The Flow Approach to the Marginal Cost

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Yale University, Cowles Foundation, NBER

Dale T. Mortensen Lecture
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University of Wisconsin-Madison
Takeway for today

➤ Misallocation of workers to jobs is a form of labor market “slack.”

➤ **Job-to-Job transitions measure misallocation by revealed preferences, and belong in the (wage) Phillips Curve.**

➤ Analysis of aggregate labor markets—theory, measurement, estimation—moved long ago from stocks (competitive market) to flows (search market). Dale Mortensen was the key player.

➤ In macroeconomics, empirical measures of labor market slack and marginal cost are mostly based on time-free (stock) variables: unemployment rate, output gap, labor share, non-participation.

The Transmission Channel of Labor Demand: Outside Offers

- Jobs are ‘good’ and ‘bad’. Workers are (first-best) misallocated.
- Even now, with unemployment < 4%, poaching mismatched workers is easy, improves allocation, possibly even reduces labor costs.
- Even when unemployment is high, poaching well-matched workers is hard, mostly results in wage raises and cost-push shocks for their employers.
- The elasticity of aggregate labor supply in efficiency units depends on both the quantity and the *quality* (allocation) of employment.
The Acceptance Ratio

- If workers quit their jobs often, to move to a different employer, even when job openings are scarce (low demand), workers must be unhappy where they are (high supply), whether because of compensation or amenities.

- **Theory**: A proxy for mismatch (misallocation) is the **Acceptance Ratio**

\[
AC = \frac{\text{Employer-to-Employer transition probability}}{\text{Unemployment-to-Employment transition probability}}
\]
The Acceptance Ratio

If workers quit their jobs often, to move to a different employer, even when job openings are scarce (low demand), workers must be unhappy where they are (high supply), whether because of compensation or amenities.

Theory: a proxy for mismatch (misallocation) is the Acceptance Ratio

\[ AC = \frac{EE}{UE} \]

= \frac{\text{search effort by employed}}{\text{search effort by unemployed}} \cdot \frac{\text{contact rate employed}}{\text{contact rate unemployed}} \cdot \frac{\text{effort to recruit employed job applicants}}{\text{effort to recruit unemployed job applicants}} \cdot \frac{\text{acceptance prob. empl.}}{\text{acceptance prob. unempl.}}

All three are high when employed workers are poorly allocated and unhappy about their jobs.

Empirics: negative causal effect of AC on wage growth.

Based on long collaboration with Fabien Postel-Vinay on theory and empirics (new draft, at last, forthcoming), and also with Shigeru Fujita on measurement. All errors are my own.
Some Facts
Monthly CPS, from Fujita, Moscarini and Postel-Vinay (2021)

![Graph showing UE and EE transition probabilities over time.](image_url)

Monthly CPS, from Fujita, Moscarini and Postel-Vinay (2021)
Empirics
The Regional Phillips Curve

Hazell, Herreno, Nakamura and Steinsson (2022 QJE)

▶ Solved forward, regional NKPC for inflation of Non tradables in region $H$

\[
\pi_H^N, t = -\mathbb{E}_t \sum_{j=0}^{\infty} \beta^j \left[ \kappa (u_H, t + j - \mathbb{E}_t u_H, \infty) + \lambda (p_H^N, t + j - p_H, t + j) + \nu_{H, t + j}^N \right] + \mathbb{E}_t \pi_H^N, \infty
\]

local (log): unemployment transitory component, relative price of Non tradables, supply shocks in Non trad., long run inflation expect.

▶ Identification. Assume:

1. $\mathbb{E}_t u_H, \infty = \bar{u}_H, \infty$ independent of time $t$;
2. $\mathbb{E}_t \pi_H^N, \infty = \mathbb{E}_t \pi^N, \infty$ common to all markets.
The Regional Phillips Curve
Hazell, Herreno, Nakamura and Steinsson (2022 QJE)

- Solved forward, regional NKPC for inflation of Non tradables in region $H$

$$
\pi_{H,t}^N = -E_t \sum_{j=0}^{\infty} \beta^j \left[ \kappa u_{H,t+j} + \lambda \left( p_{H,t+j}^N - p_{H,t+j}^H \right) + \nu_{H,t+j}^N \right] + \frac{\kappa}{1 - \beta} \bar{u}_{H,\infty} + E_t \pi_{\infty}^N
$$

local (log): unemployment transitory component, relative price of Non tradables, supply shocks in Non trad., long run inflation expect.

- Identification. Assume:

1. $E_t u_{H,\infty} = \bar{u}_{H,\infty}$ independent of time $t$;
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THE REGIONAL WAGE PHILLIPS CURVE

\[
\Delta w_{H,t}^N = -\phi E_t \sum_{j=0}^{\infty} \beta^j \left[ \kappa u_{H,t+j} + \lambda \left( p_{H,t+j}^N - p_{H,t+j}^T \right) + \nu_{H,t+j}^N \right] \\
+ \chi \Delta n_{H,t}^N + \frac{\phi \kappa}{1 - \beta} \tilde{u}_{H,\infty} + \phi E_t \pi_{\infty}^N + (1 - \phi) \pi_t^T 
\]

- With competitive labor market in \( H \), given local (log) wage \( w_{H,t} = w_{H,t}^N = w_{H,t}^T \) equalized between \( N \& T \) sectors, household supplies to the \( N \) sector labor

\[
n_{H,t}^N = \chi^{-1} \left( w_{H,t}^N - p_{H,t} \right) \Rightarrow \Delta w_{H,t}^N = \pi_{H,t} + \chi \Delta n_{H,t}^N
\]

- With time- and space-invariant spending share \( \phi \) on Nontradables, inflation in \( H \)

\[
\pi_{H,t} = \phi \pi_{H,t}^N + (1 - \phi) \pi_{H,t}^T
\]

- With same inflation in tradables everywhere, \( \pi_{H,t}^T = \pi_t^T \).
**Estimation: Design**

- Define labor market $H = \{\text{States} \times \text{Demographics}\}$.

- Project nominal wage growth $\Delta w_{S \times D,t}^N$ in Non-tradables sector in market $H = S \times D$ on: time f.e., $(S \times D)$–f.e., and

  1. $\sum_{j=0}^{20} \beta^j u_{S,t+j}^S$ [average over $D$’s of $u_{S \times D,t+j}$]
  2. $\sum_{j=0}^{20} \beta^j (p_{S,t+j}^N - p_{S,t+j}^S)$ [same across demographics $D$]
  3. $\Delta n_{S \times D,t}^N$

- Instruments: lags 4-8 and shift-share.
  Beraja, Hurst, Ospina (2019) use local house price growth

- **Theory (coming up!):** marginal cost also depends on $AC_{H,t}^N = (EE_{H,t}^N / UE_{H,t}^N)$.

  4. $\sum_{j=0}^{20} \beta^j AC_{S \times D,t+j}^N$
Data: Unbalanced Synthetic Panel

- LEHD-QWI: quarterly employment and average monthly earnings by state, 2-digit industry and demographics (either sex and education, or sex and age, or race and ethnicity), 1990Q1-2021Q3.
- LEHD-J2J: transition probabilities in and out of each 2-digit industry, job-to-job (with or without short jobless spell, use the latter) and to/from non employment, by state and same demographics as QWI, 2000Q2-2021Q1.
- Hazell et al. (2022): CPI inflation by (most) states, in $T$, $N$, all, various years.
- QCEW: Shift-share instrument, Tradable employment share by state in 1990-1999 times industry employment growth in the rest of the country.
- Similar results with: (i) shift-share from QWI at industry×demographics level; (ii) relative N/T wage by state and demographics, rather than CPI.
- Results shown for sex&education and sex&age; race and ethnicity imprecise.
### Estimation: Results

<table>
<thead>
<tr>
<th>Demographics $D \rightarrow$</th>
<th>OLS (sex and education)</th>
<th>IV (Lags&amp;Shift-Share) (sex and education)</th>
<th>(sex and age)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sum_{j=0}^{20} \beta^j u_{S,t+j}$</td>
<td>-0.049 \hspace{1cm} (-0.006)</td>
<td>-0.032 \hspace{1cm} (-0.020)</td>
<td>-0.043 \hspace{1cm} (-0.021)</td>
</tr>
<tr>
<td>$\sum_{j=0}^{20} \beta^j A_{C_N}^{S \times D,t+j}$</td>
<td>\hspace{1cm} 0.033 \hspace{1cm} (0.014)</td>
<td>\hspace{1cm} -0.095 \hspace{1cm} (0.036)</td>
<td>\hspace{1cm} -0.098 \hspace{1cm} (0.031)</td>
</tr>
<tr>
<td>$N$</td>
<td>20,280 \hspace{1cm} 15,140</td>
<td>24,350 \hspace{1cm} 18,970</td>
<td>38,960 \hspace{1cm} 30,271</td>
</tr>
</tbody>
</table>

- All regressions include $\sum_{j=0}^{20} \beta^j (p^N_S, t+j - p^S_S, t+j)$, $\Delta n^N_{S \times D, t}$, time f.e. and $S \times D$ = state $\times$ sex $\times$ education (or $\times$ age) f.e., with $\beta = 0.9872$;
- Dep. var.: log change in nominal earnings in Non-tradable industries by $S \times D$.
- Weighted by employment.
- Standard errors clustered at state level.

EE&NE separate
A New Keynesian Model with a Job Ladder

Moscarini and Postel-Vinay (2019)
Flow Chart

- **New Keynesian block.** Standard 3-equations model describes supply and demand in the Final goods market and monetary policy rule.

- **Nominal Marginal Cost.** TFP-adjust. price $\omega_t$ of an intermediate input ("Service"), sold in a competitive market.

- **Job Search block.** Firms produce Service input using labor, that they hire in a decentralized search market.
  - Replaces neoclassical labor supply.
  - Service output $\approx$ “packaged labor”.
  - Service price $\omega_t \approx$ “average nominal wage”.
Labor Market: Sequential Auctions in G.E.

- Workers and firms face search frictions in the Service sector.
- Upon meeting in pairs, draw constant match productivity $y \sim \Gamma$.
- Workers fully insure labor income risk within large household, face various types of aggregate shocks.
- Recruiters compete in contracts for both unemployed and employed workers in Sequential Auctions à la Postel-Vinay and Robin (2002).
- Meeting function and free entry pin down job creation.
- Firms evaluate profits at the household’s SDF $D_{t+\tau} = \beta^\tau U_{C,t+\tau} / U_{C,t}$. 
**Sequential Auctions: a Magic Act**

- Expected PDV of unit real revenues from Service match, until separation (prob. $\delta$)

$$W_t = \frac{\omega_t}{P_t} + (1 - \delta)\mathbb{E}_t \left[D_{t+1}^t W_{t+1}\right]$$

- Expected PDV of value of leisure (MRS) on the extensive margin (work or not)

$$\mathcal{L}_t = \frac{U_{u,t}}{U_{c,t}} + (1 - \delta)\mathbb{E}_t \left[D_{t+1}^t \mathcal{L}_{t+1}\right]$$

- Surplus from a successful match $y$ in the Service sector in units of Final good

$$S_t(y) = W_t y - \mathcal{L}_t$$

- **Job Ladder.** Even with risk-averse households and aggregate shocks, equilibrium is Rank-Preserving: better match $y > y'$ bids $S_t(y')$, wins, earns

$$S_t(y) - S_t(y') = W_t (y - y')$$

- If $y$ incumbent and $y'$ a close competitor, worker stays and receives a raise.
Job Ladder Stochastic Dynamics

- $\theta_t = v_t / [u_t + (1 - \delta)s_1 (1 - u_t)]$ job market tightness = vacancies/total search.
- Assume for simplicity unemployed accept all offers, exit with probab. $\phi(\theta_t)$.
- Employment distribution follows

\[
\ell_{t+1}(y) - \ell_t(y) = -\delta \ell_t(y) \quad \text{fired} \\
\quad + \phi(\theta_t) \Gamma'(y)u_t \quad \text{hired from unemployment} \\
\quad - (1 - \delta)s_1 \phi(\theta_t)[1 - \Gamma(y)]\ell_t(y) \quad \text{quit to better matches} \\
\quad + (1 - \delta)s_1 \phi(\theta_t) \Gamma'(y) \int_y^y \ell_t(y') \, dy' \quad \text{poached from other firms}
\]
**Free Entry and Job Creation**

\[
\kappa_v \frac{\theta_t}{\phi(\theta_t)} = \frac{u_t}{u_t + (1 - \delta)s_1 (1 - u_t)} \left( W_t \int_{y}^{\bar{y}} yd\Gamma(y) - \frac{L_t}{MRS} \right)
\]

PDV of Labor Wedge/Wage Mark-up

\[
+ \frac{(1 - \delta)s_1 (1 - u_t)}{u_t + (1 - \delta)s_1 (1 - u_t)} W_t \int_{y}^{\bar{y}} \int_{y}^{y'} (y - y') \frac{\ell_t(y')}{1 - u_t} dy' d\Gamma(y)
\]

Mismatch Wedge

- \(\ell_t(y)\) infinitely-dimensional, endogenous aggregate state variable; describes (first-best) misallocation; affects incentives to post vacancies.

- Employment allocation improves \((\ell_t \uparrow \text{FSD}) \Rightarrow \text{Mismatch Wedge falls}...\)

- ...and so do vacancy postings, hires from unemployment, job ladder upgrading, supply of Service. Nominal MC \(\omega_t\) for Final good producers rises.
**Acceptance Ratio**

- EE transition probability averaged across all $1 - u_t$ employed workers:

  $$ (1 - \delta)s_1\phi(\theta_t) \int_{\bar{y}}^{\bar{y}} [1 - \Gamma(y)] \frac{\ell_t(y)}{1 - u_t} dy $$

- Divide by UE probability $= \phi(\theta_t)$ to obtain Acceptance ratio

  $$ AC = \frac{EE}{UE} = (1 - \delta)s_1 \cdot \left(\int_{\bar{y}}^{\bar{y}} [1 - \Gamma(y)] \frac{\ell_t(y)}{1 - u_t} dy\right) \approx 30\%; \text{ Faberman, Mueller, Sahin, Topa (2021)} $$

- Employment allocation improves ($\ell_t \uparrow \text{ FSD}$) $\Rightarrow$ AC falls.
Quantitative Analysis: Some New Ingredients

- **Two intensive margins:**
  1. **recruiting**: effort by firms applies *after* meeting, no congestion
  2. **production**: either managerial effort in Final good sector (profit-based "executive compensation"), or work hours in Service sector (base wage + bonus).

- **Time aggregation**: displaced workers can search immediately
  forced EE reallocation measured by Faberman et al. (2021)

- **Persistent shocks to**: Final good TFP, Taylor rule, IES, matching efficiency.

- **Note**: discount rate shocks push consumption and job creation in opposite directions.
The Nerdy Slide
Model Soluble by Perturbation!

- $\ell_t(y) \geq 0$ never binds: Separations from job ladder rung $y$ proportional to $\ell_t(y)$.
- Match productivity set is a primitive $\Rightarrow$ log-linearize $\ell_t(y_k)$’s dynamics pointwise on a grid $\{y_k\}$.
- Log-linearize: recursions for $W_t$ and $L_t$, Free Entry, market-clearing in both sectors, NK block. Obtain State-Space representation.
- Solve for fundamental solution, check determinacy, estimate by ML, Bayesian. Faccini and Melosi (2021)
- We choose Simulated Minimum Distance to target the covariance structure of seven aggregates: non-durable consumption, inflation, nominal interest rate, unemployment, vacancies, UE and EE transition probabilities.
### Some Parameter Estimates

**Production and pricing technology**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>log TFP Final goods: persistence</td>
<td>0.73</td>
</tr>
<tr>
<td>volatility</td>
<td>0.0035</td>
</tr>
<tr>
<td>Pareto slope of match quality $\Gamma$</td>
<td>1.55</td>
</tr>
<tr>
<td>Returns to scale in Final good sector</td>
<td>0.72</td>
</tr>
<tr>
<td>Share of Managerial effort in Final good</td>
<td>0.065</td>
</tr>
<tr>
<td>Calvo probability</td>
<td>0.08</td>
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</table>

**Preferences**

<table>
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<th>Parameter</th>
<th>Estimate</th>
</tr>
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<tbody>
<tr>
<td>Average MRS $C$/leisure (extensive margin; $\simeq$ “b”)</td>
<td>0.0055</td>
</tr>
<tr>
<td>Elasticity of substitution btw varieties</td>
<td>6</td>
</tr>
<tr>
<td>Intertemporal elasticity of substitution: mean</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>persistence 0.93</td>
</tr>
<tr>
<td></td>
<td>volatility 0.0068</td>
</tr>
</tbody>
</table>
## Some Parameter Estimates

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<th>Search frictions</th>
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<tr>
<td>Elasticity of meeting function</td>
<td>0.75</td>
</tr>
<tr>
<td>Exogenous job destruction $\delta$</td>
<td>0.0275</td>
</tr>
<tr>
<td>Additional exit rate in first month of U</td>
<td>1.8</td>
</tr>
<tr>
<td>Relative efficiency of on-the-job search $s_1$</td>
<td>0.41</td>
</tr>
<tr>
<td>Elasticity of recruiting cost (intensive margin)</td>
<td>0.38</td>
</tr>
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<table>
<thead>
<tr>
<th>Taylor rule, nominal interest rate (log)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Inflation loading</td>
<td>1.73</td>
</tr>
<tr>
<td>Unemployment loading</td>
<td>-0.042</td>
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<tr>
<td>Shock: persistence</td>
<td>0.95</td>
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<tr>
<td>volatility</td>
<td>0.0020</td>
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</table>
## Model fit

<table>
<thead>
<tr>
<th></th>
<th>variance</th>
<th>autocorrelation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>data model</td>
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</tr>
<tr>
<td>aggregate consumption $C_t$</td>
<td>8.47E-5, 9.99E-5</td>
<td>.891, .857</td>
</tr>
<tr>
<td>12-month inflation $\bar{\pi}<em>t = \sum</em>{s=0}^{11} \pi_{t-s}$</td>
<td>1.62E-05, 1.66E-05</td>
<td>.943, .971</td>
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<tr>
<td>nominal interest rate $R_t$</td>
<td>1.93E-4, 1.32E-04</td>
<td>.993, .957</td>
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<tr>
<td>unemployment rate $u_t$</td>
<td>.053, .044</td>
<td>.993, .988</td>
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<tr>
<td>vacancies $v_t$</td>
<td>.033, .032</td>
<td>[.964], [.746]</td>
</tr>
<tr>
<td>UE job finding probability</td>
<td>.019, .018</td>
<td>.938, .882</td>
</tr>
<tr>
<td>EE job to job transition probability</td>
<td>.0024, .0028</td>
<td>.770, .778</td>
</tr>
<tr>
<td>$AC=UE/EE$</td>
<td>[.0110], [.0099]</td>
<td>.876, .872</td>
</tr>
<tr>
<td>Average Labor Productivity</td>
<td>[7.3E-5], [14.3E-5]</td>
<td>[.724], [.324]</td>
</tr>
</tbody>
</table>

**Table:** Simulated [untargeted] second moments, quarterly, seasonally adjusted, in logs, HP-filtered.
### Model fit: X-Correlations

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<tr>
<th></th>
<th>consump</th>
<th>infl $\pi$</th>
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<td>$\pi$</td>
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<td>R</td>
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<tr>
<td>u</td>
<td>-.70 (-.72)</td>
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<tr>
<td>v</td>
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<tr>
<td>UE</td>
<td>.74 (.75)</td>
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<td>EE</td>
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<td>[AC]</td>
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SHOCKS IN COLUMNS, PLOTTED IN RED, %
Wrapping Up

1. **Empirical evidence:** AC = EE/UE probability ratio is strongly countercyclical and negatively impacts wage growth, independently of the level of unemployment.

2. **Theory:** AC is a revealed-preference measure of misallocation.

3. **Conclusion:** *Quality, not just quantity,* of employment matters. Non-employment is just the bottom rung of a much longer ladder. Fed should watch AC.
Thank You!
Monthly CPS, from Fujita, Moscarini and Postel-Vinay (2021)
Last quarter plotted: Q1/2022 for CPS and JOLTS; Q4/2020 for LEHD.
Net Employment Reallocation between States and 6-digit Industries, QCEW
### Estimation: Results

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<tr>
<td></td>
<td>(0.020) (0.032) (0.026)</td>
<td>(0.021) (0.032) (0.003)</td>
</tr>
<tr>
<td>[ \sum_{j=0}^{20} \beta_j AC_{S \times D,t+j}^N ]</td>
<td>-0.095</td>
<td>-0.098</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(0.031)</td>
</tr>
<tr>
<td>[ \sum_{j=0}^{20} \beta_j EE_{S \times D,t+j}^N ]</td>
<td>0.005</td>
<td>-0.120</td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
<td>(0.043)</td>
</tr>
<tr>
<td>[ \sum_{j=0}^{20} \beta_j NE_{S \times D,t+j}^N ]</td>
<td>0.078</td>
<td>0.081</td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>( N )</td>
<td>24,350 18,970 18,970</td>
<td>38,960 30,271 30,271</td>
</tr>
</tbody>
</table>