k$ before meeting workers
  - Workers with different $k$ bundled in the same matching function
Production function with human capital and land

- Production function

\[ F(y, p, k, h) \propto (y \cdot p \cdot k)^{1/(1+\psi)} h^{\psi/(1+\psi)} \]

- Unemployment benefits / home production

\[ b(\ell, a, h) = b \cdot \ell \cdot h \cdot r(\ell, a)^{-\psi} \]

- Parsimoniously capture a constant replacement rate as in the data

- Convex vacancy costs

\[ c(v) = \frac{c_v}{1 + 1/\gamma} v^{1+1/\gamma} \]
Location choice of employers

- New employers choose a pair \((p, a)\) to maximize expected value of entry

Proposition (Extensions)

When \(\mu, \varphi\) are not too large, the previous results extend. In particular,

- Employers sort along the composite index

\[
\ell(p, a) = (p^p \cdot a^{-\psi})^Q
\]

- Local complementarities with

\[
\ell \cdot C(w(\ell), z(\ell))^\psi \cdot q(\ell) \cdot \left(1 + \frac{\varphi}{\Delta + \mu} \cdot u(\ell)\right)^{P/Q}
\]

where \(P = \omega + \varepsilon(1 + \eta), \ Q = \frac{1}{\omega + \psi + \varepsilon(1 + \eta + \psi)},\) and \(C\) is housing expenditures.
Assignment in two-dimensional space

\[ \ell(p, a) = \ell + d\ell \]
\[ \ell(p, a) = \ell \]
\[ z = z(\ell) \text{ indifferent} \]

Total mass of jobs: \( f_z(z(\ell))z'(\ell)d\ell \)

Mass of unemployed workers:
\[ u(\ell)L(\ell, a)D(p, a)d\ell \]
\[ \Rightarrow \text{as many vacancies } z(\ell) \]
### Table: Parameter estimates (quarterly)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Interpretation</th>
<th>Moments used</th>
<th>Estimator</th>
<th>Estimate</th>
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</thead>
<tbody>
<tr>
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<td>Discount rate</td>
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<td>MDE</td>
<td>0.009</td>
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<tr>
<td>$\Delta$</td>
<td>Labor force exit rate</td>
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<td>Drift of productivity</td>
<td>Job loss by tenure</td>
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<tr>
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<td>Bargaining power</td>
<td>Aggregate labor share</td>
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<td>Job acceptance prob.</td>
<td>MDE</td>
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<tr>
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<td>Housing prices</td>
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<td>$c_{p,a}$</td>
<td>Correlation prod.–amenities</td>
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</tr>
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Basic identifying moments

- Migration rate $\mu$
  - Directly read off time-aggregated migration rate into unemployment

- Labor force exit rate $\Delta$ and discount rate $\rho$
  - Level of unemployment rate given losing/finding/migration rates
    \[
    \Delta = \sum_c L_c \left( \frac{\bar{u}}{1 - \bar{u}} - f_{Rc} - s_c - \mu \right)
    \]
  - Interest rate: $\rho = r - \Delta$

- Expenditure shares on land for households and firms $\omega, \psi$
  - Households: national expenditure shares on land = 23%
    - Includes renters and homeowners
  - Firms: use balance sheet data, find 11%
    - Sum rental expenditures and annuitized book value of structures and land
First estimation steps

- Estimate productivity process with tenure profile of job loss and wages
  - Use solution to time-dependent KFE to get explicit expressions

- Job losing rate in first year in city $c$ satisfies
  \[ s_{1c} = s_1 \left( \frac{\delta}{\sigma}, s_c \right) \]
  - Estimate $\delta/\sigma$ with NLLS
  - Similar NLLS using wages by tenure to estimate common scale $\sigma$

- Recover local endogenous quality $z_c$ with
  \[ z_c = \frac{\delta}{s_c} \]
  - Distribution of $z_c$ identifies $F_z$
  - $z_c$ endogenous $\Rightarrow$ given $F_z$, estimated model may not match $s_c, z_c$
Time-dependent KFE

- Fix a location $\ell$ and omit location indices
- The density of $x = \log y$ over tenure $t$ is given by

$$g(t, x) = e^{-(\Delta + \mu)t} \int_{\hat{x}}^{\infty} G(t, x, x_0) g_0(x_0) \, dx_0$$

where

$$\begin{align*}
\hat{x} &= \log y \\
\Gamma(t, x) &= \frac{1}{\sigma \sqrt{2\pi t}} e^{-\frac{(x+\delta t)^2}{2\sigma^2 t}} \\
G(t, x, x_0) &= \Gamma(t, x - x_0) - e^{\frac{2\delta}{\sigma^2}(x_0-x)} \cdot \Gamma(t, x + x_0 - 2x)
\end{align*}$$
Job loss in first year

- Omit location indices
- Non time aggregated job loss rate by tenure $t$

$$s(t) = e^{-(\mu + \Delta)t} \left[ \frac{(s/R)}{\sqrt{t}} \varphi \left(R\sqrt{t}\right) + \frac{(s/R)^2}{2} e^{(s/R)^2 t} \left\{ e^{st} \Phi \left(-(R + s/R)\sqrt{t}\right) - e^{-st} \Phi \left((R - s/R)\sqrt{t}\right) \right\} \right]$$

where $s = \delta/z$ is the local average job losing rate, and $R = \delta/\sigma$.

- Time aggregated job losing rate in first year

$$s_1(R, s) = \frac{(s/R)}{4} \left\{ \frac{e^{-(D+s-(s/R)^2/2)}}{D + s - (s/R)^2/2} (s/R) + 4 \frac{E_0(R)}{\sqrt{2D + R^2}} ight.$$  

$$+ \frac{s/R}{D + s - (s/R)^2/2} \left( -1 - \frac{R - s/R}{\sqrt{2D + R^2}} E_0(R) + e^{-(D+s-(s/R)^2/2)} \text{Erf} \left[ \frac{R - (s/R)}{\sqrt{2}} \right] \right)$$

$$+ \frac{(s/R)}{D - s - (s/R)^2/2} \left( -1 + \frac{R + s/R}{\sqrt{2D + R^2}} E_0(R) + e^{-D+s+(s/R)^2/2} \text{Erfc} \left[ \frac{R + (s/R)}{\sqrt{2}} \right] \right)$$

where $D = \Delta + \mu$ and $E_0(R) = \text{Erf} \left[ \frac{\sqrt{2D+R^2}}{\sqrt{2}} \right]$
Wages by tenure

- Fix a location and omit location indices
- Average labor productivity net of human capital and relative to cutoff $y$ by tenure is

$$Y(t, s, \sigma, R) = \frac{s}{R/\sigma} \left( \frac{e^{A_4(s, R, D)t}}{s/R/\sigma - 1} + \frac{e^{A_0(s, \sigma, R)t} \text{Erf}[A_1(s, R)\sqrt{t}] - \text{Erf}[A_2(\sigma, R)\sqrt{t}] + 1}{s/R/\sigma - 1} \right. $$

$$ \left. - e^{-A_3(\sigma, D, R)t} \frac{e^{A_0(s, \sigma, R)t} (\text{Erfc}[A_1(s, R)\sqrt{t}] - 2) + \text{Erfc}[A_2(\sigma, R)\sqrt{t}]}{s/R/\sigma + 1 - 2R/\sigma} \right)$$

where $A_0(s, \sigma, R) = \frac{1}{2} \left( (s/R)^2 - \sigma^2 - 2s + 2\sigma R \right)$, $A_1(s, R) = \frac{R - s/R}{\sqrt{2}}$, $A_2(\sigma, R) = \frac{R - \sigma}{\sqrt{2}}$, $A_4(s, R, D) = \frac{(s/R)^2 - 2s - 2D}{2}$ and $A_3(\sigma, D, R) = \sigma R + D - \sigma^2/2$.

- When $\beta$ small, wages of jobs at tenure $t$ relative to new jobs at calendar time $t_{cal}$ are

$$\log \frac{W(t, t_{cal})}{W_{\text{new}}(t_{cal})} = \text{cste} + \log(s/R/\sigma - 1) + \log Y(t, s, \sigma, R, D) \equiv w(t, R, \sigma, s)$$

The slope of $Y$ with tenure falls as $\sigma$ rises

- Estimate with NLLS

$$\log \frac{W_{t_{cal}, t_{tenure}, c}}{W_{\text{new jobs}}^{t_{cal}, c}} = w(t_{tenure}, R, \sigma, s_c)$$

$W_{t_{cal}, t_{tenure}, c} = \text{wage in } c \text{ at time } t_{cal} \text{ and tenure } t_{tenure}$. $W_{t_{cal}, c}^{\text{new jobs}} = \text{wage of new jobs}$

- In practice time-aggregate numerically and estimate jointly with $\beta$
Distribution of employer quality

- Consider locations with job loss rate in \((s - ds, s]\)
  - Can be measured for any bandwidth \(ds\)

- Fraction of locations with job loss rate in \((s - ds, s]\) satisfies
  \[
  \hat{f}_s ds = f_z(z(s)) dz(s, ds)
  \]

- Given identify \(s = \delta / z(s)\), recover
  \[
  f_z(z(s)) = \frac{s^2 \hat{f}_s}{\delta}
  \]

- For simulations estimate a a Beta distribution for \(\zeta \equiv 1/z\)
  - \(f_\zeta(\zeta) \propto \left(\frac{\zeta - \zeta_1}{\zeta - \zeta_2}\right)^{g_2} \left(\frac{\zeta - \zeta_1}{\zeta - \zeta_2}\right)^{g_1}\)
  - Minimize MSE between empirical density and Beta density

- Back to job loss by tenure
- Back to table
Bargaining power

- Labor share in city $c$ is given by

$$\text{Labor Share}_c = \beta + \frac{1 - \beta}{H(s_c)}$$

where

$$H(s) = \frac{\kappa}{(\kappa - 1)(1 - \delta/s)} \quad , \quad \kappa = \frac{2\delta}{\sigma^2}$$

- Estimate $\beta$ by match aggregate labor share net of debt servicing

- Depreciation rate of HC $\varphi$: $\log \frac{w_{i1c}}{w_{i0c}} = \Phi_c + (\lambda - \varphi)d_{ic} + e_{ic}$
Unemployment scar

Worker $i$ going through an unemployment spell experiences wage losses

$$\log w_{i1c} = \Phi_c + (\lambda - \varphi)d_{ic} + \log w_{i0c} + e_{ic}$$

where $d_{ic}$ is unemployment duration, $e_{ic} \perp d_{ic}$ and is mean 0, and $\lambda = 0.0023$ from aggregate growth

<table>
<thead>
<tr>
<th>Dependent variable = post-unemployment log wage. Unemployed workers only.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Job loss × Duration</td>
</tr>
<tr>
<td>(2) Pre log wage</td>
</tr>
<tr>
<td>(3) Skill</td>
</tr>
<tr>
<td>(4) Obs.</td>
</tr>
<tr>
<td>(5) R$^2$</td>
</tr>
<tr>
<td>(6) W.-$R^2$</td>
</tr>
</tbody>
</table>

Fixed Effects

- Year ✓ ✓ ✓ ✓ ✓
- 2-digit Industry ✓ ✓
- City ✓ ✓
- Worker ✓

Standard errors in parenthesis, two-way clustered by city and 2-digit industry.

$+ p < 0.10, \; * p < 0.05, \; ** p < 0.01, \; *** p < 0.001.$
Lower bound of productivity draws

- Recover endogenous quality and threshold
  
  \[ z_{ic} = \frac{\delta}{s_{ic}} \quad \text{and} \quad y_{ic} = \frac{\rho}{\rho - \beta f_{R,ic} \bar{S}(z_{ic})} \]

- Lower bound of productivity draws \( Y \)
  
  \[ \mathbb{P}_c[\text{Contact-to-job}] = \left( \frac{Y}{y_c} \right)^{1/z_c} \]

- Recover contact-to-job prob. from duration since offer and unemp. duration
  
  - LFS reports duration since last job offer from ANPE
  
  - Duration since last offer = \( 1/f \), unemployment duration = \( 1/f_R \)

- **Assumption 1**: all contacts \( \Rightarrow \) job offer (potentially rejected)

- **Assumption 2**
  
  - Workers allowed to search for a job through ANPE and other means
  
  - But contact-to-job probability is the same for ANPE jobs and other jobs
Housing supply elasticity

- Recover endogenous quality and threshold

\[ z_{ic} = \frac{\delta}{s_{ic}} \]

\[ y_{ic} = \frac{\rho}{\rho - \beta f_{R,ic} S(z_{ic})} \]

- Construct housing demand in the model

\[ \log r_c = \text{cste} + \frac{1}{1 + \eta} \log \left( \frac{W_c}{1 - \beta + \beta \bar{y}_0 / \hat{\rho} H(z_c)} \right) L_c G(z_c, y_c) \]

- \( L_c \) is observed population

- \( H(z_c) = \frac{\kappa}{\kappa - 1} \frac{1}{1 - z_c} \)

- \( G(z_c, y_c) = \) relative expenditures of unemployed / employed / employers

- Estimate with OLS

- Only one cross-section of housing prices
Migration elasticity

- Recover endogenous quality, threshold and contact-to-job probability

\[ z_{ic} = \frac{\delta}{s_{ic}} \quad y_{ic} = \frac{\rho b}{\rho - \beta f_{R,ic}S(z_{ic})} \quad P_{ic} = \left( \frac{Y}{y_{ic}} \right)^{1/z_{ic}} \]

- Split sample into subperiods 0 and 1 and first-difference the gravity structure

\[ \log \frac{\pi_{1c}}{\pi_{0c}} = \frac{1}{\varepsilon} \log \frac{\hat{U}(W_{1c}, L_{1c}, z_{1c}, y_{1c})}{\hat{U}(W_{0c}, L_{0c}, z_{0c}, y_{0c})} + \log \frac{a_1}{a_0} \]

where \( \pi_{ic} \) are in-migration shares in period \( i \)

- \( \log a_1/a_0 \) correlated with regressors

- Use **shift-share** projections of industry-level shocks as **instruments**
  - Consider a perturbation of model w/ industry heterogeneity
  - Valid IV if industry productivity or amenity shocks = random walk
Matching function and vacancy cost elasticities

• Recover endogenous quality, threshold and contact-to-job probability

\[ z_{ic} = \frac{\delta}{s_{ic}} \quad y_{ic} = \frac{\rho b}{\rho - \beta f_{R,ic} \bar{S}(z_{ic})} \quad P_{ic} = \left( \frac{Y}{y_{ic}} \right)^{1/z_{ic}} \]

• Split sample into subperiods 0 and 1 and first-difference job finding rate

\[
\log \hat{f}_{1,0}(D_c) = \frac{1 - \alpha}{1 + \alpha \gamma} \log \hat{\theta}_{1,0}(D_c) + \frac{\gamma(1 - \alpha)}{1 + \alpha \gamma} \log \hat{J}_{1,0}(D_c) + e_c
\]

where \( D_c = \{W_{ic}, L_{ic}, u_{ic}, f_{R,ic}, z_{ic}, y_{ic}, P_{ic}, F_{iz}\}_{i \in \{0,1\}, c} \)

▶ \( e_c \) correlated with regressors when vacancy costs vary by city

• Use shift-share projections of industry-level shocks as instruments

▶ Consider a perturbation of model w/ industry heterogeneity
▶ Valid IV if industry productivity or vacancy cost shocks = random walk
Definitions of regressors for $\alpha, \gamma$

- Infer worker contact rate, market tightness and employer value

$$f_i(\mathcal{D}_c) = \frac{f_{R,ic}}{P_{ic}}$$

$$\theta_i(\mathcal{D}_c) = \frac{F'_z(z_{ic})}{u_{ic}L_{ic}} z'_{ic}$$

$\hat{J}(\mathcal{D}_c)$ is defined in the paper

where $z'_{ic}$ is obtained from a non-parametric fit for $(\ell_{ic}, z_{ic})$

- Changes over time $\hat{X}_{1,0}(\mathcal{D}_c) = \frac{X_1(\mathcal{D}_c)}{X_0(\mathcal{D}_c)}$
Over-identification

- Job loss by city and tenure
- Constant labor productivity growth rate across cities
- Labor shares by city
- Housing prices by city
- Amenities
- Sorting
Over-identification: job loss across cities and tenure

(a) Job loss in first year

(b) Job loss rate by tenure and city groups
New jobs differ across cities, unlike old jobs

**Table:** Plant-level regressions.

<table>
<thead>
<tr>
<th></th>
<th>Level (in logs)</th>
<th>Growth rate (incumb. only)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) VA/N</td>
<td>(2) VA/N</td>
</tr>
<tr>
<td>Geography</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separation rate</td>
<td>-0.373***</td>
<td>-0.241</td>
</tr>
<tr>
<td></td>
<td>(0.079)</td>
<td>(0.150)</td>
</tr>
<tr>
<td>Entrant × Separation rate</td>
<td>-0.433**</td>
<td>-0.317+</td>
</tr>
<tr>
<td></td>
<td>(0.142)</td>
<td>(0.174)</td>
</tr>
<tr>
<td>Skill mix controls</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skill mix</td>
<td>0.287**</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.107)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Entrant × Skill mix</td>
<td>0.085**</td>
<td>0.025</td>
</tr>
<tr>
<td></td>
<td>(0.031)</td>
<td>(0.039)</td>
</tr>
<tr>
<td>Fixed Effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year × Entry status</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2-digit industry × Entry status</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

| Obs.                  | 785252          | 383099                     | 383099                       | 692951    | 333873   | 333873 |
|                      |                 |                            |                             |          |          |        |
| $R^2$                | 0.173           | 0.213                      | 0.084                        | 0.005     | 0.006    | 0.003  |
|                      |                 |                            |                             |          |          |        |
| W.-$R^2$             | 0.008           | 0.080                      | 0.001                        | 0.000     | 0.000    | 0.000  |

Standard errors in parenthesis, two-way clustered by city and 2-digit industry.

$+ p < 0.10$, $^* p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$. Annual frequency, 2003-2005.

Davis-Haltiwanger growth rate. Continuing plants only. Entrant defined as less than two year old.

All value added per worker regressions are employment-weighted.
Housing prices

Figure: Housing prices: model against data.
## Labor shares across cities

**Table:** Cross-sectional regression of labor share onto log wages.

<table>
<thead>
<tr>
<th></th>
<th>(1) Data</th>
<th>(2) Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>log(Wage)</strong></td>
<td>-0.192*</td>
<td>-0.114***</td>
</tr>
<tr>
<td></td>
<td>(0.084)</td>
<td>(0.027)</td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>0.728***</td>
<td>0.724***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.003)</td>
</tr>
<tr>
<td><strong>Obs.</strong></td>
<td>348</td>
<td>348</td>
</tr>
<tr>
<td><strong>$R^2$</strong></td>
<td>0.066</td>
<td>0.046</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

$^+$ $p < 0.10$, $^* p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$

Standard errors in the model regressions reported for completeness.

They are population objects and do not reflect statistical uncertainty.
Spatial assignment

**Figure:** Estimated job quality against estimated cutoff and quadratic fit.
**Table:** Correlation of estimated amenities with observables.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weather</strong></td>
<td></td>
</tr>
<tr>
<td>Sun hours</td>
<td>0.333* (0.151)</td>
</tr>
<tr>
<td><strong>Services</strong></td>
<td></td>
</tr>
<tr>
<td>Basic public</td>
<td>0.051 (0.132)</td>
</tr>
<tr>
<td>Education</td>
<td>0.113 (0.107)</td>
</tr>
<tr>
<td>Health</td>
<td>0.223** (0.041)</td>
</tr>
<tr>
<td>Commercial</td>
<td>0.098 (0.085)</td>
</tr>
<tr>
<td><strong>Obs.</strong></td>
<td>288</td>
</tr>
<tr>
<td><strong>$R^2$</strong></td>
<td>0.517</td>
</tr>
</tbody>
</table>

Robust S.E. in parenthesis.

$^+ p < 0.10$, $^* p < 0.05$, $^{**} p < 0.01$.

Log amenities on log sun hours per month and log service establishments.
Baseline estimation

**Table:** Spatial unemployment differentials and job loss.

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Model</th>
<th>Model</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>No pooling</td>
<td>Identical loc.</td>
<td></td>
</tr>
<tr>
<td>Aggregate unemployment rate</td>
<td>0.076</td>
<td>0.076</td>
<td>0.071</td>
<td>0.076</td>
</tr>
<tr>
<td>St. dev. unemployment rate</td>
<td><strong>0.023</strong></td>
<td><strong>0.022</strong></td>
<td><strong>0.004</strong></td>
<td><strong>0.010</strong></td>
</tr>
<tr>
<td>St. dev. log unemp. / emp.</td>
<td>0.335</td>
<td>0.281</td>
<td>0.045</td>
<td>0.158</td>
</tr>
<tr>
<td>Job losing rate</td>
<td><strong>86 %</strong></td>
<td><strong>85 %</strong></td>
<td><strong>-180 %</strong></td>
<td><strong>133 %</strong></td>
</tr>
<tr>
<td>Job finding rate</td>
<td>14 %</td>
<td>15 %</td>
<td>280 %</td>
<td>-33 %</td>
</tr>
</tbody>
</table>
Spatial equilibrium with policy

**Figure:** Model’s solution in the decentralized equilibrium, the quasi-optimal policy and the French EZ program.
Aggregate gains from place-based policies

<table>
<thead>
<tr>
<th></th>
<th>Laissez-faire</th>
<th>EZ program</th>
<th>Quasi-optimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate unemployment rate</td>
<td>0.076</td>
<td>0.076</td>
<td>0.071</td>
</tr>
<tr>
<td>St. dev. unemployment rate</td>
<td>0.022</td>
<td>0.020</td>
<td>0.004</td>
</tr>
<tr>
<td>Aggregate welfare gains (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td>0.23</td>
<td>5.08</td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>0.09</td>
<td>2.93</td>
<td></td>
</tr>
<tr>
<td>Human capital</td>
<td>0.13</td>
<td>1.10</td>
<td></td>
</tr>
</tbody>
</table>
Welfare decomposition

- Expected utility of movers with human capital $k = 1$, $\mathcal{M}$, solves

\[
\mathcal{M} \frac{1+\eta+\psi}{\omega+\psi+\varepsilon(1+\eta+\psi)} = \int U_1(\ell, \mathcal{M})^{1/\varepsilon} A(\ell) F_\ell(\ell) d\ell
\]

- $U_0(\ell, \mathcal{M}) = \mathcal{M} \frac{\omega+\psi}{\omega+\psi+\varepsilon(1+\eta+\psi)} U_1(\ell, \mathcal{M})$, utility of unemployed resident in $\ell$ with
  - Preference $\zeta = 1$ for location
  - Human capital $k = 1$

- $A(\ell) = \mathbb{E}\left[a \frac{1}{\omega+\varepsilon(1+\eta)} \left(1 + \frac{\eta \psi}{\omega+\psi+\varepsilon(1+\eta+\psi)}\right) | \ell\right]$ captures amenities within $\ell(p, a) = \ell$

- Aggregate utilitarian welfare writes

\[
\mathcal{W} = \left\{ \int \left\{ U_0(\ell, \mathcal{M}) \left[ 1 + \beta(1 - u(\ell)) \Sigma(\ell) \right] \right\}^{1/\varepsilon} \tilde{k}(\ell)^{1/\varepsilon} L(\ell) dF_\ell(\ell) \right\}^\varepsilon
\]

- $L(\ell) = \mathbb{E}[L(p, a)|\ell(p, a) = \ell]$ is average population
- $\Sigma(\ell)$ is expected surplus
- $\tilde{k}(\ell)$ is average human capital
- $\mathcal{M}$ includes rebated profits $\propto$ earnings

Back
### Employment effects of a “Million Dollar Plant”

<table>
<thead>
<tr>
<th>Metric</th>
<th>Greenstone et al.</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDP employment share (%)</td>
<td>1.70</td>
<td>1.78</td>
</tr>
<tr>
<td>MDP output share (%)</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>TFP gains at other employers (%)</td>
<td>1.80</td>
<td>1.91</td>
</tr>
<tr>
<td>Job multiplier</td>
<td></td>
<td>-0.55</td>
</tr>
<tr>
<td>Unemp. rate change (p.p.)</td>
<td></td>
<td>-0.21</td>
</tr>
<tr>
<td>Job losing</td>
<td></td>
<td>-119%</td>
</tr>
<tr>
<td>Job finding</td>
<td></td>
<td>+19%</td>
</tr>
<tr>
<td>Population change (%)</td>
<td></td>
<td>0.58</td>
</tr>
<tr>
<td>Welfare gains (%)</td>
<td></td>
<td>1.15</td>
</tr>
<tr>
<td>Unemployed</td>
<td></td>
<td>0.67</td>
</tr>
<tr>
<td>Employed</td>
<td></td>
<td>0.09</td>
</tr>
<tr>
<td>Human capital</td>
<td></td>
<td>0.39</td>
</tr>
</tbody>
</table>
Attracting optimal “Million Dollar Plant” raises welfare

Figure: Local gains from the optimal “Million Dollar Plant” by population quantile.