The Evolution of U.S. Wages: Skill Prices versus Human Capital

Lutz Hendricks

UNC

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Motivation

3 facts about post-war U.S.:

1. Educational attainment has increased.
2. Unskilled wages have declined (since the mid 1960s).
3. The college wage premium has roughly doubled (since 1980).

The Questions

1. Do the wage movements reflect changes in
    - skill prices or
    - labor quality (human capital)?
2. How can skill prices be inferred from measured wages?

The problem: wages confound skill prices and human capital.

Why Is This Interesting?

1. Rising education may mean: less able students enter higher education levels.
   Does this account for falling unskilled wages?
2. The correlation between schooling and ability has increased over time.
   Does this account for the rising college premium?
3. Implications for returns to schooling, contribution of human capital to growth, ...

The Idea

View the age wage profiles of various cohorts through the lens of human capital theory.

Theory implies:

1. Concave age efficiency profiles.
2. When skill prices grow, wages of all cohorts move together.
3. As schooling expands, the relative abilities of college / high school educated workers change.

The Approach

- Develop a model of school choice and on-the-job training.
- Calibrate the model to fit the age wage profiles of synthetic cohorts..
- The model measures:
  - unobserved skill prices and labor qualities
  - the abilities of workers by [schooling, cohort]

Result Preview

1. One-third of the growth in the college wage premium is growth in the relative human capital of college educated workers.
2. Half of the college wage premium in 2000 reflects the relative human capital of college graduates.
3. Unskilled wages did not fall nearly as much as the data suggest.

A Roy/Ben-Porath Model

Model Outline

- Overlapping generations.
- Endowments at birth:
  - ability (learning productivity) a,
  - human capital h_1,
  - school preferences p.
- Choose from 4 school levels:
  - high school dropout (HSD) and graduate (HSG)
  - college dropout (CD) and graduate (CG)
- Attend school for T_s periods and produce human capital.
- Work until age T with on-the-job training.
  - Maximize lifetime earnings.

Work Phase

State variables: human capital h, age t, $z = (a, s, \tau)$: ability, schooling, cohort.

$$V(h_t, t, z) = \max_{l_t} y(l_t, h_t, t, z) + R^{-1} V(h_{t+1}, t+1, z)$$

subject to law of motion for h:

$$h_{t+1} = (1-\delta) h_t + \underbrace{e^{\theta a}}_{\text{ability}} \underbrace{A(s) e^{g_A t}}_{\text{productivity}} \underbrace{(h_t l_t)^{\alpha}}_{\text{inputs}}$$

definition of period earnings

$$y(l_t, h_t, t, z) = w_{s,t+\tau-1} h_t (\ell_{t,z} - l_t)$$

time constraint $0 \le l_t \le \bar{l} \ell_{t,z}$.

Schooling Phase

School choice:

$$W(h_1, a, p, \tau) = \max_s W_s(h_1, a, p, \tau)$$

$$W_s(h_1, a, p, \tau) = \ln\left(R^{-T_s+1} V(h_{T_s+1}, T_s + 1, a, s, \tau)\right) + \pi_\tau p T_s + \mu_{s,\tau}$$

h_{T_s+1}: produced using the job-training technology with $l_t = \ell_{t,s,\tau}$.

$\pi_\tau p T_s$: a stand-in friction to ability sorting (psychic cost).

$\mu_{s,\tau}$: chosen so that the model matches observed schooling for each cohort

Skill Prices

- For now: partial equilibrium.
- Skill prices $w_{s,v}$ are exogenous.
- GE is a task for future work.

Calibration

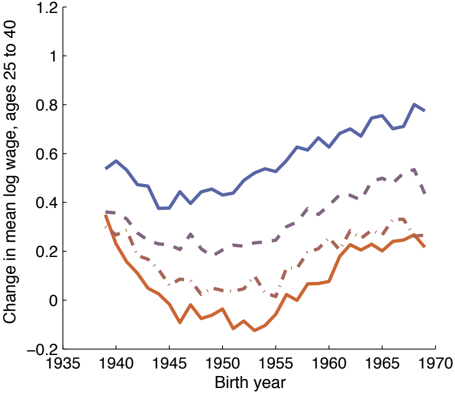
Calibration Strategy

Choose parameters to match:

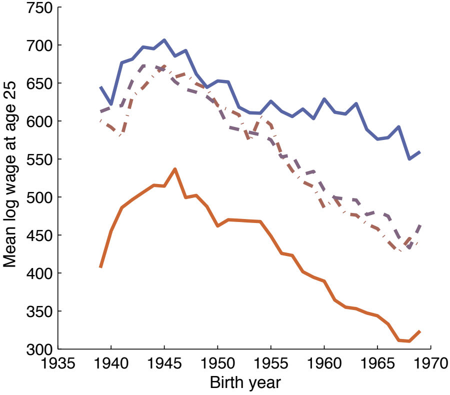
1. Age wage profiles
   mean log wages for 5 synthetic cohorts (CPS data)
2. IQ scores of college / high school students (Taubman/Wales).
   In the model: IQ is a noisy measure of a and h_1.
3. β_{IQ}: coefficient from regressing log wage (age 40) on IQ
   (and school dummies)

Age Wage Profiles

Slopes of age wage profiles



Intercepts of age wage profiles



Fixed parameters

Parameter	Description	Value
T	Lifespan	50
Birth cohorts	Cohort 1	1930 - 1936
	Cohort 2	1937 - 1943
	Cohort 3	1944 - 1950
	Cohort 4	1951 - 1957
	Cohort 5	1958 - 1964
T_s	School duration	$(1, 3, 5, 7)$
$\ell_{t,s,\tau}$	Market hours	CPS data
R	Gross interest rate	1.04

Calibrated Parameters

- Job training / schooling technology.
- Preferences shocks.
- IQ distribution given (a, h_1).
- Endowments: $(a, \ln h_1, p) \sim N$
- Skill prices: $w_{s,v}$
  - calibrate at 5 dates; cubic spline in between.

Calibrated Parameters

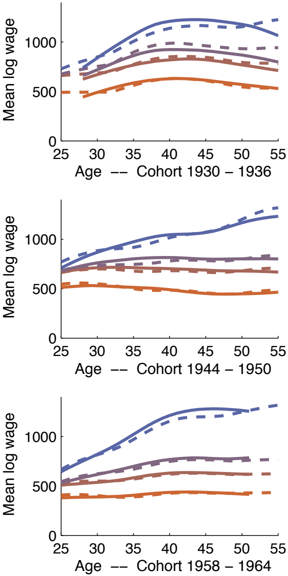
Highlights:

1. Human capital production function is strongly concave: $\alpha = 0.24$
    - estimates in the literature: 0.5 to 1
    - important for effect of training on lifetime earnings
2. Human capital endowments decline over time: $g_{h1} = -0.011$
    - b/c mean log wages are falling over time in the data

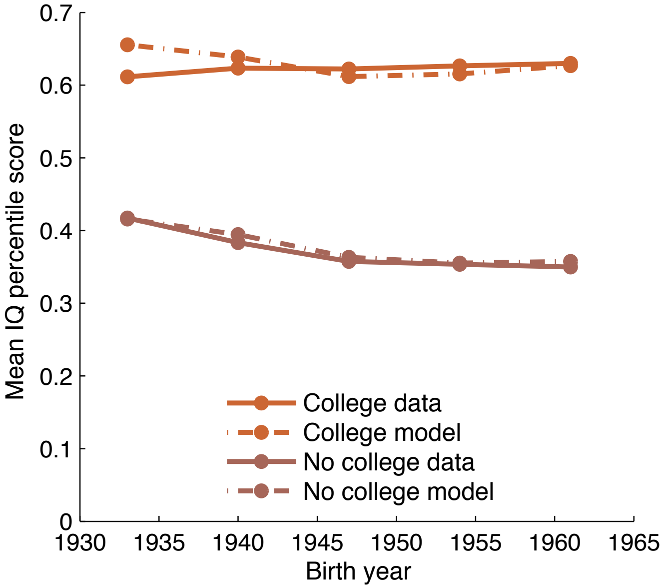
Calibrated Parameters

Parameter	Description	Value
On-the-job training		
$A(s)$	Productivity	0.690 0.769 0.953 0.925
$g(A(s))$	Productivity growth rate	0.0007
α	Curvature	0.237
δ_h	Depreciation rate	0.044
Endowments		
σ_{h1}	Dispersion of h_1	0.011
$g(h_1)$	Growth rate of h_1	-0.0110
θ	Ability scale factor	0.150
π	Psychic cost scale factor	0.182
$g(\pi)$	Growth rate of π	-0.0387
γ_{pa}	Governs correlation of π and a	0.500
γ_{ha}	Governs correlation of $\ln h_1$ and a	0.747
γ_{hp}	Governs correlation of $\ln h_1$ and π	0.302
σ_{IQ}	Noise in IQ	0.854
$\gamma_{IQ,a}$	Governs correlation of a and IQ	0.776

Model Fit


Mean log wage
1000
500
0
25 30 35 40 45 50 55
Age -- Cohort 1930 – 1936
Age -- Cohort 1937 – 1943
Age -- Cohort 1944 – 1950
Age -- Cohort 1951 – 1957
Age -- Cohort 1958 – 1964

Model Fit



0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Mean IQ percentile score
1930
1935
1940
1945
1950
1955
1960
1965
Birth year
College data
College model
No college data
No college model

Results

Revisions to Wage Growth

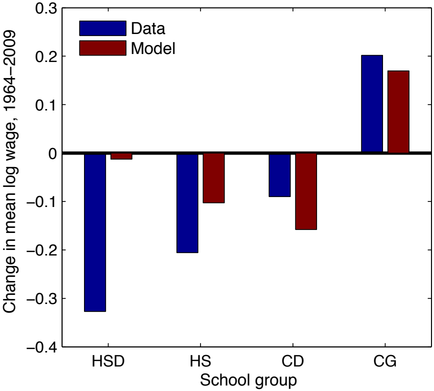
The question:

> *How much do the growth rates of wages differ from the growth rates of skill prices?*

The experiment:

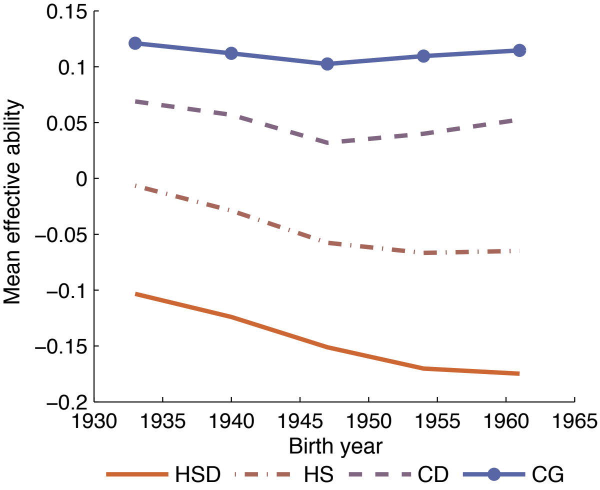
Compare the paths of data wages $z_{s,v}$ with model skill prices $w_{s,v}$.

Revisions to Wage Growth

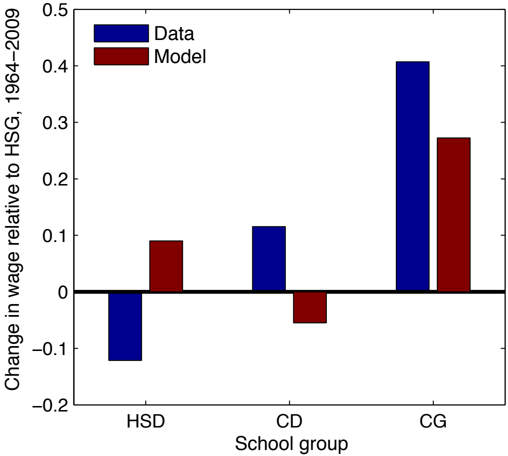


Unskilled model wages grow much faster than data wages.

Changing Student Abilities



Revisions to Changes in Skill Premiums



One-third of the rise in the college wage premium is due to human capital, not skill prices.

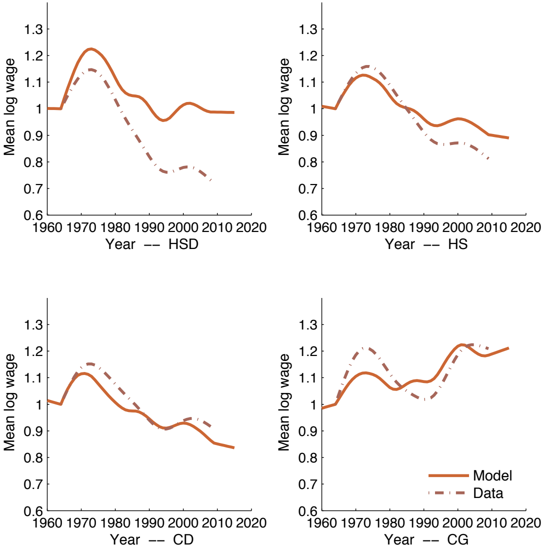
Revisions to Wage Growth

	Skill price growth		Skill premium growth	
School group	Data	Model	Data	Model
HSD	-32.7	-1.3	-12.1	9.0
HS	-20.6	-10.3	0.0	0.0
CD	-9.0	-15.8	11.6	-5.5
CG	20.2	17.0	40.7	27.2

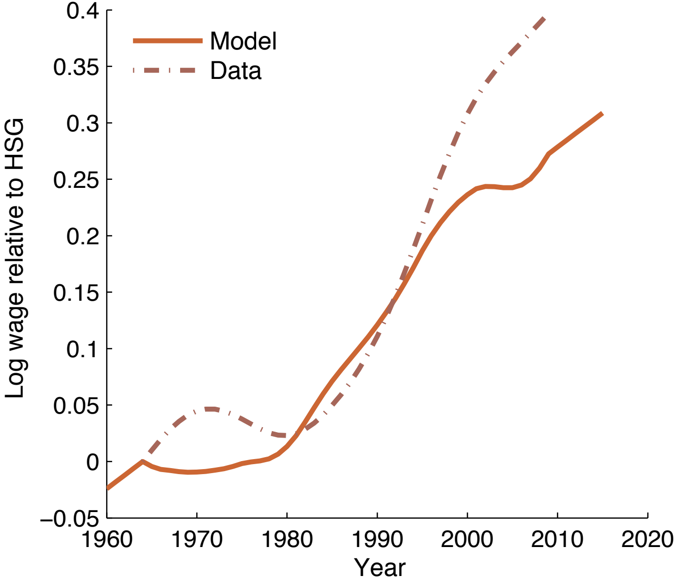
Result:

One-third of the rise in the college wage premium is due to human capital, not skill prices.

Revisions to Wage Growth



College Premium



Revisions to Skill Premiums

The question:

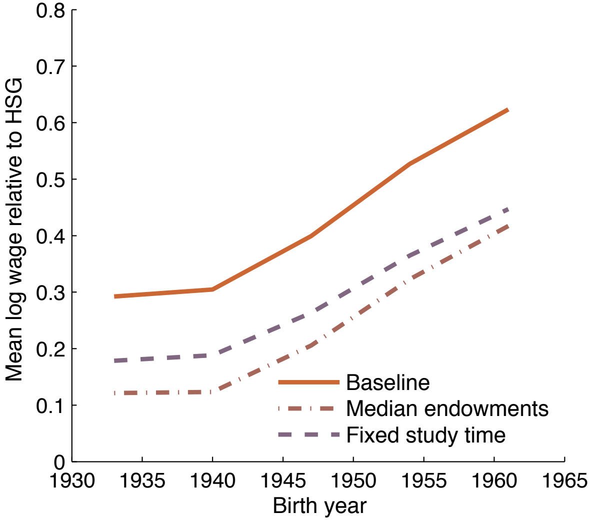
> *How much do selection / investment contribute to skill premiums at a point in time?*

Experiment: solve the model for 3 scenarios:

1. Baseline
2. No selection: workers in all school groups have mean endowments $a = 0$ and $\ln h_1 = g_{h1}\tau$
3. Common investment: workers in all school groups share $l_{t,s}$ set to median age profile of high school graduates

Compute mean log wages at age 40 for each cohort / school group.

Selection and the College Wage Premium



Selection accounts for **half** of the year 2000 college wage premium.

Selection and Lifetime Earnings

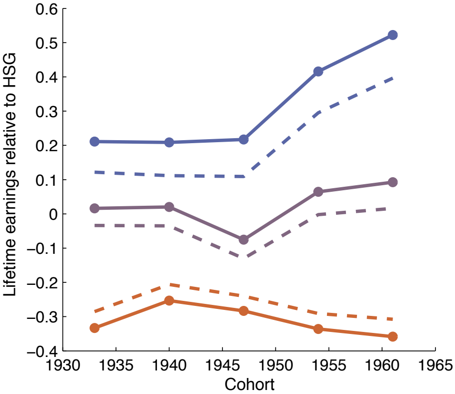
The question:

> *How much of the lifetime earnings gap CG / HSG is due to selection?*

The experiment:

- Solve the model with random school assignment.
- Compare lifetime earnings by (s, τ) with baseline.

Selection and Lifetime Earnings



Result: 15 log points of the college lifetime earnings premium are due to selection

Training and Lifetime Earnings

- Kuruscu (2006): Job-training has almost no effect on lifetime earnings
  - typical estimates of the curvature of the human capital production function: $\alpha \in [0.5, 1]$.
  - human capital depreciation must then be small: $\delta \cong 1\%$
- This model: $\alpha = 0.24$, $\delta = 4.4\%$.
  - different because I fit cohort age-wage profiles (as opposed to cross sections)
- Training then increases lifetime earnings between 50% and 80%.

Conclusion

- A simple human capital model accounts well for the age wage profiles of cohorts observed since 1930.
- Labor quality accounts for
    - **half** of the college wage premium (1960 cohort)
    - **1/3** of the rise in the college wage premium
    - **1/4** of the lifetime college earnings premium (1960 cohort)