Heterogeneity, Selection and Labor Market Disparities

Alessandra Bonfiglioli    Gino Gancia

UPF and CREI

ESSIM, 30 May 2014
Motivation

- developed countries differ markedly in a number of social and economic indicators
  - inequality
  - labor and total factor productivity
  - human capital
  - firms characteristics and distribution
- proposed explanations:
  - policy distortions
  - culture
- our answer:
  - multiple equilibria sustained by different beliefs on the importance of effort for finding good jobs
Beliefs, Selection and Multiple Equilibria

- key assumptions:
  - ability can be increased investing effort, but effort raises also the variance of the ability distribution
  - firms can screen workers at a cost $\rightarrow$ screening profitable if ability is dispersed enough
- complementarity between between effort choice and firms’ hiring policy
  - if agents put effort $\rightarrow$ higher heterogeneity $\rightarrow$ firms screen workers
  - if firms screen workers $\rightarrow$ agents find it profitable to put effort
The Model in Brief

- heterogeneous firms and workers à la Helpman et al. (2010)
- labor market frictions:
  - search frictions
  - costly screening of workers’ ability
- technology:
  - decreasing returns to employed worker
  - output increasing in average ability of employed workers
- firms screen workers only if ability is sufficiently dispersed
  - more productive firms screen more, hire more able workers, pay higher wages
workers can invest costly effort to improve ability before seeking a job
  - effort raises both mean and variance of ability

if workers believe that firms will screen,
they put effort $\rightarrow$ ability *sufficiently dispersed* $\rightarrow$ firms screen

self-sustaining beliefs and screening

two equilibria: screening vs no screening
Main Results

- with screening (relative to no screening):
  - higher productivity
    - higher ability
    - better workers selection
    - tougher firm selection
  - firm-level outcomes:
    - bigger firms in terms of revenue
    - positive sorting between firms and workers
    - more dispersion
  - higher wage inequality (both between and within)
  - unemployment may be lower
Motivating Evidence: Economic Disparities

- **wage inequality and labor productivity:**

<table>
<thead>
<tr>
<th>Country</th>
<th>College Premium</th>
<th>Var. log wages</th>
<th>GDP/hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>1.8</td>
<td>0.44</td>
<td>60.2$</td>
</tr>
<tr>
<td>IT</td>
<td>1.51</td>
<td>0.17</td>
<td>45.6$</td>
</tr>
<tr>
<td>ES</td>
<td>1.48</td>
<td>0.23</td>
<td>47.5$</td>
</tr>
</tbody>
</table>

- **firm-level outcomes:**
  - US firms are bigger + higher covariance (size, productivity) (Bartelsman et al., 2013)
  - dispersion: st.dev. ln(revenue) 30% higher in US than IT/ES
  - selection: survival probability at 4 years 10% lower in US than IT
  - US firms value more selecting talented workers (Bloom et al., 2010)
Motivating Evidence: Cultural Disparities

- World Value Survey, respondents who strongly agree that:
  - "hard work brings success"
    - USA → 26.4%, ITA→ 14.6%, ESP→ 12.2%
  - "success is a matter of luck and connections”
    - USA → 2.3%, ITA → 8.9%, ESP → 7.8%
  - "competition is good"
    - USA → 29.6%, ITA → 19.2%, ESP → 15.6%
Motivating Evidence: Human Capital Disparities

- share of working-age (or 25-34) population with tertiary education (OECD, 2013):
  - USA → 42% (43%)
  - ITA → 15% (21%)
  - ESP → 32% (39%)

- expenditure in tertiary education as a share of GDP (OECD, 2013):
  - USA → 2.8%
  - ITA → 1%
  - ESP → 1.3%

- education outcome: test results (e.g., PISA)
  - USA higher average scores than ITA and ESP
  - USA more dispersed scores than ITA and ESP
  - USA more discipline at school than ITA and ESP
Related Literature

- multiple equilibria based on
  - political preferences:
  - human capital externalities:
  - statistical discrimination:
    - e.g., Coate & Loury (1993)

- allocation of talent and economic performance

- wage inequality with imperfect labor markets and firm heterogeneity
Preferences and Demand

- unite mass of households with size $\bar{L}$ and utility function:

$$U = q + \frac{Q^\zeta}{\zeta}, \quad \zeta \in (0, 1)$$

homogeneous goods: $Q$ "advanced", $q$ "residual"

- demand for $Q$:

$$Q = P^{-\frac{1}{1-\zeta}}$$

  - $P = \text{price of the advanced good}$
  - $p = 1 \text{ price of the residual good (numeraire)}$

- assume $q > 0$ in eq.
Technology

- both goods are produced with labor
- \( q \) requires 1 unit of labor per unit of output and is sold at \( p = w = 1 \)
- \( Q \) produced by heterogeneous firms with DRS and:
  - fixed entry cost \( f_e \)
  - productivity \( \theta \) drawn from a Pareto: \( G(\theta) = 1 - (1/\theta)^z, \ z > 1 \)
  - fixed production cost \( f_d \)
  - exit if profits \( \pi < 0 \)
  - free entry: mass \( M \) of entering firms is endogenous
  - all costs expressed in terms of the residual good
Technology and Frictions

- output of firm with $\theta$ productivity, $h$ employees of average ability $\bar{a}$:

$$y = \theta h^{\gamma} \bar{a},$$

- $\gamma \in (0, 1)$: span of control
- $a = \text{ability} \sim \text{Pareto}: I(a) = 1 - (1/a)^k$, $k > 1$

- firm pays $bn$ to match randomly with $n \geq h$ workers
  - $b$ will depend on labor market tightness

- unobservable ability
  - firm pays $\left[(a^*)^\delta - 1\right] c/\delta$ to screen out workers with $a < a^*$

$$\bar{a} = \frac{k}{k-1} a^* \quad \text{and} \quad h = n \left(\frac{1}{a^*}\right)^k$$

- if $k < 1/\gamma$, then $y$ increases with screening:

$$y = \theta \frac{k}{k-1} (a^*)^{1-\gamma} n^\gamma$$
Firm’s Problem

- wage bargaining as in Stole and Zwiebel (1996):
  - firm’s share of revenues $= 1 / (1 + \gamma)$

- firm solves

$$\pi (\theta) = \max_{n > 0, a^* \geq 1} \left\{ \frac{r (\theta)}{1 + \gamma} - bn - c \frac{(a^*)^\delta - 1}{\delta} - f_d \right\}$$

- with $r (\theta) = Q^{-(1-\zeta)} \theta n^\gamma k (a^*)^{1-\gamma^k} / (k - 1)$
- f.o.c.:

  $$n : \frac{\gamma}{1 + \gamma} r (\theta) = bn (\theta)$$
  $$a^* : \frac{1 - \gamma^k}{1 + \gamma} r (\theta) = c (a^* (\theta))^\delta \text{ for } k < 1 / \gamma$$

- more productive firms sample more workers: $n$ increasing in $\theta$
- more productive firms screen harder: $a^*$ increasing in $\theta$
Firm-Level Outcomes

- profits of firms with $\theta$ productivity become:

$$\pi (\theta) = \frac{\Gamma}{1 + \gamma} r (\theta) - f$$

- with $\Gamma \equiv 1 - \gamma - \Pi_s \frac{1-\gamma^k}{\delta} > 0$ and $f = f_d - \Pi_s c / \delta$
- indicator $\Pi_s = 1$ if $a^* > 1$, zero otherwise

- revenues are increasing in $\theta$ → firms exit if $\theta < \theta^*$

- wages and employment of firms with $\theta$ productivity become:

$$w (\theta) = ba^* (\theta)^k \quad \text{and} \quad h (\theta) = \frac{\gamma ca^* (\theta)^{\delta-k}}{(1 - \gamma k) b}$$

- also $w$ and $h$ increasing in $\theta$ (assume $\delta > k$)
Advanced Sector Equilibrium

- find the equilibrium values of $\theta^*$, $Q$ and $M$ by imposing
  - zero-profit cutoff
    \[ \pi (\theta^*) = \frac{\Gamma}{1 + \gamma} r (\theta^*) - f = 0 \]
  - free-entry
    \[ f_e = \int_{\theta^*}^{\infty} \pi (\theta) \, dG (\theta) \]
  - product market clearing
    \[ PQ = M \int_{\theta^*}^{\infty} r (\theta) \, dG (\theta) \]
ability distribution depends on workers’ effort choice:

- effort, $\eta \in \{0, 1\}$, costs $\eta$ and raises mean and variance of $a$:

$$k = \begin{cases} 
  k_0 \to \infty & \text{if } \eta = 0 \\
  k_1 < 1/\gamma & \text{if } \eta = 1
\end{cases}$$

- individual choice unobservable, $k$ observed by firms

occupational choice:

$$1 = \frac{N}{L} \frac{wh}{n} - \eta \eta$$

- employment in the residual sector vs job seeking in the advanced sector

search cost $b$ increases with tightness, $N/L$:

$$b = \alpha \left( \frac{N}{L} \right)^\beta, \quad \alpha > 1 + \eta, \quad \beta > 0$$

- with $N = $ sampled and $L = $ job-seeking workers
Multiple Equilibria

- there exist two pure-strategy equilibria with $I_\eta = I_s$
  1. high effort + screening
     - if workers put effort $\rightarrow k_1 < 1/\gamma \rightarrow$ firms screen
     - if firms screen $\rightarrow$ workers invest
       (or else be unemployed since $1 < a^*$)

  2. low effort + no screening
     - if workers do not invest $\rightarrow k_0 \rightarrow \infty \rightarrow$ firms do not screen
     - if firms do not screen $\rightarrow$ workers do not invest
       (or else they would face equal job opportunities, but waste the cost $\eta$)

- the result generalizes to any $k_0 > 1/\gamma$, under parameter restrictions
Comparing Equilibria: Unemployment

- unemployment rate

\[ u = 1 - \frac{N H}{L N} \]

- in the screening equilibrium:
  - frictional unemployment \((N/L)\) is lower (to compensate workers for \(\eta\))
  - but screening generates unemployment \((H/N < 1)\)
  - overall the unemployment rate is lower if

\[
(1 + \eta)^{1+\beta} > \frac{z\Gamma_1 - 1 - k_1/\delta}{z\Gamma_1 - 1} a^* (\theta_1^*)^k
\]
Comparing Equilibria: Wages

- in the screening equilibrium, wage inequality is higher
  - between the two sectors: "skill premium" = \( \bar{w}/1 \)
    \[
    \frac{\bar{w}_1}{\bar{w}_0} > \frac{w_1 (\theta_1^*)}{b_0} = \frac{b_1 a^* (\theta_1^*)^{k_1}}{b_0} > 1
    \]
    with \( \bar{w} = \) average wage in the advanced sector
  - within the advanced sector:
    \[
    SD (\log w_1) = \frac{k_1}{k_1 + \delta (\Gamma_1 z - 1)} > 0 = SD (\log w_0)
    \]
Comparing Equilibria: Firm Productivity

- in the screening equilibrium, firms are more productive
  - firm selection:
    \[ \frac{\theta_1^*}{\theta_0^*} = \left( \frac{z\Gamma_0 - 1 f_1}{z\Gamma_1 - 1 f_0} \right)^{1/z} > 1 \]
    - since \( \Gamma_0 / \Gamma_1 > f_0 / f_1 \) (for \( a^* (\theta_1^*) > 1 \)), and hence also \( \bar{\theta}_1 > \bar{\theta}_0 \)
    - intuition: screening makes more productive firms even more profitable
      \( \rightarrow \) least productive firms must exit
  - higher average ability of all workers
    \[ \mathbb{E} [a|I_s = 1] = \frac{k_1}{k_1 - 1} > 1 = \mathbb{E} [a|I_s = 0]. \]
  - workers’ selection \( \rightarrow \) higher average ability of hired workers:
    \[ \mathbb{E} [\bar{a}|I_s = 1] = \frac{k_1 a^* (\theta_1^*)}{k_1 - 1} \frac{k_1 + \delta (\Gamma_1 z - 1)}{k_1 + \delta (\Gamma_1 z - 1) - 1} > 1 \]
Comparing Equilibria: Firm’s Revenue and Employment

- in the screening equilibrium:
  - revenues are higher
    \[
    \frac{\bar{r}_1}{\bar{r}_0} = \frac{z\Gamma_0 - 1}{z\Gamma_1 - 1} \frac{f_1}{f_0} > 1
    \]
  - screening \(\rightarrow r\) steeper in \(\theta\) + higher \(\bar{\theta}\)
  - and more dispersed
    \[
    \frac{SD(\log r_1)}{SD(\log r_0)} = \frac{\Gamma_0}{\Gamma_1} \frac{f_1}{f_0} > 1
    \]
  - employment may be higher or lower:
    \[
    \frac{h_1(\theta_1^*)}{h_0(\theta_0^*)} = \frac{\Gamma_0}{\Gamma_1} \frac{f_1}{f_0} \frac{b_0}{b_1} a^*(\theta_1^*)^{-k}
    \]
  - profitability (+), tightness (-), screening (-)
Comparing Equilibria: Numerical Example

- data on US (screening eq.) and IT/ES (no-screening eq.)
- parameter set so as to match:
  - unemployment rate of 10% in IT/ES
  - skill premium in IT/ES
  - variance of sales in IT/ES
  - 10% elasticity of wage to firm size

- remaining parameters:
  - $\gamma \in \{0.2, 0.5, 0.8\}$
  - $k \in \{1.1, 1.5, 2\}$
  - here we only report $k = 1.1$
Comparing Equilibria: Numerical Example

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Model A</th>
<th>Model B</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma$</td>
<td>0.2</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>$\Delta \bar{w}$</td>
<td>23%</td>
<td>23.1%</td>
<td>22.3%</td>
</tr>
<tr>
<td>$SD (\ln w_1)$</td>
<td>0.66</td>
<td>0.098</td>
<td>0.092</td>
</tr>
<tr>
<td>$u_1$</td>
<td>5%</td>
<td>9.7%</td>
<td>9.1%</td>
</tr>
<tr>
<td>$\Delta \bar{r}$</td>
<td>150%</td>
<td>9.6%</td>
<td>5.5%</td>
</tr>
<tr>
<td>$\Delta SD (\ln r)$</td>
<td>30%</td>
<td>8.8%</td>
<td>5.2%</td>
</tr>
<tr>
<td>$\Delta \bar{h}$</td>
<td>50%</td>
<td>-11%</td>
<td>-13.7%</td>
</tr>
</tbody>
</table>

Note: $\Delta = \%$ differences between eq. with/without screening

- explain $\sim 10\text{-}20\%$ of differences in firm/labor-market outcomes
  - does well on wages
  - does not generate enough dispersion and differences in size
Extensions and Robustness

- unemployment in the residual sector
  - lower unemployment rate in the screening equilibrium becomes more likely

- costly entry in the advanced sector labor market
  - e.g., minimum education attainment costs $\varepsilon$
  - allows to obtain skill premium + lower unemployment in the advanced sector

- search cost as a function of the unemployment rate
  - discarded sampled workers are hirable:
    - lower search cost in the screening equilibrium:
      \[ b = \frac{\alpha}{\beta} \left( \frac{H}{L} \right) < \frac{\alpha}{\beta} \left( \frac{N}{L} \right) \]
    - lower unemployment in the screening equilibrium
Conclusions

- a model to explain the divergence in a set of labor market outcomes:
  - multiple equilibria sustained by beliefs on the value of effort and ability
  - investment in effort raises both mean and variance of ability
  - complementarity between hiring policy and workers’ effort
  - two equilibria:
    - screening + high effort vs no screening - low effort
    - different labor market outcomes and firms distribution

- can explain around 10-20% of the differences in firm/labor-market outcomes

- policy implications: how to make the screening equilibrium more likely?

- further extensions:
  - learning dynamics and equilibrium selection
  - shocks and cyclical properties across different equilibria
  - endogenous degree of frictions