

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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 - 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?
⇒ 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

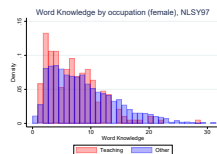
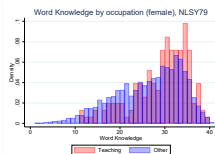
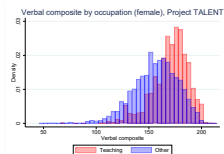
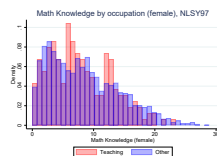
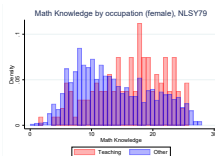
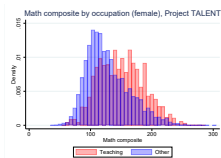
Stylized Fact #3

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:

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

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

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

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

where

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

Model

Constraints, Laws of Motion

$$t \left[\sum_{g=1}^G \int_0^{\infty} \omega_T(h_{T,g}(a)) f_{T,g}(a) da + \sum_{g=1}^G \int_0^{\infty} \omega_O(h_{O,g}(a)) f_{O,g}(a) da \right]$$
$$= \sum_{g=1}^G \int_0^{\infty} \omega_T(h_{T,g}(a)) f_{T,g}(a) da$$

$$f_{T,g}(a) = \int_0^{\bar{a}_g^{-1}(a)} f(a, b) db$$

$$f_{O,g}(b) = \int_0^{\bar{a}_g(b)} f(a, b) da$$

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

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

Model

Occupational Threshold

$$a_{T,g}^*(a_O) = \bar{a}_g(a_O, \tilde{H}_T)$$

such that

$$V_{O,g}(a_O, \tilde{H}_T) = V_{T,g}(a_{T,g}^*(a_O), \tilde{H}_T), \text{ for all } a_O \in (0, \infty)$$

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*
- $\omega(\cdot, \cdot)$ is proportional to the *number of students* in a teacher's class:

$$\omega(h_{T,g}, \tilde{H}_T) = \lambda N(h^T, \tilde{H}^T)$$

$$\begin{aligned}
 &= \frac{H'^O A'^O}{\frac{M}{2} \sum_{g=1}^G \int_0^\infty f_{O,g}(a) da} \cdot \overbrace{N(1, \tilde{H}^T) (h^T)^{\frac{\beta}{\sigma}}}^{\substack{= \frac{M}{2} \frac{1}{\tilde{H}^T}}} \\
 &\quad \text{total output (next period)} \\
 &= \frac{\overbrace{H'_O A'_O}}{\underbrace{\sum_{g=1}^G \int_0^\infty f_{O,g}(a) da}_{\substack{\text{fraction of prospective} \\ \text{production workers in class}}}} \cdot \underbrace{\frac{(h_{T,g})^{\frac{\beta}{\sigma}}}{\tilde{H}_T}}_{\substack{\text{fraction of students taught}}}
 \end{aligned}$$

Equilibrium

Given occupational choices of today's "old" and aggregate human capital \tilde{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

▶ Wage Profile ▶ Parameter Restrictions

Occupational Choice Boundary...

...does not depend on aggregate state $\widetilde{H^T}$

$$\begin{aligned} & \frac{a_O^{\frac{\alpha}{1-\eta}}}{\bar{a}_T(a_O)^{\frac{\alpha\beta}{\sigma-\eta\beta}}} \cdot \frac{\tau_{O,g}^{\frac{1}{1-\eta}}}{\tau_{T,g}^{\frac{\sigma}{\sigma-\eta\beta}}} \cdot \frac{1-\eta}{1-\frac{\beta\eta}{\sigma}} \cdot \frac{1+\tau_{O,g}^e}{1+\tau_{T,g}^e} \cdot \left(\frac{1-s_{O,g}}{1-s_{T,g}} \right)^{\frac{1}{\mu}} \cdot \frac{s_{O,g}^{\frac{\phi}{1-\eta}}}{s_{T,g}^{\frac{\phi\beta}{\sigma-\eta\beta}}} \\ &= \frac{\sum_{g=1}^G \tau_{O,g}^{\frac{\eta}{1-\eta}} \cdot s_{O,g}^{\frac{\phi}{1-\eta}} \cdot \int_0^\infty a^{\frac{\alpha}{1-\eta}} f_{O,g}(a) da}{\sum_{g=1}^G \tau_{T,g}^{\frac{\eta\beta}{\sigma-\eta\beta}} \cdot s_{T,g}^{\frac{\phi\beta}{\sigma-\eta\beta}} \cdot \int_0^\infty a^{\frac{\alpha\beta}{\sigma-\eta\beta}} f_{T,g}(a) da \cdot \sum_{g=1}^G \int_0^\infty f_{O,g}(a) da} \end{aligned}$$

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:

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

Calibration

Assumptions and Normalization

Parameter	Definition	Determination	Value
$\tau_{i,men}^w$	Labor market barriers for men	Assumption	0
$\tau_{i,men}^e$	Human capital barriers for men	Assumption	0
$\tau_{T,g}^w$	Labor market barriers for all groups	Assumption	0
$\tau_{T,g}^e$	Human capital barriers for all groups	Assumption	0
$\tau_{i,g}^e$	Human capital barriers for other groups	Normalization	0
A_T	Teachers productivity	Normalization	1
μ_a	Mean ability distribution	Normalization	0
σ_a	St.dev. ability distribution	Normalization	1

Calibration

Baseline Parameters

Param.	Definition	Determination
α	Ability elasticity of human capital	Wage dispersion
η	Goods elasticity of human capital	Aggregate education spending share
ϕ	Time elasticity of human capital	Mincerian return to education for other
A_i	Occupation-specific productivity	Labor market shares for men
$\tau_{i,g}^w$	Labor market barriers for other groups	Group gap in labor market shares by occupation

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
λ_m	Scale for male labor market barriers	Share of teachers among men
λ_f	Scale for other group labor market barriers	Share of teachers among other group

Summing up

Results

- ▶ 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

Ongoing and Future Work

- ▶ Calibrate reduction in discrimination & barriers:
 - static gains (as in Hsieh et al., 2019) vs.
 - dynamic effects (human capital accumulation)
- ▶ Multiple locations differentiated by amenities and/or local tax rates (implicit school segregation by income)

Optimal Time Investment

$$s_{T,g} = \frac{\mu\phi}{\mu\phi + \frac{\beta}{\sigma} - \eta}$$

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

► Back

Optimal Goods Investment

$$\begin{aligned}
e_{T,g} &= \frac{\beta}{\sigma} \cdot \eta^{\frac{1}{1-\eta}} \cdot \left(\frac{2\tilde{H}_T}{M} \right)^{\frac{1}{1-\eta}} \\
&\times \frac{\sum_{g=1}^G A'_O{}^{\frac{1}{1-\eta}} \cdot \tau_{O,g}^{\frac{\eta}{1-\eta}} \cdot s_{O,g}^{\frac{\phi}{1-\eta}} \cdot \int_0^\infty a^{\frac{\alpha}{1-\eta}} f_{O,g}(a) da}{\sum_{g=1}^G f_{O,g}(a) da} \\
&\times \frac{\tau_{T,g}^{\frac{\sigma}{\sigma-\eta\beta}} \cdot s_{T,g}^{\frac{\phi\beta}{\sigma-\eta\beta}} \cdot a_T^{\frac{\alpha\beta}{\sigma-\eta\beta}}}{\sum_{g=1}^G \tau_{T,g}^{\frac{\eta\beta}{\sigma-\eta\beta}} \cdot s_{T,g}^{\frac{\phi\beta}{\sigma-\eta\beta}} \cdot \int_0^\infty a^{\frac{\alpha\beta}{\sigma-\eta\beta}} f_{T,g}(a) da} \\
e_{O,g} &= \left(\tau_{O,g} \cdot \eta \cdot \left(\frac{2\tilde{H}_T}{M} \right)^\sigma \cdot A'_O{}^\eta \cdot s_{O,g}^\phi \cdot a_O^\alpha \right)^{\frac{1}{1-\eta}}
\end{aligned}$$

Aggregate Laws of Motion

$$\begin{aligned} \tilde{H}'_T &= \left[\left(\frac{\beta}{\sigma} \right)^\eta \cdot \eta^{\frac{1}{1-\eta}} \cdot \left(\frac{2\tilde{H}_T}{M} \right)^{\frac{\sigma}{1-\eta}} \right. \\ &\times \left(\frac{\sum_{i=2}^I \sum_{g=1}^G A'_i{}^{\frac{1}{1-\eta}} \cdot \tau_{i,g}^{\frac{\eta}{1-\eta}} \cdot s_{i,g}^{\frac{\phi}{1-\eta}} \cdot \int_0^\infty a^{\frac{\alpha}{1-\eta}} f_{i,g}(a) da}{\sum_{i=2}^I \sum_{g=1}^G f_{i,g}(a) da} \right)^\eta \\ &\times \left. \left(\sum_{g=1}^G \tau_{T,g}^{\frac{\eta\beta}{\sigma-\eta\beta}} \cdot s_{T,g}^{\frac{\phi\beta}{\sigma-\eta\beta}} \cdot \int_0^\infty a^{\frac{\alpha\beta}{\sigma-\eta\beta}} f^{g,T}(a) da \right)^{\frac{\sigma-\eta\beta}{\beta}} \right]^{\frac{\beta}{\sigma}} \\ H'_O &= \sum_{g=1}^G \left(\tau_{O,g}^\eta \cdot \eta^\eta \cdot \left(\frac{2\tilde{H}_T}{M} \right)^{\frac{\sigma}{1-\eta}} \cdot A'^\eta_O \cdot s_{T,g}^\phi \right)^{\frac{1}{1-\eta}} \cdot \int_0^\infty a^{\frac{\alpha}{1-\eta}} f_{O,g}(a) da \end{aligned}$$

Teacher's Wage Profile

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

$$\times \frac{\tau_{T,g}^{\frac{\eta\beta}{\sigma-\eta\beta}} \cdot s_{T,g}^{\frac{\phi\beta}{\sigma-\eta\beta}} \cdot a_T^{\frac{\alpha\beta}{\sigma-\eta\beta}}}{\sum_{g=1}^G \tau_{T,g}^{\frac{\eta\beta}{\sigma-\eta\beta}} \cdot s_{T,g}^{\frac{\phi\beta}{\sigma-\eta\beta}} \cdot \int_0^\infty a^{\frac{\alpha\beta}{\sigma-\eta\beta}} f_{g,T}(a) da}$$

► Back

Some Parameter Restrictions

- ▶ $\beta < 1 - \eta$ to guarantee existence of stable $\widetilde{H}^T = \widetilde{H}^{T'} > 0$
- ▶ $\frac{\sigma}{\beta} > \eta$ and $\mu\phi > 0$ for $s^{T*} \in (0, 1)$
- ▶ $1 > \eta$ and $\mu\phi > 0$ for $s^{O*} \in (0, 1)$

▶ Back