EFFICIENCY AND LABOR MARKET DYNAMICS IN A MODEL OF LABOR SELECTION

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MOTIVATION

- Goals of project
- Explain business-cycle volatility in unemployment and job-finding
- Using efficient allocations
  - (Avoid wage formation altogether…)
- Using costs of hiring distinct from vacancy posting costs
  - (Note: Efficient allocations in “baseline” search and matching framework will not get us there)
    - “Shimer puzzle”
METHODOLOGY

- Methodology of project
- Exploit cross-sectional heterogeneity amongst (potential) new hires’ characteristics
- Discipline with micro-economic data
- Micro-data about cross-sectional heterogeneity?
  - Person $i$-specific productivity difficult (impossible?) to measure (“How much can person $i$ produce?”)
  - Wage data easily available
    - BUT our model intentionally avoids how wages are determined
    - (return to this point soon...)
- Our framework uses micro-level “match quality” data
  - Costs of “integrating” / “training” potential new hires
DATA

- **Empirics**

- **Cost of training / hiring**
  - Apply only in the first period of employment
  - As new workers learn the methods of their new firm

- **Incumbent workers incur zero training costs**

- **Real life examples of training costs**
  - Shadowing other workers to observe how job is performed
  - Understanding the culture of the firm
  - Computer setup and configurations
  - Etc...

- **Barron, Black, and Loewenstein (1989 *JLE*)**
  - Firm-level costs of interviewing/hiring/training/integrating new workers
  - Based on 1982 EOPP (Employment Opportunities Pilot Project)
  - “...workers of varying abilities are matched to positions with different training requirements.”
DATA

- Barron, Black, and Loewenstein (1989 *JLE*)
  - Firm-level costs of interviewing/hiring/training/integrating new workers
  - Based on 1982 EOPP (Employment Opportunities Pilot Project)

- Reports first moments and cross-sectional second moments

- (Any other evidence on cross-sectional second moments?...)

- 1982 EOPP data continues to be used in various applications
  - Different investment in match-specific capital for different education groups (Cairo and Cajner, 2013 WP)
  - Size of labor turnover costs (relevant for search and matching models) – e.g., Silva and Toledo (2009 *MD*)
  - Effects of training costs of firm-specific labor turnover (Dolfin 2006 *Applied Economics*)
MODEL

- **Main components**
  - Fixed cost $\gamma^h$ of “training” each new hire (systematic component)
  - Idiosyncratic training cost for each new hire $i$

- **Total training cost for new worker $i$ in period $t = \gamma^h + \varepsilon^i$**

  Idiosyncratic training/residual cost for new hire $i$

  $\varepsilon^i \sim$ iid $\ln N(0, \sigma^2_\varepsilon)$
**DISTRIBUTION**

- Cross-sectional distribution of training costs in period $t$

\[ \tilde{\varepsilon}_t \] determined endogenously
MODEL

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  - Idiosyncratic training cost for each new hire $i$

- **Total training cost for new worker $i$ in period $t = \gamma^h + \varepsilon^i$**

  $\varepsilon^i \sim \text{iid } \ln N(0, \sigma^2_{\varepsilon})$

- **Cross-sectional SD $\sigma_{\varepsilon}$ informed by Barron et al**

- **Dispersion of training costs considered a primitive**
  - (Similar to matching function taken as primitive in DMP-based models)

- **No search and matching component**
  - To focus on the endogenous selection component
  - Davis, Faberman, and Haltiwanger (2013 QJE): Evidence of heavily reliance on other margins for hiring in addition to vacancy postings (JOLTS)
Main Results and Contributions

- Efficient volatility arises and is meaningful
  - No wage decentralization in model
  - Conditional on TFP shocks

Empirical elasticity = 2.9

\[ \text{elasticity} = 1.2 \]

\[ \text{elasticity} = 0.3 \]
**EX-ANTE VS. EX-POST HIRING COSTS**

- Think about selection model as hiring candidates who have the “best skills”
- Interpret “matching process” as a costly “contact process” or “meeting process”
- But also allow other costs in the hiring of workers

**Economic Intuition**

- The firm evaluates applicants.
- The firm selects which applicant(s) are “good enough”.
- The firm pays cost to train/integrate new worker(s).
- The firm hopes to “receive applications” – probability of receiving is $< 1$.
- Probability an applicant is selected is $< 1$.

**Matching phase of hiring new workers**

**Selection phase of hiring new workers**

November 17, 2015
Think about selection model as hiring candidates who have the “best skills”
Interpret “matching process” as a costly “contact process” or “meeting process”
But also allow other costs in the hiring of workers

Meetings are costless ex-ante.
But can meet \( m \) different opportunities (sequential search)

Baseline: Each unemployed individual meets only one firm in any period
Can generalize to allow \( N \) Poisson meetings per period (i.e., \( N=2, N=3, \ldots \))
MAIN RESULTS AND CONTRIBUTIONS

- Efficient volatility occurs and is meaningful
  - No wage decentralization in model
  - Conditional on TFP shocks

- Elasticity of hiring rate wrt TFP: Empirical value = 2.9
  - Has not appeared in literature (as far as we know...)
  - Constructed using data from Shimer (2005) and Michaillat (2012)
  - (Potentially?) another contribution

- Endogenous value from previous example: 1.2
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Caveat / Question
- Depends on the data we employ to calibrate SD $\sigma_\varepsilon$ ...
- ... we use training cost dispersion
- What if we use new hires’ wage dispersion as “upper bound” on SD $\sigma_\varepsilon$?

$$\sigma_\varepsilon \text{ from wage dispersion} = 1.5 \sigma_\varepsilon \text{ from hiring cost dispersion}$$

→ Volatility results dampen a tiny bit...
Definitions
**SELECTION MARGIN**

- Optimal decision characterized by cutoff rule
  - Choose endogenous threshold $\tilde{\varepsilon}_i$ below which everybody is selected to work
- CDF (hiring rate, aka selection rate, aka job-finding rate)
  \[
  \eta(\tilde{\varepsilon}_i) = \int_{\varepsilon_i \leq \tilde{\varepsilon}_i} f(\varepsilon_i^i) \cdot d\varepsilon_i^i
  \]
**Selection Margin**

- Optimal decision characterized by cutoff rule
  - Choose endogenous threshold $\tilde{\epsilon}_t$ below which everybody is selected to work

- CDF (hiring rate, aka selection rate, aka job-finding rate)
  $$\eta(\tilde{\epsilon}_t) = \int_{\epsilon^i_t \leq \tilde{\epsilon}_t} f(\epsilon^i_t) \cdot d\epsilon^i_t$$

- Training cost for threshold new worker $= \gamma^h + \tilde{\epsilon}_t$

- Average idiosyncratic training costs for those individuals who are hired
  $$H(\tilde{\epsilon}_t) = \int_{\epsilon^i_t \leq \tilde{\epsilon}_t} \epsilon^i_t f(\epsilon^i_t) \cdot d\epsilon^i_t$$
Social Planner Model
(Partial Equilibrium)
EFFICIENT SELECTION

- Dynamic surplus maximization problem

\[
\max_{\{n_t, \tilde{e}_t\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \left( \frac{1}{1+r} \right)^t \left[ z_t n_t + s_t (1 - \eta(\tilde{e}_t)) b - s_t \eta(\tilde{e}_t) \left( \gamma^b + \frac{H(\tilde{e}_t)}{\eta(\tilde{e}_t)} \right) \right]
\]

\[
n_t = (1 - \rho) n_{t-1} + s_t \eta(\tilde{e}_t)
\]

\[
s_t = lfp - (1 - \rho) n_{t-1}
\]

\textit{lfp fixed in partial equilibrium}
EFFICIENT ALLOCATION

Definition: efficient allocations are endogenous processes \( \{\tilde{\epsilon}_t, n_t\}_{t=0}^\infty \) that satisfy

\[ \gamma^h + \tilde{\epsilon}_t = z_t - b + \left( \frac{1 - \rho}{1 + r} \right) E_t \left\{ H(\tilde{\epsilon}_{t+1}) - \tilde{\epsilon}_{t+1} \eta(\tilde{\epsilon}_{t+1}) + \gamma^h + \tilde{\epsilon}_{t+1} \right\} \]

Selection condition

\( \gamma^h + \tilde{\epsilon}_t \)
- Asset value of a new worker

\( z_t - b \)
- Asset value of a replacement new worker

\( \left( \frac{1 - \rho}{1 + r} \right) E_t \left\{ H(\tilde{\epsilon}_{t+1}) - \tilde{\epsilon}_{t+1} \eta(\tilde{\epsilon}_{t+1}) + \gamma^h + \tilde{\epsilon}_{t+1} \right\} \)
- Expected social cost of a replacement new worker hired in \( t+1 \)

Law of motion for aggregate labor

\[ n_t = (1 - \rho)n_{t-1} + s_t \eta(\tilde{\epsilon}_t) \]

taking as given initial labor \( n_{-1} \) and exogenous stochastic process \( \{z_t\}_{t=0}^\infty \)
Shape of Distribution

Slope of Distribution at Threshold

How to Calibrate $\sigma_\varepsilon$
ELASTICITIES

- Steady-state elasticities

- Elasticity of selection threshold wrt TFP
  \[ \frac{\partial \ln \tilde{e}}{\partial \ln z} = \frac{z}{\tilde{e}} \cdot \frac{1+r}{r + \rho + (1-\rho)\eta(\tilde{e})} \]

- Elasticity of hiring rate wrt TFP
  \[ \frac{\partial \ln \eta(\tilde{e})}{\partial \ln z} = \frac{\partial \ln \eta(\tilde{e})}{\partial \ln \tilde{e}} \cdot \frac{\partial \ln \tilde{e}}{\partial \ln z} = \frac{\eta'(\tilde{e})}{\eta(\tilde{e})} \cdot z \cdot \left( \frac{1+r}{r + \rho + (1-\rho)\eta(\tilde{e})} \right) \]

- Empirical data to measure slope at endogenous cutoff point \( \tilde{e} \)?
- Depends on shape of distribution...
**UNIFORM DISTRIBUTION**

- Warm-up example
- $\eta'(\tilde{\epsilon})$ independent of $\epsilon_i$

$\sigma_{\epsilon}$ is population SD
$\sigma_{\epsilon}^*$ is sample SD
($= 40\%$ of MPL in Barron et al evidence)
ELASTICITIES

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- Elasticity of selection threshold wrt TFP
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  \[ = \frac{\eta'(\tilde{\varepsilon})}{\eta(\tilde{\varepsilon})} \cdot z \cdot \left( \frac{1 + r}{r + \rho + (1 - \rho)\eta(\tilde{\varepsilon})} \right) \]

Warm-up example

U[-1.2, 1.2]  
\( \rho = 0.1 \)  
\( r = 0.01 \)  
\( \eta(\varepsilon) = 0.58 \)

\[ = 1.15 \]

Compared to 2.9 empirical elasticity
ELASTICITIES

- **Steady-state elasticities**

- **Elasticity of selection threshold wrt TFP**
  \[
  \frac{\partial \ln \tilde{\epsilon}}{\partial \ln z} = \frac{z}{\tilde{\epsilon}} \cdot \frac{1+r}{r + \rho + (1-\rho)\eta(\tilde{\epsilon})}
  \]

- **Elasticity of hiring rate wrt TFP**
  \[
  \frac{\partial \ln \eta(\tilde{\epsilon})}{\partial \ln z} = \frac{\partial \ln \eta(\tilde{\epsilon})}{\partial \ln \tilde{\epsilon}} \cdot \frac{\partial \ln \tilde{\epsilon}}{\partial \ln z}
  = \frac{\eta'(\tilde{\epsilon})}{\eta(\tilde{\epsilon})} \cdot \frac{z}{(r + \rho + (1-\rho)\eta(\tilde{\epsilon}))}
  \]

  **Warm-up example**
  
  \[
  \rho = 0.1 \quad r = 0.01 \quad \eta(\epsilon) = 0.58
  \]
  
  \[
  = 1.15
  \]

  Compared to 2.9 empirical elasticity

- **Two micro data sources to measure** \( \sigma_\epsilon^* \)
  - Short-term training cost dispersion (EOPP: Employment Opportunity Pilot Project)
  - Wage dispersion for new hires
Quantitative DSPE example

Distribution of training costs assumed log-normal

- $\sigma_\epsilon$ chosen to hit cross-sectional SD of training costs of 40 percent of MPN

- Barron, Black, and Loewenstein (1989, p. 5): SD across new hires of training costs during first three months of employment = 207 hours (= 40% of MPL)

- In our model implies the SD is 40% of worker’s long-run MPL (which is endogenous in the GE model)
CALIBRATION

- Quantitative DSPE example

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- Calibrate $\gamma''$ to hit average hiring rate $\approx 58\%$ (a macro calibration approach)
  - Average hiring cost turns out > Barron et al’s measure ( = 150 hours)
  - Nobody has negative training costs $\rightarrow$ skewed distribution
CALIBRATION

- Quantitative DSPE example
- Conventional parameters
  - \( r = 0.01 \)
  - Standard quarterly TFP process
    \( (\rho_z = 0.95, \sigma_z = 0.007) \)

- Outside option \( b \)
- \( b = 0 \)
- Doesn’t matter at all for efficient allocations!

\[
\frac{\partial \ln \eta(\tilde{\varepsilon})}{\partial \ln z} = \frac{\partial \ln \eta(\tilde{\varepsilon})}{\partial \ln \tilde{\varepsilon}} \frac{\partial \ln \tilde{\varepsilon}}{\partial \ln z}
\]

\[
= \frac{\eta'(\tilde{\varepsilon})}{\eta(\tilde{\varepsilon})} \cdot z \cdot \left( \frac{1 + r}{r + \rho + (1 - \rho) \eta(\tilde{\varepsilon})} \right)
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CALIBRATION

- Quantitative DSPE example
- Conventional parameters
  - $r = 0.01$
  - Standard quarterly TFP process ($\rho_z = 0.95, \sigma_z = 0.007$)
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CALIBRATION

- Quantitative DSPE example

- Conventional parameters
  - $r = 0.01$
  - Standard quarterly TFP process ($\rho_z = 0.95$, $\sigma_z = 0.007$)

- Outside option $b = 0$

- Various $\sigma_\varepsilon$ values
  - $= 0.2$
  - $= 0.4$ (Barron et al)
  - $= 0.6$ (wage dispersion)
Sequential Search
SELECTION AND SEQUENTIAL SEARCH

- The model readily admits sequential search (e.g., McCall (1970), Mortensen (1970))

- Suppose Poisson meetings $N$ occur during a quarter
- Baseline considered: $N = 1$

- For $N \geq 1$ meetings during period, job-acceptance condition modifies to

$$\eta(\tilde{c}_i) = m(\tilde{c}_i) \cdot \sum_{j=1}^{N} (1 - m(\tilde{c}_i))^{j-1}$$

- $\eta(\tilde{c}_i)$ is probability that a searching worker accepts a job within a quarter
- $m(\tilde{c}_i)$ is chance that a searching worker accepts a particular contact $m$ during a quarter

- $m = 1 \Rightarrow \eta(\tilde{c}_i) = m(\tilde{c}_i)$
- $m = 2 \Rightarrow \eta(\tilde{c}_i) = m(\tilde{c}_i) \{1 + (1 - m(\tilde{c}_i))\}$
- $m = 3 \Rightarrow \eta(\tilde{c}_i) = m(\tilde{c}_i) \{1 + (1 - m(\tilde{c}_i)) + (1 - m(\tilde{c}_i)) \cdot (1 - m(\tilde{c}_i))\}$
SELECTION AND SEQUENTIAL SEARCH

- $m = 1$
- $m = 2$
- $m = 3$
General Equilibrium
GENERAL EQUILIBRUM

- Endogenous labor supply (endogenous LFP)
- Physical capital investment
- (hence MRSs and MRTs nest textbook RBC model)