Schooling Over Time

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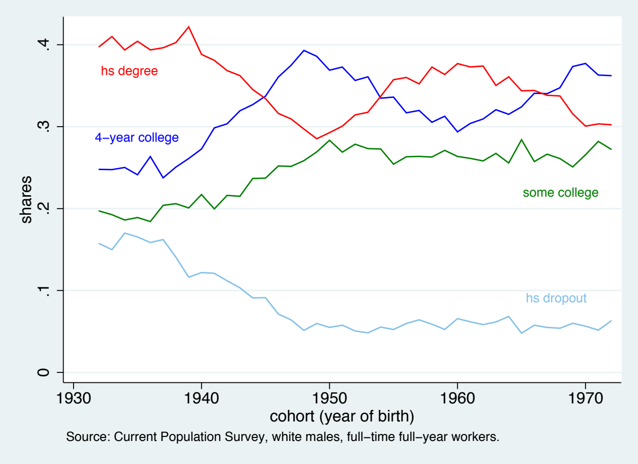
Facts to be explained

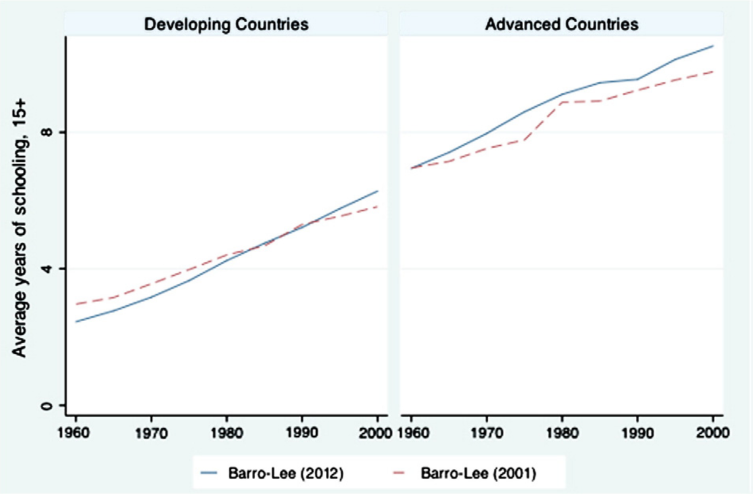


(a) Educational attainment by birth cohort.

Source: Castro and Coen-Pirani (2016)

US education rose until the 1950 cohort, then flattened

Facts to be explained



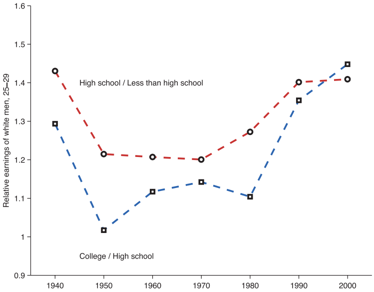
Source: Barro and Lee (2013)

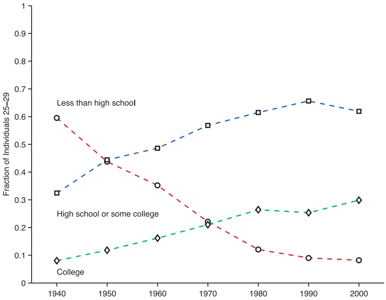
Restuccia and Vandenbroucke (2013)

The return to schooling has been increasing since the 1970s

Does this explain the rise in educational attainment?

Motivation





White Men

Motivation

An odd idea:

- the skill premium is U-shaped
- schooling rises until the 1950 cohort, then flattens
- the college premium rises after 1980
- how does that support a big role for the college premium?

Model Elements

Demographics:

- in each period a unit mass of persons are born
- life expectancy is $T(\tau)$

Endowments at birth:

- a with cdf A (Normal): taste for schooling

Schooling

- 3 discrete levels: <HSG, HSG, college
- duration: s_i
- human capital: $h(s,e) = s^{\eta} e^{1-\eta}$

Technology

- output is produces from 3 types of labor
- nested CES with skill bias parameters $z_{i,t}$

$$Y = z_t F\left(G\left(z_{1,t}H_{1,t}, z_{2,t}H_{2,t}\right), z_{3,t}H_{3,t}\right) \tag{1}$$

- constant skill-biased technical change: g_i is constant over time

$$H_{i,t} = \sum_{\tau} \int_{a} h\left(s_i, e\left(a, \tau\right)\right) A\left(da\right) \tag{2}$$

Prices

- r is exogenous
- $w_t(s)$: wages equal marginal products

Individual problem

Step 1: school choice

$$\max V_{\tau}(s) - as \tag{3}$$

Individual problem

Step 2: utility maximization

$$V_{\tau}(s) = \max_{c_t, e} \sum_{t=\tau}^{\tau+T(\tau)-1} \beta^{t-\tau} \ln(c_t) \tag{4}$$

subject to a lifetime budget constraint

$$h(s,e)\, W_{\tau}(s) = e + \sum_{t=\tau}^{\tau+T(\tau)-1} r^{\tau-t} c_t \tag{5}$$

$$W_{\tau}(s) = \sum_{t=\tau+s}^{\tau+T(\tau)-1} r^{\tau-t} w_t(s) \tag{6}$$

$$h(s,e) = s^{\eta} e^{1-\eta} \tag{7}$$

School choice

Equivalent to maximizing (log) lifetime earnings net of e. Call that $I_\tau(s)$

Perfect school sorting by a

Closed form solution (key equation of the paper):

$$a_{ij,\tau} = \frac{1-\beta^{T(\tau)}}{1-\beta} \frac{1}{s_i - s_j} \ln\left(I_\tau(s_i) / I_\tau(s_j)\right) \tag{8}$$

Schooling depends on:

- future wages
- life-expectancy

Key for elasticity of s to I

- log utility (hidden parameter)
- distribution of school "costs" (hidden parameters)
- school costs enter as as (linear, interacted with schooling)

Calibration

$a \sim N\left(\mu, \sigma^2\right)$

- (claimed robust against using a Beta distribution)

h production function: $\eta = 0.9$

- would anything change if we took that purely invented h out of the model?

Goods production:

- elasticities of substitution are 3 and 1.64
- probably not import (model matches observed wages)

Calibrated parameters

- distribution of a
- level and growth of skill bias parameters

Targets:

- fraction by s of 1921 cohort
- relative wages over time

Key:

- do these moments contain ANY info about the elasticity of schooling w.r.to lifetime earnings?

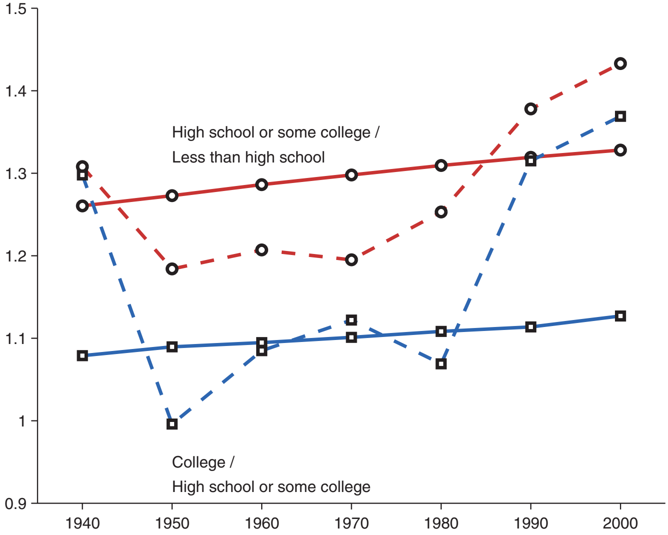
Experiment

Steady state in 1850

Exogenous variables constant until 1910, then growing at a constant rate (forever)

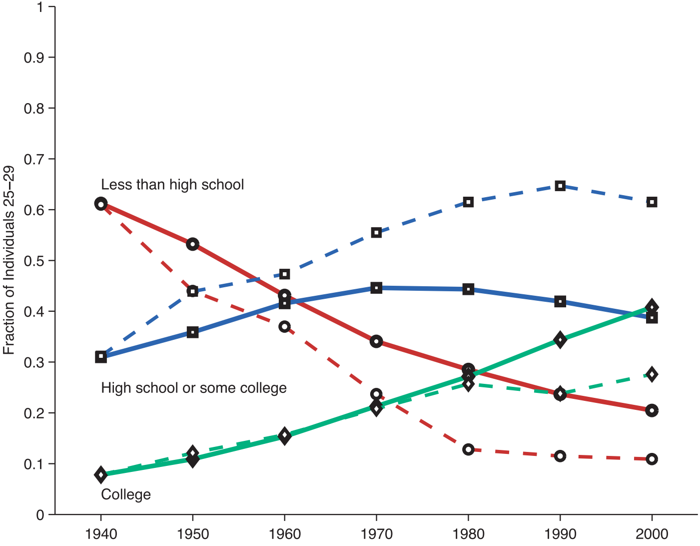
(No terminal steady state?)

Fit: Wages



Why not fit wages over time? Because the model then falls apart.

Results



Main driver: skill-biased technical change.

Thoughts

The paper is rather thin on data.

- there is little we can look at to "check" the model
- RV do look at the elasticity of s to tuition (but there is no tuition in the model!)

Thoughts: Identification

As so often, the key question is identification.

- what do learn from data on years of schooling and wages about the elasticity of schooling w.r.to wages?
- the result is purely driven by functional forms

What could go wrong:

- financial constraints keep kids out of college early on
- low ability students cannot graduate
- the cost of schooling changes over time
- cohort effects

Castro and Coen-Pirani (2016)

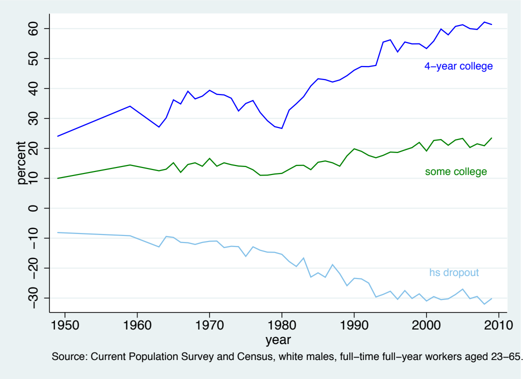
The story:

- consider the cohorts 1932-1972
- the rise in schooling until 1948 is explained by the rising college wage premium (static expectations)
- the stagnation after 1948 is explained by declining abilities (test scores)

Another odd story:

- the college premium really started to rise after 1980 (when the 1960 cohort made schooling decisions)
- the test score decline is only half of the story: test scores rose massively before 1948
- if we ran this model past the 1973 cohort, it would imply a massive increase in the fraction of college graduates

Data: college premium



(b) Wage premiums relative to high school degree.

Note the oddity: we want to explain the rise in schooling 1950-70 with the slight rise in the college premium

But we ignore the massive rise in the college premium after 1980

Data: test scores

A well-known decline in test scores after the 1950 cohort (SAT, ACT).

What is actually used is the only consistently recorded test score series available: ITBS

- administered to 95% of Iowa 8th graders since

Why is there no graph of the test score time series in the paper?

Because the deline is not the entire story...

Test scores

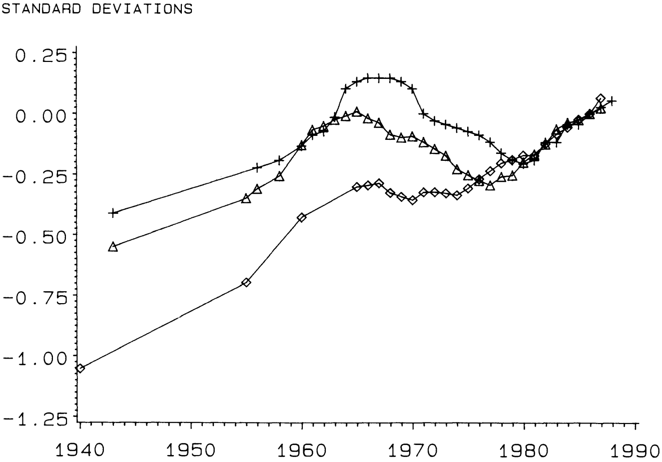


FIGURE 1. IOWA TEST SCORE TRENDS FOR IOWA STUDENTS. + = ITED, GRADE 12. △ = ITED, GRADE 9 AND ITBS, GRADE 8. ◇ = ITBS, GRADES 3 AND 4. ABSCISSA = STANDARD DEVIATION UNITS; ORDINATE = YEARS. ◇◇◇◇ = GRADES 3 AND 4. ⊟⊟⊟⊟ = GRADES 8–9, ++++ = GRADE 12

Source: Bishop (1989)

Model Outline

Partial equilibrium

A person is born with learning ability θ and h_7

He must stay in school until age 17

After that, students choose between 4 stopping dates (school durations S_j)

Schooling is a Ben-Porath technology

$$h_{a+1} = \theta h_a^{\gamma} x_a^{\phi} + (1-\mu) h_a \tag{9}$$

After schooling, h_a / h_{7+S_j} evolves according to a quadratic.

School choice

Agents maximize discounted utility

$$\sum_{a=17}^{A} \beta^a \ln(c_a) + \sigma\left(\xi_i^j + \bar{\xi}^j\right) \tag{10}$$

The ξ are preference shocks (type I extreme value)

Static expectations over future wages.

Characterization

Perfect credit markets => closed form solution for consumption.

The agent effectively cares about log lifetime earnings.

Type I extreme value shocks => closed form solutions for choice probabilities.

Calibration: skill prices

- tricky, because no longer directly observed
- assume time invariant quadratic experience profiles of h
- then one can identify skill prices up to a linear trend from wage data

Skill prices

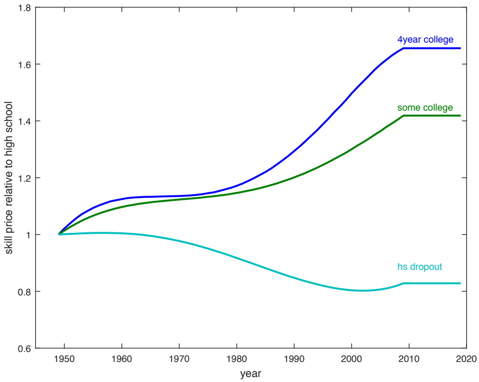


Figure 3: Skill Prices (relative to high school)

These are (oddly) not the skill prices implied by the model.

Linear trends are invented.

Calibration

Ben-Porath parameters are taken from a different paper: You (2014)

- magic!

Calibrated:

- preference shocks,
- wage intercepts and linear trend growth rates
- average learning ability in 1953 (mean θ)

Calibration targets

1. Fraction in each school group (first and last cohorts)
2. Wage premiums for 27 year olds (first and last cohorts)
3. Aggregate wage growth
4. Standard deviation of log wages (1932 cohort; net of factor for shocks)
5. Tuition (not important)
6. Test score decline between 1953 and 1963 cohorts (0.36 std dev)

Test scores in the model

Assume: Test score $= \beta_0 + \beta_1 \ln h_{15}$

Then 0.36 std dev drop in mean test scores implies

- mean log h_{15} dropped by 0.36 std dev log h_{15}

This breaks down when test scores are not perfect measures of human capital.

Given how central the test scores are, one would have expected more attention to them.

It looks like test scores outside of the 1953-63 period are free parameters

Identification

Key items to identify:

1. How responsive is schooling to wages?
   1.1 Nothing in the data used seems to provide information on this
2. How much do test scores affect school choices?
   2.1 Why not use test scores of college / non-college students?

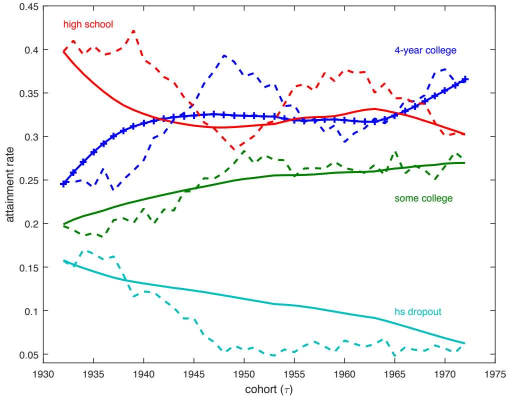
Results

Relative abilities of school groups essentially don't change over time

Problem:

- test scores are assumed to measure h_{15} perfectly
- there is big time divergence in test scores between college and non-college students (Hendricks and Schoellman, 2014)
- how does that fit together?

Results



(c) Attainment (static)

Main result is a breakdown of the rise in schooling into the various driving forces.

Thoughts

It's hard to take the quantitative results very seriously.

The model does not fit anything.

- Is there any way to "test" it?

The calibration does not seem to provide much info about key parameters.

Other stories in the literature

One could take the test score story more seriously

- the time series of test scores actually lines up reasonably with that of average years of schooling

School choice changes from "income is important" to "cognitive skills are important"

- Hendricks et al. (2015)
- are early cohorts borrowing constrained?
- the rise of standardized testing?

Better college preparation?

- the high school curriculum has changed dramatically

References I

Barro, R. J. and J. W. Lee (2013): "A new data set of educational attainment in the world, 1950–2010," *Journal of Development Economics*, 104, 184 – 198.

Bishop, J. H. (1989): "Is the Test Score Decline Responsible for the Productivity Growth Decline?" *The American Economic Review*, 79, pp. 178–197.

Castro, R. and D. Coen-Pirani (2016): "Do Returns to Skill Explain the Evolution of Educational Attainment in the US?" *American Economic Journal: Macroeconomics*.

Hendricks, L., C. Herrington, and T. Schoellman (2015): "Family Background, Academic Ability, and College Decisions in the 20th Century U.S." Mimeo. University of North Carolina.

Hendricks, L. and T. Schoellman (2014): "Student Abilities During the Expansion of U.S. Education," *Journal of Monetary Economics*, 63, 19–36.

References II

Restuccia, D. and G. Vandenbroucke (2013): "The Evolution of Education: A Macroeconomic Analysis," *International Economic Review*, 54, 915–936.

You, H. M. (2014): "The contribution of rising school quality to U.S. economic growth," *Journal of Monetary Economics*, 63, 95 – 106.