Introduction

Education is one of the largest sectors in the economy, and thus can be studied from a large amount of angles.

- Early Childhood Education (beyond just "being watched")
- Elementary/Secondary School
- Postsecondary Education

Education can be studied from a lot of angles:

Micro: Applying theories of labor economics and consumer theory to education.

Econometrics: Use data to analyze educational policies.

Macro: Investigate global demand for education-as-a-commodity.

Education System Basics

Returns to Education: There is a large return to education; those with a high school education tend to make far less than those with a bachelor's degree and up. Perceived value of being more education in private or public market.

Labor Market Outcomes: The more educated you are, the more likely to have a job; unemployment rates for high school graduates are higher than unemployment rates for college graduates.

Public Spending: Approximately 5–6% of GDP is spent on education in most OECD countries.

Funding Structure: Public schools are primarily funded through state and local governments — property taxes the largest source of funding for education, but federal government has started to fund more schools in recent years.

Growth of Education over Time: Claudia Goldin's 1993 paper "The Human-Capital Century and American Leadership" shows that the 20th century was really the century of greater and greater access and attainment in education.

Why Do We Get Educated?

Human Capital

What is human capital?

- Labor.
- Complexity or efficiency of work.

How does human capital differ from capital?

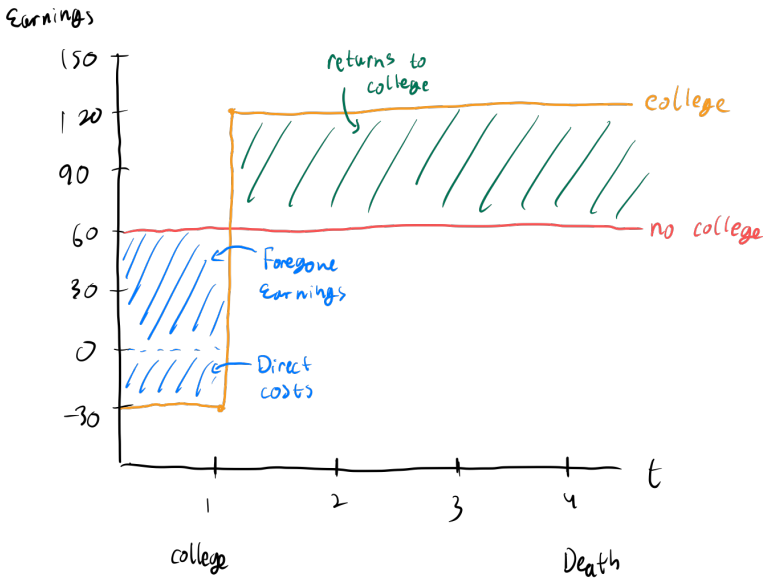
- Less static.
- Differential depreciation — potential for appreciation (people can skill up).
- Higher variance.
- Unionization/collective bargaining.
- Idea generation.
- Potentially greater mobility.
- Returns to human capital come in the form of wages — human capital is owned by the human that holds it.
- Cannot be collateralized.
- Divisibility (or lack thereof).

Education: how much?

Discrete Model: To college or not?

- Direct costs: tuition, room and board.
- Indirect costs: foregone earnings.
- Returns: expected future earnings (requires college degree or not).

We will assume that "college" is period 1, and college grads earn more post-college, and there is a discount rate r.



The discount rate of \$100 in $t > 0$ periods is worth $\frac{100}{(1+r)^t}$ in period 0 (aka today).

We generally think about r in terms of the interest rate — money today is worth more than money in the future due to the ability to invest.

The *present value* of a stream of money is found as follows:

$$\begin{aligned}
\text{PV} &= \frac{100}{(1+r)} + \frac{100}{(1+r)^2} + \cdots + \frac{100}{(1+r)^n} \\
&= \sum_{t=1}^{n} \frac{100}{(1+r)^t} && (1) \\
(1+r)\text{PV} &= 100 + \frac{100}{(1+r)} + \cdots + \frac{100}{(1+r)^{n-1}} \\
&= 100 + \sum_{t=1}^{n-1} \frac{100}{(1+r)^t} && (2) \\
(1+r)\text{PV} - \text{PV} &= 100 + \sum_{t=1}^{n-1} \frac{100}{(1+r)^t} - \sum_{t=1}^{n-1} \frac{100}{(1+r)^t} - \frac{100}{(1+r)^n} && (2)-(1) \\
r\text{PV} &= 100 - \frac{100}{(1+r)^n} \\
\text{PV} &= \frac{100}{r}\left(1 - \frac{100}{(1+r)^n}\right)
\end{aligned}$$

As n becomes larger, then the PV of the asset is larger. For example, if $n = 40$, $Y = 60,000$, and $r = 0.05$, then the PV of this revenue stream is approximately \$1 million.

Bringing this to the model, where F denotes direct tuition cost, Y_0 denotes earnings with no schooling, and Y_S denotes earnings with schooling (where school occurs in period 1).

$$\begin{aligned}
\text{PV}_0 &= \frac{Y_0}{(1+r)} + \frac{Y_0}{(1+r)^2} + \cdots + \frac{Y_0}{(1+r)^n} \\
\text{PV}_S &= -F + \frac{Y_S}{(1+r)^2} + \cdots + \frac{Y_S}{(1+r)^n} \\
\text{NPV}_S &= \text{PV}_S - \text{PV}_0 \\
&= \underbrace{-F - \frac{Y_0}{(1+r)}}_{\text{Cost}} + \underbrace{\sum_{t=2}^{n} \frac{Y_S - Y_0}{(1+r)^t}}_{\text{Benefit}} \\
&= -F - \frac{Y_0}{1+r} + \frac{Y_S - Y_0}{r}\left(1 - \frac{1}{(1+r)}\right)\frac{1}{1+r}
\end{aligned}$$

To find if education is worth it, we calculate if $\text{NPV}_S > 0$.

Continuous Model (or Mincer Model): To take an extra year of education or not?

- S is a discrete, integer choice (denoting a year of education).
- Y_S is salary after schooling for S years.
- There are zero direct costs of school.
- Years in labor force, K, are equivalent regardless of S.

We choose S where marginal benefit is equal to marginal cost.

$$\begin{aligned}
\text{PV}_S &= \text{PV}_{S+1} \\
\sum_{t=1}^{K} \frac{Y_S}{(1+r)^t} &= \sum_{t=2}^{K+1} \frac{Y_{S+1}}{(1+r)^t} \\
\frac{Y_S}{r}\left(1 - \frac{1}{(1+r)^K}\right) &= \frac{Y_{S+1}}{r}\left(1 - \frac{1}{(1+r)^K}\right)\frac{1}{1+r} \\
Y_S &= Y_{S+1}\frac{1}{1+r} \\
1 + r &= \frac{Y_{S+1}}{Y_S}
\end{aligned}$$

We choose school until the marginal rate of return is equal to the discount rate.

Housekeeping, January 30: Schedule for discussion and presentation is located at this link, and the guidelines for classroom activities are located at this link.

Educational Landscape

The human capital system consists of a number of components.

- Trade, technical, and vocational education (generally falls under post-secondary education)
- Early childhood education — Ages 6 weeks–5, includes day care and pre-K
- Primary education — Ages 5–12, Grades K–5/6

- Secondary education — Ages 12–18, Grades 6–12
- Post-secondary education — two year/community college, four year college
- Graduate education — profession-oriented (MBA, JD), research-oriented (master's, PhD), certification (CPA, CFA, actuarial credentialing)
- Adult education (GED, college)

In primary and secondary education, primary choice facing consumers of education is between public and private education.

Human Capital Model: Choice of Schooling Quantity

The human capital model indicates that consumers of education choose their amount of schooling, S, based on the following factors:

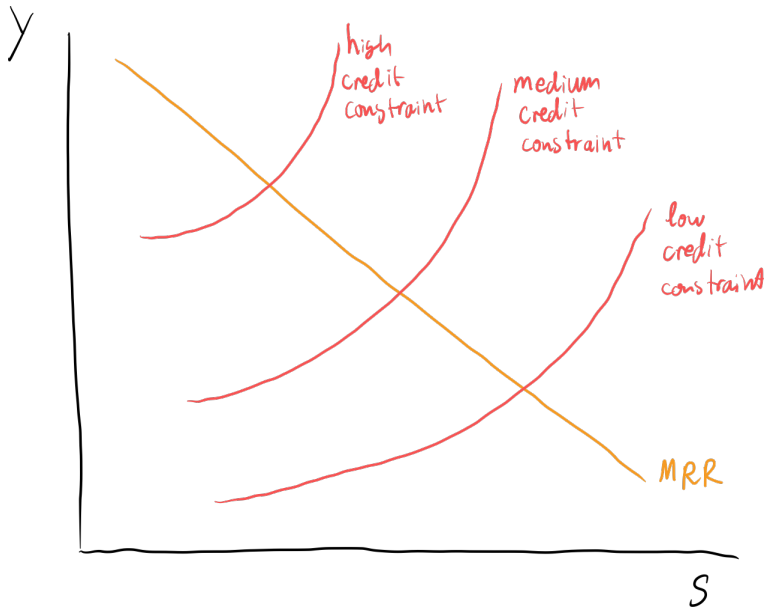
- Discrete: Y_S (income from having been schooled) vs Y_0 (income without schooling)
- Continuous: $\frac{Y_{S+1}}{Y_S}$ (marginal rate of return from schooling)
- F (the cost of schooling)
- r (discount rate)

However, this leads us to ask an important question — why might S differ?

- Differing (marginal) rates of return — job-specific factors, overqualification, ability, quality of education
- Different cost of education — borrowing, aid, credit constraints

  Comment: Credit constraints increase exponentially as quantity of schooling increases.

A model of credit constraints' effects on choices of education can be seen as follows:



Broadly speaking, if S differs because of marginal rate of return, then subsidies may be inefficient — subsidies will cause inefficient excess schooling.

However, if S differs because of cost, then subsidies improve overall output and efficiency.

Signaling

The basic idea behind the human capital model is that by getting more educated, you become smarter and have a higher rate of return — regardless of whether or not you get a degree. Now, we will discuss a model where schooling does not indicate one's level of smartness.

Assumptions:

(1) No human capital accrued at school.

(2) Two types of workers: low ability (L) of proportion p with productivity 1 and high ability (H) of $1-p$ with productivity 2.

(3) Cost of education is lower for type H. For type L, the cost of education is c, and for type H the cost of education is $c/2$.

(4) Generic employer who, if they distinguish H and L, pay marginal benefit — wage to L is 1, wage to H is 2.

(5) If the employer cannot distinguish between H and L, then they pay the expected marginal benefit, $(1-p)(2)+(p)(1)=2-p$.

Game Play:

- Employer forms belief $w(S)$ about the worker productivity
- Employer sets $w(S)$
- Workers observe $w(S)$ and decide on S
- Workers are hired and firms observe their productivity

Types of Equilibria:

- Separating equilibrium: a situation where H chooses education and L does not choose education. In this case, education serves as a pure signal of high productivity — there is no separating equilibrium where H chooses no education and L chooses education.
- Pooling equilibrium: all workers choose education, and the employer cannot differentiate, meaning the employer pays $2-p$ to all workers.

Finding a Separating Equilibrium: We assume that there is a separating equilibrium — H chooses $S=1$ and L chooses $S=0$. Then, the employer forms beliefs to set a wage structure as follows:

$$w(S)=\begin{cases}2 & S=1\\ 1 & S=0\end{cases}.$$

In order to be an equilibrium, both H and L types need to have an incentive not to deviate.

- H Type Equilibrium Condition: Return to education is higher than return to non-education.

$$\begin{aligned}2-\frac{c}{2}&>1\\ c&<2\end{aligned}$$

- L Type Equilibrium Condition: Return to non-education is higher than return to education.

$$\begin{aligned}1&>2-c\\ c&>1\end{aligned}$$

Therefore, if $c\in(1,2)$, we can find a separating equilibrium.

Finding a Pooling Equilibrium: We assume that there is a pooling equilibrium where all players are educated — H chooses $S = 1$ and L chooses $S = 1$. Then, the employer forms beliefs to set a wage structure as follows:

$$w(S) = \begin{cases} 2 - p & S = 1 \\ 1 & S = 0 \end{cases}$$

In order to be an equilibrium, both H and L types need to have an incentive not to deviate.

- H type equilibrium Condition: Return to education is higher than return to non-education.

$$(2 - p) - \frac{c}{2} > 1$$
$$c < 2 - 2p$$

- L type equilibrium condition: Return to education is higher than return to non-education.

$$(2 - p) - c > 1$$
$$c < 1 - p$$

Therefore, so long as $c < 1 - p$, both types of employees will choose education over non-education. Essentially, if the cost of education is very low, then everyone will choose education.

Working through a similar set of logic, we can also find a sufficient c such that everyone chooses no education.

$$w(S) = \begin{cases} 2 - p & S = 0 \\ 2 & S = 1 \end{cases},$$

if $c > 2p$. Notice that both of these pooling equilibria are more likely to exist the higher proportion of H types.

Signal vs Index

- Signal: implicit assurance of skill or quality, chosen by worker, not readily apparent. Examples include education levels.
- Index: worker cannot control said assurance of skill or quality, but predetermined, generally a source of discrimination. Examples include disability, race, gender, and age.

The signaling model starts with employers offering different wages based on a signal — the signal is something a worker has some level of control.

However, the signaling model could also be thought of as an indexing model (by varying parameters p and c while equalizing productivity). Essentially, the signaling model is about a legal form of discrimination (education-based discrimination), but we can apply it to illegal forms of discrimination.

Human Capital and Signaling Model: Features

Human Capital	Both Models	Signaling Model
positive externalities	inequality	pure private returns
education is efficient		education is inefficient

Claudia Goldin: The Human-Capital Century

- The 20th century was the century where people became educated — early on, few people even had a primary education, but now, the vast majority of people obtain secondary school.
- Education is democratic.
  - Democracy is a government by the people, for the people.
  - Power is not vested by God or inherent in blood, but governance comes from the consent of the governed.
  - Public demand for education leads to more education being delivered.
  - Education provides both skills and time to create better citizens.
- Virtues: egalitarianism, forgiveness (possibly changing), separation of church and state.
- Primary education was very common across the rich world, but secondary education was far more common in the United States than other countries.
- Specifically, American secondary education was about *general* education (algebra, writing, reading comprehension, etc.), not merely vocational or technical training. The European system is much more heavily tracked.
- Idea that one would spend years 10–18 in education began in the United States. Adults were better able to establish themselves in the new economy, and the underlying structures were exported to the rest of the United States.
- European systems developed out of monarchy/aristocracy, leading to deterministic ideas of the demands of the economy.
- Decentralized American education system — curriculum followed the economy, rather than determined for the economy.
- The standards for general education developed around a pure method of approach towards problems.
- Rise of large corporations generated large need for management, idea generation, communication — had to do HR, accounting, etc. at a scale never seen before. Skills were meant to be portable and transferable, which the decentralized American education system satisfied the demand for.

Understanding Causality

When discussing questions in economics, there are two basic approaches:

- Theory: models (as discussed in our model of human capital and the signaling model).
- Empirics: using data to understand the dynamics of the world.

For example, we may want to understand the impact of a good teacher in the role of educational success through different measures:

- Pass rates or graduation rates.
- College entrance rates.
- Test scores.
- Earnings.

We can think of each of these as our Y_i, our outcome variable of interest. At the same time, we have to measure the quality of a teacher, X_i, through different mechanisms:

- Education
- Course Evaluations (with adequate controls for race and gender)
- Subject

Defining Causality

The impact of variable A *causally* affects variable B as the change in B if A, and only A, is altered. Causality is usually defined using a counterfactual.

In the case of education, for Y_i, student i's outcome, with Y_{1i} for an outcome for a student with a good teacher and Y_{0i} for a student with a bad teacher. We define D_i, our dummy variable, as 1 if the teacher is good and 0 if the teacher is bad.

$$Y_i = Y_{0i} + D_i \underbrace{(Y_{1i} - Y_{0i})}_{\text{treatment effect}}.$$

Potential Outcomes Framework

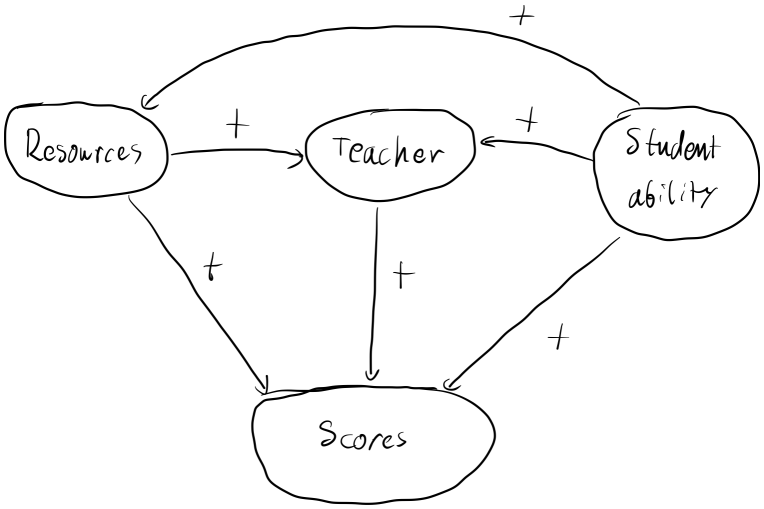
- What does a researcher observe? We assume $N > 1$. In this case,

$$\begin{aligned} E(Y_{1i}|D_i = 1) - E(Y_{0i}|D_i = 0) = & \text{ observed difference of } D_i = 1 \\ = & \overbrace{E(Y_{1i}|D_i = 1) - \underbrace{E(Y_{0i}|D_i = 1)}_{\text{counterfactual}}}^{\text{Average Treatment Effect (impact of good teacher)}} \\ & + \overbrace{\underbrace{E(Y_{0i}|D_i = 1)}_{\text{counterfactual}} - E(Y_{0i}|D_i = 0)}^{\text{selection bias}} \end{aligned}$$

Therefore, we can see that the observed difference is a function of treatment and selection bias. The most difficult part of empirical research is finding situations where selection bias is as close to zero as possible.

In regression analysis, we might have the model that states

$$\text{score}_i = \beta_0 + \beta_1 \text{TeacherQuality}_i + \varepsilon_i.$$



Suppose that teachers matter — even then, there are other variables, such as resources or intrinsic ability. The diagram depicts the various ways that selection bias can create positive correlation.

In this case, $\hat{\beta_1}$ will be biased by selection. This is known as omitted variable bias, and violates the principle that $\text{Cov}(X, \varepsilon) = 0$.

To resolve this, we may update our regression model to control for the omitted variable of resources, denoted Z.

$$\begin{aligned} \text{score}_i &= \beta_0 + \beta_1 \text{TeacherQuality}_i + \beta_2 \text{Resources}_i + \varepsilon_i \\ \text{observed effect} &= E(Y_{1i}|D_i = 1, Z) - E(Y_{0i}|D_i = 1, Z) + \underbrace{E(Y_{0i}|D_i = 1, Z) - E(Y_{0i}|D_i = 0, Z)}_{\text{selection bias}}. \end{aligned}$$

However this still leaves out other omitted variables (such as parental involvement). As we add more control variables, selection bias should reduce. All these control variables exist to mitigate selection bias and make a non-experimental setting as close to an experiment as possible.

There are a few major ways to identify causality:

(1) Experiments

(2) Instrumental Variables

(3) Difference-in-difference

(4) Regression discontinuity

(5) Panel data

Experiments

The "cleanest" way to

- Identify a Target Population.
- Randomize Population.
  - Treatment group experiences condition.
  - Control group does not experience condition.
- Experiments have the following desirable properties:
  - Internal Validity: $E(\varepsilon|X) = 0$ (error is uncorrelated with independent variable)
  - Randomness
- However, true randomness is difficult to attain. The ABCs of experiments also threaten internal validity.
  - Attrition: individuals drop out of experiments.
  - Balance: distribution of covariates may not be the same across groups.
  - Compliance: not everyone assigned to a treatment may experience it.
- There are also other limits:
  - Feasibility: expense, time, or even full impossibility.
  - Ethics: some experiments may pose ethical issues
  - External validity: experiments may only provide insights to specific situations.

- Threats to internal validity:
  - Poor randomization
  - Experimental contamination
  - Response rate, compliance
  - Attrition
- Threats to external validity:
  - Non-representative sample
  - Treatment depends on experiment
  - Excessive controls, Hawthorne effect
  - Scalability

Many experiments in the economic literature occur through lotteries.

- Project Star: randomly assigned students to teachers and class sizes.
- Perry Preschool: balanced lottery for access to early childhood education.
- Expanding Opportunities Project: lottery for access to mentoring for high school students and college resources.

Carrell et al.: A's from Zzzz's? The Causal Effect of School Start Time on the Academic Achievement of Adolescents

- Why might we be skeptical of a paper without the controlled environment inherent at USAFA?
  - Student choice.
  - Grading style.
  - Teacher quality, teaching style, teacher tiredness, experience based on time period.
  - Student selection into teachers.
  - Commutes.
  - Extracurriculars and physical fitness.
  - Food and energy.
  - Study habits.
  - Circadian rhythm.
  - Cheating.
  - Day of week.
- What is special about the USAFA?
  - Common exam timings.
  - Course difficulty held constant.
  - Mandatory breakfast.
  - Grading styles held constant.
  - No choice in schedule.
  - No commutes.
  - Physical fitness requirements.

  - No zero period classes.
  - Teachers are randomized.

  From a policy perspective, if the problem is time of day, then shifting schedules will do a lot of good. However, if the problem is being driven by sleep, then shifting time of day may not increase benefits all that much.

- How do they get to causality? Generally, we need variance in X to find $\hat{\beta}_1$.
  - Shifting of schedules.
  - Block schedule that is not constant on day of week.
- External Validity?
  - The fact that attendees to the academy opt into the particular regimentation, and yet their outcomes for morning classes are so negative, suggests that the effects are actually larger than seen in the paper.

Quasi-Experimental Causality

In the Carrell et al. paper, rather than an experiment, they used a "good" regression (essentially, a substantial set of randomization). However, now, we will examine three different methods of quasi-experimental causality.

Difference-in-difference:

- Used in: analyzing results of natural experiments.
- Need: treatment variable, "pre" and "post" data on the same observations, two dummy variables and an interaction term. Control variable needs to be credible as a counterfactual.
- Can: provide credibly causal estimates that remove omitted variable bias, if used right.
- Example:
  - Rosenwald initiative: some counties received money for school construction, others did not; counties that received money were similar to those that did not. Counties that got schools ended up with higher increase in literacy than those that did not receive schools. The treatment effect accounts for the gain in literacy *relative to counterfactual*.
- Benefit of difference-in-difference is that it's okay for the samples to be unbalanced. All we need is believing both groups were trending in the same direction, which is a weaker assumption, known as the parallel trends assumption.

Instrumental Variables:

- Used in: dealing with omitted variable bias.
- Require: fluke or randomness in source of causality that is not correlated with error.
- Example:
  - Hurricanes in Puerto Rico caused schools to become more crowded close to the path of the hurricane.
  - Use Z_i to isolate part of class size that is only due to storm to obtain unbiased effect of class size on test scores.

Regression Discontinuity:

- Arbitrary cutoff, hard or impossible to manipulate.
- Observations below cutoff do not receive a treatment, observations above cutoff do receive a treatment.

- Jump at the cutoff suggests credibly causal effect of treatment.
- Strong external validity.
- Examples:
  - PSAT: hard to control whether under or over threshold of National Merit Scholarship. Results suggest effect of receiving money is quite positive.
  - Head Start: based on Congress's design, the poverty line cutoff suggests we can examine results based on counties just below or above the cutoff.

The Market for Education

Education productivity: What, in our experience, has increased our education productivity?

- extracurriculars (sports, paper, clubs, etc.)
- peer pressure
- productive procrastination
- siblings
- jobs/internships (skills, selection, etc.)
- literacy
- food, recess
- problem sets and hands-on practice
- "the grind"
- time management

Today is effectively a recap of intermediate microeconomics, applying towards education concepts.

Supply: Schools or teacher labor hours.

Demand: Students.

Externalities: Positive externalities? Negative externalities?

- Positive spillovers from higher education — higher innovation, better functioning (political institutions), higher total factor productivity.

Market Competition: Cases for high vs. low market concentration.

- Some competition (public vs. private school).
- If one does not have the means to afford private school, often have one choice of school to send child to — moving has high costs. Lots face a monopolistic market.
- Paradigm primarily applies toward primary education.

Asymmetric Information: Asymmetric information occurs when the supplier or demander of the education doesn't know the answer.

- Quality of school or teacher is often hard to measure.
- Schools may be terrible but that news may not be available to the students.

Natural Monopolies: Often lend themselves to government regulation.

- Electricity transmission: very high fixed cost, very low marginal cost.

- Education can also be thought of as a natural monopoly. Extremely expensive to develop a new school, but (relatively) low cost to enroll a new student. Transportation costs also increase the cost of switching.

Economies of Scale: Declining costs, increased returns to scale.

- Large public universities tend to spend much less per student than small colleges.

Tracking or Stratifying: different lanes or tracks, ones that aren't obtained early enough are closed off.

- Certain opportunities may be forever closed if you didn't obtain a certain math class in 7th grade.
- Higher education is a bit of a tracking system too.
- Tracking in education increases the older one is.

Suppliers:

- Public: state or local government.
- Private non-profit: parochial school, secular private schools.
- Private for-profit: most common for higher or adult education.

Government Involvement: Education is quite like the electricity or healthcare market — asymmetric information, high costs to switching, extensive public involvement.

- Argument for public provision: positive externalities tend to be underfunded.
- Feature of public provision: subject to intervention (Brown v. Board, No Child Left Behind, Serrano v. Priest).
- Almost $1 Trillion per year is spent by local and state governments on education, approximately $200 billion per year is spent by the federal government, 50% of which is spent on K–12 education. There has been a trend towards greater centralization of education finance.

Inputs:

- In micro, we have a utility function, $U(X_1, X_2)$.
- Demand for education: student production function.
- Supply for education: school production function.
- We will refer to a general education production function $y = f(x_1, x_2)$.

  We often assume that the production function is linear.

$$y_i = \beta_0 + \beta_1 x_{1i} + \cdots + \beta_K x_{Ki} + \varepsilon_i$$

  Linearity is not necessarily justifiable — learning new things is hard, and certain skills (such as literacy) are often more valuable than other skills.

  We can also think of education production in a value-added model.

$$y_{it} - y_{it-1} = \beta_0 + \beta_1 x_{1it} + \cdots + \beta_K x_{Kit} + \varepsilon_{it}$$

  However, the problem with the input model is that we can't really measure or control a lot of these factors (like parental involvement).

Outputs:

- Students with education.

- Research.

Hedonic Approach:

- Price tells all (i.e., the value is what people are willing to pay).
- Valuation of non-market amenities is capitalized into the value of houses.

Broad Trends on Education Spending:

- America has roughly 18K school districts.
- There are approximately 50 million students, with average spending 18K per student, meaning we spend approximately 900 billion per year.
- Education spending per pupil (in today's dollars) has expanded quite a bit since the 1940s.
- Reasons for increased spending:
  - Infrastructure is more expensive.
  - Human labor hours are more expensive.
  - Economical to invest more in educating children.

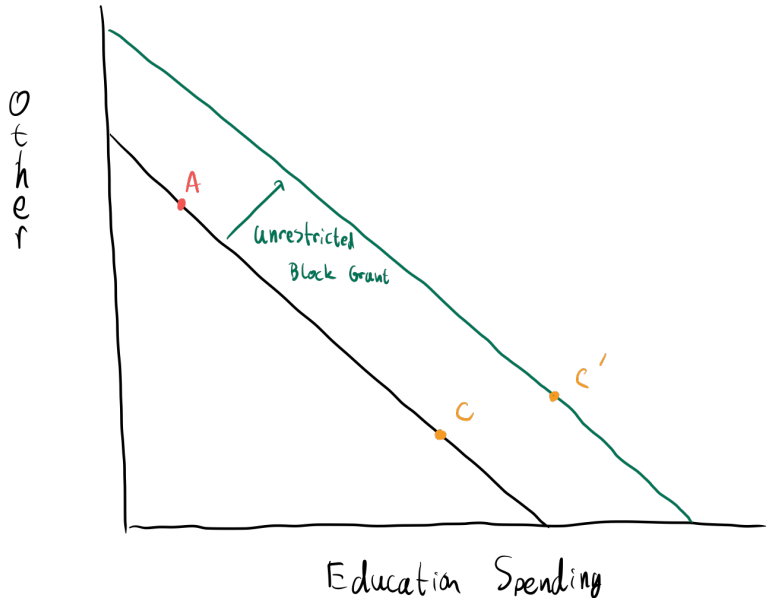
Local Spending:

- Tradition has been through property tax paid for by homeowners and businesses.
- Trend over time has been towards centralized public spending; federal sources make up approximately 10% (mostly Title I and Free/Reduced Price Lunch). States tend to spend money through income tax, sales tax, excise tax, etc.
- Serrano v. Priest: fully local funding is unconstitutional. Between 1971 and 2010, 47 states adopted some form of finance equalization policy.

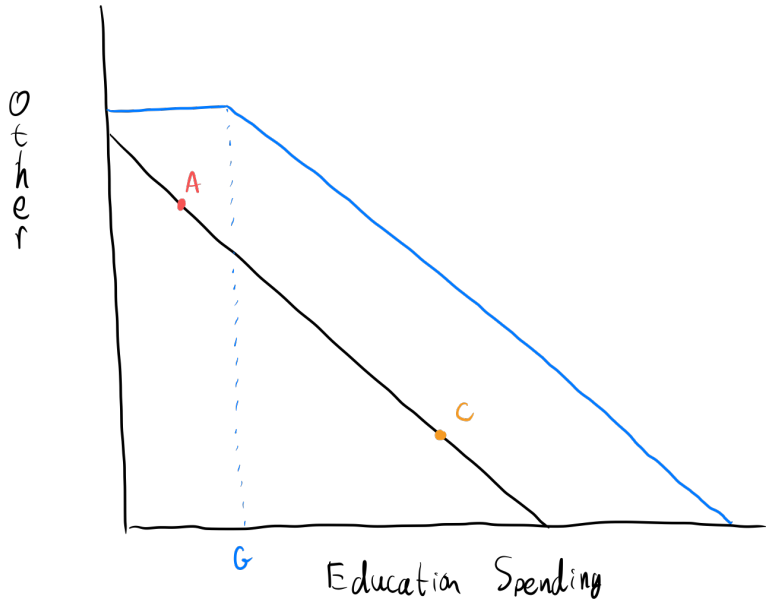
Housekeeping: Problem set 2 due February 27. Midterm 1 on February 29.

Forms of State Aid: States support school funding through using state tax money to shift budget constraints in the locality ($B = X + R$).

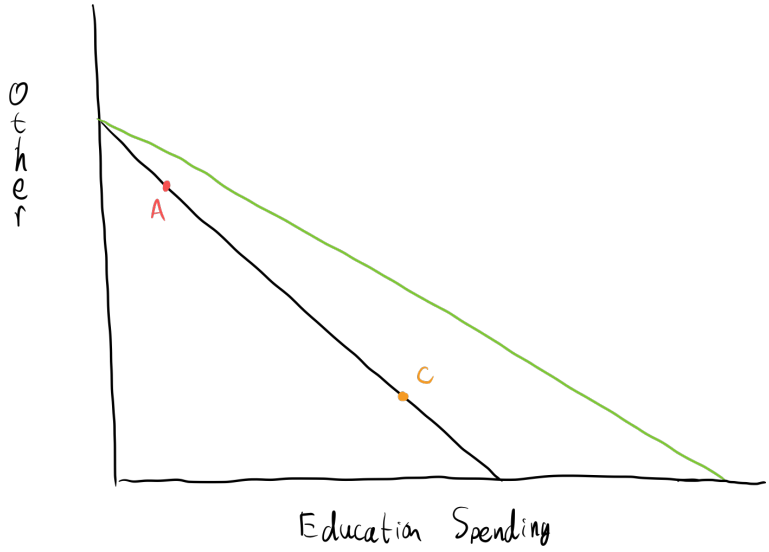
- Block grant: unconditional funding for district. Assuming that education and other spending are normal goods (positive income effect)



- Conditional block grant: must be spent on education; $B = X + R + G$ if $R \geq G$.



- Matching grant: funding for district proportional to its spending. Reduces the price of education relative to other public spending. Substitution effect suggests more education spending, income effect suggests more other spending.



The matching grant is most likely to increase relative education spending of all the classes of grants.

Grants In Practice:

- Foundation grant: states guarantee minimum level of funding (restricted block grant).
- Power equalization grant: states subsidize tax revenue for low-income areas (matching grant).
- Equalization grant: direct aid on the basis of wealth (unrestricted block grant).
- Centralization: 100% state funding.

Foundational Grant: Deep Dive Let $B_d = W_d \tau_d$. Then, the grant to d is denoted $G_d = \max\{0, F - (\tau^F W_d)\}$, where F is the foundation level and τ^F is the foundation rate. If the wealth of the district is less than the

foundation level, the government will grant money to make up the difference.

Wealthy districts will not be affected by the foundation grant (as their endowment exceeds the foundation level).

In theory, the foundation grant could tax away from rich districts to distribute toward poorer districts — this would prompt wealthy districts to reduce their tax rates until they reach the foundation level, and likely decrease overall education spending.

Politically speaking, centralization and equalization of funding tends to be impossible (and it's not clear that it's desirable to have fully equal spending). Perverse effect of school funding equalization tends to be lower total education spending.

However, grants tend to reduce inequality — but not by much.

Tiebout Sorting

Overview: People will move to areas that reflect their preferences for education (or any public service). Local governments are competing with each other.

Why Local Governments? There are multiple reasons for local government-provided public education

- Transportation
- Grade consistency
- No credit constraints
- Economies of scale (in special education or athletics)

Why Taxes? Suppose there was publicly provided education, but financing was voluntary. However, this brings a free-rider problem (the Nash equilibrium of public goods spending is lower than the optimal quantity of public goods spending).

Tiebout Sorting: Assuming a large metropolitan area with a high quantity of districts, similar housing stock, high mobility, and elastic funding, people will "vote with their feet" to the district with their preferred public goods spending. Housing prices serve as the market clearing mechanism.

Consequences of the Tiebout Model:

- There is no need to ask people's willingness to spend, as their preferences are revealed through migration.
- Allocative efficiency: consumers live where services match their preferences.
- Productive efficiency: local governments produce services at a rate to match population preferences.

Challenges:

- Mobility is often limited.
- Consumers are often not fully informed.
- There are often not a lot of options.
- Assumption of fully local return (absence of spillovers).
- Assumption of zero resource constraints.
- Property taxation.

- Reflects preferences of parents over children.

Evidence for Tiebout Sorting:

- Schooling is often a large part of choice of residence.
- Hedonic model suggests yes.
- The next question is whether or not competition between schools increases academic achievement.
- Hoxby (2000) suggests that Tiebout sorting improves educational outcomes.

Lori L. Taylor: Government's Role in Primary and Secondary Education

- Migration through high schools — what happens after? Brain drain: people who get educated in a community leave for a different location.
- In-migration of educated people has a tendency to yield *decreased* education spending; while the questions in the paper are still relevant, the paper still deals with data limitations.
- Rationales for government spending:
  - Market failure.
  - Externalities.
  - Altruism.
  - Alternatives: cultivating virtues.
- Paper takes for granted that there is a private return to education. The question is whether or not the government should be involved.
- Second-best externalities as a rationale: higher education leads to higher incomes, which leads to higher tax revenue and amenities. If the marginal tax dollar is a positive return, and education has a positive return on taxes spent, then private returns to education do not reflect social returns.
- First-best externalities: spillovers lead to higher productivity, reduction in crime (since you're preoccupied with school). However, education outside of its role as preoccupation does not indicate that education has benefits.
- Corrective policies:
  - Market failure: ensure that financing options for education are of similar price to other forms of loans.
  - Externalities: the government should subsidize education proportional to the size of the externality. Since the private return to education is high, suggests that most of the payment for education should fall on parents.
  - Altruism: society should transfer resources, but does not imply that the government should operate education.
- Benefit to public education vs. access to education.
  - Currently, education access is based around public school districts.
  - Alternative may include voucherization: every school has a price, give every child a voucher for reimbursement of certain amount of cash. Potentially more efficient.
  - Voucherization leads to the question of how much power should parents have over their children's education.

- Parental involvement in (primary and secondary) education:
  - In favor: it's very hard to make an argument against parental control without it spiraling into a lot of authoritarianism.
  - Implication is not in favor of tax-supported, government-run public education.
  - However, there are a lot of arguments against the idea of near-full parental control over children's education.
- Potential outcomes framework:
  - There's a lot of stuff that we're doing today that is mostly due to path dependence. It's nearly impossible to imagine a world without a lot of public education.
  - This paper brings the argument that core economic arguments do not necessarily lead you to the model of education that we have today.

Primary Education Policy

Consider some of the inputs of the education production function:

- Textbooks;
- Teachers;
- Infrastructure;
- Student Funding;
- Class size;
- Computers;
- Community;
- Greenery;

We can see that a lot of these inputs ultimately come down to school funding.

Primary question: does funding schools better matter — however, there is a large endogeneity problem when simply regressing educational outcomes vs. school funding. Once we are able to remove this endogeneity problem, our question is now between the different methods of spending.

Rosenwald Schools: Philanthropic initiative, built 5000 schools in various counties around the United States south built using using matching grants. Some counties got multiple new schools, others got 1 or 0 new schools.

Treatment group saw literacy grow faster: 6% increase in literacy above and beyond the counterfactual (particularly beneficial for Black students).

Card and Krueger (1996): Compared North and South Carolina — little differences in characteristics of Black population in states, but had different economies. North Carolina was dependent on tobacco (less labor-intensive, easy to mechanize) while South Carolina was dependent on cotton (labor-intensive). Emphasis on education in South Carolina for Black students was lower than in North Carolina — North Carolina had bad schools, but South Carolina had worse schools.

The average class size for Black students in South Carolina was substantially higher than in North Carolina. However, around 1920, there is a large convergence of school funding and class sizes start converging too.

Card and Krueger compare outcomes for Black students in NC vs. SC (with White students as a control), as quasi-experimental in returns to student funding.

Card and Krueger found that the decline in class sizes increased relative wages by 6%. Takeaway: class sizes matter.

Green and Hofmann (1965): Prince William County, Virginia closed all public schools from 1959–1963.

Primary Takeaways: Increasing funding tends to yield positive educational outcomes. However, there is actually mixed evidence.

Trends in Data: School spending has increased about 10x since 1940 to today, salaries are up 45% in real terms, and student:teacher ratios are down 44%. However, despite this increase in school resources, NAEP scores have not increased all that much.

We see that states that spend more have more educated populations and better outcomes, but increased spending over time does not predict a change in outcomes. Effectively, the places with better education outcomes demand higher education spending, but that does not imply that increasing education funding helps increase education outcomes.

Caroline M. Hoxby: Does Competition Among Public Schools Benefit Students and Taxpayers?

- Good empirical work requires data expertise. A simple model like $A_i = \beta_0 + \beta_i C_i$ will be affected by so many elements in the potential outcomes framework.
- Broadly speaking, choice increases education productivity.
- However, the instrumental variable chosen does not necessarily allow for full predictive power, ultimate results are based on very few metropolitan areas.

Teachers: Education Production Function and Labor Market

Measuring Teacher Impact: Teachers are probably the most important input into the education production function; we may be curious as to how to measure quality.

- The value-add model uses quantitative measurements to see how students' results grow as a result of the teacher's teaching.
- Policy has a tendency to focus on short-run value add (via test scores, for instance).
- However, test scores do happen to correlate well with other measures we tend to care about (e.g., graduation rates, incomes).

There are some particular issues with the teacher value-add model:

- Mobility
- Selection Bias
- Small N, teacher turnover

We can also use a Bayesian approach (from Chetty 2014).

$$\theta_j^* = \tau \overline{Y_j} + (1-\tau)\mu_\theta,$$
$$\tau = \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\epsilon^2/N}$$

where θ_j^* is teacher quality, $\overline{Y}_j$ is test scores, and μ_θ is the teacher value add, and σ_ϵ^2 denotes the variance of students' test scores. Essentially, as classes become large, $\tau \to 1$ and teacher quality is more predicted by test scores.

Evidence for Teacher Impact: From Rivkin, Hanushek, and Kain (2005), Rockoff (2004), and Chetty et al. (2014), we find:

- A 1 st. dev. improvement in teacher quality increases test scores by 0.1 standard deviations.
- A 1 st. dev. deviation improvement in teacher quality is equivalent to reducing class size by 10 students.
- A 1 st. dev. teacher improvement does not fade, increasing college going by 0.5% and earnings by 0.09%.
- The NPV for 1 year of education at 1 st. dev. above mean is $115,000.

From this evidence, we can see that teachers do matter. However, we don't know how to predict teacher quality. There is some correlational evidence.

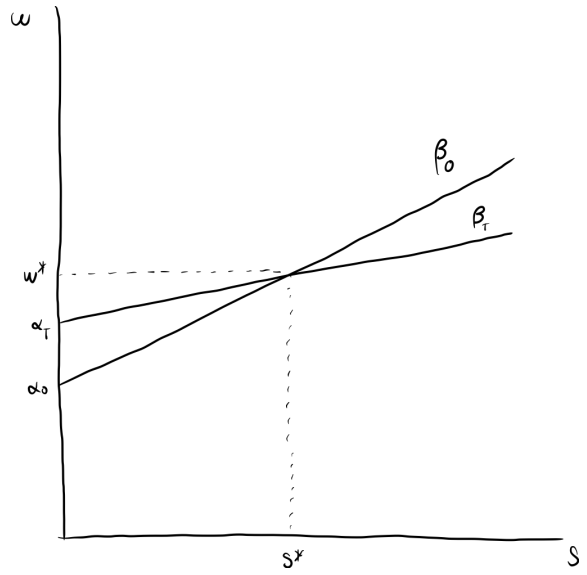
- Experience above 6 years tends to lead to improved outcomes (but there is obviously survivorship and selection bias)
- There is no evidence that credentialing or degrees matter.
- There is limited role model evidence (e.g., Teach For America leads to small, increased college applications, but not increased college going, increased chance of women majoring in STEM if their intro track professors are women). However, taking the role model evidence to its full extent leads to full segregation, which wholly unactionable.

Teacher Labor Market: Wages are the price of labor, supply is teachers and demand is students and administration.

- Increased population, smaller class size, district resources, and school choice all can affect demand for teachers.
- Outside options, working conditions, salary structures, and credentialing rules all can affect the supply of teachers.

The Roy Model: Understanding teacher supply based on skills and outside options.

- Skill collapsed into one dimension, s.
- Potential teachers live in one period.
- Teachers choose the profession that yields the highest lifetime income.
- Teaching has wage structure $w_T = \alpha_T + \beta_T s$ and other careers has wage structure $w_O = \alpha_O + \beta_O s$



We can see some potential changes in the w/s relationship.

- Alternative labor market options increase α_O for people at all skill levels and increase β_0.
- Teacher unionization compresses the wage scale, meaning s is not rewarded as much, so β_T reduces.

Empirical Results:

- There has been a substantial increase in teacher unionization (including Meet and Confer provisions and collective bargaining contracts) from the 1960s to the current era.
- There has also been a large increase in the proportion of women in other educated professions (such as medicine and law).
- In alignment with these trends, there has been a reduction in teacher aptitude relative to the college graduate population.
- However, despite the relative reduction in teacher aptitude, NAEP scores have been stagnant for White Americans and have actually increased for African-Americans (contrary to the expectation that they would reduce).
- There are many potential sources of this trend not related to teachers, such as environmental improvements.

Carrell and West: Does Professor Quality Matter?

- Teaching to the test: experience both from the paper and personal high-stakes testing experience suggests that it may be detrimental.
- There is evidence that teachers would be better off knowing *less* about the standardized tests.
- Causality is much stronger in the Air Force Academy due to randomization; however, selection in non-random assignment of classes suggests the effects may go in either direction.
- From the paper, we can answer the question of teachers mattering (yes), but that good teachers may not be the ones who have the best contemporaneous value-add.

School Accountability

- Principal-agent problem: government wants to increase educational performance, incentives can be implemented at different levels.
  - School accountability: rewards and punishments at the school level.
  - Teacher accountability: rewards and punishments for teachers.
  - Student accountability: rewards and punishments for students.
- Potential outcomes to incentivize:
  - Expected future earnings.
  - College acceptance rate.
  - Standardized test scores.

  If the focus is on standardized test scores, the most likely lever to be effective is at the school level.
- We looked at teacher quality last time, where we saw that teachers vary in quality and they affect their students' outcomes. However, teachers are often subject to a rigid pay scale (and said rigid pay scale is often part of the appeal of teaching).
- Proposals for merit-based pay are based in the idea that tying teachers' salary to education productivity provides an incentive for increasing education productivity.
- The primary measure of education productivity is standardized test scores.
- Tennessee merit pay program:
  - Five pay stages not based on test scores — principal, peer, and external evaluations.
  - Teachers could opt in or opt out.
  - The treatment was not randomly assigned — comparing teachers who chose to opt in vs. those who did not would yield a biased estimate of the effect of merit pay.
  - Dee and Keys (2005) used data from Project STAR, which randomly assigned students and teachers to classes of different sizes (and vice versa). They were able to make across-classroom comparisons within the same school.
  - They found that merit pay was associated with statistically significant gains in math test scores.
  - Merit pay improved for both beginner teachers and experienced ones too.
- Many states had merit pay programs in the 1980s, but by 2008 only 8 states had some form of teacher merit pay.
- Teach for America:
  - Program that provides a "fast track" for teacher certification, two year commitment to the program, with no requirement for a particular degree.
  - Lowers the cost of entering the teaching profession, and the marginal teacher is more highly skilled (by the Roy model).
  - Raymond and Fletcher (2000) took a sample of non-TFA and TFA teachers from Houston, and compared student test score gains (controlling for other factors influencing teacher type).
  - They found that TFA teachers were no worse than non-TFA teachers, and TFA teachers were associated with significant gains in math scores. TFA teachers also had lower variance in the distribution of their outcomes.

  - New TFA teachers were much stronger than new non-TFA teachers, but those relative gains are temporary compared to all other teachers.
  - However, as TFA expanded, the marginal hire became less skilled — and competition for TFA teachers became stronger.

- Features of school accountability programs:
  - Student achievement (typically measured by standardized test scores).
  - Public reporting of school performance.
  - Rewards or sanctions based on performance.
- Federal No Child Left Behind Act passed in 2001, and public reporting laws spread in the late 1990s, growing from 5 states to 45 by 2002.
- Accountability measures generally required that children in grades 3–8 be tested, focused on mathematics and English reading.
- Sanction for underperformance usually resulted in vouchers for parents of students, schools reconstituted as charters, or administration replaced.
- Why accountability might not work:
  - Test scores are noisy measures (variation in test scores is often random).
  - We want to know the value of $V(\varepsilon)/V(y^*)$.
  - We can measure in three ways: levels, changes (across cohorts), gains (within cohort).
  - Concerns include school size — we see that test scores become more clustered around the mean at larger schools than smaller schools. Small schools thus have more noise to them. The Bill and Melinda Gates foundation famously had to course-correct regarding school size after mistaking this noise for causation.
  - We see that levels have the least noise, gains have the second least noise, and changes have the largest noise.
  - Using test score gains requires lots of data, and we should avoid drawing strong inferences from single-year changes.
- Jacob (2003) found that there was better student performance, but there was also a rise in special education, more non-participation and non-reporting bias, implying that schools did change behavior.
- Figlio and Winicki (2002) found that there was an increase in average calories for school lunches in underperforming districts during testing weeks (versus non-underperforming districts). This is a potential mechanism for increased test scores.

Dee and Jacob: The Impact of No Child Left Behind

- NCLB was probably the longest-lasting education reform, so there is more evidence for its effects than other federal school accountability measures.
- Paper finds robust benefits for fourth grade math (via NAEP scores) from NCLB.
- NCLB also improved math scores especially for Black and Hispanic students.
- However, improvement in reading scores was not statistically significant.

School Choice and Peer Effects

- Broadly speaking, there are two methods to "do" school choice.
  - Vouchers: funding for schools follows the student.
  - Charter Schools: publicly-funded, privately-operated schools. Generally operated via lottery admissions with pupil-based funding. Grew in popularity during the 2000s and 2010s.
- Traditional model is generally neighborhood-dependent (your address is zoned for a particular school that you go to). Almost every school district has some mechanism to allow students to attend schools that aren't the neighborhood school.
- We can view charter schools as creating competition in the education market (as opposed to the current model of local public school monopolies). The marginal benefit to charter schools tends to decrease as their quantity increases.
- Question: would you rather attend Occidental with La Verne students or attend La Verne with Occidental students?
- The answer to the question "do your classmates matter?" is generally "yes," but there are lots of endogenous effects.
- Manski (1993) posits that social effects are important.

  $$Y_{ig} = \beta_0 + \beta_1 \overline{Y}_{-ig} + \beta_2 \overline{X}_{-ig} + \beta_3 X_i + \delta_g + \varepsilon$$

  Essentially, we say that your outcomes are a function of the outcomes of your peers, as well as X, or background characteristics of your peers and yourself.

  However, it's hard to exactly pin down why peers matter. We call β_1 the endogenous parameter (or effort effect) and β_2 the exogenous parameter (or contextual effect).

  We can see that the model is decent at describing the world, but it can never actually be run. There is a large problem of reverse causality — if your friends affect you, then you affect your friends.

  We should care about peers, but it's very hard to understand their effects.
- Hoxby (2000) studies the question in primary school, while Sacerdote (2000) studies the question at college. Both try to find a way to overcome the endogeneity problem.
- Sacerdote uses random assignment of roommates to obtain his results.
- Genealogy of Peer Effects Literature:
  - Manski (1993): peer effects are important, but hard due to reflection, selection, and endogenous sorting.
  - Hoxby (2000) and Sacerdote (2000) study contextual effects and effort effects.
  - Sacerdote uses random roommate assignments, shows presence of some peer effects. However, Sacerdote cannot break apart contextual vs. effort effects.
  - Hoxby looks at multiple years of data from a large group — variance on gender, race, and socioeconomic status (free or reduced lunch eligibility). Classrooms with lots of girls tend to have better educational outcomes for everyone (including boys).
  - Carrell (2002) takes a similar approach to Hoxby, and links domestic violence to peer achievement.

  - Once economists settled on a model that they're convinced gives credible results, Brown (2004) uses it for golf.
  - Ross (2008) uses an instrumental variable for high school peer effects to separate β_1 and β_2. They're able to find that both exist.
  - Carrell et al. (2008) uses USAFA data to find non-linear peer effects. Up until this paper, we don't know whether peer effects are welfare-improving. They find that peer effects exist for some students and not for others — bottom tercile students benefit from high SAT-verbal score peers.
  - Carrell et al. (2013) run a controlled experiment based on Carrell et al. (2008) by designing optimal peer groups.

- One of the newer approaches is a focus on the effects of variance in peers, as well as social networks (calculated using an adjacency matrix).
- Other measures of peer effects are focused on homophily (i.e., people tend to associate with similar people). Currani, Jackson, and Pin (2009) take a baseline of 0 for random friendships, and find that particular racial groups befriend each other at a rate above random. Specifically, they find that homophily peaks around 40–50% of the population.
  - Most predictive is gender, second-most predictive is race, and third most-predictive is academic ability.
  - In the Carrell experiment paper, we could see that there was more clustering.
- Measuring peer effects from social networks is likely to bring even more endogeneity, but improves our assumptions.
- Sharing ideas is effectively free — rates of sharing ideas, however, requires more friends. Students with similar levels of academic aptitude tend to share more ideas and do better as a result.

Derek Neal: How Vouchers Could Change the Market for Education

- Parents care a lot about the institution as well as the peers — under voucherization, we may wonder what parents might value.
- Efficiency of vouchers relative to Tiebout sorting vs. geography.
  - Practicality: if low-income families are given vouchers, would they be able to afford private schools or would private schools have to subsidize tuition? Idea would be that religious schools (or schools run like religious schools) would be more affordable.
  - Elasticity of demand: certain private schools have very inelastic demand.
  - Vouchers would reduce the location value of wealthy neighborhoods. However, in urban areas where options are higher and transportation costs are lower, it's likely that vouchers would increase the value of such locations.
- Vouchers might increase sorting. Increasing heterogeneity of education increases variance, including the possibility of very high costs.
  - Benefit of sorting: broadening the base of demand could provide more specialized education relative to the current system.
  - Downside of sorting: very few barriers to creating a school with very high social costs (à la the "Eastside Ku Klux Klan Academy").

Carrell, Sacerdote, and West: From Natural Variation to Optimal Policy? The Importance of Endogenous Peer Group Formation

- External validity: variance in the AFA is much likely to be smaller than the average high school (or even many colleges). The AFA is already effectively tracked — it has high admission standards.
- The tracking in the paper is much more hyper-local than tracking in a typical high school.
- Cliques often form due to similar interests/circumstances. We would expect that dedication at the AFA is higher than at a typical high school, so the peer effects might be muted.
- At the AFA, there is more contact with peers than at a typical high school or college, so the peer effects may be increased.
- Randomized experiment in an external setting yielded some peer group formations between people of higher relative ability and lower relative ability.
- Experiment setup had control group (with squadrons randomized on the basis of ability), and treatment groups (one of a large number of top and bottom tercile students, and one of a large number of middle tercile students).
- Middle tercile group found significant positive effects, but in treatment group with large number of top and bottom tercile students, bottom tercile students had worse results.
- It is likely that top tercile students are largely unaffected by peer effects — self-drive tends to be higher. Additionally, measurable achievement is capped — it's effectively impossible to go past a 4.0. It is possible that the intervention reduced their abilities, but they were above the cutoff nonetheless.

The Market for Higher Education

- Modern universities can largely be traced back to the University of Bologna (1088) and Oxford University (1096).
- Before the 1800s, the structure of higher education was largely focused on teaching rather than research — lots of education was focused on preparing people to be priests.
- In 1776, there were 18 universities, total enrollment of around 750.
- Clark (2014) found that ancestors attending early universities predicted wealth today.
- Goldin and Katz (1999) find that higher education starts to take off in the late 19th century, as demand for scientific research and technical knowledge increased with the rise of industrialization.
- With the passage of the G.I. Bill in 1944, many more veterans start to attend higher education, coinciding with the entrenchment of state higher education systems (such as the University of California).
- During the Cold War, demand for scientific research grew significantly, and the modern university comes into its own during this period. Women also start entering the sciences as their labor market options expand dramatically.
- At a macro-level, not much has changed from the 1980s to present (in terms of the style and quality of higher education). Enrollment has largely plateaued (due to demographic shifts). There is a lower level of state support for higher education, in part because people will pay a lot of money for higher education.
- There is much heterogeneity and stratification in higher education.
  - Chicago has 83 four-year universities, with over 100 private two-year institutions.

  - The University of Chicago spends upwards of $60K/student/year.
  - There are 5 four-year public institutions in Chicago with a total of 60K students.
  - There are 22 two-year public universities, which expend less than $3,000 per student per year.
  - Heterogeneity refers to the offerings in the higher education market.
  - Stratification tends to refer to the rankings/differences by grouping of higher education.

- Higher education is a customer input technology — inputs are the outputs, and (selective) higher education rival.
- Higher education is also a mixed market — there are private and public options with not-for-profit and for-profit segments in private education.
- The primary market failure in higher education is *asymmetric information*.
  - Finances (primarily apply to higher education).
  - Faculty and major quality, as well as student opportunity.
  - Peers.
  - Alumni.
  - Spending per student.
  - Future plans.

  Asymmetric information leads to principal-agent problems; schools do not have the same incentives as students in achieving a goal.
- Marginal cost of higher education tends to decrease as enrollment increases — large public institutions tend to educate students at a much lower cost per student.
- Higher education also has economies of scope — efficiencies in increasing variety of educational offerings. Pretty much no college offers a major in only one course of study, as opposed to private industries that feature extreme specialization.
  - Increase diversity and obtain a larger demographic of students.
  - Major shopping and uncertainty.
  - Common needs — registration systems, grant administration, etc.
- The government serves many roles in higher education.
  - Appropriations — primarily at the state level.
  - Financial aid (directly to students) — 90% federal, 10% state.
  - Research funds, through the NSF and NIH.
  - Land grants — public universities do not pay rent or property taxes on their land.
  - Not-for-profit status is often provided to institutions of higher education, exempting their earnings from taxation.
- Public institutions tend to get more money from the state (and less from endowments), while private schools reverse this order.
  - Endowments tend to withdraw approximately 5% of the endowment per year to use in their annual budget — endowments can grow about 5% YoY, so the endowment can be maintained. (Author's note: asset managers are thieves, I get 7% YoY on my Vanguard account and I'm not charge 1% AUM.)
  - If the state drops funding by $1, then endowment needs to increase by $20 to make up the budget loss.
  - States have been pulling back on higher education spending over the last 50 years, meaning endowments tend to need to grow even faster. As a result, tuition tends to increase.

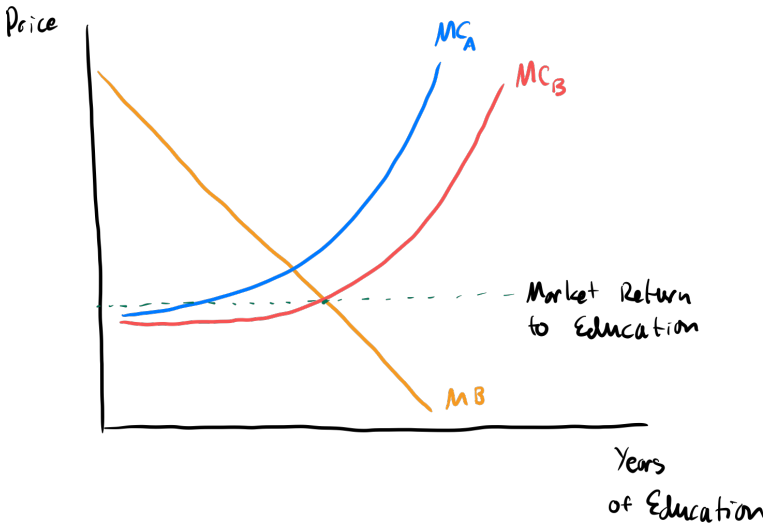
The Cost Disease in Higher Education

- Hoxby discusses MOOCs as a way to "standardize" non-selective education, vs. the investment style of education inherent in selective colleges. One probably wouldn't expect particularly strong cost reductions beyond a certain point, due to the other factors driving people towards college educations (especially at liberal arts colleges), such as personal interaction with other students and professors.
- "Buying the best:" amenity creep (colleges will better recruit students when they offer better amenities), pressure to increase teacher-student interaction opportunities, offering more and more merit aid, etc. all contribute to costs spiraling upward.

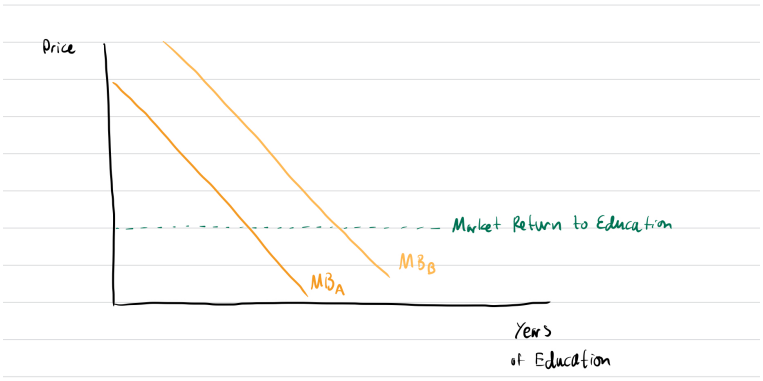
  Recall that all the inputs to the education production function tend to correlate with income — merit aid systems tend to privilege wealthier students. Desire to increase prestige of student population yields increased costs for providing aid to people who do not necessarily need it.
- Average student pays around 54% of total tuition cost. If a college wants to increase its budget by \$1, the college effectively needs to increase its tuition by \$1.87.
- Federal student loans have an interest rate lower than the market interest rate — students are able to afford a larger loan package from a federal loan than from a private loan. Since funding is effectively guaranteed, schools can increase their prices further. Schools capture a large proportion of the subsidy.
- Baumol's cost disease: Mozart's String Quartet will always require four people — certain things require a certain amount of labor or time regardless of technological improvements. Higher education is generally quite resistant to productivity improvements. Professors are effectively paid to force us to spend more time learning a topic.
- There is a lot of resistance to change in higher education — even if offering PhD programs is inefficient relative to postdocs, or maintaining the tenure system relative to mandatory retirement is inefficient, schools still keep them in place.
- The wage structure of faculty tends not to be set by productivity (relative to typical private industries). Wages tend to be set on the basis of alternatives — general economic growth outside academia yields growth in faculty wages.
- There are a host of downsides to hybrid learning — it's often harder to learn with hybrid learning, with less flexibility and an often bad learning environment. Additionally, in-person education consists of dedicated time — reduces procrastination.
- Potential methods to reduce inequality between institutions — changing endowment system, increasing progressivity of education subsidies.

Demand for College and Bargaining Model

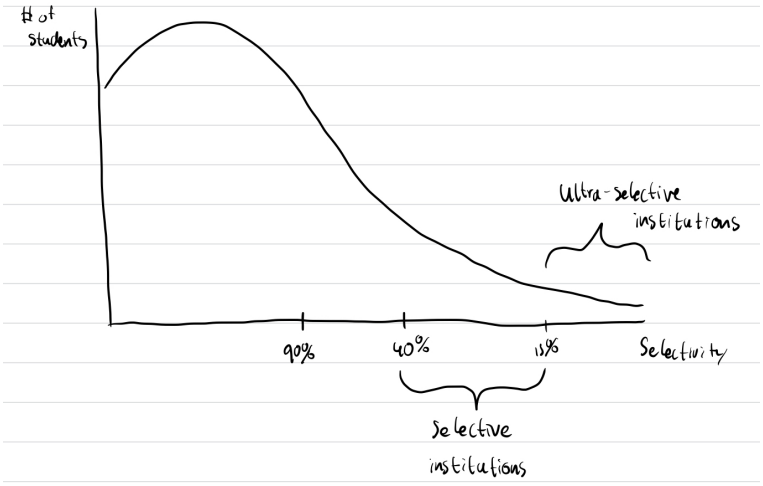
- In the market for higher education, the quantity demanded is usually years of education, and price is tuition (or cost of education).
- There are two main constraints — short-run credit constraints (students without capital need to borrow money for college) and long-run credit constraints. If student A and student B are similar ability, but student A receives a higher interest rate than student B, then



- Long-run credit constraints refers to constraints in education from earlier in life — students with under-resourced primary educations are less prepared for college educations today.



- Most of the time, when we buy things, the prices are non-negotiable. However, much of the *money* that we spend is negotiable. Large purchases such as houses, cars, or education have negotiable prices.
- We have two players, S (for student) and U (for university), with values $v_S(U)$ (value to student S of attending university U) and $v_U(S)$ (value to university U of student S attending); we have t for transfers, d_S and d_U denoting outside options, and π_S, π_U denoting bargaining weights, where $\pi_S + \pi_U = 1$.
- Most students attend non-selective colleges — namely, large public institutions. Clear admission standards tend to yield very high admission rates.



- We have that net utility $U_S + U_U = (V_S(U) + t) + (V_U(S) - t)$, where t denotes the transfer from the university to the student. Students maximize U_S on the basis of their outside options and bargaining power.

$$U_S = d_S + \pi_S \underbrace{(V_S(U) - d_S - d_U)}_{\text{value of match}}$$
$$U_U = d_U + \pi_U \underbrace{(V_U(S) - d_S - d_U)}_{\text{value of match}}.$$

  We can assume that d_U is close to 0. Transfers are thus measured by the value of the student to the school.

  - Leverage factors: skills, location (can go both directions), prestige, timing, legacy, academic quality.

- In a large outlay industry, it is standard that assets save money. This applies to higher education as much as any other large outlay industry.

- However, at the same time, higher education is considered a "progressive" industry, as it could potentially promote both types of equity.

  - Vertical equity: burden of payment is proportionally similar. Wealthier families (generally) pay more for higher education than less wealthy families.
  - Horizontal equity: families of the same means face the same price.

- There are various forms of financial support for higher education.

  - Loans: reduce NPV of education cost by not accruing interest until after college.
  - Grants and scholarships: reduce the price of education.
  - Expected Family Contribution: families tend to turn over much more financial information to institutions of higher education than other industries, and the existence of EFC informs the price of education.

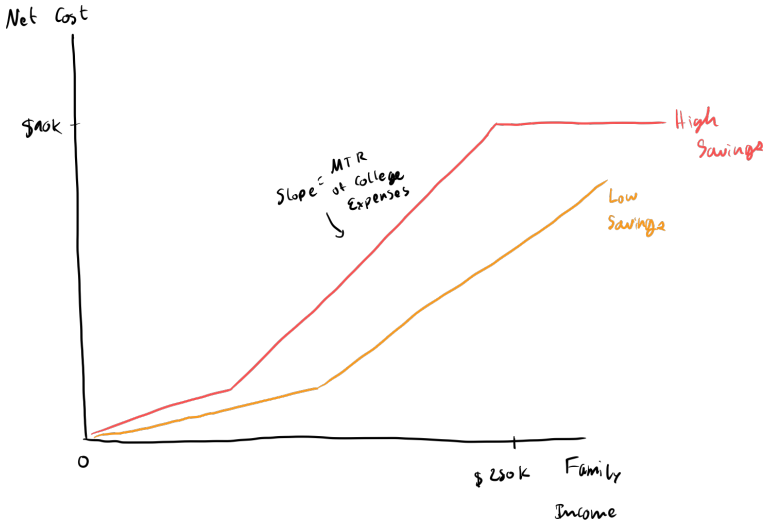
- Spending paradox: considering two families of equal income, the family that *saves* more is punished. In an attempt to promote vertical equity, we end up promoting irrational consumption. However, what cuts against this effect is the enrollment management system (and the lack of need-blind admissions). Students with lower assets can face riskier admissions at particular institutions.

  - Tuition net of expected family contribution is equal to the demonstrated need.

  What else is notable about higher education is that registration, enrollment, etc. is not determined on the basis of financial contribution to the school. When determining need, there are the following factors.

  - Parental income.
  - Student income.
  - Parental assets (except for 529 accounts)

- The ideal graph of higher education spending is akin to the following.



Linos et al., "Demystifying college costs: how nudges can and can't help"

- Different applications of nudges — while information doesn't reflect experience, anchoring bias is very powerful.
- Imagining education as a manufacturing supply chain, there is a narrowing effect as time in education goes on. There is a long list of things that have to go right to go to college.
  - Readiness
  - Application and information
  - Admissions (and money)
  - Decision
- We have to care a lot about the admissions elasticity of particular steps in this pipeline.

Arcidiacono et al., "Racial Preferences in University Admissions"

- David Card points out that Arcidiacono et al. leave out ALDC and artistic/musical admits — however, that is a non-trivial proportion of the data (25%).
- Arcidiacono et al. argue that ALDC applicants face a different admission process than academic admits. Looking at ALDC applicants in a different paper, however, they don't actually look at it.
- However, at the same time, Arcidiacono et al. may not account for all OVB.
- Potential solutions: selecting for diversity on other factors, lottery above a certain test score cutoff.