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?

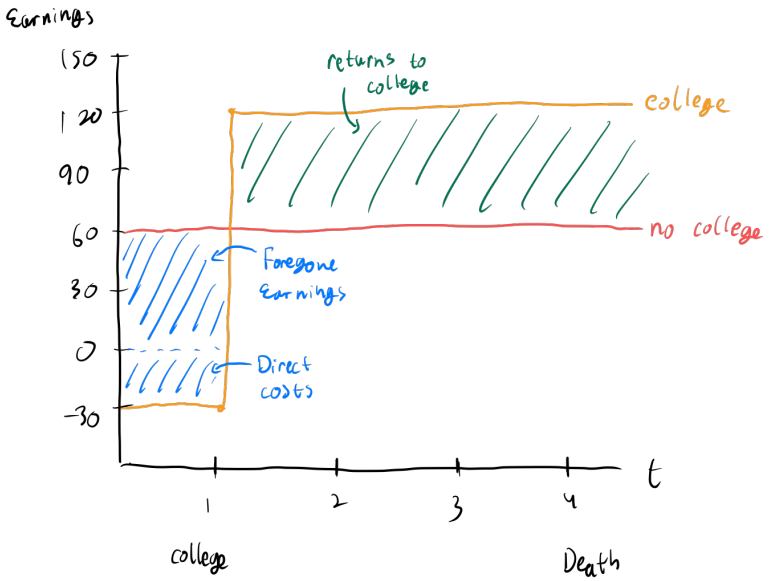
- Less static.
- Differential depreciation — potential for appreciation (people can skill up).
- Higher variance.
- Unionization/collective bargaining.
- Idea generation.
- Potentially greater mobility.
- Returns to human capital come in the form of wages — human capital is owned by the human that holds 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:

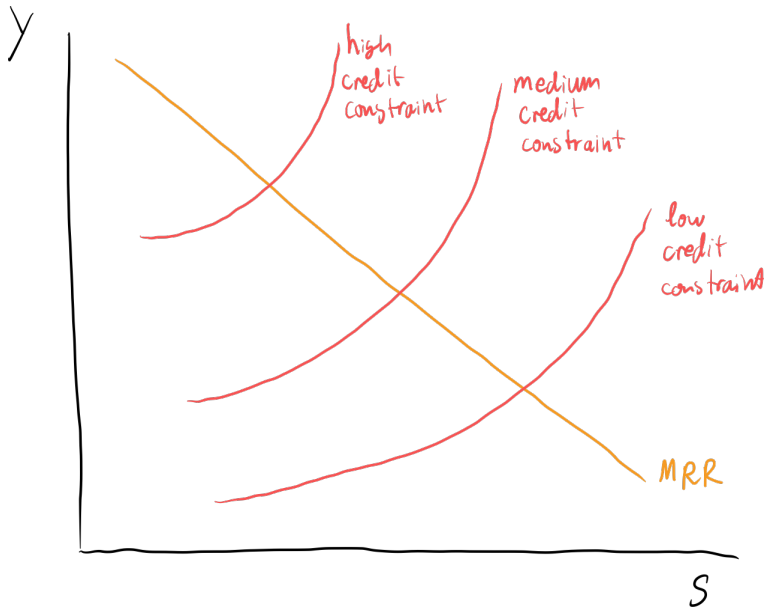
- Discrete: Y_S (income from having been schooled) vs Y_0 (income without schooling)
- Continuous: $\frac{Y_{S+1}}{Y_S}$ (marginal rate of return from schooling)
- F (the cost of schooling)
- r (discount rate)

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.

Solving an 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:

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

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