Student Abilities During the Expansion of U.S. Education, 1950-2000

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School Attainment, 1896-1965 Cohorts, Men
Expansion of U.S. Education

Add two ingredients:

1. Heterogeneous ability
2. Positive sorting

Implies:

• Decline in average ability for given educational attainment.
Stylized Outcomes, 1915 & 1965 Cohorts

- C+: 0.09  \(E(a): 1.83\)
- SC: 0.09 \(E(a): 1.13\)
- HS: 0.30 \(E(a): 0.47\)
- <HS: 0.53  \(E(a): -0.76\)

- C+: 0.28  \(E(a): 1.19\)
- SC: 0.29  \(E(a): 0.19\)
- HS: 0.33  \(E(a): -0.66\)
- <HS: 0.10  \(E(a): -1.76\)
Interpreting wages:

\[ \log(w|s) = \log(h|s) + \log(z|s) \]

Two common inferences:

- \( \Delta \log(w|s) = \Delta \log(z|s) \)
  - Downward bias.
- \( \Delta[\log(w|C) - \log(w|HS)] = \Delta[\log(z|C) - \log(z|HS)] \)
  - Unsigned bias.
Preview

- Model of school choice
- Calibrate to data on wages, earnings, attainment, and AFQT

Two main results:
1. Wage growth depressed 31-58 percentage points
2. Rising college skill premium entirely due to changing relative ability
Demographics and Endowment

Demographics:

- Discrete time, $t = 0, 1, ..$
- Birth cohort $\tau$
- Workers live $T$ years
- Age $v$, $t = \tau + v - 1$. 
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- Birth cohort $\tau$
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Ability Endowment
- Ability: $A$
  - $a \equiv \log(A) \sim N(\mu_a, \sigma_a)$
- Noisy signal $A^*$
  - $a^* \equiv \log(A^*) \sim N(a, \sigma_{a^*})$
Preferences

\[ U_q = \sum_{v=1}^{T} \beta^v [\log(c_{s,q,v}) + \xi \log(1 - l_{s,v})] - \chi_{s,\tau} \]

- \( q = (A^*, \tau) \) is type
- \( c_{s,q,v} \) is consumption
- \( l_{s,v} \) is labor input, taken exogenously
- \( \chi_{s,\tau} \) is disutility of school
Budget Constraint

\[
\sum_{v=1}^{T} \frac{C_{s,q,v}}{R^v} = E A^* (Y(s, A))
\]

\[
Y(s, A) = \sum_{v=T_s+1}^{T} \frac{x_{T+v-1}z_{s,\tau+v-1} l_{s,v} e_{s,v} A^{\eta_s}}{R^v}
\]

- \(x_{T+v-1}\) is TFP
- \(z_{s,\tau+v-1}\) is school-specific productivity
- \(e_{s,v}\) is experience, taken exogenously
- \(\eta_s\) captures complementarity
  - \(\eta_{s+1} > \eta_s\) implies sorting
Increases in Attainment

What increases schooling attainment?

1. Changes in relative costs, \( g(\chi_s) \)
2. SBTC, \( g(z_s) \)
3. Other factors act similarly.
Parameters to Calibrate

- $R = 1.05, \beta = 1/R$
- $T = 70$
- $z_1 = 1, g(z_1) = 0, \mu_a = 1, \eta_1 = 1$
  - Normalizations
Parameters to Calibrate

- $R = 1.05, \beta = 1/R$
- $T = 70$
- $z_1 = 1, g(z_1) = 0, \mu_a = 1, \eta_1 = 1$
  - Normalizations

- $x_{2000}, g_1(x), g_2(x), z_{2000,s}, g(z_s), \chi_s$
  - Census wages & attainment, men 35-44.

- $\eta_s \sigma_a, \sigma_a^*$
  - Relationship between schooling, wages, and AFQT (NLSY79)
  - Dispersion of earnings (PSID)
NLSY79: Wages, Education, and Aptitudes

Nationally representative sample

- AFQT test
NLSY79: Wages, Education, and Aptitudes

Nationally representative sample
  - AFQT test

What is AFQT?
  - A noisy signal of a noisy signal.
  - $AFQT \sim N(a^*, \sigma_{AFQT})$

Moments:
  - Sorting by AFQT quintile-education
  - Returns to normalized AFQT by education group
PSID: Dispersion of Permanent Earnings

Wage Dispersion:
- Model: ability
- Data: ability, plus transitory shocks, plus luck
PSID: Dispersion of Permanent Earnings

Wage Dispersion:
- Model: ability
- Data: ability, plus transitory shocks, plus luck

Solution:
- Fit RIP earnings process:

\[
\log(w_{j,t}) = \alpha_j + X_{j,t}\beta + \zeta_{j,t} + \varepsilon_{j,t}
\]
\[
\zeta_{i,t} = \rho\zeta_{i,t-1} + \hat{\varepsilon}_{i,t}
\]

Moments
- Standard deviations of \(\alpha\) for each \(s\)
Calibration

Strategy:
- Use $\chi_{s,\tau}$ as residuals to fit attainment exactly
- Calibrate other parameters to minimize loss function.

Main parameters:
- $\sigma_a = 0.56$
- $\sigma_a^* = 0.22$
Fit: Sorting

[Graphs showing comparisons between data and model predictions for different AFQT quintiles.]
Fit: AFQT and Wages

- Returns to AFQT by School Category

- Model vs. Data comparison

- Categories: <HS, HS, SC, C+
Fit: Dispersion of Permanent Earnings
## Results

### Decomposing Changing Wage Levels

<table>
<thead>
<tr>
<th></th>
<th>Data Wages</th>
<th>Model Wages</th>
<th>Skill Price</th>
<th>Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;HS</td>
<td>0.21</td>
<td>0.1</td>
<td>0.62</td>
<td>-0.52</td>
</tr>
<tr>
<td>HS</td>
<td>0.27</td>
<td>0.25</td>
<td>0.84</td>
<td>-0.58</td>
</tr>
<tr>
<td>SC</td>
<td>0.28</td>
<td>0.22</td>
<td>0.7</td>
<td>-0.48</td>
</tr>
<tr>
<td>C+</td>
<td>0.59</td>
<td>0.48</td>
<td>0.79</td>
<td>-0.31</td>
</tr>
</tbody>
</table>

Hendricks/Schoellman ()

Student Abilities

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## Decomposing Changing Wage Premia

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<th>Model Wages</th>
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<th>Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;HS-HS</td>
<td>-0.07</td>
<td>-0.15</td>
<td>-0.21</td>
<td>0.06</td>
</tr>
<tr>
<td>SC-HS</td>
<td>0.01</td>
<td>-0.03</td>
<td>-0.14</td>
<td>0.11</td>
</tr>
<tr>
<td>C+-HS</td>
<td>0.32</td>
<td>0.22</td>
<td>-0.05</td>
<td>0.27</td>
</tr>
</tbody>
</table>
Understanding Wage Premia

\[ C+: 0.09 \quad E(a): 2.02 \]
\[ SC: 0.09 \quad E(a): 1.26 \]
\[ HS: 0.30 \quad E(a): 1.63 \]
\[ <HS: 0.53 \quad E(a): 0.58 \]

\[ C+: 0.28 \quad E(a): 1.67 \]
\[ SC: 0.29 \quad E(a): 1.11 \]
\[ HS: 0.33 \quad E(a): 0.63 \]
\[ <HS: 0.10 \quad E(a): 0.02 \]
Calibrated model of school choice, rise in schooling. Key findings:

- Ability is highly dispersed, signals are fairly precise
- Human capital growth understated by 31-58 percentage points
- Skill premium explained by relative ability
- Even $\sigma_a \approx 0.25$ gives 10% bias to each
## Parameters

<table>
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<tr>
<th>Moment</th>
<th>Value</th>
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</tr>
</thead>
<tbody>
<tr>
<td>(x_{2000})</td>
<td>7.906</td>
<td>(g_{x,&lt;1975})</td>
<td>2.67%</td>
</tr>
<tr>
<td>(z_{2000,2})</td>
<td>0.776</td>
<td>(g_{x,\geq1975})</td>
<td>-0.13%</td>
</tr>
<tr>
<td>(z_{2000,3})</td>
<td>0.556</td>
<td>(g_{z_2})</td>
<td>0.43%</td>
</tr>
<tr>
<td>(z_{2000,4})</td>
<td>0.415</td>
<td>(g_{z_3})</td>
<td>0.15%</td>
</tr>
<tr>
<td>(\eta_1)</td>
<td>1.0000</td>
<td>(g_{z_4})</td>
<td>0.33%</td>
</tr>
<tr>
<td>(\eta_2)</td>
<td>1.0001</td>
<td>(\sigma_a)</td>
<td>0.558</td>
</tr>
<tr>
<td>(\eta_3)</td>
<td>1.0004</td>
<td>(\sigma_{a^*})</td>
<td>0.220</td>
</tr>
<tr>
<td>(\eta_4)</td>
<td>1.0007</td>
<td>(\sigma_{AFQT})</td>
<td>0.848</td>
</tr>
</tbody>
</table>
Robustness: Changing Variance of Noise

- Returns to AFQT vs. Standard Deviation of Noise
- S.D. of Permanent Earnings vs. Standard Deviation of Noise
- Growth in HS Wage, 1950-2000 vs. Standard Deviation of Noise
- Change in College Premium, 1950-2000 vs. Standard Deviation of Noise
Robustness: Changing Variance of Ability

- Returns to AFQT
- Growth in HS Wage, 1950-2000
- S.D. of Permanent Earnings
- Change in College Premium, 1950-2000