The Allocation of Teaching Talent and Human Capital Accumulation

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Introduction

- Public education in U.S. has gone through major (positive) changes since end of WW II:
  - Annual real expenditures per student: $2,100 (1950s) to $12,000 (2010s)
  - Student-teacher ratio: 27 (1955) to 16 (2010s)
- Evolution of educational outcomes doesn't compare favorably with countries at similar income level (e.g. *PISA* assessments)
- Potential explanations include:
  - U.S. education underfunded by international comparison
  - Role of (powerful) teachers' unions

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  - Role of (powerful) teachers' unions
  - Occupational choice
  - Local funding for public education (e.g. property taxes)

Research Questions

- To what extent do changes in career opportunities in other occupations affect selection of workers into teaching careers?

- To what extent are static efficiency gains associated with improved career opportunities in non-teaching occupations muted or amplified by dynamic effects?
  $\Rightarrow$ human capital accumulation channel

What We Do

- Highlight stylized facts
- Develop a novel theory of occupational choice and human capital formation:
  - non-linear wages $\Rightarrow$ comparative and absolute advantage
  - intergenerational dynamics of human capital accumulation
- Combine three longitudinal surveys:
  - Project TALENT, NLSY79, NLSY97

Stylized Fact #1

Majority of (Public) School Teachers is Female

	% Female	Time Period
Project TALENT	61.1	early 70s
NLSY79	77.7	1986-1993
NLSY97	77.1	2009-2013
NCES (2006)	75	2003-4

Stylized Fact #2

Educational Barriers / Labor Market Discrimination

- Females face low barriers / discrimination in teaching
- Barriers / discrimination in non-teaching occupations falling over time

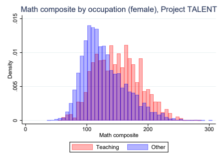
Stylized Fact #3

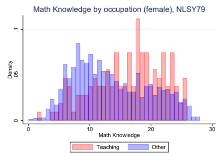
Occupational Choice

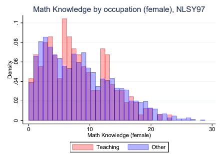
- Share of women in teaching: 4.6% in 1970 to 6.7% in 2010
- Share of men in teaching: 2.9% in 1970 to 2.1% in 2010
- Sharp rise in female labor force participation rate
- Slight decline in male labor force participation rate

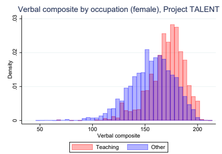
Stylized Fact #4

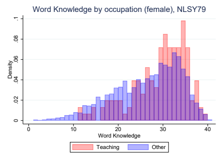
Ability Distribution of Females by Occupation

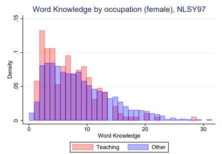












Model

Overview

- OLG
- Non-linear version of occupational choice model
- Educational barriers / labor market discrimination (as in Hsieh et al., 2019)

Model

Endowments, Preferences

- Each period, a measure M of agents is born and lives for two periods: "young" and "old"
- G groups of individuals
- With occupation-specific abilities from $F_a(\vec{a})$
- $\log$ preferences over consumption and leisure:

$$\mu \ln C_g' + \ln (1 - s_{i,g})$$

Model

Technologies

- "Young" make occupation-specific time and goods investments
- "Old" work as teachers or production workers

Human capital production (teaching) depends on teacher's $h_{T,\hat{g}}$, class size $N(h_{T,\hat{g}})$, own ability a_i, time $s_{i,g}$ and goods $e_{i,g}$ investments:

$$h'_{i,g}(a_i) = (h_{T,\hat{g}})^{\beta} a_i^{\alpha} (s_{i,g})^{\phi} (e_{i,g})^{\eta} \big(N(h_{T,\hat{g}})\big)^{-\sigma}$$

$$\text{where } \widetilde{H}_T = \sum_{\hat{g}=1}^{G} \int_0^{\infty} (h_{T,\hat{g}}(a))^{\frac{\beta}{\sigma}} f_{T,\hat{g}}(a) da$$

Final output production depends on adult worker's human capital $h_{O,g}$ and exogenous productivity A_O:

$$y_g = A_O h_{O,g}$$

Model

Values

$$V_g(a_T, a_O, \widetilde{H}_T) = \max_{\{s_{O,g}, s_{T,g}, e_{O,g}, e_{T,g}\}} \left\{ V_{O,g}(a_O, \widetilde{H}_T), V_{T,g}(a_T, \widetilde{H}_T) \right\}$$

where

$$\begin{aligned}
V_{O,g}(a_O, \widetilde{H}_T) &= \ln\left(1 - s_{O,g}\left(a_O, \widetilde{H}_T\right)\right) \\
&\quad + \mu \ln \Big[{h'}_{O,g} A'_O (1 - t')(1 - \tau^{\omega'}_{O,g}) \\
&\quad - e_{O,g}(a_O, \widetilde{H}_T)(1 + \tau^{e}_{O,g}) \Big], \\
V_{T,g}(a_T, \widetilde{H}_T) &= \ln\left(1 - s_{T,g}\left(a_T, \widetilde{H}_T\right)\right) \\
&\quad + \mu \ln \Big[\omega'_{T,g}(h'_{T,g})(1 - t')(1 - \tau^{\omega'}_{T,g}) \\
&\quad - e_{T,g}(a_T, \widetilde{H}_T)(1 + \tau^{e'}_{T,g}) \Big]
\end{aligned}$$

Model

Constraints, Laws of Motion

$$
\begin{aligned}
{\color{red}t}\Bigg[\sum_{g=1}^{G}\int_0^\infty (1-\tau^{\omega}_{T,g})\omega_{T,g}\left(h_{T,g}(a)\right) f_{T,g}(a)da \\
+\sum_{g=1}^{G}\int_0^\infty (1-\tau^{\omega}_{O,g})A_O h_{O,g}(a) f_{O,g}(a)da\Bigg] \\
=\sum_{g=1}^{G}\int_0^\infty (1-\tau^{\omega}_{T,g})\omega_{T,g}\left(h_{T,g}(a)\right) f_{T,g}(a)da \\
f_{T,g}(a) = \int_0^{\bar{a}_g^{-1}(a)} f\left(a,b\right)db \\
f_{O,g}(b) = \int_0^{\bar{a}_g(b)} f\left(a,b\right)da
\end{aligned}
$$

$$
H'_O = \sum_{g=1}^{G}\int_0^\infty \left(\frac{2\widetilde{H}_T}{M}\right)^{\sigma} a^{\alpha} s_{O,g}\left(a,\widetilde{H}_T\right)^{\phi} e_{O,g}(a,\widetilde{H}_T)^{\eta} f_{O,g}(a)da
$$

$$
\widetilde{H}'_T = \sum_{g=1}^{G}\int_0^\infty \left(\left(\frac{2\widetilde{H}_T}{M}\right)^{\sigma} a^{\alpha} s_{T,g}\left(a,\widetilde{H}_T\right)^{\phi} e_{T,g}(a,\widetilde{H}_T)^{\eta}\right)^{\color{red}\frac{\beta}{\sigma}} f_{T,g}(a)da
$$

Model

Occupational Threshold

$$a^*_{T,g}(a_O) = \bar{a}_g\big(a_O, \widetilde{H}_T\big)$$

such that

$$V_{O,g}(a_O, \widetilde{H}_T) = V_{T,g}\left(a^*_{T,g}(a_O), \widetilde{H}_T\right), \text{ for all } a_O \in (0, \infty)$$

Model

- Assignment of students to teachers is random
  $\Rightarrow$ distribution of students' skill identical across classrooms
- Teachers with different $h_{T,g}$ vary with respect to class *size*

$$h_{T,g}^{\beta} N(h_{T,g})^{-\sigma} = \left(\frac{2\widetilde{H}_T}{M} \right)^{\sigma}$$

- Teacher's wage $\omega_{T,g}$ depends on teacher's human capital:

$$\omega_T(h_{T,g}) = \kappa h_{T,g}^{\gamma}$$

Equilibrium

Given occupational choices of today's "old" and aggregate human capital $\widetilde{H}_T$ and H_O, the equilibrium consists of individual choices of "young" $\{e_{T,g}, s_{T,g}, e_{O,g}, s_{O,g}\}$, the occupational choice boundary $a^*_{T,g}(a_O)$, the corresponding densities $f_{T,g}$ and $f_{O,g}$, and occupation- and group-specific wage profiles $\{\omega_{T,g}, \omega_{O,g}\}$ such that:

1. Individuals solve their problem ▸ Time Investment ▸ Goods Investment
2. Aggregate human capital follows the laws of motion ▸ Laws of Motion
3. Government budget constraint is satisfied

Occupational Choice Boundary...

... depends on aggregate state $\widetilde{H^T}$

$$\frac{\bar{a}_T(a_O)^{\frac{\alpha}{\frac{1}{\gamma}-\eta}}}{a_O^{\frac{\alpha}{1-\eta}}} \cdot \frac{s_{T,g}^{\frac{\phi}{\frac{1}{\gamma}-\eta}}}{s_{O,g}^{\frac{\phi}{1-\eta}}} \cdot \frac{\tau_{T,g}^{\frac{1}{1-\eta\gamma}}}{\tau_{O,g}^{\frac{1}{1-\eta}}} \cdot \frac{1+\tau_{T,g}^e}{1+\tau_{O,g}^e} \cdot \left(\frac{1-s_{T,g}}{1-s_{O,g}}\right)^{\frac{1}{\mu}}$$

$$\times \frac{(\kappa \cdot \gamma)^{\frac{1}{1-\eta\gamma}}}{A_O'^{\frac{1}{1-\eta}}} \cdot \frac{\frac{1}{\gamma}-\eta}{1-\eta} \cdot \eta^{\frac{\eta(\gamma-1)}{(1-\eta)(1-\eta\gamma)}} \cdot \left(\frac{2\widetilde{H}_T}{M}\right)^{\frac{\sigma(\gamma-1)}{(1-\eta)(1-\eta\gamma)}} = 1$$

where

$$\tau_{i,g} = \frac{(1-t)(1-\tau_{i,g}^{\omega})}{1+\tau_{i,g}^e}$$

Data

- Micro-data on abilities and occupational choice:
  1. Project TALENT (1960-1975):
     - representative 5% sample of high school population in 1960
     - follow-up surveys at 1, 5, and 11-year post graduation
  2. NLSY 79
  3. NLSY 97
- *Math*, *Verbal*, and *Social* abilities
- Occupational choice 11 years after (likely) high school graduation in all surveys ($\sim$ age 29)

Occupation-specific Abilities

- Ability rank from NLSY 79 and NLSY 97:
  Math, *Verbal*, and *Social* (Guvenen et al, 2020)
- "Crosswalk" from composite math and verbal scores in Project TALENT to AFQT equivalents (Air Force, 1990)
- Social composite in Project TALENT (Deming, 2017)
- Skill requirements by occupation from O*NET:
  Math, *Verbal*, and *Social* (Guvenen et al, 2020)
- Occupation-specific ability:

$$\bar{a} = \frac{a_m + a_v + a_s}{b_m + b_v + b_s} + \sum_{i=\{m,v,s\}} \frac{a_i}{b_i} \cdot \left| \frac{a_i}{a_v + a_m + a_s} - \frac{b_i}{b_v + b_m + b_s} \right|$$

Calibration

Assumptions and Normalizations

Parameter	Definition	Determination	Value
$\tau^w_{o,\text{men}}$	Labor market barriers for men	Assumption	0
$\tau^e_{o,g}$	Human capital barriers for all groups	Assumption	0
$\tau^w_{T,g}$	Labor market barriers in teaching (all groups)	Assumption	0
$\tau^e_{T,g}$	Human capital barriers in teaching (all groups)	Assumption	0
α	elasticity of human capital with respect to idiosyncratic ability	Normalization	1

Calibration

Baseline Parameters

Parameter	Definition	Determination	Value
θ	shape parameter of Fréchet-distributed idiosyncratic abilities	wage dispersion in non-teaching occupations (indirect inference)	1.476
η	goods elasticity of human capital	aggregate education spending share (indirect inference)	0.103
ϕ	time elasticity of human capital	Mincer returns to education (non-teaching) (indirect inference)	0.999
γ	curvature of wage function in teaching	wage dispersion in teaching (indirect inference)	0.83
A_o	occupational productivities (non-teaching)	labor market shares for men	
$\tau^w_{o,\text{women}}$	labor market barriers (non-teaching) faced by women	labor market shares for women	
κ	scale parameter of wage function in teaching	fraction of males who are teachers	
λ_f	aggregate labor market barrier for women in non-teaching occupations	fraction of females who are teachers	

Calibration

Benchmark Calibration

Parameter	Definition	Empirical Targets
β	Teacher elasticity of human capital	Skill composition by occupation and group
σ	Class size elasticity of human capital	Normalization to 1
μ	Trade-off between consumption and time spent accumulating human capital	Schooling of teachers relative to schooling of others

Summing up

Results

- Develop a novel theory of occupational choice and human capital formation:
  - non-linear wages
  - intergenerational dynamics of human capital accumulation
- Calibrate reduction in discrimination & barriers:
  - static gains (as in Hsieh et al., 2019) vs.
  - dynamic effects (human capital accumulation)

Ongoing and Future Work

- Multiple locations differentiated by amenities and/or local tax rates (implicit school segregation by income)

Optimal Time Investment

$$s_{T,g} = \frac{\mu\phi}{\mu\phi + \frac{1}{\gamma} - \eta}$$

$$s_{O,g} = \frac{\mu\phi}{\mu\phi + 1 - \eta}$$

Back

Optimal Goods Investment

$$e_{T,g} = \left((\kappa \cdot \gamma \cdot \eta \cdot \tau_{T,g})^{\frac{1}{\gamma}} \cdot a_T^{\alpha} \cdot s_{T,g}^{\phi} \cdot \left(\frac{2\widetilde{H}_T}{M} \right)^{\sigma} \right)^{\frac{1}{\frac{1}{\gamma} - \eta}}$$

$$e_{O,g} = \left(A'_O \cdot \eta \cdot \tau_{O,g} \cdot a_O^{\alpha} \cdot s_{O,g}^{\phi} \cdot \left(\frac{2\widetilde{H}_T}{M} \right)^{\sigma} \right)^{\frac{1}{1-\eta}}$$

where

$$\tau_{i,g} = \frac{(1-t)(1-\tau_{i,g}^{\omega})}{1+\tau_{i,g}^{e}}$$

Back

Aggregate Laws of Motion

$$\widetilde{H}'_T = \left[(\kappa \cdot \gamma \cdot \eta)^{\frac{\eta}{1-\eta\gamma}} \cdot \left(\frac{2\widetilde{H}_T}{M}\right)^{\frac{\sigma}{1-\eta\gamma}} \right.$$
$$\left. \times \sum_{g=1}^{G} \tau_{T,g}^{\frac{\eta}{1-\eta\gamma}} \cdot \int_0^\infty s_{T,g}^{\frac{\phi}{1-\eta\gamma}} \cdot a^{\frac{\alpha}{1-\eta\gamma}} f_{T,g}(a) da \right]^{\frac{\beta}{\sigma}}$$
$$H'_O = (A'_O \cdot \eta)^{\frac{\eta}{1-\eta}} \cdot \left(\frac{2\widetilde{H}_T}{M}\right)^{\frac{\sigma}{1-\eta}} \cdot \sum_{g=1}^{G} \tau_{O,g}^{\frac{\eta}{1-\eta}} \cdot \int_0^\infty s_{O,g}^{\frac{\phi}{1-\eta}} \cdot a^{\frac{\alpha}{1-\eta}} f_{O,g}(a) da$$

where

$$\tau_{i,g} = \frac{(1-t)(1-\tau_{i,g}^{\omega})}{1+\tau_{i,g}^{e}}$$

Back