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
  - 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
  - intergenerational dynamics of human capital accumulation
- Combine three longitudinal surveys:
  - Project TALENT, NLSY79, NLSY97

Stylized Fact #1

Majority of (Public) School Teachers is Female

Time Period		% Female
early 70s	Project TALENT	61.1
	Census 1980	59.8
1986-1993	NLSY79	77.7
	Census 1990	74.8
2009-2013	NLSY97	77.1
	ACS 2009-2013	76.4
2003-2004	NCES (2006)	75

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

Trends in Occupational Choice

- Share of women in labor force who choose teaching:
  9.5% in 1970 to 9.0% in 2010
- Share of men in labor force who choose teaching:
  2.9% in 1970 to 2.5% in 2010
- Sharp rise in female labor force participation rate:
  33.8% in 1970 to 64.4% in 2010
- Decline in male labor force participation rate:
  87.5% in 1970 to 77.1% in 2010

Model

Three Major Building Blocks

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

Simple Two-Sector Model

Endowments, Preferences

- Each period, a measure M of agents is born and lives for two periods: "young" and "old"
- $G = 2$ groups of individuals
- $I = 2$ occupations indexed by $i \in \{1, \ldots, I\}$
- Occupational abilities $\vec{a}$ drawn from joint distribution $F(\vec{a})$
- $\log$ preferences over consumption and leisure:

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

Simple Two-Sector 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:

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

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

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

Simple Two-Sector Model

Education Sector

- 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*

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

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

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

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

Simple Two-Sector 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

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

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 investment and occupational choice problems ▸ Time Investment ▸ Goods Investment
2. Aggregate human capital follows the laws of motion ▸ Laws of Motion
3. Government budget constraint is satisfied ▸ Constraint

Occupational Choice Boundary...

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

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

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

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)

Calibration

Calibrate to 1970, 1990, and 2010: 2 groups, 21 sectors

- Assumptions: no barriers for men, no barriers for women in teaching ▸ Assumptions
- Time-invariant parameters: match wage dispersion, educational attainment and investment ▸ Time-Invariant
- Time-varying parameters: match occupational shares ▸ Time-Varying

Preliminary Results

- Ability composition of teachers change over time:
  - Women with lower ability become teachers
    ▸ Distribution of Abilities (female)
  - Men with higher ability become teachers
    ▸ Distribution of Abilities (male)
- Human capital investment decline over time, given ability
  ▸ HC Investment
- More women become teachers
- Fewer men become teachers
- $\Rightarrow$ Same level of aggregate teaching human capital ▸ HC

Counterfactual Experiment 1

- "Freeze" women's occupational barriers at 1970 level (i.e., τ_w constant over time)
- Use occupational productivities from benchmark calibration

Counterfactual 1: Results

- Ability composition of teachers differ:
  - Women with (relatively) higher ability become teachers
    ▸ Distribution of Abilities (female)
  - Men with (relatively) lower ability become teachers
    ▸ Distribution of Abilities (male)
- Human capital investment is (relatively) lower, given ability
  ▸ HC Investment
- (Relatively) fewer women become teachers
- (Relatively) more men become teachers
- $\Rightarrow$ (Relatively) lower level of aggregate teaching human capital ▸ HC

Conclusion

Results

- Develop a novel theory of occupational choice and human capital formation:
  - non-linear wages
  - intergenerational dynamics of human capital accumulation
- Combine Project TALENT, NLSY79, NLSY97

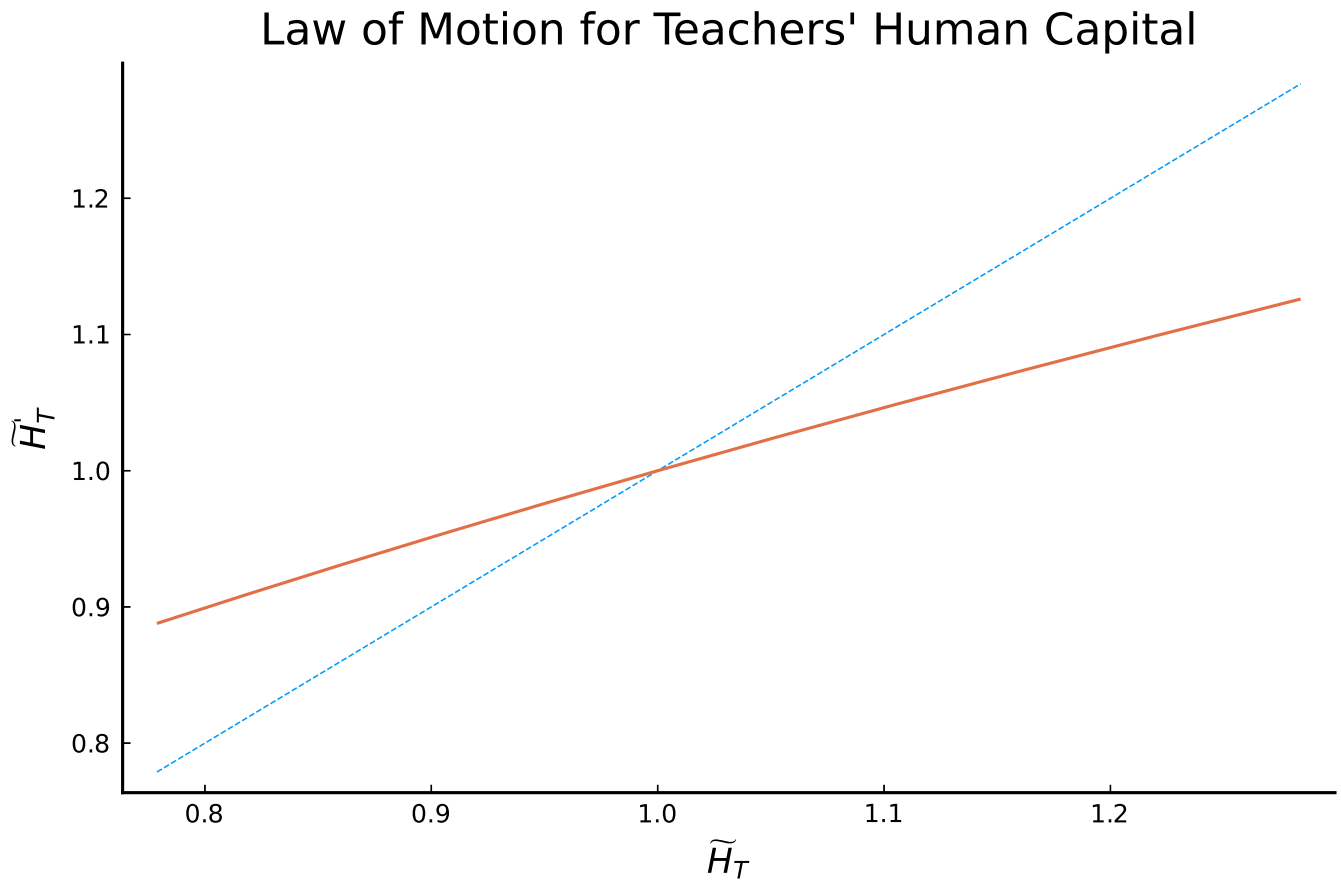
Ongoing and Future Work

- Decomposition:
  - 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)

Occupations

1. Executives, Administrative, and Managerial
2. Management Related
3. Architects, Engineers, Math, and Computer Science
4. Natural and Social Scientists, Recreation, Religious, Arts, Athletes
5. Doctors and Lawyers
6. Nurses, Therapists, and Other Health Service
7. Teachers, Postsecondary
8. Teachers, Non-Postsecondary and Librarians
9. Health and Science Technicians
10. Sales, All
11. Administrative Support, Clerks, Record
12. Fire, Police, and Guards
13. Food, Cleaning, and Personal Services and Private Household
14. Farm, Related Agriculture, Logging, and Extraction
15. Mechanics and Construction
16. Precision Manufacturing
17. Manufacturing Operators
18. Fabricators, Inspectors, and Material Handlers
19. Vehicle Operators
20. Home Production

Law of Motion



Simple Two-Sector Model

Occupational Threshold

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

such that

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

Back

Simple Two-Sector Model

Constraints

$$t\left[\sum_{g=1}^{G}\int_{0}^{\infty}(1-\tau_{T,g}^{\omega})\omega_{T,g}\left(h_{T,g}(a)\right)f_{T,g}(a)da\right.$$
$$\left.+\sum_{g=1}^{G}\int_{0}^{\infty}(1-\tau_{O,g}^{\omega})A_{O}h_{O,g}(a)f_{O,g}(a)da\right]$$
$$=\sum_{g=1}^{G}\int_{0}^{\infty}(1-\tau_{T,g}^{\omega})\omega_{T,g}\left(h_{T,g}(a)\right)f_{T,g}(a)da$$

$$f_{T,g}(a)=\int_{0}^{\bar{a}_{g}^{-1}(a)}f\left(a,b\right)db$$

$$f_{O,g}(b)=\int_{0}^{\bar{a}_{g}(b)}f\left(a,b\right)da$$

Back

Simple Two-Sector Model

Laws of Motion

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

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

Back

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

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
A_{12}	productivity in "Fire, Police,..."	normalization	1
β	elasticity of human capital with respect to teacher's human capital	free parameter	0.5
σ	elasticity of human capital with respect to class size	free parameter	0.5

▸ Back

Calibration

Time-Invariant Parameters

Parameter	Definition	Determination	Value
θ	shape parameter of Fréchet-distributed idiosyncratic abilities	wage dispersion in non-teaching occupations	1.476
η	goods elasticity of human capital	aggregate education spending share	0.103
ϕ	time elasticity of human capital	years of education (non-teaching)	1.028
γ	curvature of wage function in teaching	wage dispersion in teaching	0.83
μ	trade-off between consumption and time spent accumulating human capital	Mincerian returns to education (non-teaching)	0.714

Back

Calibration

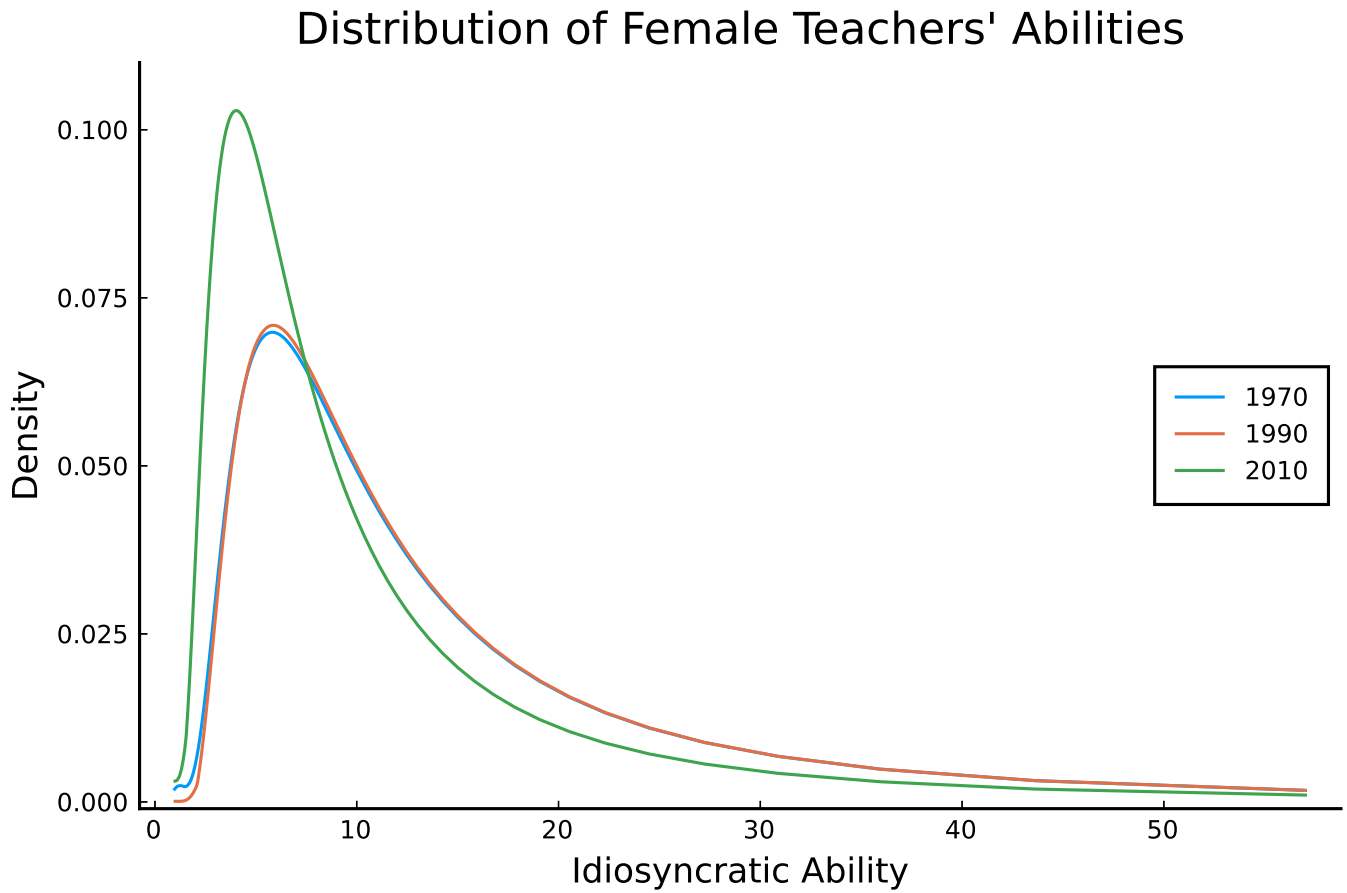
Time-Varying Parameters

Parameter	Definition	Determination
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

Back

Distribution of Teaching Abilities

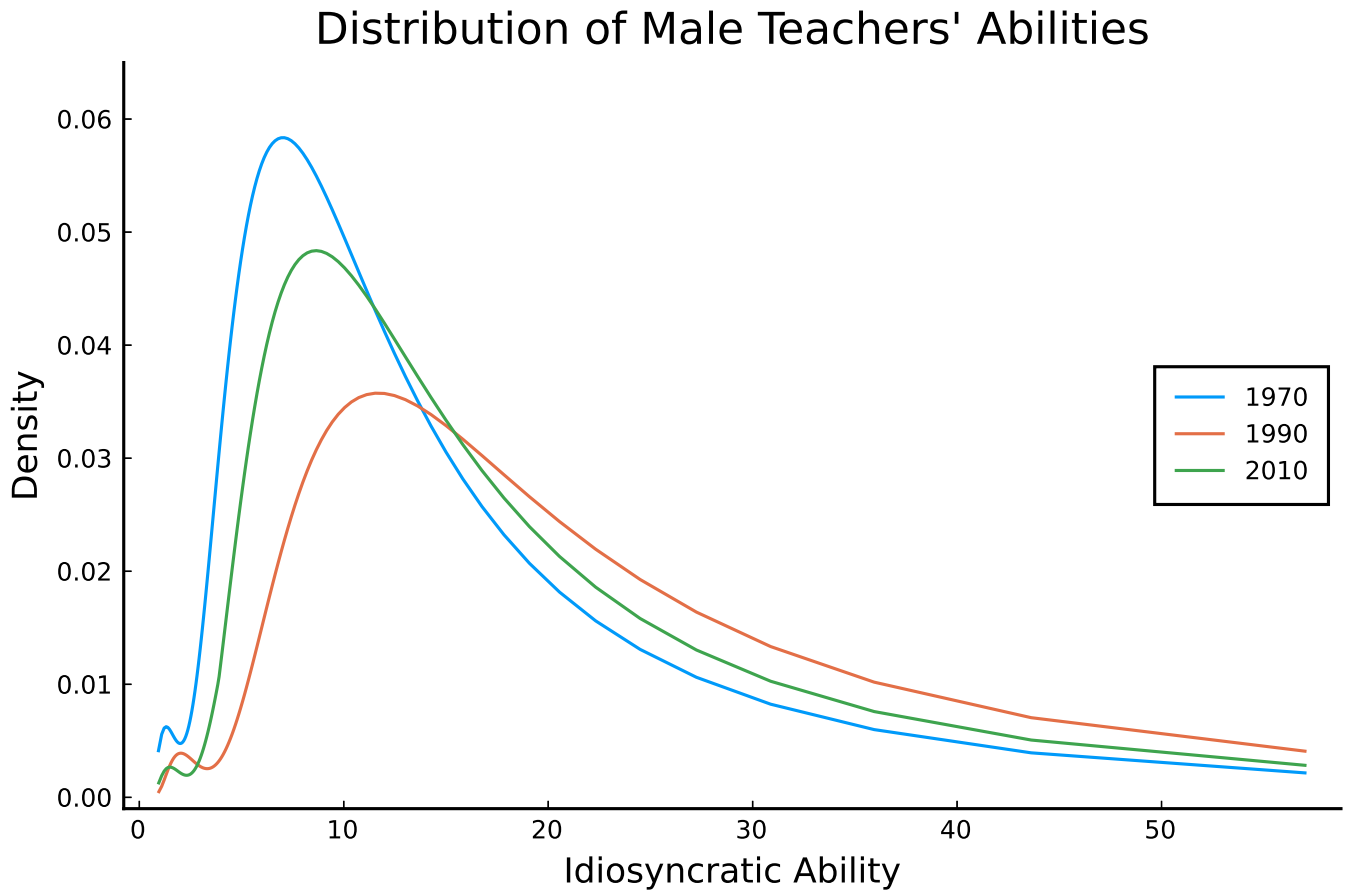
Female workers with lower abilities become teachers



Back

Distribution of Teaching Abilities

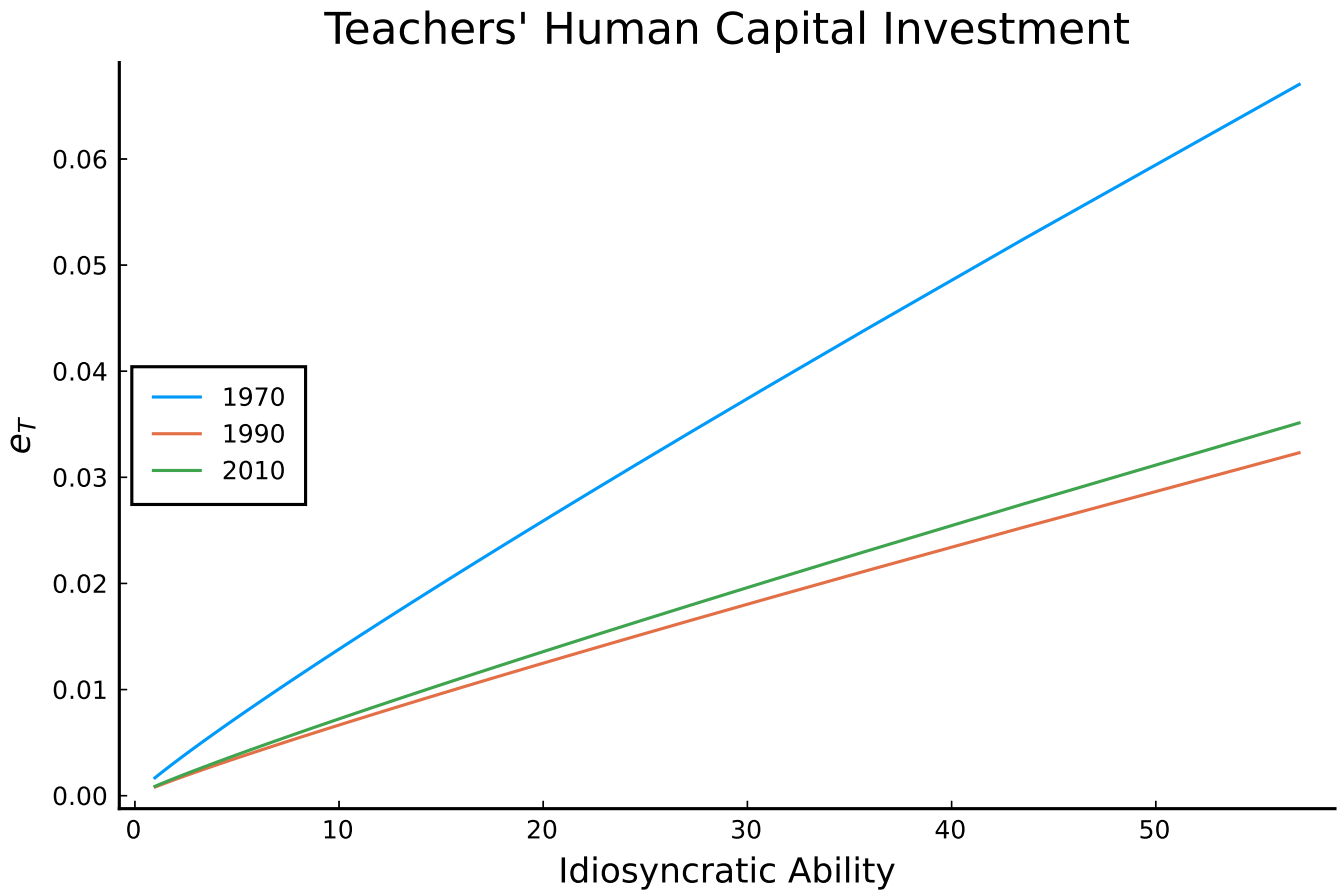
Male workers with higher abilities become teachers



Back

Human Capital Investment

Human capital investment decline over time, given ability



Back

Human Capital

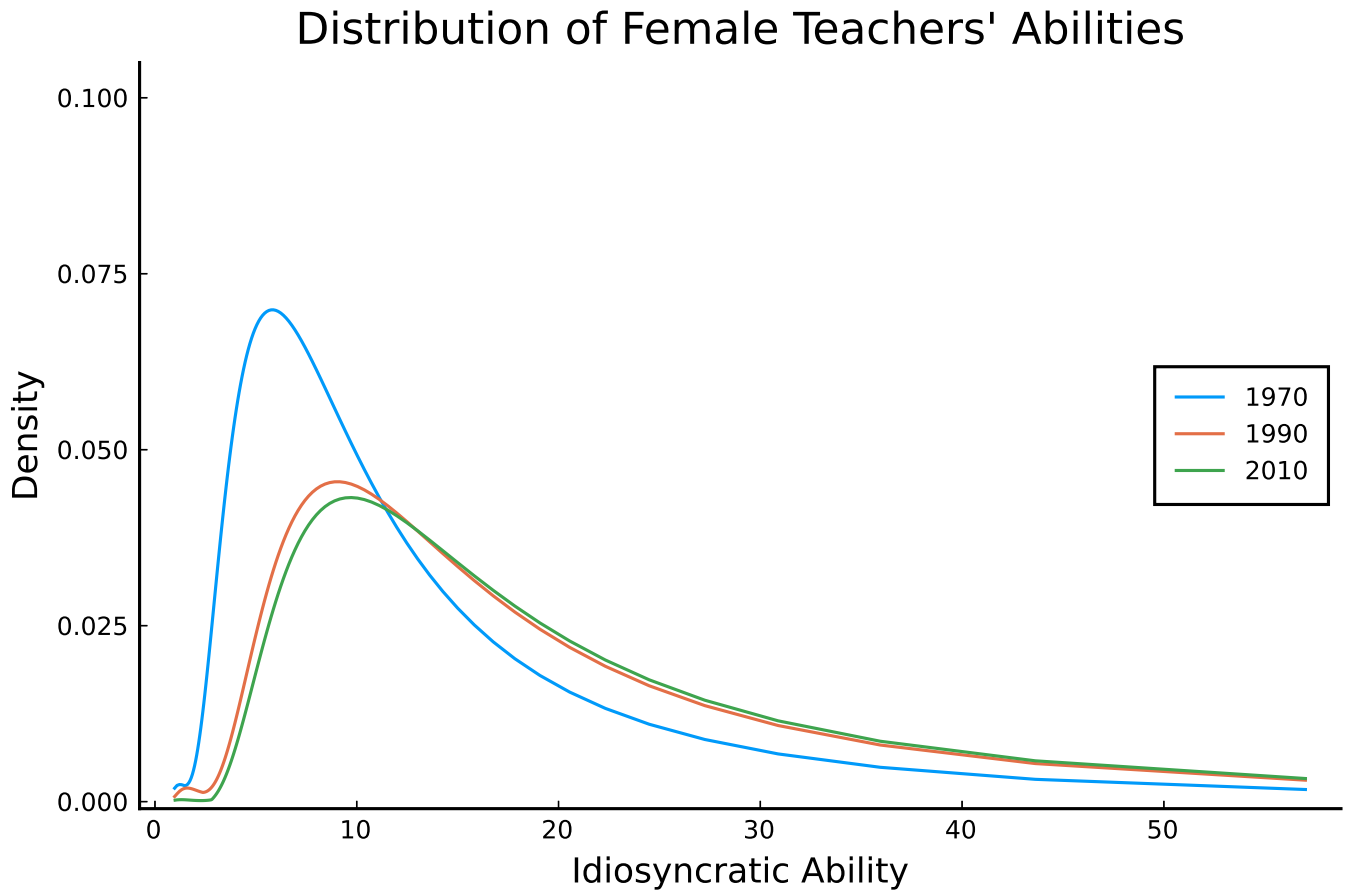
Values Relative to 1970 Calibration

	1970	1990	2010
measure of teachers (female)	1	1.000	1.765
measure of teachers (male)	1	0.462	0.731
$\widetilde{H}^*_T$ per teacher (female)	1	0.732	0.665
$\widetilde{H}^*_T$ per teacher (male)	1	1.069	1.107
$\widetilde{H}^*_T$	1	0.620	1.002

Back

Counterfactual 1: Distribution of Teaching Abilities

Female workers with (relatively) higher abilities become teachers



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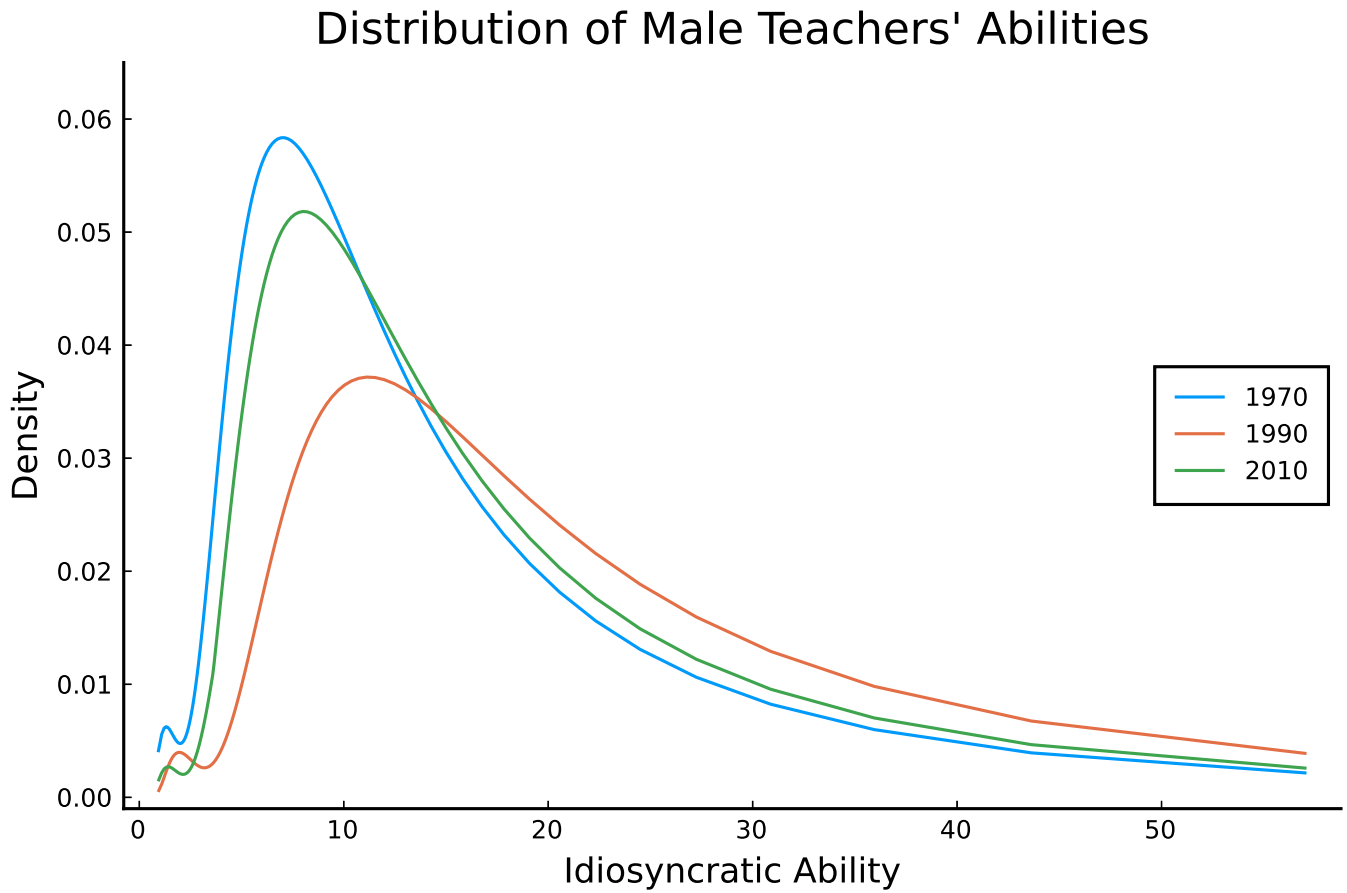
Counterfactual 1: Distribution of Teaching Abilities

Male workers with (relatively) lower abilities become teachers



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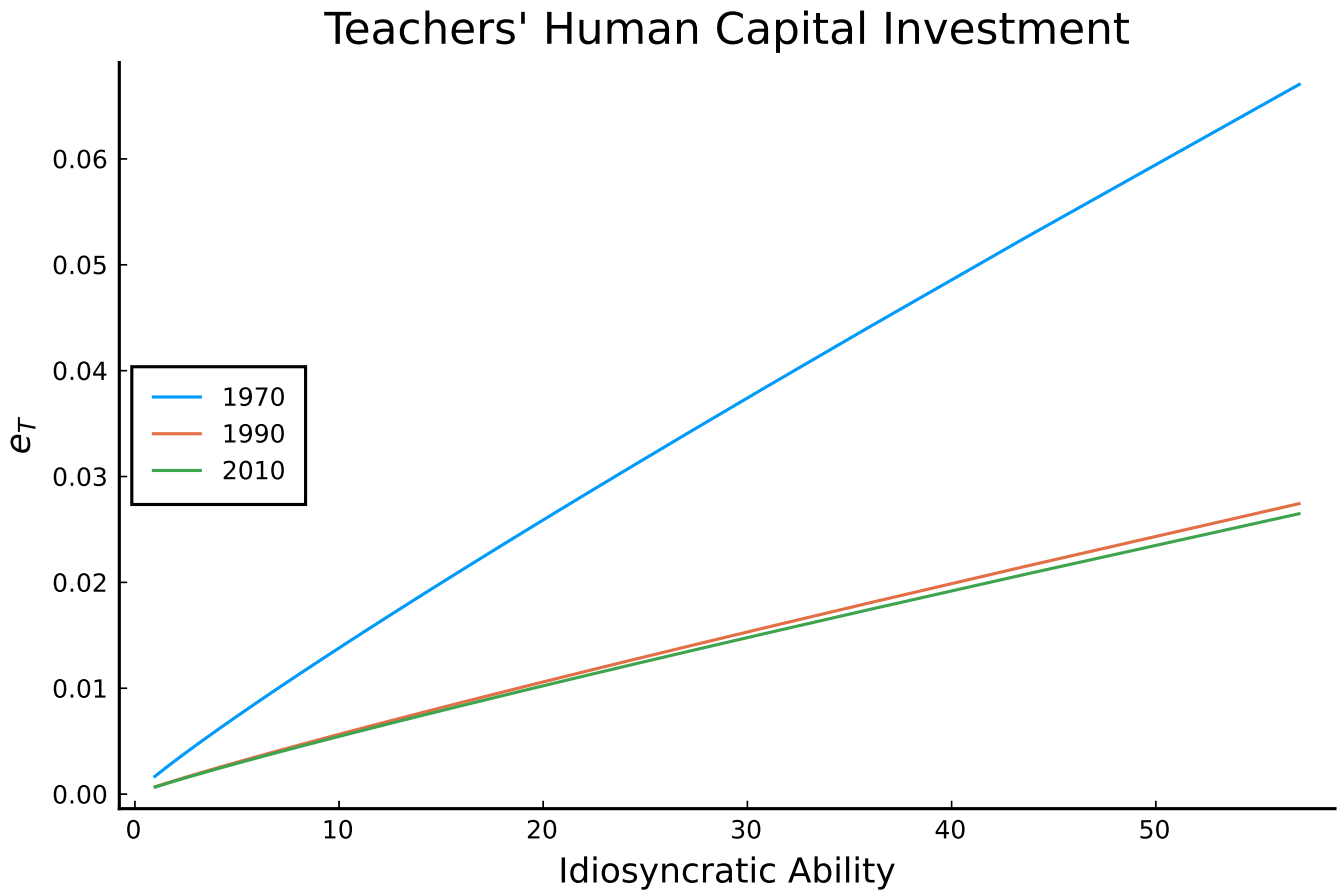
Counterfactual 1: Human Capital Investment

Human capital investment is (relatively) lower, given ability



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Counterfactual 1: Human Capital

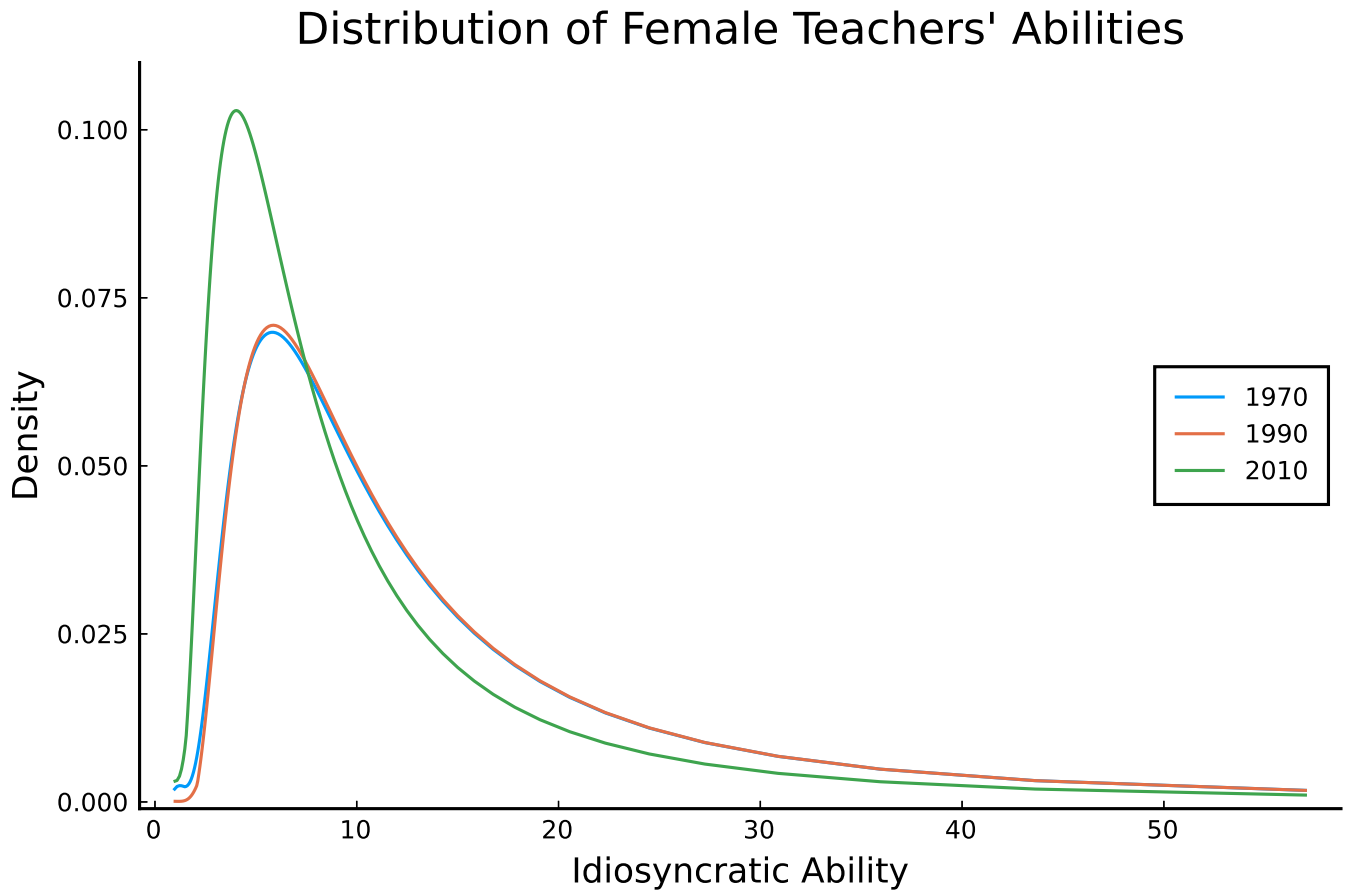
Values Relative to 1970 Benchmark Calibration

	1970	1990	2010
measure of teachers (female)	1	0.482	0.467
measure of teachers (male)	1	0.491	0.813
$\widetilde{H}_T^*$ per teacher (female)	1	0.908	0.991
$\widetilde{H}_T^*$ per teacher (male)	1	0.851	0.739
$\widetilde{H}_T^*$	1	0.428	0.528

▸ Back ▸ Baseline

Baseline: Distribution of Teaching Abilities

Female workers with lower abilities become teachers



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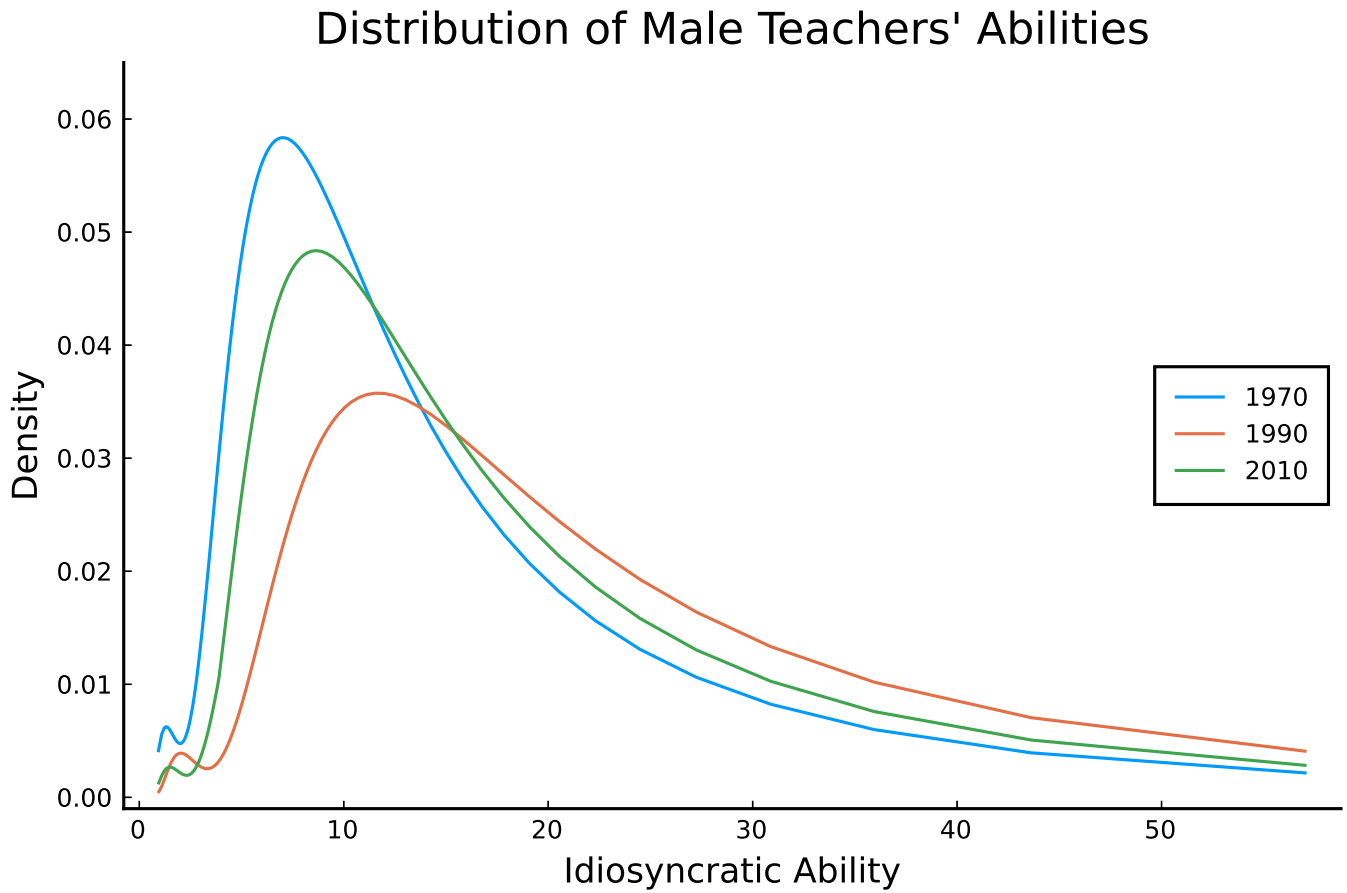

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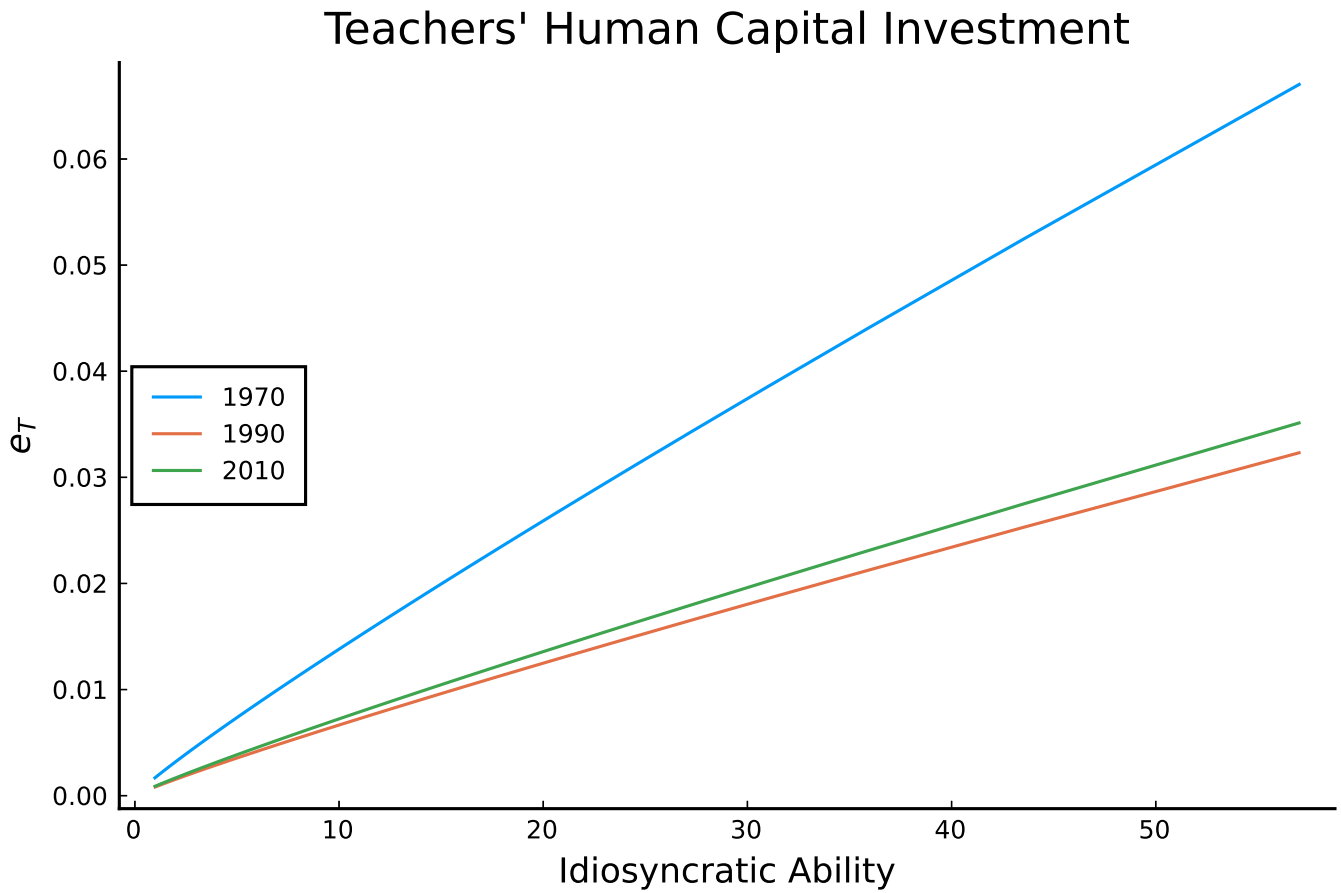

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