The Effects of Technological Change on Schooling and Training Human Capital

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Motivation

- Technological change has considerable impact on human capital, schooling, training, and wage inequality.

- Theoretical studies, such as Gould, Moav, and Weinberg (2001) and Helpman and Rangel (1999), explain effects of technological change on wage inequality and economic transition paths by

    - assuming that technological change only causes obsolescence for training human capital, not for schooling human capital.

- There is little empirical evidence for the differential effects of technological change on schooling and training human capital.

Research Question

- How does technological change affect differently the human capital obtained from schooling (general skills) and that obtained from training (technology-specific skills)?

Methodology

- Incorporate the differential effects of technological change on schooling and training human capital in a model of human capital investment.

- Estimate model parameters with nonlinear least squares method by matching predicted wage profiles to observed ones from data.

- Simulate wage profiles to illustrate the effects of technological change on wage inequality.

Key Findings

- Training human capital is more vulnerable to obsolescence due to technological change than is schooling human capital.

- Individuals with more schooling might enjoy an advantage in dealing with technological change.

Significance

- Provide empirical evidence for differential effects of technological change on the obsolescence of schooling and training human capital.

- Support results from Gould, Moav, and Weinberg (2001) and Helpman and Rangel (1999) on effects of technological change on wage inequality.

Human Capital Production Function

- For training: $h_{I,t} = \alpha_1 h_{S,t-1}{}^{\alpha_2} I_t{}^{\alpha_3} h_{I,t-1}{}^{\alpha_4} + (1-\alpha_5 \pi_t) h_{I,t-1}$
- For schooling: $h_{S,t} = \beta_1 S_t{}^{\beta_2} h_{S,t-1}{}^{\beta_3} + (1-\beta_4 \pi_t) h_{S,t-1}$
- For total human capital: $H_t = h_{S,t}{}^{\gamma_1} h_{I,t}{}^{\gamma_2}$
- Identification of the obsolescence effects of T.C.
  - Two opposing effects of T.C. on H.C.: augmentation effects vs. obsolescence effects
  - α_5 , β_4 represent the net effects of T.C.
  - Given that augmentation effects are probably the same for different types of H.C., α_5 and β_4 indicate the difference in obsolescence effects of T.C. on schooling and training H.C..

Initial States

- Initial schooling human capital

$$\ln h_{S,0} = \theta_1 + \theta_2 \cdot Grade + \theta_3 \cdot AFQT$$

- Initial training human capital

$$\ln h_{I,0} = \lambda_1 + \lambda_2 \cdot Age$$

Data and Sample

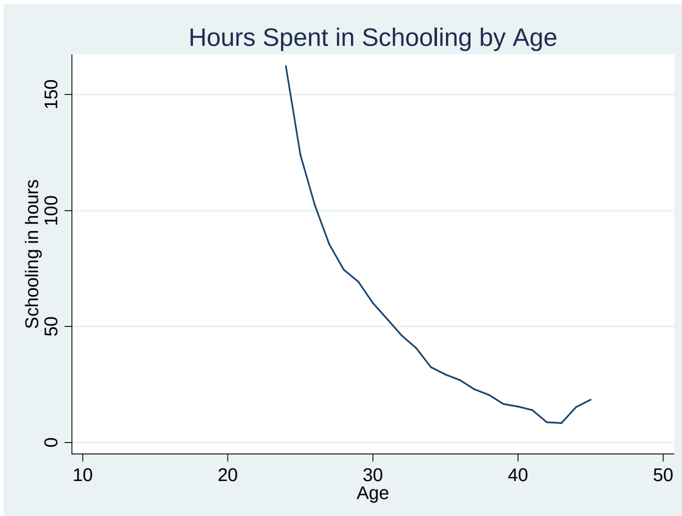
- Micro Dataset
  - National Longitudinal Survey of Youth 79 (1979-2004)

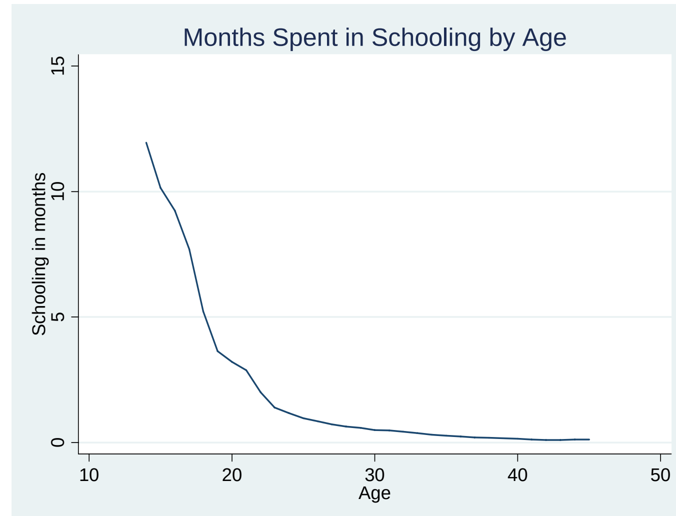
- Sample
  - Civilian white males in core random sample
  - Manufacturing industries
  - Sample size: 351

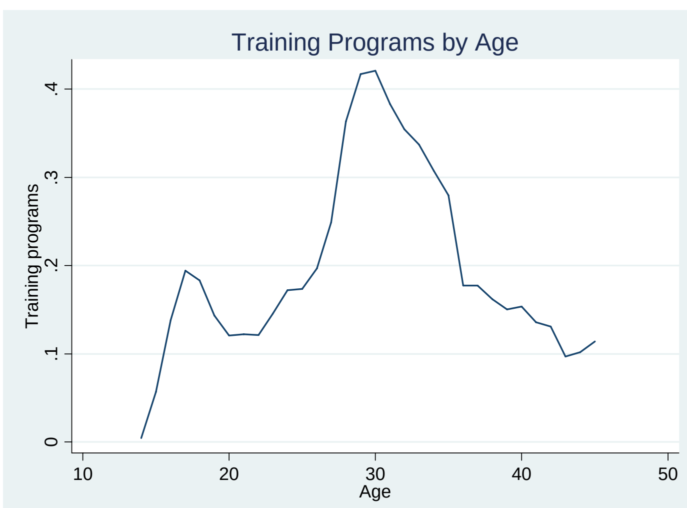
Variable Definition

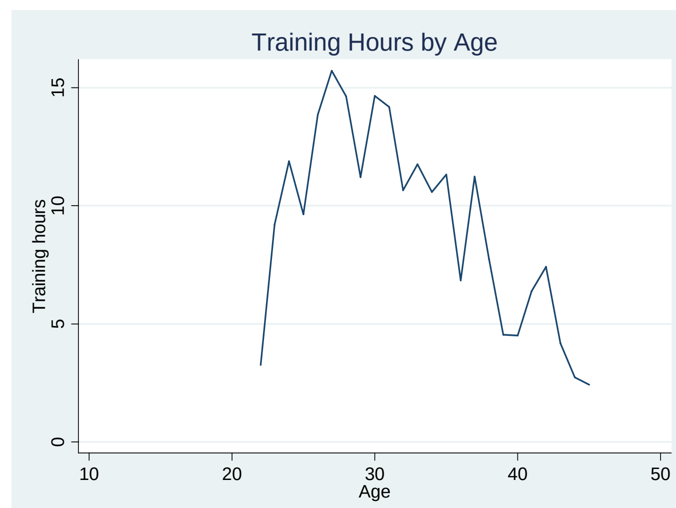
- Schooling
- Training
- Measures of technological change:
  - ratio of R&D funds to net sales
  - Jorgenson TFP growth series
  - NBER TFP growth series

Life-cycle Profiles of Schooling and Training

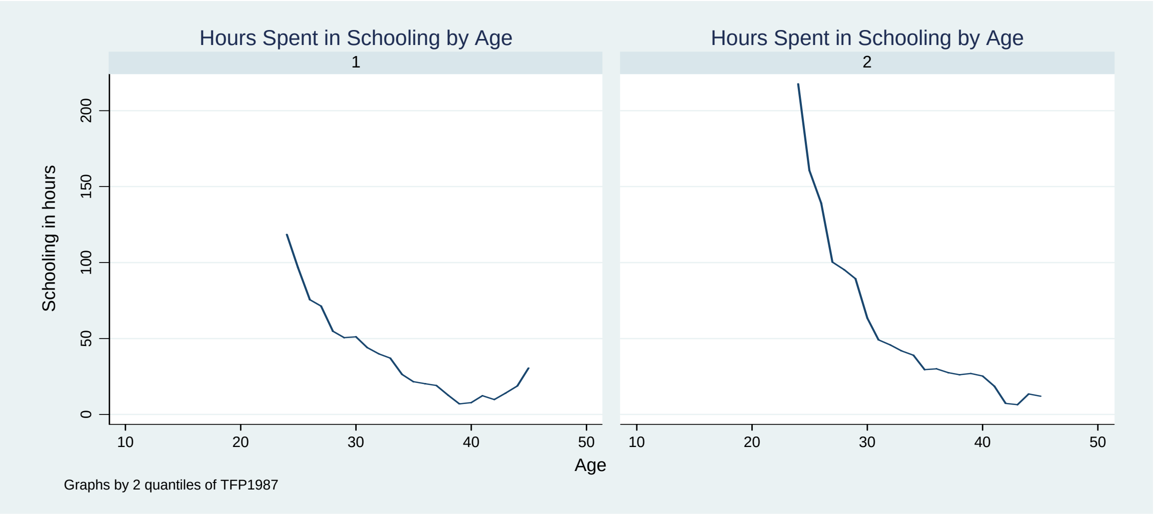


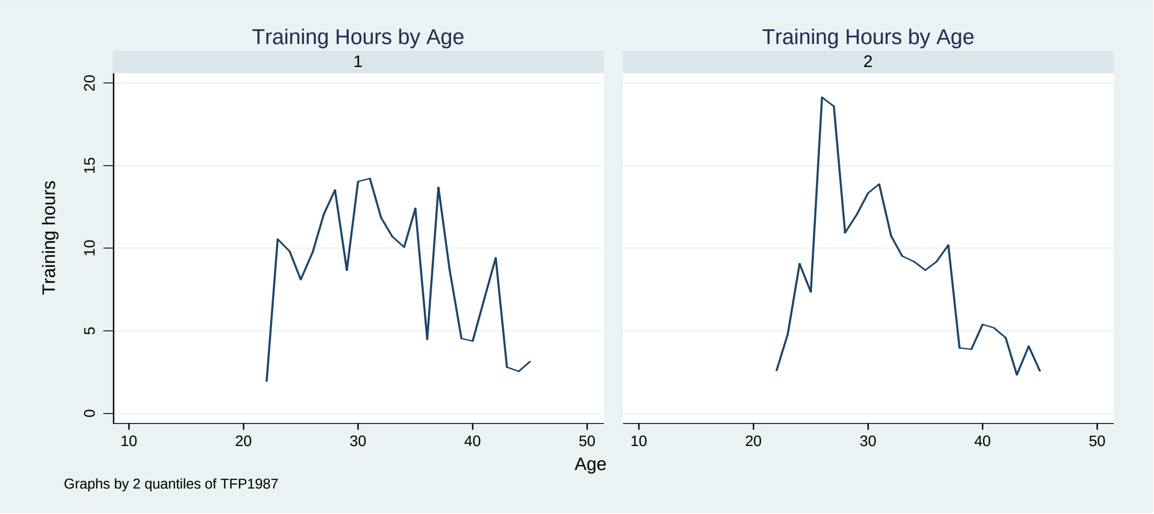






Profiles by Jorgenson TFP





Estimating Rental Rates of Human Capital

- For those who *did not invest in human capital* in period *t*,

$$\ln \frac{W_{t+1}}{W_t} = \ln \frac{R_{t+1}}{R_t} + \gamma_1 \ln\left(1 - \beta_4 \cdot \pi_t\right) + \gamma_2 \ln\left(1 - \alpha_5 \cdot \pi_t\right)$$

- Normalize initial rate in 1987 to one

- Nonlinear Least Squares estimates of rental rate in each year by *minimizing sum of squares error*

NLS Estimates of Rental Rate of Human Capital

Year	*Estimate*	*Approximate St. Error*	*Approximate*	*95% Confidence*	*Number of Observations*
1988	1.0627	0.0315	1.0008	1.1246	373
1989	1.0652	0.0271	1.0119	1.1186	381
1990	1.0895	0.0276	1.0353	1.1438	365
1991	1.0475	0.0258	0.9967	1.0983	363
1992	1.0636	0.0226	1.0193	1.1080	363
1993	1.0796	0.0242	1.0320	1.1272	350
1994	1.1102	0.0318	1.0476	1.1728	351

Estimating Parameters in Human Capital Production Functions

- For any set of parameters, any initial years of schooling, AFQT, and age, any path of rental rates, any path of technological change, any path of schooling, any path of training, the *predicted wage profiles* are

$$W_{it}\left(v; Grade, AFQT, Age, \tilde{\pi}, \tilde{S}, \tilde{I}\right)$$

- Estimate model parameters using NLS, minimizing the distance between predicted wage profiles and observed ones from data, i.e., minimizing sum of squares error

$$\sum_i \sum_t \left\{W_{it}{}^* - W_{it}\left(v; Age, Grade, \tilde{R}, \tilde{\pi}, \tilde{S}, \tilde{I}\right)\right\}^2$$

Parameter	*Estimate*	*Approximate Standard Error*	*t-value*
α_1	0.338	0.564	0.60
α_2	0.050	1.423	0.04
α_3	0.304	0.080	3.83
α_4	0.807	1.912	0.42
α_5	0.770	0.389	1.98
β_1	0.102	0.055	1.85
β_2	0.395	0.475	0.83
β_3	0.860	0.287	3.00
β_4	-0.279	0.602	-0.46
γ_1	0.456	0.152	3.00
θ_1	0.449	0.793	0.57
θ_2	0.089	0.028	3.13
θ_3	0.006	0.002	2.58
λ_1	0.869	0.767	1.13
λ_2	0.060	0.020	2.92

Estimation Results

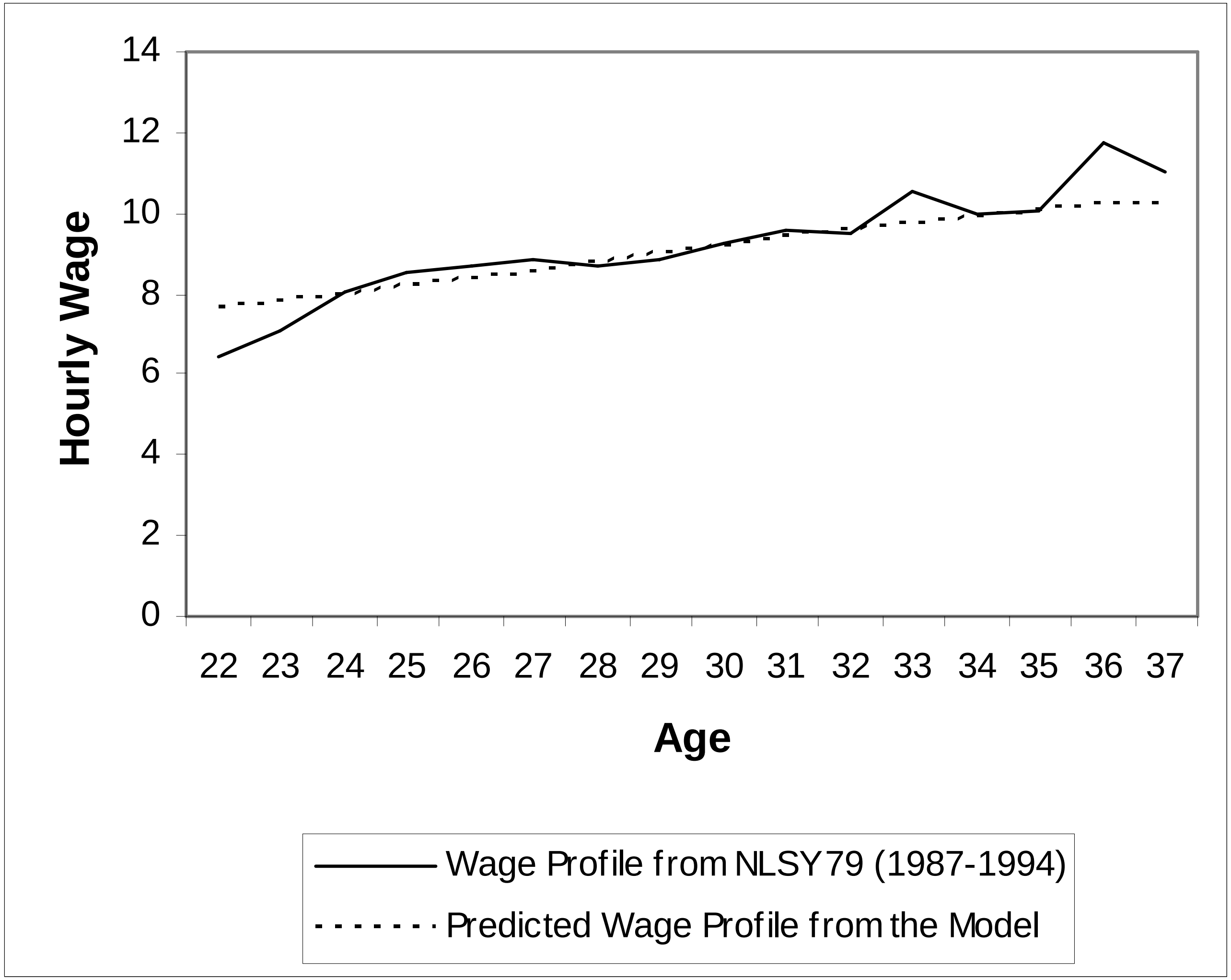
- Estimate of α_5 is a positive value of 0.77

  →Net effect of technological change on training human capital is rapid obsolescence.

- Estimate of β_4 is a negative value of 0.28 (but insignificant)

  →Productivity of schooling human capital might increase under rapid technological change in spite of obsolescence.

Predicted vs. Observed Wage Profile



Work To Do

- Estimate model parameters with alternative measures of technological change to test the robustness of the results
- Extend the time period and expand the sample
- Simulate wage profiles to illustrate the effects of technological change on wage inequality.