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
  - Occupation-specific abilities

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

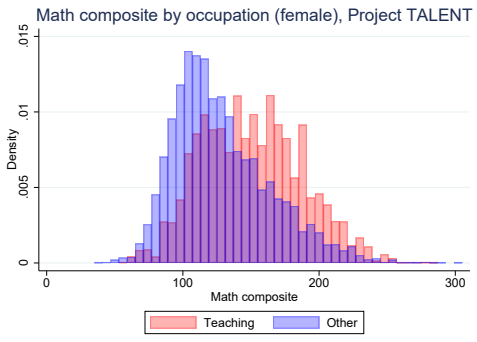
Stylized Fact #3

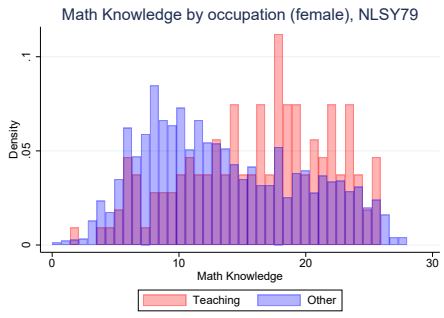
Trends in Occupational Choice

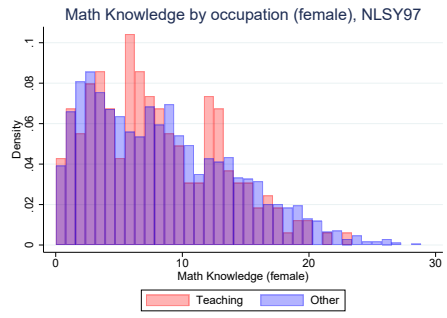
- Share of women choosing teaching:
  3.4% in 1970 to 6.0% in 2010
- Share of men choosing teaching:
  2.6% in 1970 to 1.9% in 2010
- Sharp rise in female labor force participation rate
- Slight decline in male labor force participation rate

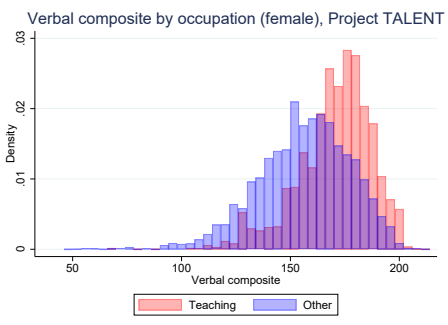
Stylized Fact #4

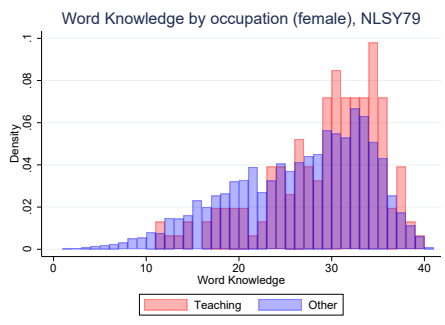
Trends in Ability Distribution of Females by Occupation

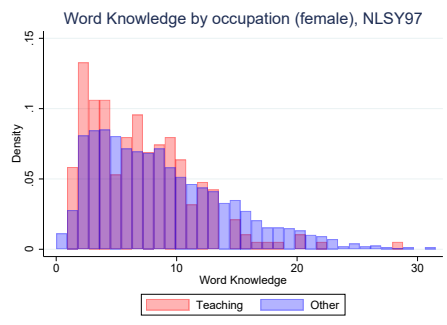












Model

Three Major Building Blocks

- 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
- I 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:

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

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

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

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

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

Simple Two-Sector Model

Constraints

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

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

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

Simple Two-Sector Model

Laws of Motion

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

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

Simple Two-Sector Model

Occupational Threshold

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

such that

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

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*

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

- 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 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

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)

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
σ	elasticity of human capital with respect to class size	normalization	1

Calibration

Baseline Parameters

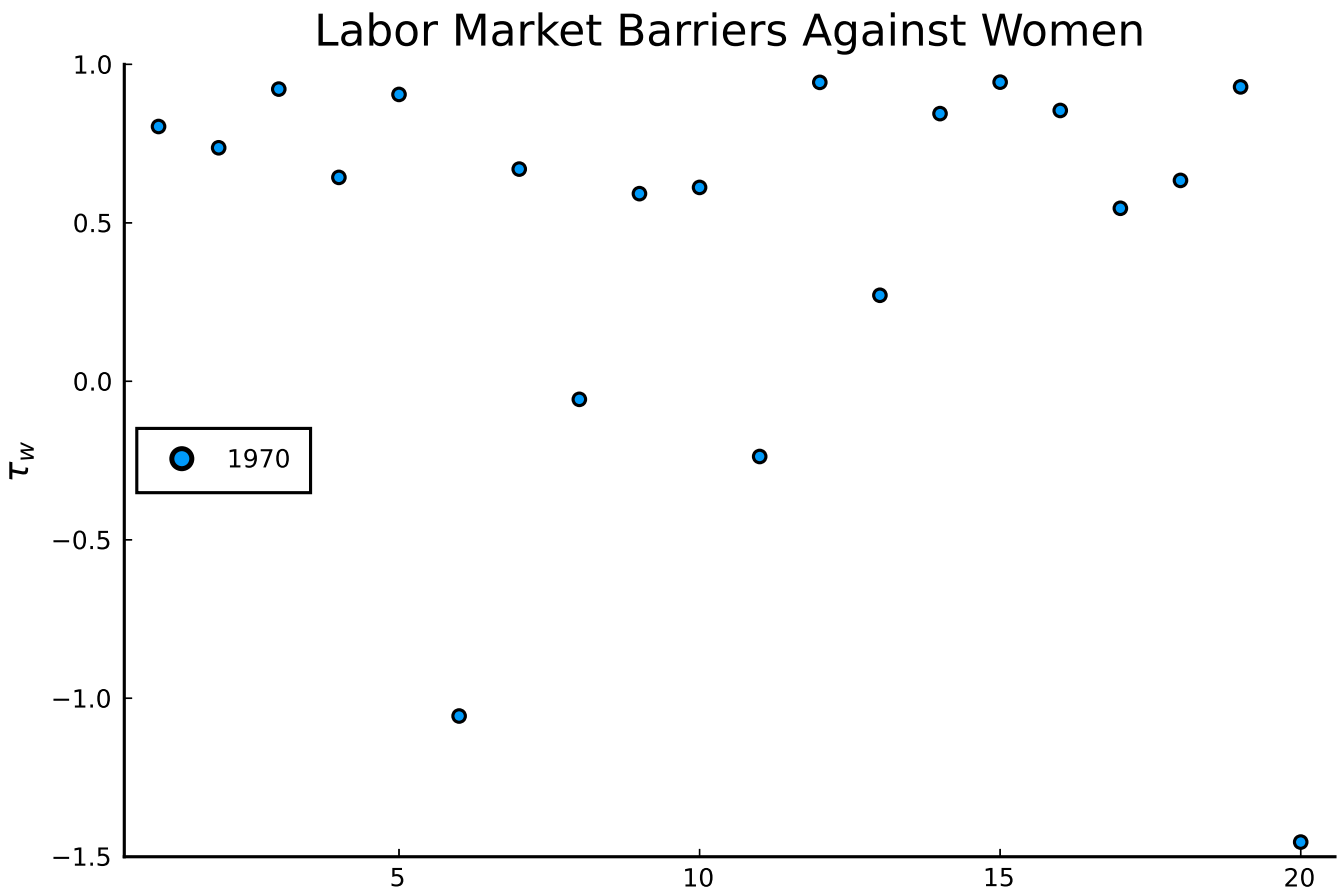
Parameter	Definition	Determination	Value
θ	shape parameter of Fréchet-distributed idiosyncratic abilities	wage dispersion in non-teaching occupations (indirect inference)	1.476
η	goods elasticity of human capital	aggregate education spending share (indirect inference)	0.103
ϕ	time elasticity of human 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
β	elasticity of human capital with respect to teacher's human capital	skill composition by occupation and group	0.5
μ	trade-off between consumption and time spent accumulating human capital	schooling of teachers relative to schooling of others	0.714

Calibration

Baseline Parameters by Year

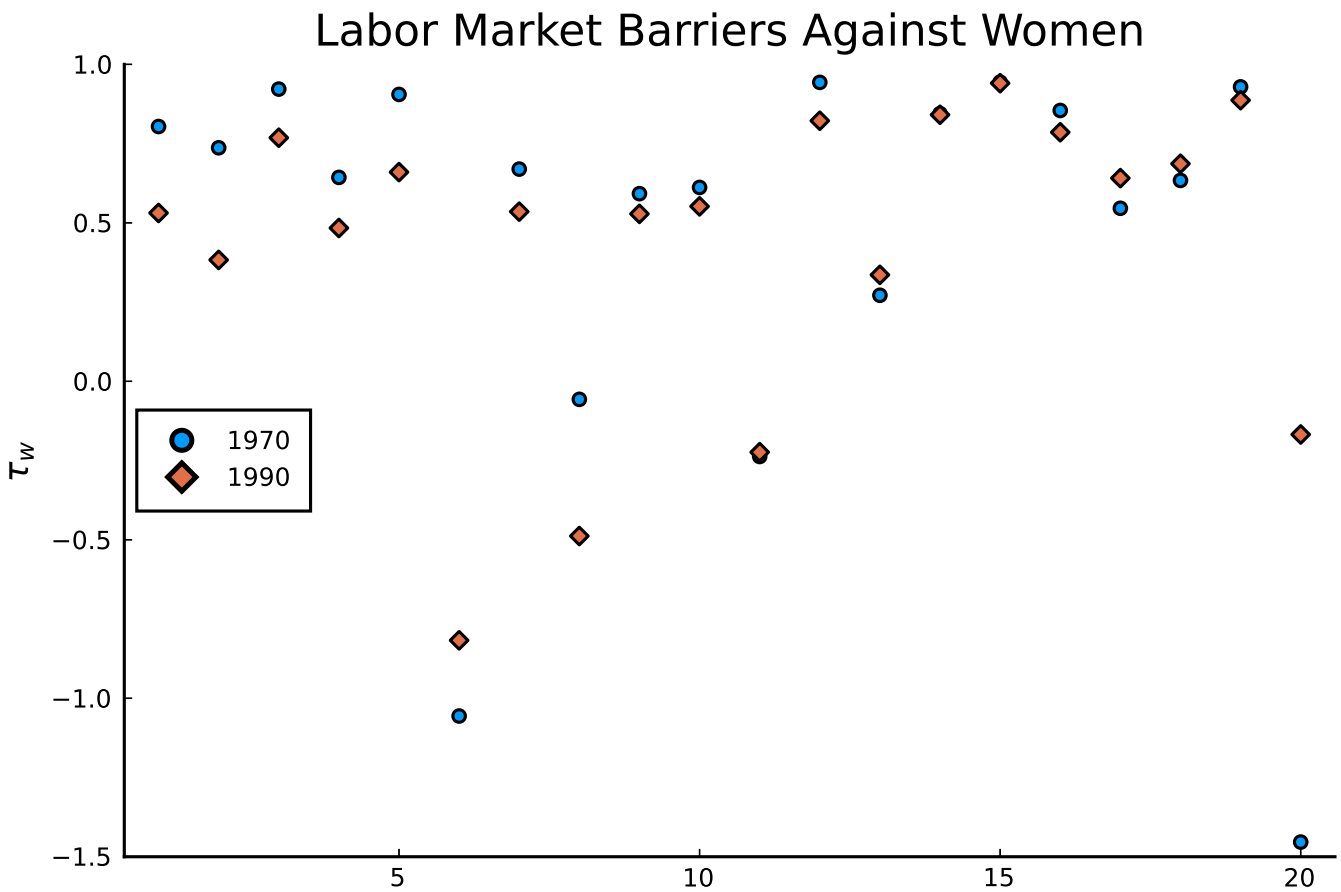
Parameter	Definition	Determination
A_o	occupational productivities (non-teaching)	labor market shares for men
$\tau^w_{o,\text{women}}$	labor market barriers (non-teaching) faced by women	labor market shares for women
κ	scale parameter of wage function in teaching	fraction of males who are teachers
λ_f	aggregate labor market barrier for women in non-teaching occupations	fraction of females who are teachers

Labor Market Barriers



▸ Occupations

Labor Market Barriers



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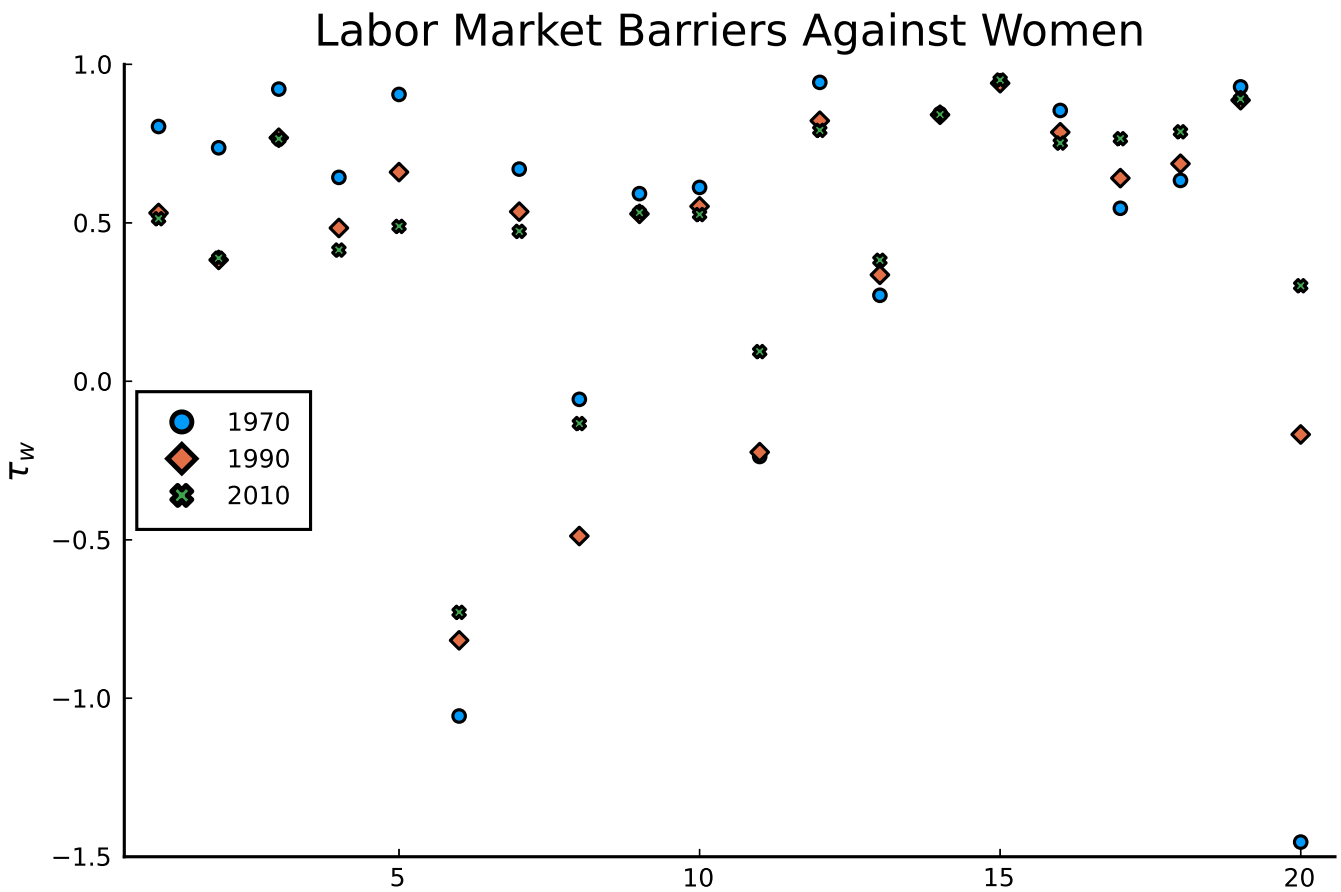
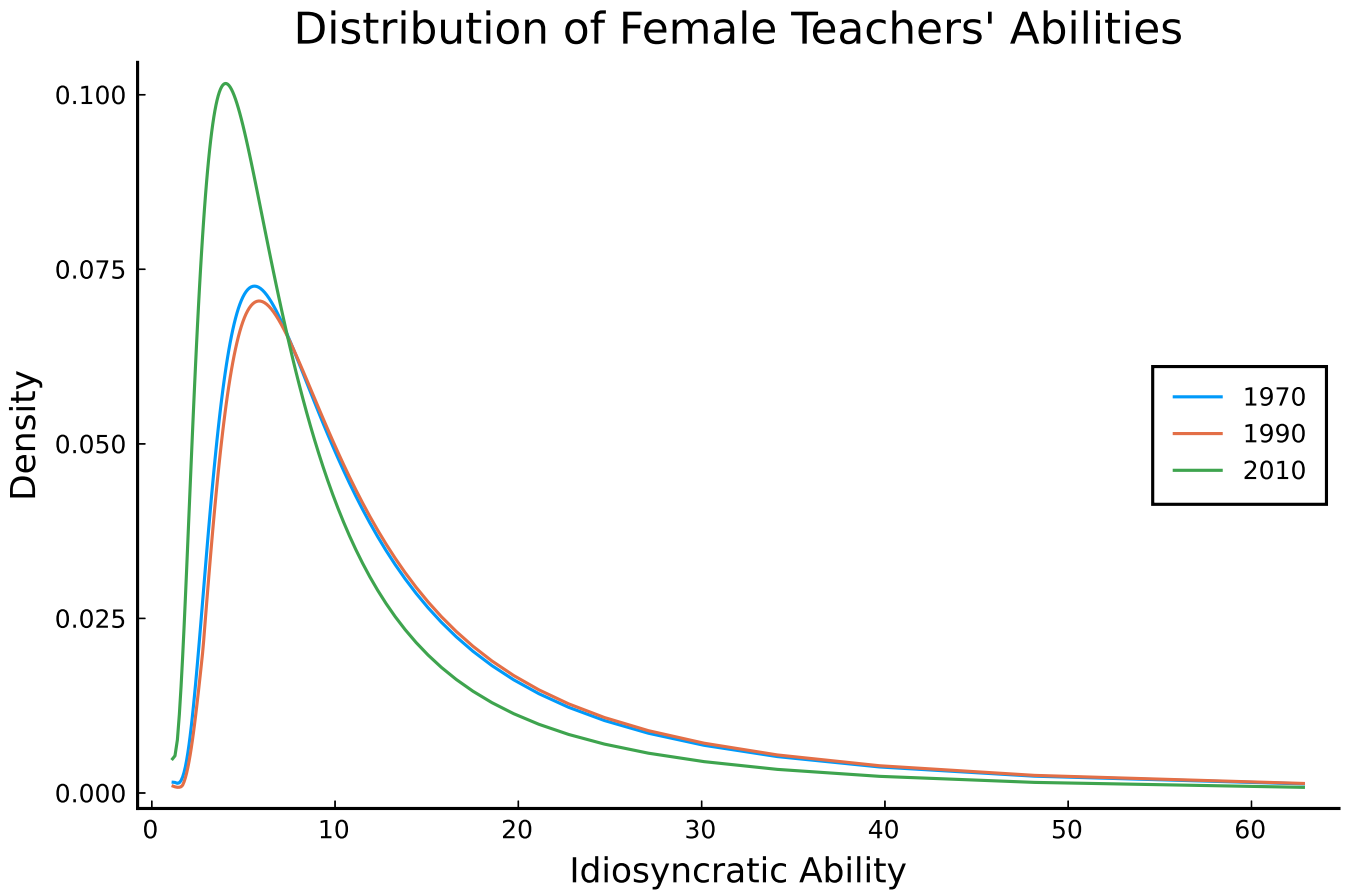


▸ Occupations ▸ Occupational Productivity

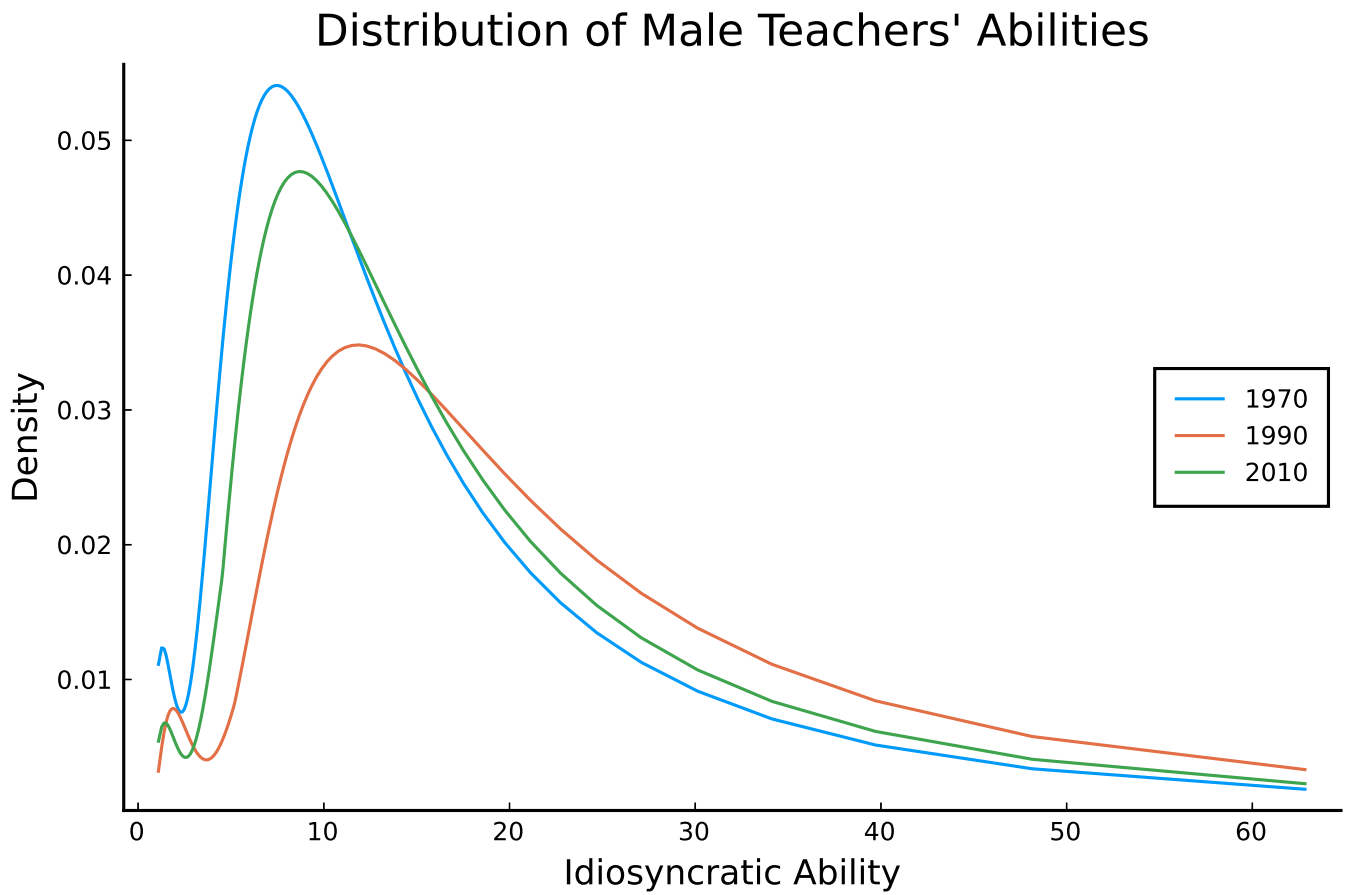
Distribution of Teaching Abilities

Female workers with lower abilities become teachers



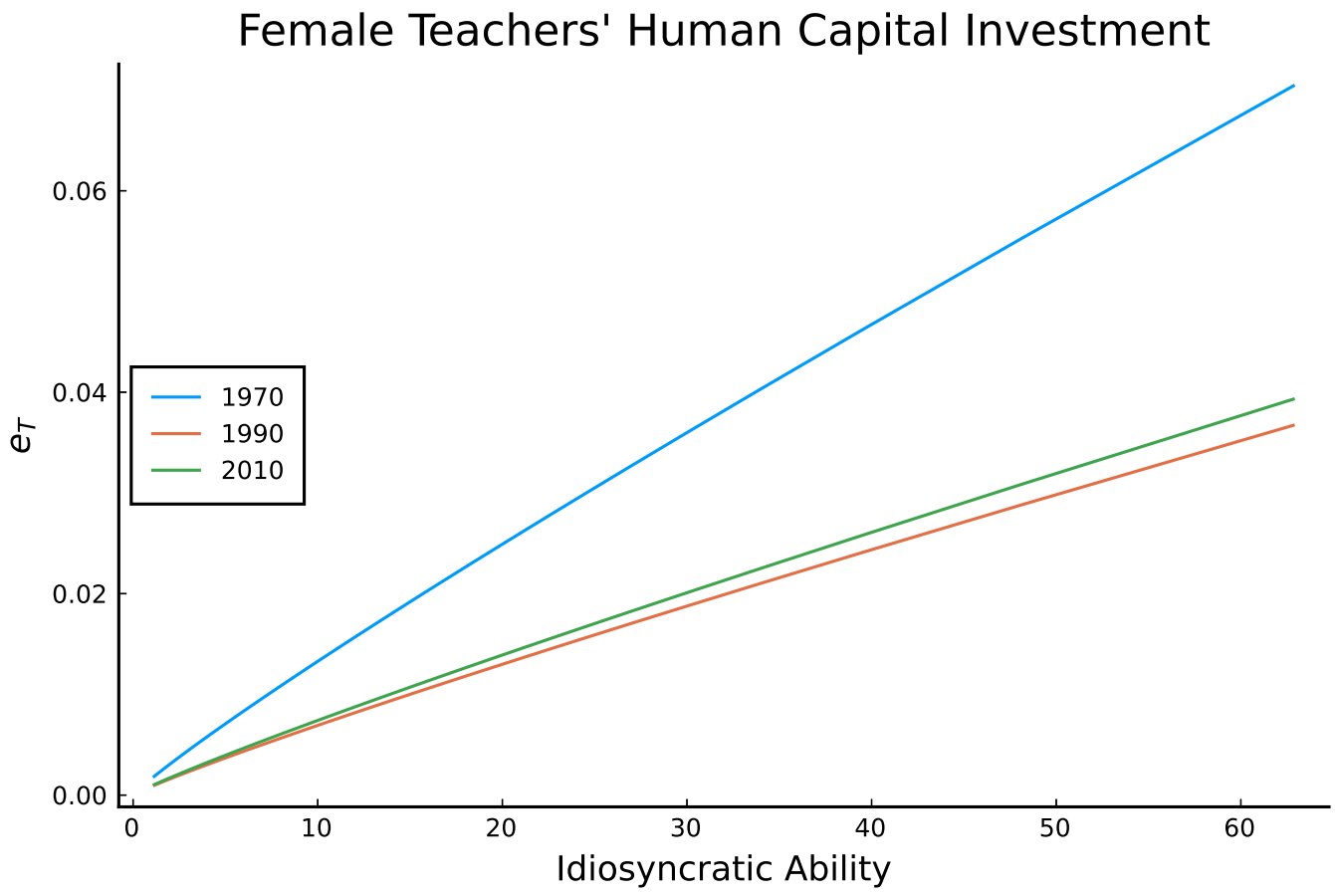
Distribution of Teaching Abilities

Male workers with higher abilities become teachers



Human Capital Investment

Human capital investment decline over time, given ability



Summing up

- Ability composition of teachers change over time:
  - Women with lower ability select into teaching career
  - Men with higher ability select into teaching career
- Human capital investment drop over time, given ability

Conclusion

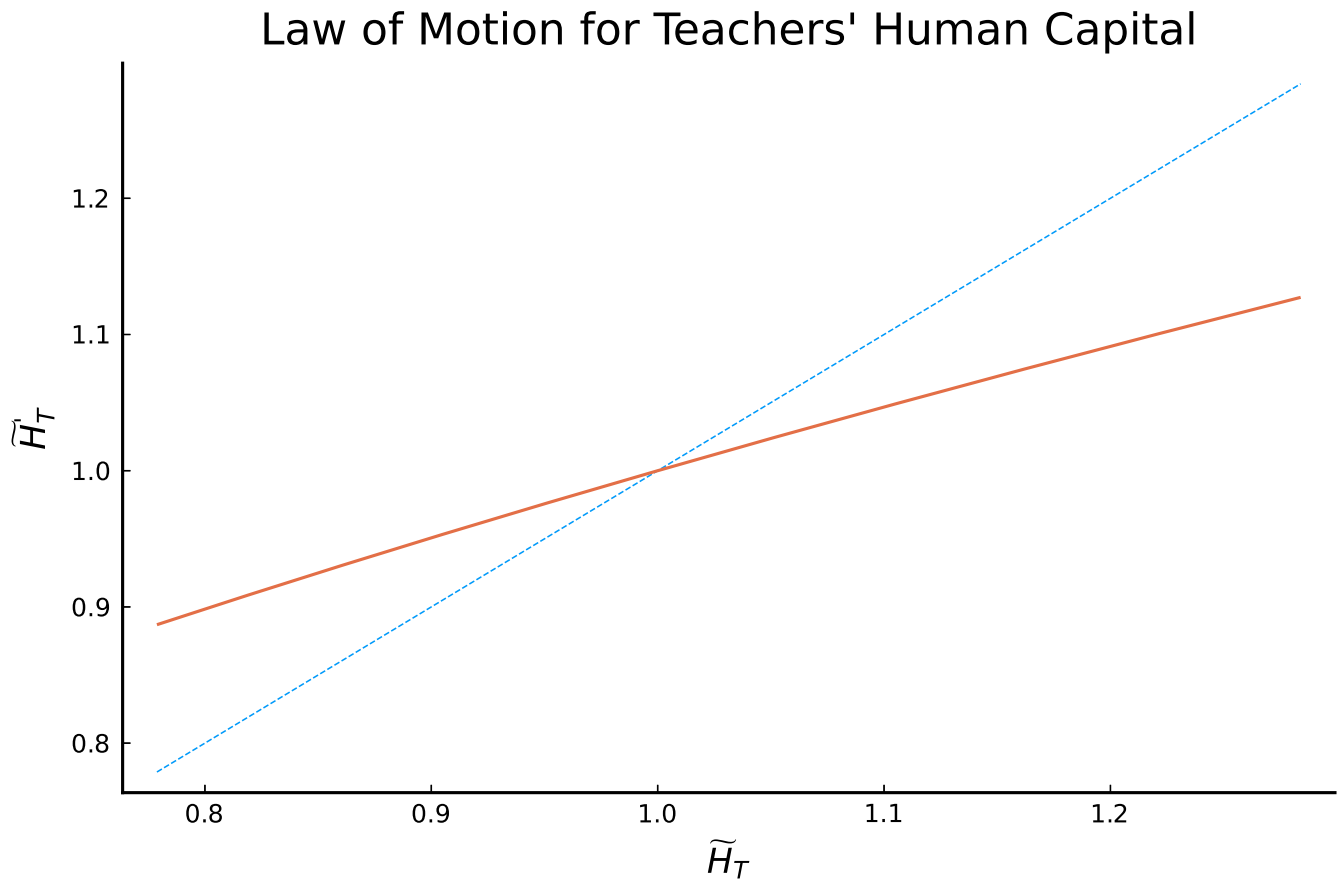
Results

- Develop a novel theory of occupational choice and human capital formation:
  - non-linear wages
  - intergenerational dynamics of human capital accumulation
- Calibrate reduction in barriers

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)

Law of Motion



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

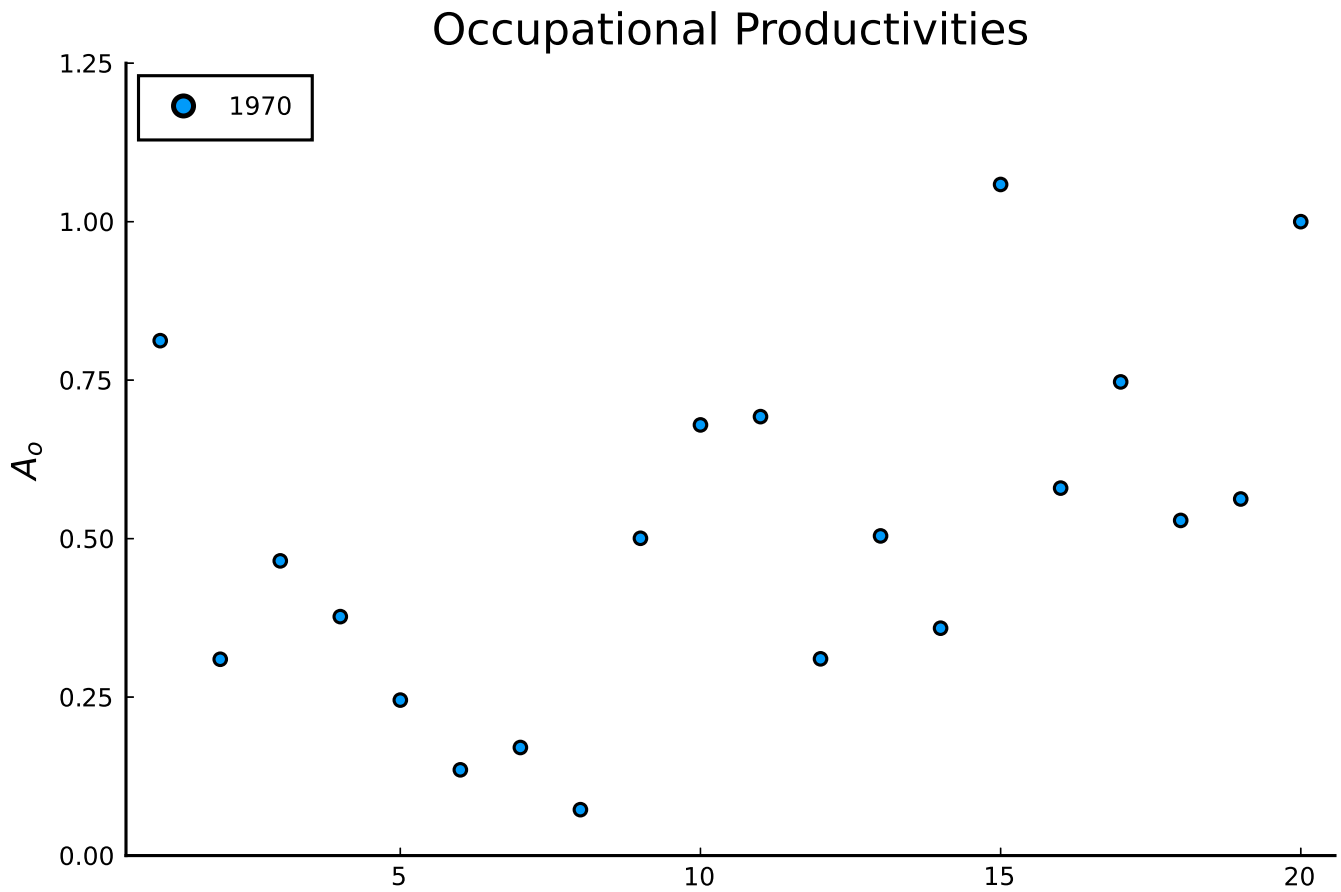
$$\tau_{i,g} = \frac{(1-t)(1-\tau_{i,g}^{\omega})}{1+\tau_{i,g}^{e}}$$

▸ Back

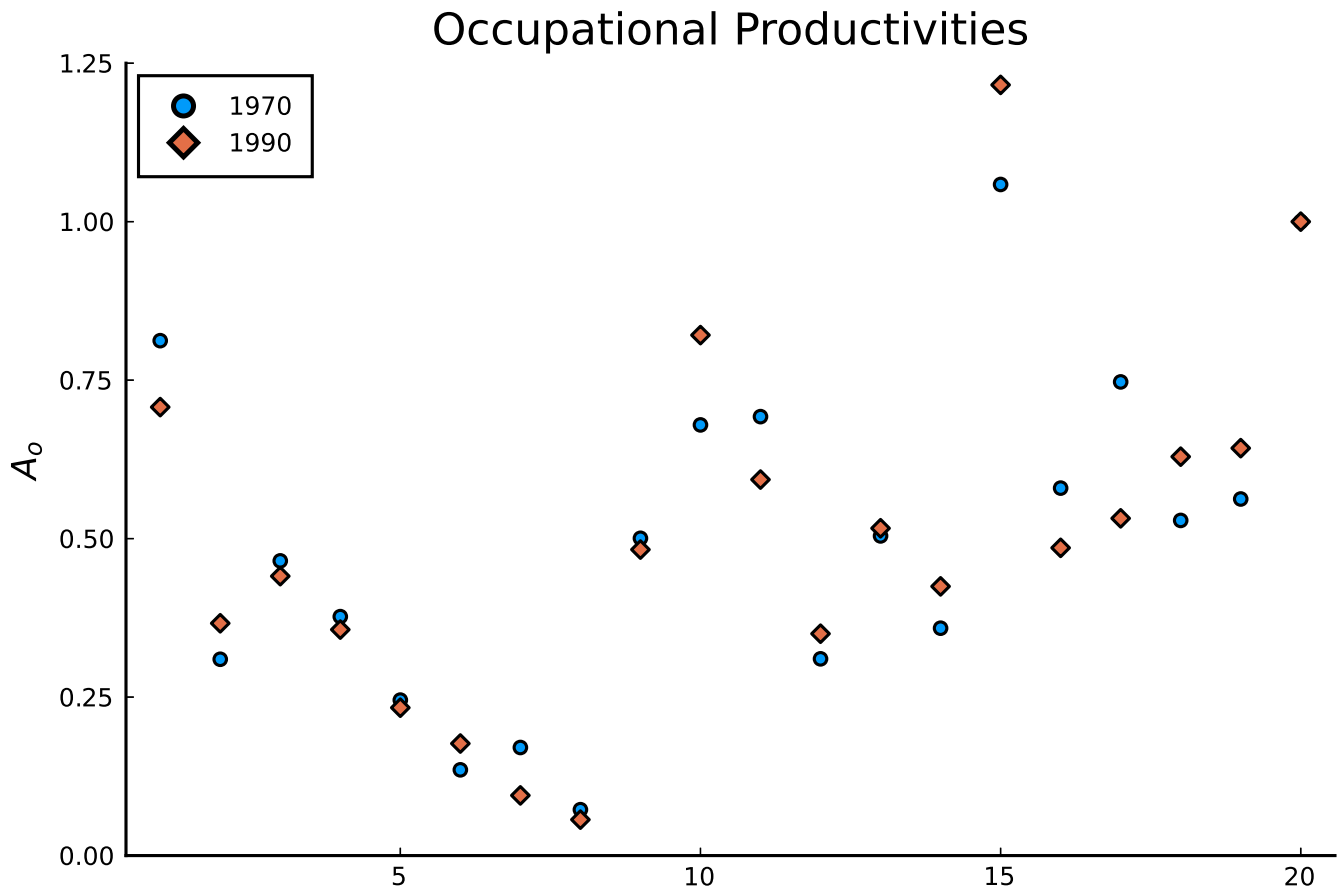
Occupations

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

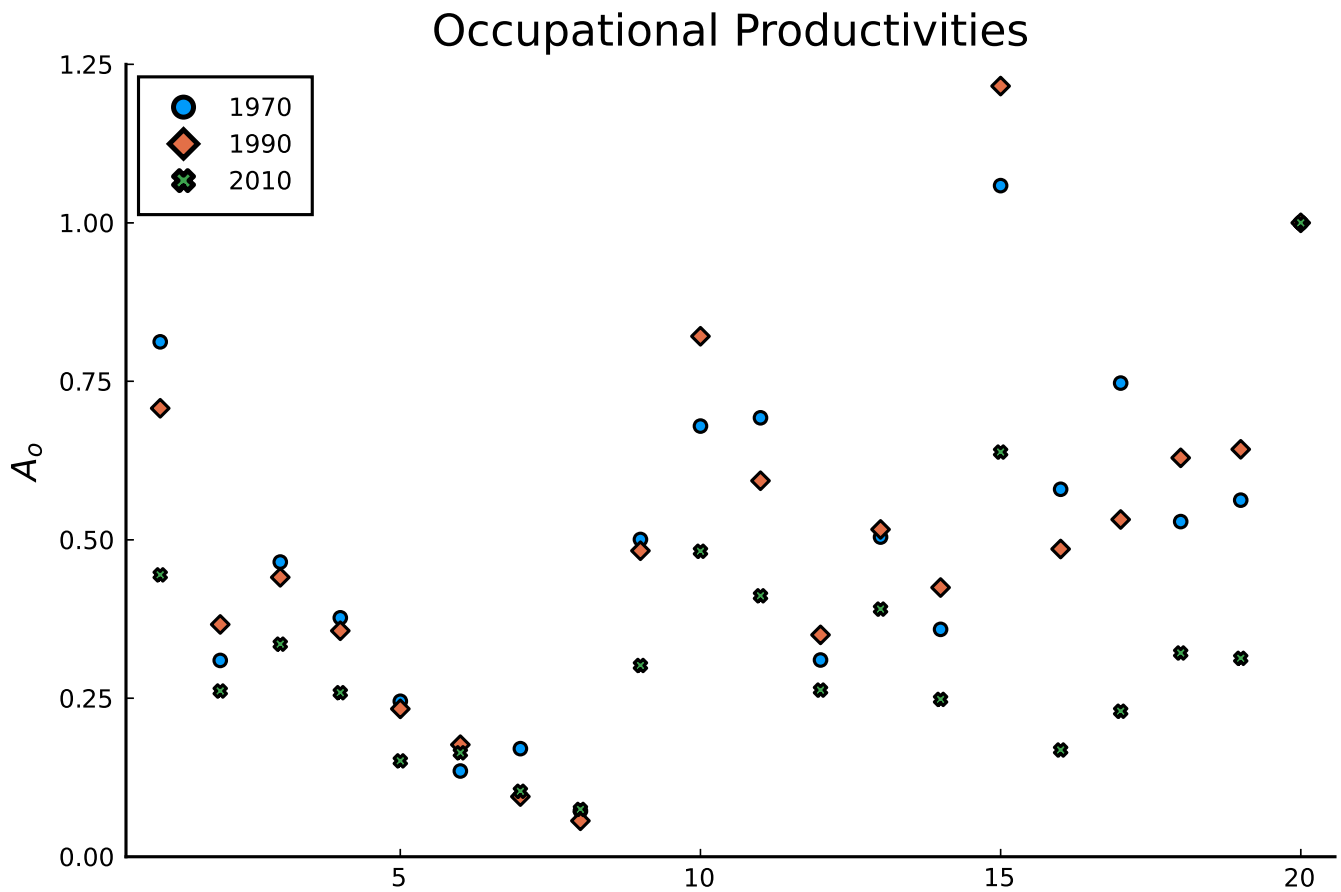
Occupational Productivity



Occupational Productivity



Occupational Productivity



▸ Occupations ▸ Back