Human Capital: Education

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Autumn, 2024

Roadmap

1. Introduction

2. Human Capital Analysis

3. A Simple Two-Period Model

4. A Simple Multiple-Period Model ⋆

5. Empirical Study of Return to Schooling

Why go to college?

Google

Why go to college

すべて 画像 動画 ニュース 書籍 ウェブ 地図 ⋮ もっと見る ツール

Why go to college?

ウェブの情報から

Earning more	Develop skills	Career advancement
More job opportunities	Job security	Changing careers
Build a professional network	Career Opportunities	Discover your passion
Job satisfaction	Make friends	Networking
Personal development	You are drawn to college traditions	Achieve your personal goals
Become independent	College education and wages	Employment benefits
International work opportunities	It is an investment	Make valuable connections
Networking opportunities	Study something you enjoy	The College Experience

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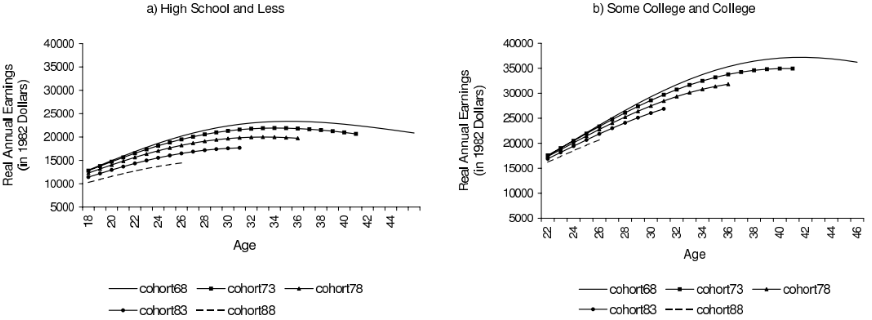
フィードバック

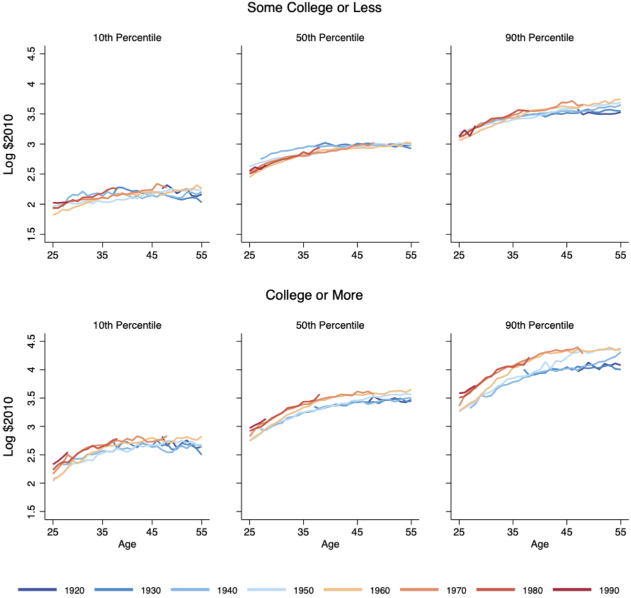
Life-Cycle Earnings Profiles in US by Education

(Kambourov and Manovskii, 2009)



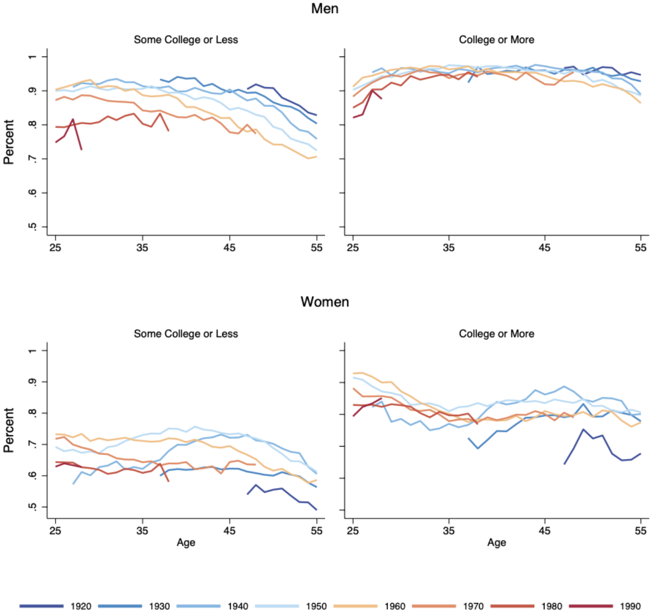
Life-Cycle Earnings Profiles in US within Education

(Blundell et al., 2023)



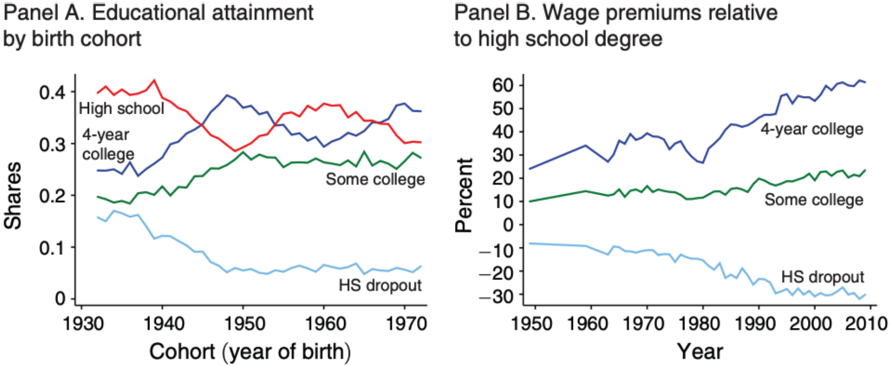
Life Cycle Employment Rates in US by Education

(Blundell et al., 2023)



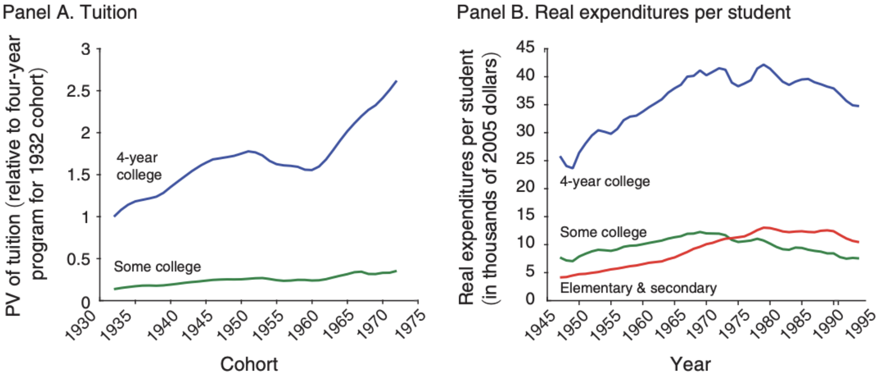
Educational Attainment and Wage Premiums in US

(Castro and Coen-Pirani, 2016)



Tuition and Education Expenditures in US

(Castro and Coen-Pirani, 2016)

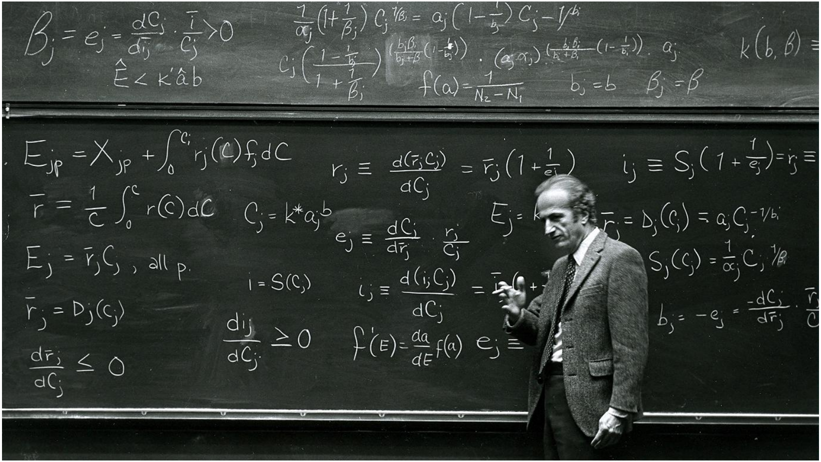


Roadmap

The History of "Human Capital"

- Until the 1950s:
  - Education and skills were largely ignored by mainstream economists on labor economics and economic growth
  - Regard benefits of education as being concentrated at the political and moral level rather than at the economic level
- Friedman and Kuznets (1945) (link):
  - Descriptive analysis on earning difference due to length of occupational training and credit constraints (e.g. Physicians)
- Becker (1962, 1964) (link):
  - A unified and parsimonious theoretical framework as the beginning of modern human capital analysis
- "Human capital is so uncontroversial nowadays that it may be difficult to appreciate the hostility in the 1950s and 1960s"
  - "alleged to be demeaning because it treated people as machines"
  - "schooling as an investment ... was considered unfeeling and narrow"

Gary Becker (check his own lecture videos in 2010!)



The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1992 was awarded to Gary S. Becker "for having extended the domain of microeconomic analysis to a wide range of human behaviour and interaction, including nonmarket behaviour"

The Success of Human Capital Theory

- Gradually, economists, and others, accept the concept of human capital as a valuable tool
- As it became clear that the analysis of human capital can help explain many regularities in labor markets and the economy
  - Determinants and economic consequences of schooling
  - Work experience, on-the-job training, and life cycle wage growth
  - Earning differences across different demographic groups
  - Effects of mortality, income taxes, technological changes, and structural transform
  - Economic growth and development
  - ...

What is Human Capital?

- The set of skills of workers as a form of capital that is
  - productive and marketable
  - acquirable through investments
- It does not need to be a very explicit set but can
  - be defined as college degree or years of schooling
  - include non-cognitive abilities or soft skills, e.g. attitudes towards work, motivation and attention, interpersonal and social skills
- A board definition of HC also includes ”Innate Ability”
  - Not acquirable, but ”born with”
  - Often assumed to avoid modeling the acquiring processes that are of no interests
  - The ”nature vs. nurture” is a super tough and tricky empirical question, and there is no definitive answers (see Cunha et al. (2006); Cunha and Heckman (2007); Houmark et al. (2024))
- While in nature human capital is multi-dimensional, today we assume it’s uni-dimensional for simplicity (like ”level” in game)

Sources of Human Capital

- (Biology/Sociobiology)
- Early childhood education
- Schooling
- School quality and non-schooling investments
- Training and Learning-by-doing (post-schooling HC)

- There is also depreciation of human capital

Human Capital Analysis

- *"Human capital analysis starts with the assumption that individuals decide on their education, training, medical care, and other additions to knowledge and health by weighing the benefits and costs." —Becker (1993)*
  - I.e. the essence is to put benefits and costs into one framework to do the analysis
- Benefits:
  - Improvement in earnings
  - Improvement in choices of occupations
  - ...
  - More likely to get married
  - Cultural and other non-monetary gains
- Costs:
  - Foregone value of the schooling time ("opportunity cost")
  - Direct costs of education
  - Uncertainty
  - Cultural penalties
- The benefits can be not only private but also social

Present Value

- Any study of an investment decision must contrast expenditures and receipts incurred at different times
- Do same amount of money value the same at different times?
- Suppose the gov gives you a choice between two offers: You can have either $10,000$ yen today or $10,000$ yen next year. Which offer would you take?
- $\Rightarrow$ The value of a yen received today is not the same as the value of a yen received tomorrow
- One reason: if the interest rate is 5% per year, then receiving $9,524$ yen today ($10,000 \div 1.05$) would be same as $10,000$ yen next year
- Other reasons: death rate; change in utility; option value; ...

Present Value

- So future value needs to be discounted to be compared with present value

- Formally, the present (discounted) value of a receipt/payment y next year is

$$PV = \frac{y}{1+r}$$

  - where r is the interest rate, also called discount rate
  - Another way is to write $PV = \beta y$, where $\beta = \frac{1}{1+r}$ is discount factor

- For a receipt/payment y two years from now:

$$PV = \frac{y}{(1+r)^2}$$

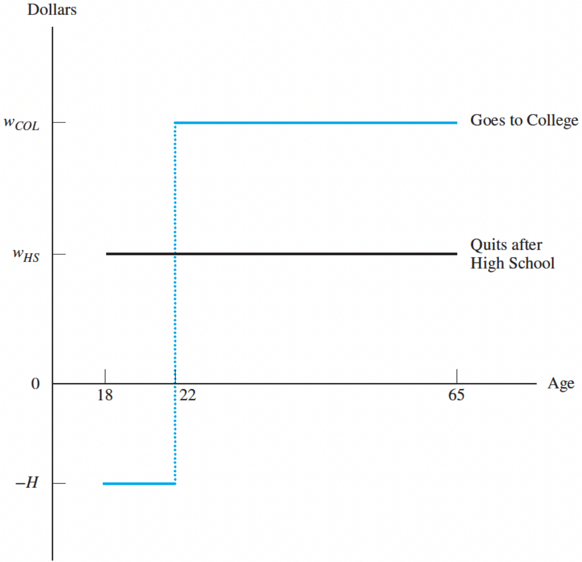
- For a series of values $\{y_t\}$ with $t = 0, 1, \ldots, T$:

$$PV = \sum_t \frac{y_t}{(1+r)^t} = \sum_t \beta^t y_t$$

Compare PV of Going to College with Not at Age 18

FIGURE 6-1 **Potential Earnings Streams Faced by a High School Graduate**

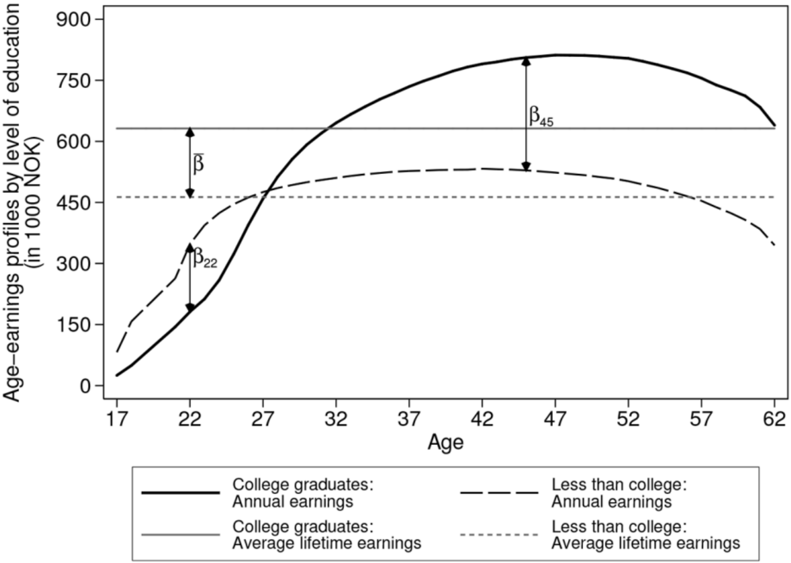
A student who quits school after getting his high school diploma can earn w_{HS} from age 18 until retirement. If he goes to college, he forgoes these earnings and incurs a cost of H dollars for 4 years and then earns w_{COL} until retirement.



Compare PV of Going to College with Not at Age 18

- $PV_{HS} = w_{HS} + \frac{w_{HS}}{(1+r)} + \frac{w_{HS}}{(1+r)^2} + \cdots + \frac{w_{HS}}{(1+r)^{46}}$
- $PV_{COL} = -H - \frac{H}{(1+r)} - \frac{H}{(1+r)^2} - \frac{H}{(1+r)^3} + \frac{w_{COL}}{(1+r)^4} \ldots + \frac{w_{COL}}{(1+r)^{46}}$
- Let's assume a student chooses schooling to maximize the present value of lifetime earnings
- Then she/he attends college if $PV_{COL} > PV_{HS}$
- Four factors matter here: w_{HS}, w_{COL}, H, r
- (One can define an "internal rate of return" (IRR) as a r that leads to $PV_{HS} = PV_{COL}$ and compare it with the interest rate)

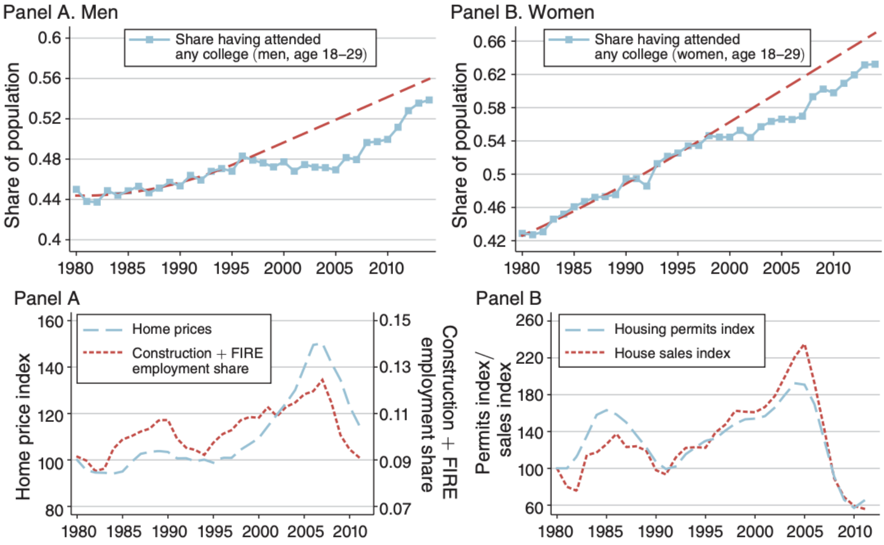
Real Age-Earning Profiles in Norway (Bhuller et al., 2017)



("There is virtually no pecuniary cost of schooling (such as tuition or fees) in Norway")

An Example of Opportunity Cost Impact on Education

Charles et al. (2018) argue US housing boom during 2000-2006 increased young adult men and women without college training, raising their opportunity cost of college-going



Roadmap

Model Setting

- Agent:
  - An individual before going to college (indexed as i)
- Decision/Choice:
  - Consumption/Saving/Borrowing
  - Investment in education
- Time:
  - Two periods dynamics model
  - Education choice only at 1st period
- Equilibrium:
  - Partial equilibrium (e.g. wage is exogenously given)

Model Setting

- Period 1:
  - receives income y_i from parents
  - consumes c_i^1; saves or borrows s_i
  - decides whether to go to college, $e_i = 0$ or 1
  - if not going to college, receives a wage w_h
  - cost of education, θ_i
- Period 2:
  - receives a wage w_c if educated and w_h if not educated
  - receives a saving or pays a debt of $(1 + r)s_i$
  - consumes c_i^2
- How to think the wages: $w_h = wh$; $w_c = w(h + \Delta h)$
  - h is initial human capital; Δh is additional human capital obtained from college education; w is unit skill price
  - Note that this is itself a "causal model"

The Decision Problem

- Decision problem:

$$\max_{e_i, c_i^1, c_i^2} U \equiv \ln c_i^1 + \ln c_i^2$$

  subject to

$$c_i^1 = y_i - e_i\theta_i + (1 - e_i)w_h - s_i$$
$$c_i^2 = e_i w_c + (1 - e_i)w_h + (1 + r)s_i$$

  - The budget constraint at each period combines two possible cases

- We can combine two budget constraints by discounting all 2nd period terms into the 1st period when the decision is made:

$$c_i^1 + \frac{c_i^2}{1+r} = e_i\left(\frac{w_c}{1+r} - \theta_i\right) + (1 - e_i)\left(w_h + \frac{w_h}{1+r}\right) + y_i$$

  - Saving s disappears b.c. $-s + s\frac{1+r}{1+r} = 0$
  - To see it more clear, think a simple system $\begin{aligned} c^1 &= y^1 - s_i \\ c^2 &= y^2 + (1+r)s_i \end{aligned}$

Separate Theorem

- This problem can be split into two sub-problems:
  - First maximize the PDV of household life income (the RHS of budget constraint; let's denote as C)
  - Then decide the allocation of the life income
- The education decision only matters for the first sub-problem
- This ”separation” is available due to our simple setups
- It does not hold when
  - There are imperfect capital markets
  - e directly enters the utility function (e.g. when leisure matters)

The Solution of Education Problem

- Let's rewrite the first sub-problem:

$$\max_{e_i \in \{0,1\}} C \equiv e_i \left(\frac{w_c}{1+r} - \theta_i \right) + (1 - e_i) \left(w_h + \frac{w_h}{1+r} \right) + y_i$$

- The agent will choose to go to college only if:

$$\underbrace{\frac{w_c - w_h}{1+r}}_{\text{"marginal" benefits}} \geq \underbrace{\theta_i + w_h}_{\text{"marginal" costs}}$$

  - Here we are again simply comparing the outcomes of two choices!

- A greater skill premium ($w_c - w_h$) will encourage schooling

- A higher education cost, θ, a higher foregone cost, w_h, and a higher discount rate, r, will discourage schooling

- The allowance from parents, y, does not matter here

The Solution of Consuming Problem

- For the second sub-problem:
$$\max_{c_i^1, c_i^2} \ln c_i^1 + \ln c_i^2$$
subject to
$$c_i^1 + \frac{c_i^2}{1+r} = C^*$$
    - C^* is the solved PDV from the first sub-problem
- Substitute the budget constraint into the problem: $\max_{c_i^1} \ln c_i^1 + \ln(1+r)(C^* - c_i^1)$
- Take the FOC: $1/c_i^1 = 1/(C^* - c_i^1)$
- The solution: $c_i^{1*} = C^*/2$; $c_i^{2*} = (1+r)C^*/2$
- Intuition: the future consumption c^2 is a cheaper good

Practical Issues

- In practice, this solution may be difficult to achieve for a variety of reasons
- A major one is that above setup allows the agent to borrow to finance education (and current consumption) and to pay them back later
- This may be not possible under credit constraint

More Practical Constraints

- Let's now modify the budget constraints so that borrowing at 1st period is not allowed:

$$
\begin{aligned}
c_i^1 &= y_i - e_i\theta_i + (1 - e_i)w_h - s_i \\
s_i &\geq 0 \\
c_i^2 &= e_i w_c + (1 - e_i)w_h + (1 + r)s_i
\end{aligned}
$$

- Let's further assume no saving (i.e. agents are hand-to-mouth, $s_i = 0$) to ease the analysis

- Then if schooling $\begin{aligned} c_i^1 &= y_i - \theta \\ c_i^2 &= w_c \end{aligned}$ and if not $\begin{aligned} c_i^1 &= y_i + w_h \\ c_i^2 &= w_h \end{aligned}$

More Practical Constraints

- Investing: $U(e=1 \mid y_i, \theta_i) = \ln(y_i - \theta_i) + \ln w_c$
- Not investing: $U(e=0 \mid y_i, \theta_i) = \ln(y_i + w_h) + \ln w_h$
- The agent will invest in education if
$$\frac{y_i(w_c - w_h)}{w_c} \geq \theta_i + w_h^2 / w_c$$
- Thus now, higher allowance y_i, means more likely to investment in education, contrasting with the non-credit-constrained case

Roadmap

Model Setting

- Agent:
  - An individual before schooling
- Decision/Choice:
  - Time used (investment) in education
- Time:
  - T periods dynamic model
  - Education decision at each period
- Market:
  - Perfect capital market
- Equilibrium:
  - Partial equilibrium

Model Setup

- Period 1:
  - hold initial human capital h_1
  - invest time $e_1 \in [0, 1]$ to education
  - use the rest of time to work and obtain wage $h_1(1 - e_1)$ (normalize $w = 1$)
  - achieve $h_2 = \mathcal{H}(e_1, h_1)$ at the end of the period
- Period 2:
  - hold human capital h_2
  - invest $e_2 \in [0, 1]$
  - use the rest of time to work and obtain wage $h_2(1 - e_2)$
  - achieve $h_3 = \mathcal{H}(e_2, h_2)$ at the end of the period
- ...
- $h_{t+1} = \mathcal{H}(e_t, h_t)$ is called human capital production function
  - Assume strictly increasing and concave in s_t

Problem

- The problem:

$$\max_{\{e_1, e_2, \ldots, e_T\}} (1 - e_1) h_1 + \beta (1 - e_2) h_2 + \ldots + \beta^{t-1} (1 - e_T) h_T$$

s.t.

$$h_2 = \mathcal{H}(s_1, h_1), h_3 = \mathcal{H}(s_2, h_2), \ldots, h_T = \mathcal{H}(s_{T-1}, h_{T-1})$$
$$0 \leq e_t \leq 1$$

- Note that in the last period, the problem is simple:

$$\max_{e_T} \beta^{T-1} (1 - e_T) h_T$$

  - The solution is clearly $e_T = 0$ as there is no future concerns

- Then the second last period:

$$\max_{e_{T-1}} \beta^{T-2} (1 - e_{T-1}) h_{T-1} + \beta^{T-1} \mathcal{H}(e_{T-1}, h_{T-1})$$

  - Now the solution depends on the FOC as there is future concern

Problem in a Recursive Form

- Through a backward induction, at each period we need to only consider a problem with one choice: the current education time
  - Assuming that all forward problems will be solved optimally

- The problem can thus be written as a "Bellman equation":

$$V_t(h_t) = \max_{e_t} (1 - e_t) h_t + \beta V_{t+1}(h_{t+1})$$

s.t.

$$h_{t+1} = \mathcal{H}(e_t, h_t)$$
$$0 \leq e_t \leq 1$$

- $V_t(h_t)$ is a value function which says that the PDV of all current and future values is a function of current human capital (h_t) assuming the agent takes all optimal actions at current and future time

- For the final period, the value function is simply $V_T(h_T) = (1 - e_T) h_T$

FOC and Envelope Condition

- When e_t is interior, the FOC for investment:

$$\underbrace{h_t}_{\text{marginal cost}} = \underbrace{\beta \frac{\partial V_{t+1}\left(h_{t+1}\right)}{\partial h_{t+1}} \frac{\partial \mathcal{H}\left(e_t, h_t\right)}{\partial e_t}}_{\text{marginal benefit}}$$

  - The marginal cost is less wage (and consumption) today
  - The marginal benefit is more wage tomorrow and thereafter

- Recall $\mathcal{H}$ is a concave function in $e \Rightarrow$ As β or $\left[\frac{\partial V_{t+1}(H_{t+1})}{\partial H_{t+1}}\right]$ increases, so does e (to balance the FOC)
  - Note h_t is given to the recursive problem (i.e. a state variable)

- The model is completed with the envelope condition:

$$\frac{\partial V_t\left(h_t\right)}{\partial h_t} = \left(1 - e_t\right) + \beta \frac{\partial V_{t+1}\left(h_{t+1}\right)}{\partial h_{t+1}} \frac{\partial \mathcal{H}\left(e_t, h_t\right)}{\partial h_t}$$

  - I.e. combined with FOC, they fully describe the dynamics of this model

Ben-Porath Model

- Let's assume the function $\mathcal{H}()$ takes the Ben-Porath (1967) functional form:

$$\mathcal{H}\left(e_t, h_t\right) \equiv A\left(e_t h_t\right)^{\alpha} + h_t$$

  - One can also add $-\sigma h_t$ to captures the idea of human capital depreciation

- This simplifies the analysis considerably because one can get a closed-form solution for

$$\frac{\partial V_t\left(h_t\right)}{\partial h_t} = 1 + \beta^1 + \ldots + \beta^{T-t} = \frac{1-\beta^{T+1-t}}{1-\beta}$$

  - Thus V_t' is strictly decreasing in t and does not depend on h_t

- Thus marginal return to investment is simply the discounted flow of future increases in earnings power due to one unit increase in human capital

A Trick of Derivation

- To see this, rewrite the problem as

$$V_t\left(h_t\right) = \max_{c_t \equiv h_t e_t} h_t - c_t + \beta V_{t+1}\left(h_t + A c_t^{\alpha}\right)$$

  , where $h_t e_t$ is monetary cost of investment, i.e. foregone earnings

- Hence the envelope condition becomes

$$V_t'\left(h_t\right) = 1 + \beta V_{t+1}'(h_{t+1})$$

- Then do backward induction using $V_T'(h_T) = (1 - e_T) = 1$:

$$\begin{aligned} & V_{T-1}' = 1 + \beta \\ \Rightarrow\ & V_{T-2}' = 1 + \beta(1 + \beta) \\ & \Rightarrow \ldots \\ & \Rightarrow V_t' = 1 + \beta^1 + \ldots + \beta^{T-t} \\ & \Rightarrow V_t' = \frac{1 - \beta^{T+1-t}}{1 - \beta} \end{aligned}$$

  - The last step obtains by deducting a $\beta V_t'$ from both sides

Solution

- When investment is interior, we get the optimal investment through FOC:

$$h_t = \beta V'_{t+1} A h_t^{\alpha} \alpha e_t^{\alpha-1}$$
$$\Rightarrow h_t e_t = \left[\beta V'_{t+1} A \alpha\right]^{\frac{1}{1-\alpha}}$$

- As workers age, both the "monetary" and time investment must fall as the marginal future value falls
- Time investment falls for one more reason: foregone earning also increases
  - Check the FOC; This effect dominates the increased efficiency of investment
  - Initial human capital affects the time investment but does not affect investment as foregone earning ("Ben-Porath neutrality")
- Recall one constraint is that $e_t \leq 1 \Rightarrow$ Early in life this constraint may bind, in which case $e_t = 1$ and earnings are 0 (i.e. schooling)

e (left panel) and h (right panel) over Lifecycle

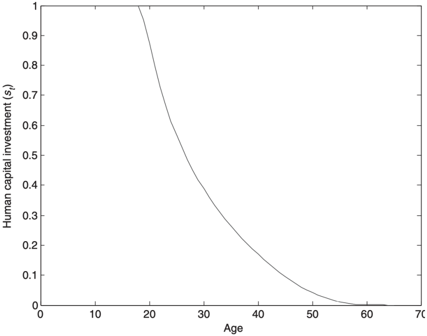


Figure 1

Human capital investment.

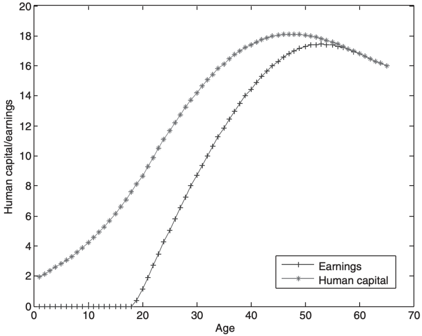


Figure 2

Human capital and earnings over the life cycle.

Roadmap

What Purposes for Empirical Studies?

- We have ”seen” many benefits from education, such as lifecycle earning and employment rate, from the data
- So what’s the purpose for more empirical studies?
- 1. Estimation
  - How much does one year difference in schooling affect wage?
  - Estimate the key parameters in our economics model using a statistical model
  - ~~*(Let’s put things into a regression and get some quantitative results)*~~
- 2. Causal inference
  - Our economics model can be wrong and then the statistical model used can be ill-suited
  - Econometricians are always cautious to draw strong inferences about the ”causal effect” (here of schooling)
  - Main concern here: ”ability bias” (as ommited-variable or confounder)

Mincer Regression

- The typical empirical model to estimate the relationship between wages and schooling:

$$\ln W_i = \alpha + \beta S_i + \gamma_1 X_i + \gamma_2 X_i^2 + \varepsilon_i$$

  - S_i is the full-time schooling years for individual i
  - X_i is years of work since completing schooling, i.e. experience
  - ε is a statistical residual
  - A similar form can be derived from one simple version of the human capital model, where S_i is i's optimal schooling years choice
  - Demographic controls like gender can be also added

- This model has been estimated for most countries of the world by OLS, generally yielding estimates of β ranging from $.05$ to $.10$

- We can also relax the linear assumption of schooling effects by replace years S_i with a dummy variable
  - We can also use dummy variable of education level to estimate "college premiums" (relative to e.g. high-school dropouts)

Plots of Coefficients $\beta(s)$ (Krueger and Lindahl, 2001)

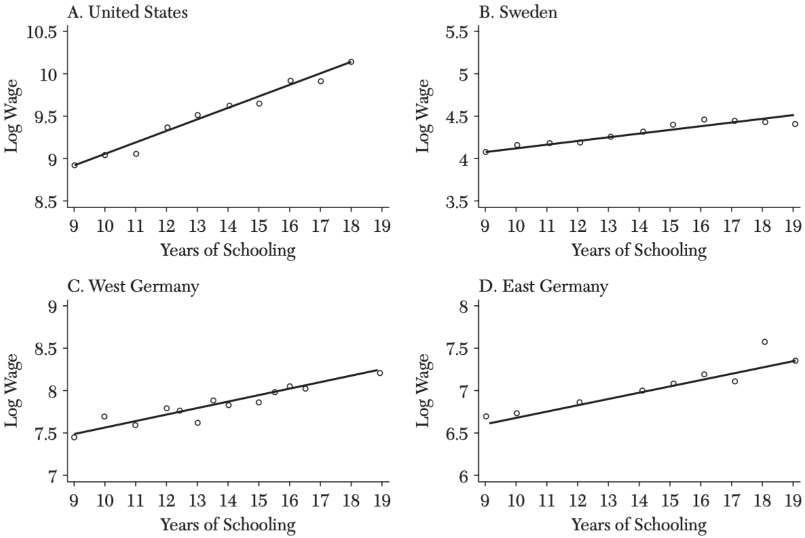


Figure 1. Unrestricted Schooling-Log Wage Relationship and Mincer Earnings Specification

"The log-linear relationship provides a good fit to the data"

Regression = Comparison *(see the original tweet thread!)*

Peter Hull
@instrumenthull

Regression is a tool for making comparisons

If you don't know / can't easily explain what comparisons you're trying to make, then you don't understand the regression you're running

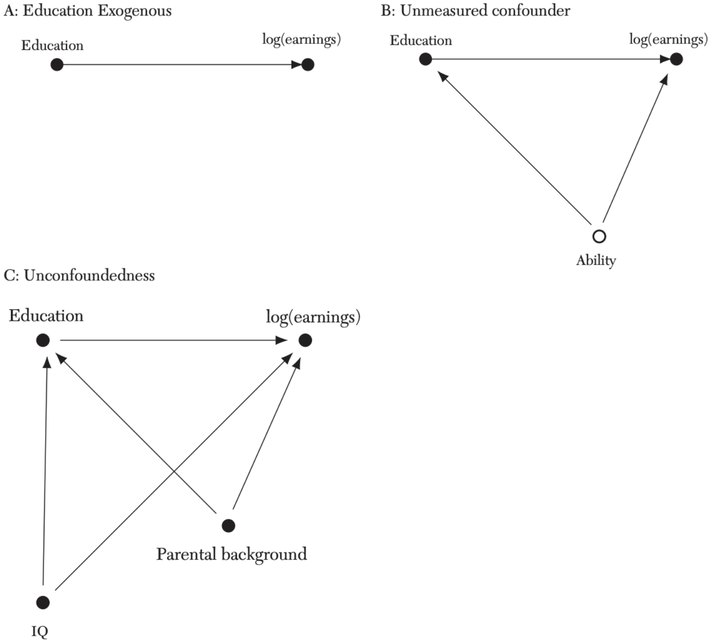
ポストを翻訳

午後10:05 · 2024年4月2日 · **12.2万** 件の表示

Ability Bias

- Econometricians often only observe a limited set of human capital, which does not include ”innate ability”
- If more able ones also take longer schooling and earn higher earnings, we can overestimate return to education
  - E.g. if $\ln W_i = \alpha + \beta S_i + \gamma_1 X_i + \gamma_2 X_i^2 + \varepsilon_i + [\alpha_i - \alpha]$, then $\text{cov}(S_i, \alpha_i) > 0$ as the decision of S_i will depend on α_i
  - If inverse case is true, we underestimate return to education
- Ideally, we want to do experiments to obtain causal effects
  - Why need experiments? We want to **compare apple with apple**!
  - In social science, our observed data is mostly not from experiments
- Other unobserved factors that affect earnings (e.g. soft ability or connection) can play a similar role
- Although early surveys of this literature concluded that such biases were small, many econometricians continue to be skeptical

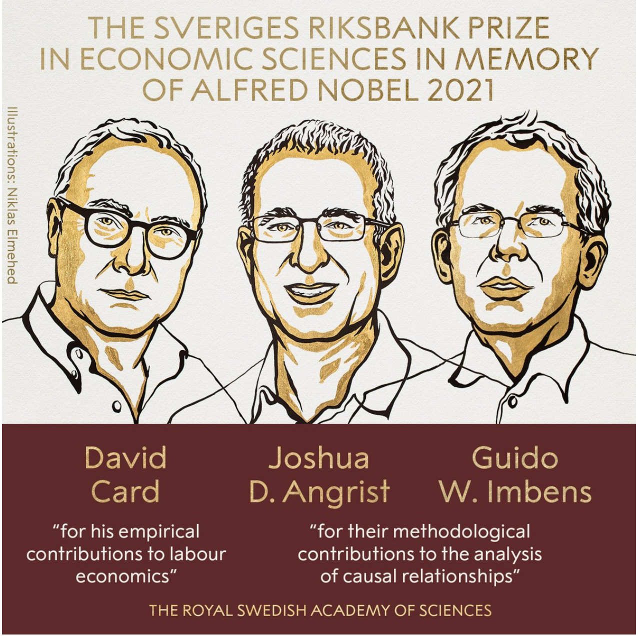
Casual Graph (DAG) of Education on Earning (Imbens, 2020)



Econometricians' Solutions

- The idea is to approach an experimental setup
  - Also called natural experiments or quasi-experiments
- 1. Control those confounders, i.e. those innate abilities
  - Use test scores or IQ tests
  - Use family/parental background measures
- 2. Family Fixed Effects (FE) model, i.e. compare siblings or twins
  - Assume same causal effect of (education and) the unobserved confounder (genetic or social background)
- 3. Instrumental Variables (IVs), i.e. use only education variations exogenous (irrelevant) to confounders
  - Use quarter of birth (and school start age cutoffs and compulsory schooling laws) (Angrist and Krueger, 1991)
  - Use distance to college (Card, 1993)
- Most "experimental" results are found to be similar to the conventional OLS results

Credibility Revolution led by Labor Economists *(an intro)*



Casual Graph of Econometricians' Solutions (Imbens, 2020)

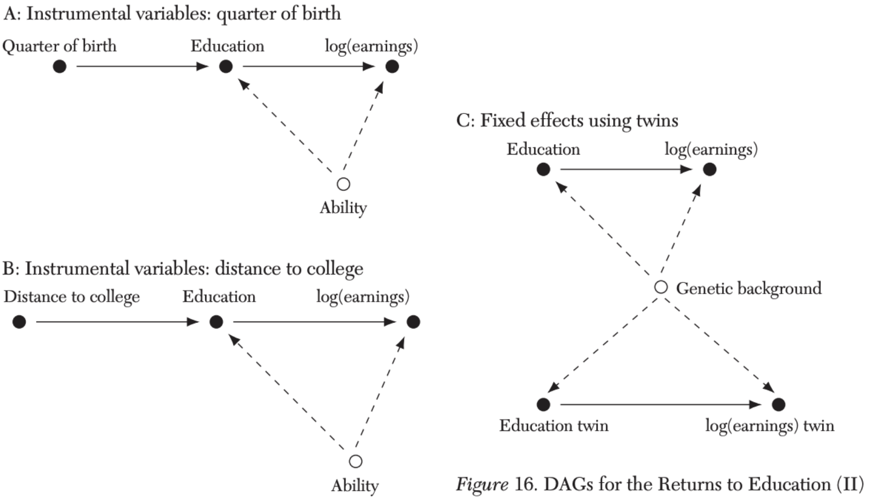


Figure 16. DAGs for the Returns to Education (II)

Quarter of Birth as IV (Angrist and Krueger, 1991)

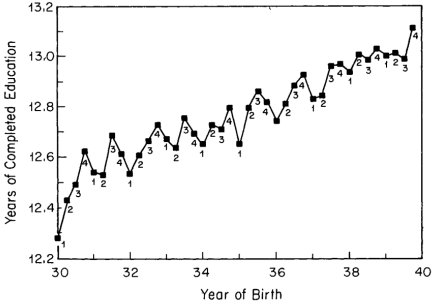


FIGURE I
Years of Education and Season of Birth
1980 Census
Note. Quarter of birth is listed below each observation.

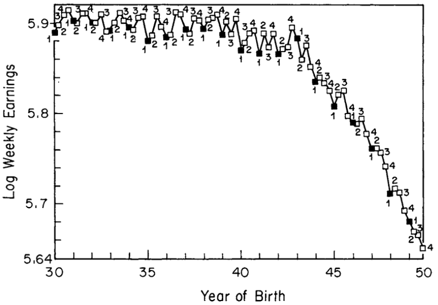
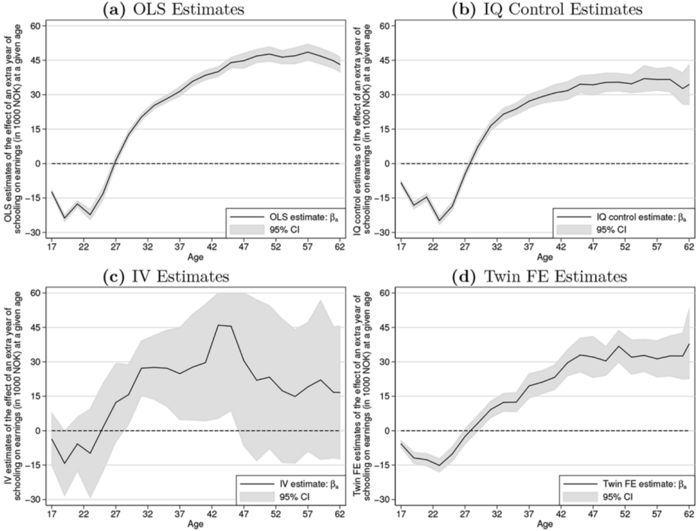


FIGURE V
Mean Log Weekly Wage, by Quarter of Birth
All Men Born 1930–1949; 1980 Census

Estimation Results of β_a using Norwegian Panel Data

Bhuller et al. (2017): $W_{ia} = \alpha_a + \beta_a S_{ia} + \varepsilon_{ia}$

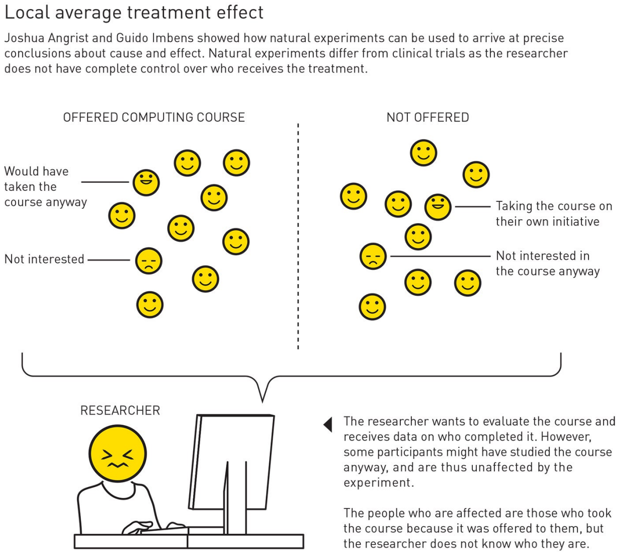


"Ability bias does not seem to explain why more individuals do not acquire additional schooling despite its high estimated financial return"

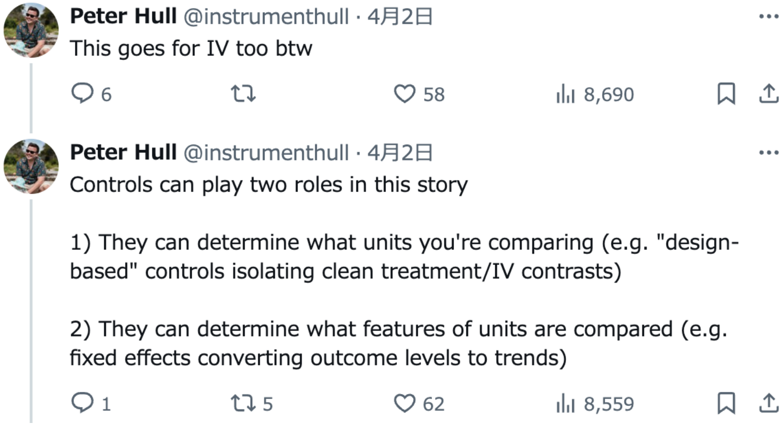
So Why Not Everyone Going to College?

- This is even more puzzling if considering nonpecuniary benefits from schooling (Oreopoulos and Salvanes, 2011)
- Unfortunately, selection based on ability or comparative advantage is still a concern
  - B.c. IV estimations show only "local" effects and there can have heterogeneous effects (i.e. β_i potentially correlated with S_i and α_i)
  - See Meghir and Rivkin (2011) and Heckman et al. (2018)
  - More about self-selection in Week04

Local Average Treatment Effect



Regression = Comparison *(see the original tweet thread!)*



Peter Hull @instrumenthull · 4月2日 ···

This goes for IV too btw

6 58 8,690

Peter Hull @instrumenthull · 4月2日 ···

Controls can play two roles in this story

1) They can determine what units you're comparing (e.g. "design-based" controls isolating clean treatment/IV contrasts)

2) They can determine what features of units are compared (e.g. fixed effects converting outcome levels to trends)

1 5 62 8,559

So Why Not Everyone Going to College?

- Other explanations:
  - Credit constraint (Lochner and Monge-Naranjo, 2011, 2012)
  - Family background and parental investment (Becker and Tomes, 1979; Björklund and Salvanes, 2011)
  - Psychic costs; Uncertainty about future earnings gains (Cunha et al., 2005; Heckman et al., 2006)
  - Uncertainty of completing school (Athreya and Eberly, 2021)
  - Ex-ante (mis-)belief on education return and costs (Jensen, 2010; Hoxby and Turner, 2015; Delavande and Zafar, 2019)
  - Social and cultural barriers (Akerlof and Kranton, 2002; Fryer Jr and Levitt, 2010)

Social vs. Private Returns

- So far we have been focused only on private returns
- The social return to education can, of course, be higher or lower than the private monetary return
  - Technological adoption and progress
  - A reduction in crime and welfare participation
  - Better gender perceptions
  - More informed political decisions
  - ...
- The social return to education can also be less than the private return
  - Esp. when the innate ability selection is an important concern, e.g. see Kim et al. (2024) on Korea's education competition (more on next week)
  - Education reduces fertility as we see in the first class
- There are different strands of literature to estimate these effects

Reference I

Akerlof, G. A. and R. E. Kranton (2002). Identity and schooling: Some lessons for the economics of education. *Journal of economic literature 40*(4), 1167–1201.

Angrist, J. D. and A. B. Krueger (1991). Does compulsory school attendance affect schooling and earnings? *The Quarterly Journal of Economics 106*(4), 979–1014.

Athreya, K. and J. Eberly (2021). Risk, the college premium, and aggregate human capital investment. *American Economic Journal: Macroeconomics 13*(2), 168–213.

Becker, G. S. (1962). Investment in human capital: A theoretical analysis. *Journal of political economy 70*(5, Part 2), 9–49.

Becker, G. S. (1964). *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education, First Edition*. Number beck-5 in NBER Books. National Bureau of Economic Research, Inc.

Becker, G. S. (1993). Nobel lecture: The economic way of looking at behavior. *Journal of political economy 101*(3), 385–409.

Becker, G. S. and N. Tomes (1979). An equilibrium theory of the distribution of income and intergenerational mobility. *Journal of political Economy 87*(6), 1153–1189.

Ben-Porath, Y. (1967). The production of human capital and the life cycle of earnings. *Journal of political economy 75*(4, Part 1), 352–365.

Bhuller, M., M. Mogstad, and K. G. Salvanes (2017). Life-cycle earnings, education premiums, and internal rates of return. *Journal of Labor Economics 35*(4), 993–1030.

Björklund, A. and K. G. Salvanes (2011). Education and family background: Mechanisms and policies. In *Handbook of the Economics of Education*, Volume 3, pp. 201–247. Elsevier.

Reference II

Blundell, R. W., H. Lopez, and J. P. Ziliak (2023). Labour market inequality and the changing life cycle profile of male and female wages. Technical report, IFS Working Papers.

Card, D. (1993). Using geographic variation in college proximity to estimate the return to schooling.

Castro, R. and D. Coen-Pirani (2016). Explaining the evolution of educational attainment in the united states. *American Economic Journal: Macroeconomics 8*(3), 77–112.

Charles, K. K., E. Hurst, and M. J. Notowidigdo (2018). Housing booms and busts, labor market opportunities, and college attendance. *American Economic Review 108*(10), 2947–2994.

Cunha, F. and J. Heckman (2007). The technology of skill formation. *American economic review 97*(2), 31–47.

Cunha, F., J. Heckman, and S. Navarro (2005). Separating uncertainty from heterogeneity in life cycle earnings. *oxford Economic papers 57*(2), 191–261.

Cunha, F., J. J. Heckman, L. Lochner, and D. V. Masterov (2006). Interpreting the evidence on life cycle skill formation. *Handbook of the Economics of Education 1*, 697–812.

Delavande, A. and B. Zafar (2019). University choice: The role of expected earnings, nonpecuniary outcomes, and financial constraints. *Journal of Political Economy 127*(5), 2343–2393.

Friedman, M. and S. Kuznets (1945). *Income from Independent Professional Practice*. National Bureau of Economic Research, Inc.

Fryer Jr, R. G. and S. D. Levitt (2010). An empirical analysis of the gender gap in mathematics. *American Economic Journal: Applied Economics 2*(2), 210–240.

Reference III

Heckman, J. J., J. E. Humphries, and G. Veramendi (2018). Returns to education: The causal effects of education on earnings, health, and smoking. *Journal of Political Economy 126*(S1), S197–S246.

Heckman, J. J., L. J. Lochner, and P. E. Todd (2006). Earnings functions, rates of return and treatment effects: The mincer equation and beyond. *Handbook of the Economics of Education 1*, 307–458.

Houmark, M. A., V. Ronda, and M. Rosholm (2024). The nurture of nature and the nature of nurture: How genes and investments interact in the formation of skills. *American Economic Review 114*(2), 385–425.

Hoxby, C. M. and S. Turner (2015). What high-achieving low-income students know about college. *American Economic Review 105*(5), 514–517.

Imbens, G. W. (2020). Potential outcome and directed acyclic graph approaches to causality: Relevance for empirical practice in economics. *Journal of Economic Literature 58*(4), 1129–1179.

Jensen, R. (2010). The (perceived) returns to education and the demand for schooling. *The Quarterly Journal of Economics 125*(2), 515–548.

Kambourov, G. and I. Manovskii (2009). Accounting for the changing life-cycle profile of earnings. *Unpublished manuscript, University of Toronto*.

Kim, S., M. Tertilt, and M. Yum (2024). Status externalities in education and low birth rates in korea. *American Economic Review 114*(6), 1576–1611.

Krueger, A. B. and M. Lindahl (2001). Education for growth: Why and for whom? *Journal of economic literature 39*(4), 1101–1136.

Reference IV

Lochner, L. and A. Monge-Naranjo (2012). Credit constraints in education. *Annu. Rev. Econ. 4*(1), 225–256.

Lochner, L. J. and A. Monge-Naranjo (2011). The nature of credit constraints and human capital. *American economic review 101*(6), 2487–2529.

Meghir, C. and S. Rivkin (2011). Econometric methods for research in education. *Handbook of the Economics of Education 3*, 1–87.

Oreopoulos, P. and K. G. Salvanes (2011). Priceless: The nonpecuniary benefits of schooling. *Journal of Economic perspectives 25*(1), 159–184.