

Human Capital

Econ 3470 Lecture 6

Labor Economics

2016-2017 Term 1

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Introduction

Prior assumption: worker homogeneity & wage exogeneity

Inconsistent with observations at both microeconomic and macroeconomic level.

At the aggregate level:

- The growth rate of outputs (real GNP) has been larger than the sum of the growth rates of the factors of production: man-hours, capital and land
只关心了man hour而没有看每个hour的作用是否一样！
- The rate of accumulation of physical capital, in particular, has been slower than the real growth rate, which is counter-intuitive since we would expect economic growth to be closely related to investment in capital
- The real wage rate has been increasing over time, reflecting an increase in the marginal product of labor

Introduction

Labor input is not homogeneous but can be augmented through investment in human capital.

Increase in human capital over time

- accounts for a large part of the discrepancy between the growth rate of quantities of inputs and outputs.
- explains change in real wage over time and the different at any point in time.

Introduction

Before concept of human capital focuses on the effect of fixed costs of employment (e.g. training) on the demand of labor by firms.

Now concentrate on the supply side of the problem and analyse the individual worker's decision to invest in human capital.

It is not restricted to training provided by employers, but on any kind of human capital investment. These include:

- Education & training
- Search activities & migration 找到了更好、更合适的工作
- Health services & facilities

⇒ first and the last improves the productivity of labor input, while the second improves the match between workers and jobs and therefore raises outputs.

Rules for Optimal Investment

Individuals invest in human capital incurs both costs and returns.

These returns include:

- Higher future earnings wage premium
- Consumption value - learning can be fun. Education, in particular, has often been pursued as much for its pecuniary returns as for its consumption value
- Non-pecuniary returns, such as better jobs, prestige and greater productivity in non-market activities which enhances the quality of life
教育的作用在除了工作外的其他方面都有体现

Rules for Optimal Investment

Costs include:

- Out-of-pocket or direct expenditures 直接缴纳的学费
- Forgone earnings: this include wage and non-wage penalties (for any part-time instead of full-time employment) as a result of education or training 其他的机会成本 (如果不上学你可以做的其他事情)
- Psychic losses: learning is often stressful and time-consuming, reducing the amount of leisure available to the individual 上学本身的 stressful

Demand for human capital therefore depends on whether the returns justify the costs.

Returns and costs often occur over more than one period, therefore it is the value of such returns and costs over time rather in any particular period that matters.

Discounted Present Value Approach

Assume for simplicity that the individual is considering whether to undergo an investment program (e.g. schooling), and that his work life lasts n periods. Let

$X_t = X$ represent unskilled labor's income path

Y_t = income path of an individual who invests in the first m periods

i = real interest rate

$$\text{Cost: } V(X) = \sum_{j=0}^{n-1} \frac{X_j}{(1+i)^j}$$

something you can earn if you don't go to school

$$\text{Benefit: } V(Y) = \sum_{j=0}^{n-1} \frac{Y_j}{(1+i)^j}$$

something you earn if you go to school

Discounted Present Value Approach

$$\begin{aligned}\text{Net benefit of investment} &= d \\ &= V(Y) - V(X) \\ &= \sum_{j=0}^{n-1} \frac{Y_j - X_j}{(1+i)^j}\end{aligned}$$

Discounted Present Value Approach

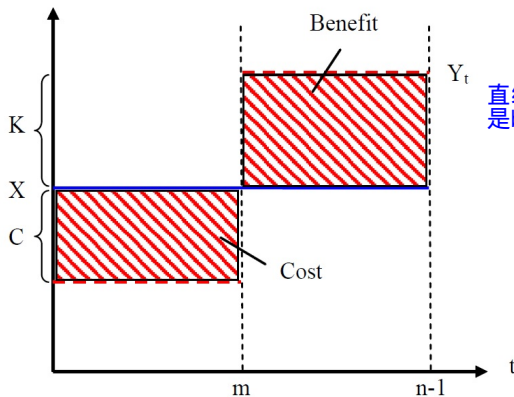


Figure 1: Cost vs. Benefit

Discounted Present Value Approach

If $m = 1$, $\text{cost} = C$, 这里假设只上1年学

Net benefit of investment = d

$$= \sum_{j=1}^{n-1} \frac{K_j}{(1+i)^j} - C$$

If $\sum_{j=1}^{n-1} \frac{K_j}{(1+i)^j} > C$, then invest.

Decision rule: invest in all opportunities with $d > 0$.

Discounted Present Value Approach

If $MC \uparrow \Rightarrow HC \downarrow$, if $MB \downarrow \Rightarrow HC \downarrow$.

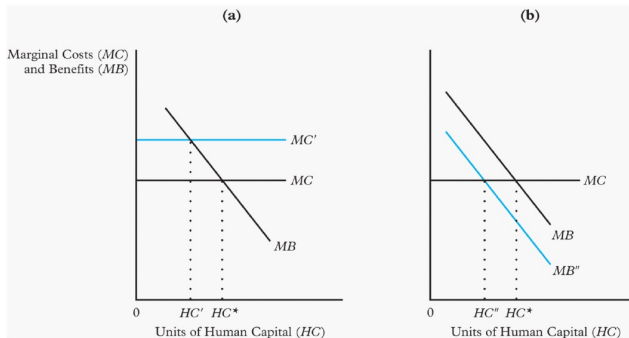


Figure 2: The Optimum Acquisition of Human Capital

如果要用marginal cost和marginal benefit的理论来看，在这里MC就是C，这里MR下降，因为教育的边际效应递减（education premium变小）

Internal Rate of Return Approach

Answer question: "How large could the discount rate be and still render the investment profitable?"

Internal rate of return: the discounted rate such that the DPV of benefits is just equal to the DPV of costs.

Let r = internal rate of return for the investment project

找到一个discount rate让其无利可图

Procedure

- Set the present value of benefits equal to cost and solve for r
- Compare r to the rate of return on other investments

Internal Rate of Return Approach

$$d = 0$$

$$\sum_{j=0}^{n-1} \frac{Y_j - X_j}{(1+r)^j} = 0$$

Other things (including risk) being the same, any investment with an internal rate of return higher than the market interest rate will bring higher returns than the market alternative, and should be pursued.

Thus, an individual should invest in all projects with $r \geq$ the market interest rate.

Internal Rate of Return Approach

If $m = 1$

$$C = \sum_{j=1}^{n-1} \frac{K}{(1+r)^j}$$

Since $\sum_{j=0}^n \lambda^j = \frac{1-\lambda^{n+1}}{1-\lambda}$

$$C = K \left[\left(1 - \frac{1}{(1+r)^n}\right) \frac{1+r}{r} - 1 \right]$$

If n large ($\rightarrow \infty$)

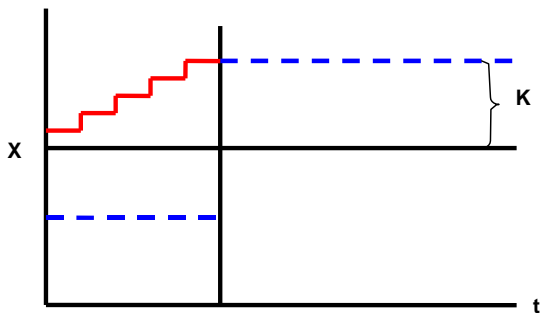
$$\begin{aligned} C &= K \left[\frac{1+r}{r} - 1 \right] \\ &= \frac{K}{r} \\ \Rightarrow r &= \frac{K}{C} \end{aligned}$$

Internal Rate of Return Approach

If $m > 1 \Rightarrow$

X_t no longer reflects potential wage (earnings) path. Previous training raises potential income and cost of continuing training.

Internal Rate of Return Approach



Internal Rate of Return Approach

Assume that $n \rightarrow \infty$

$$\text{For period 0, } C_0 = \frac{K_1}{r_0}$$

$$K_1 = r_0 C_0$$

$$\begin{aligned} \text{For period 1, } X'_1 &= X_1 + K_1 \\ &= X_1 + r_0 C_0 \end{aligned}$$

$$\text{For period 2, } X'_2 = X_2 + r_0 C_0 + r_1 C_1$$

$$\vdots$$

Until period $m - 1$

Internal Rate of Return Approach

Assume $r_i = r$ for all i ,

$$C_0 = X_0 - Y_0$$

$$\begin{aligned} C_1 &= X'_1 - Y_1 \\ &= X_1 + rC_0 - Y_1 \end{aligned}$$

$$C_2 = X_2 + \sum_{i=0}^1 rC_i - Y_1$$

\vdots

$$C_{m-1} = X_{m-1} + \sum_{i=0}^{m-2} rC_i - Y_{m-1}$$

Internal Rate of Return Approach

m equations, $m + 1$ unknowns (C_0, \dots, C_{m-1}, r) .

$$\sum_{j=0}^{\infty} \frac{Y_j - X_j}{(1+r)^j} = 0$$

can solve out r .

Internal Rate of Return Approach

If no unambiguous value for m , usually expect r to \downarrow with \uparrow investment in human capital.

Reasons

- Human capital is embodied in the person doing the investing. That is, it cannot be produced by someone else and then transferred to the person. As such, its production is limited by the physical and mental capacities of the person, which cannot be indefinitely expanded. Thus, memory capacity, physical size, energy available for productive activities are all limited and result in diminishing returns.

Internal Rate of Return Approach

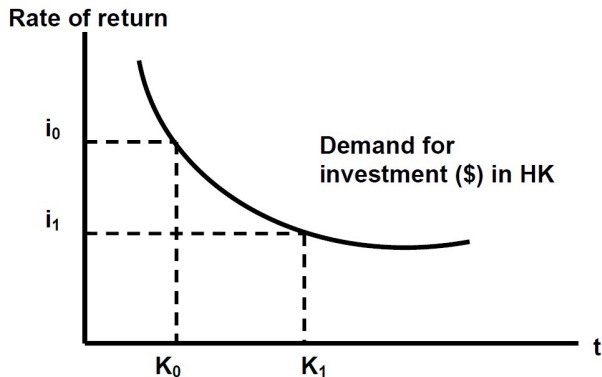
- Time constraint: the person's own time must be used in human capital investment. Other inputs are usually very imperfect substitutes for own time. Since endowment of time in each period cannot be expanded, efficiency in human capital accumulation will decline.
- Spreading investment overtime also constrained by \uparrow costs & \downarrow returns
 - costs: \uparrow human capital investment, $\uparrow X'_t$, \uparrow forgone income
 - returns: \uparrow human capital investment, \downarrow number of remaining periods for recouping returns of investment & returns more heavily discounted (because they come later in life)

Internal Rate of Return Approach

The internal rate of return approach, however, suffers from two shortcomings:

- The equation defining r is not linear, which means that there are, in general, i different roots if there are i periods in the horizon. Even if we disregard the complex roots, there is usually no unique root by which we can use to compare with the market rate.

Internal Rate of Return Approach



Internal Rate of Return Approach

- The internal rate of return is not a valid rule for choosing among alternative projects.

If two projects, A and B, show internal rates of return which are higher than the market interest rate but A is higher than B, it is not necessarily true that A should be preferred over B.

Let the 2 projects last for one year.

Project	Cost	Return	r
A	\$1m	\$1.1m	10%
B	\$10k	\$20k	100%

Project A must be preferred since it brings a much higher net returns than B even though the internal rate is much higher in B.

⇒ using the discounted present value approach can avoid both of the above problems, and is therefore to be preferred.

Supply of funds for human capital investment

Supply curve is the supply of funds for investment in human capital.

If capital market is perfect and no government subsidy for human capital investment \Rightarrow borrow for investment in human capital investment on the basis of existing or future human capital (as in the case of borrow for investment in physical assets).

If capital market is imperfect \Rightarrow the cost of financing would generally increase with the amount of investment.

Similarly, financing human capital investment where funds are from various sources and cost.

Supply of funds for human capital investment

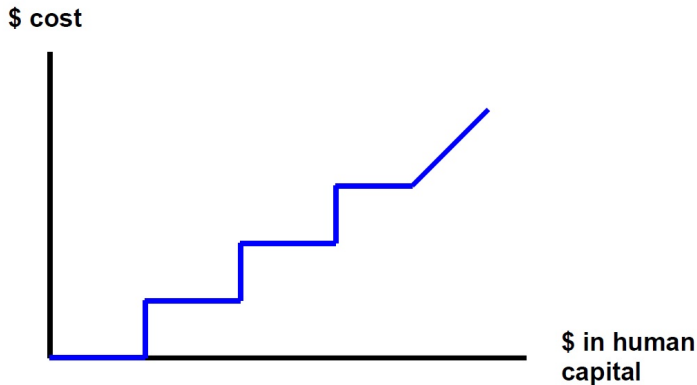
In ascending order of costs, parental transfer, public subsidies, government loans for higher education, own resources, and commercial loans.

Small investments, low-cost funds would be sufficient.

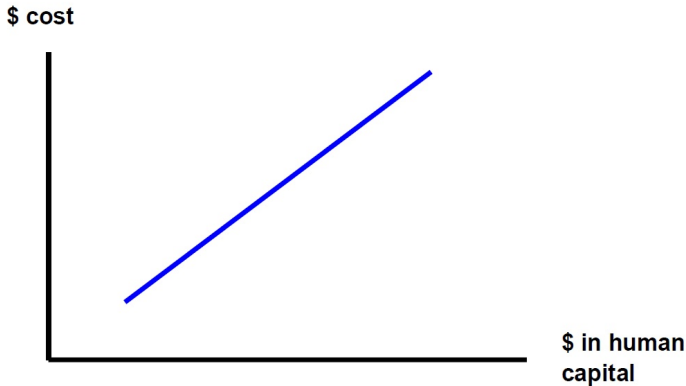
Go to higher cost funds once low-cost funds are exhausted.

⇒ marginal cost of financing human capital investment is increasing, or the supply curve is positively sloped.

Supply of funds for human capital investment



Supply of funds for human capital investment



Supply of funds for human capital investment

Note:

- Forgone earnings, and other component of the cost of human capital are not mentioned in the derivation of this supply curve. Because the derived supply curve is the marginal cost of funds for human capital investment, not the marginal cost of human capital.
- Forgone earnings enter the analysis on the demand side, where the demand for investment in human capital is captured by the rate of return that each dollar of investment brings.
- Cost of funding consider only money side, other time costs are considered in demand.

The Equilibrium

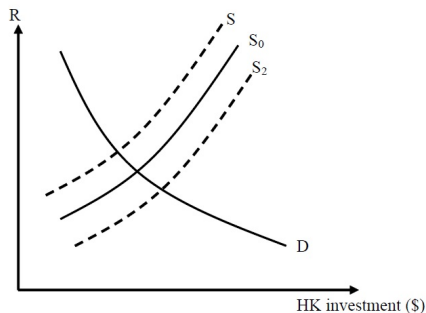
Given the supply and the demand curves, the optimal amount for investment of each individual is given by the intersection between the two curves.

Different individuals will invest differently, since both the supply and demand conditions may differ across individuals.

The Equilibrium

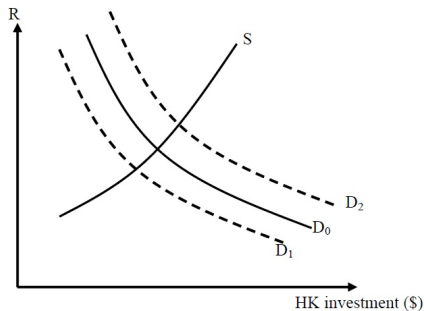
If individuals have same innate abilities \Rightarrow rate of returns to investment would be similar.

Differences in investment behavior would then be the result of differences in opportunities and they represent different points on the same demand curve.



The Equilibrium

If individuals' market opportunities do not differ much but innate abilities do \Rightarrow not much variation in the supply curve and difference in investment behavior \Rightarrow results from difference in demand curves of individuals \Rightarrow the observed behavior would then trace out the supply curve.



The Equilibrium

Do not in general draw conclusion

$$E_i = b_0 + b_1 S_i + \overbrace{b_2(\text{parental income}) + \dots}^{\text{control for supply side variables}} + \overbrace{b_3(\text{ability}) + \dots}^{\text{control for demand side variables}}$$

The Equilibrium

Look at a typical situation: A, high school; B, university.

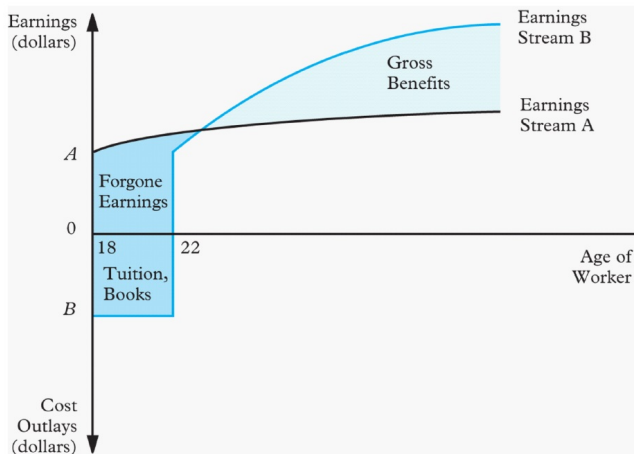


Figure 3: Alternative Earnings Streams

The Equilibrium

Predictions:

- Higher $r \Rightarrow$ less schooling (high discount rate \Rightarrow present oriented)
- Young age \Rightarrow more schooling
- Schooling \downarrow if costs of schooling \uparrow
- University attendance \uparrow if the gap $(W_U - W_H) \uparrow$, where U is university, H is high school

Government subsidy for education

Government often plays a prominent role in supplying funds for investment in education.

Most countries, education is subsidized, although to different degrees.

Why?

Often justify on both equity and efficiency grounds.

Government subsidy for education

Equity

Without government intervention, individuals with same abilities but different opportunities \Rightarrow different educational attainment and earnings.
 \Rightarrow inequitable, since the difference in background is entirely out of control of the students.

By subsidizing education, individuals will not be deprived of opportunities simply because they cannot afford it.

May also be an efficiency problem, as the difference in opportunities actually arises from imperfections in the capital market. With government subsidy liquidity constraint can be relaxed and allow some worthwhile investment infeasible.

Government subsidy for education

⇒ means to provide equal opportunities for deprived students.

Objective: aids for students with proved needs rather than universal subsidy would be the solution. Otherwise, not only those in need, but also those who can afford education without government subsidy would still be able to enjoy such benefit.

In fact, many studies have found that in most developed countries, it is the middle class that benefit most from government subsidy by substituting public resources for private investment in education. Also, if the purpose of public subsidy is to redress capital market imperfections, then loans rather than outright subsidy should be given out.

Government subsidy for education

Efficiency

Education brings external benefits to society. i.e. social returns to education $>$ private returns, \Rightarrow individuals underinvest in education without subsidy. Government subsidy for education would bring about an efficient solution.

External benefits to decline with the level of education so that at high level (e.g. tertiary education), most if not all of the benefits will be collected by the students themselves, which implies that subsidy for tertiary education should be low.

Government subsidy for education

Apart from Socialist states, the degree of subsidization is correlated to the degree of development seems to indicate that the prominence of the middle class and the increasing influence of the educational profession have something to do with the observation. These are the sectors that benefit most from public intervention in education, and therefore they have been most vocal in the support for such intervention.

Empirical Analysis of Investment in Education

Rate of return to education: 5% - 15%

The most direct approach is to study the difference in earnings of individuals with different educational level.

Simple estimates of these rates are, however, subject to different biases:

Empirical Analysis of Investment in Education

1. Ability bias

If there are significant differences in ability across individuals, then the rate of return to education may be overestimated.

We assumed an unskilled worker would, after the same years of education as a university graduate, earn the same amount as the latter.

Disregarding any difference in ability between the two, \Rightarrow likely to result in overestimating the returns to education (ability is lumped together, with the returns to education).

Empirical Analysis of Investment in Education

Solve by somehow control for the difference in ability, such as including proxies of ability in the regression equation:

$$E_i = b_0 + b_1S_i + \dots + b_nA_i + \epsilon_i$$

Proxies for abilities (such as IQ) are imperfect measures of market ability. If the difference in ability is not adequately controlled for, then the rate of return to education would partly reflect the return to ability, so that the estimate is **biased upward**.

Empirical Analysis of Investment in Education

2. Leisure \downarrow as education $\uparrow \Rightarrow$ estimates tend to **overestimate** return to education

There tends to be a negative relationship between education and leisure. Those with more education \Rightarrow earn more, have a higher wage, and enjoy less leisure.

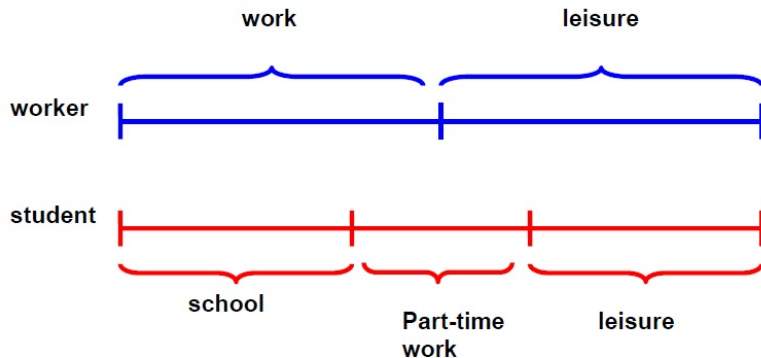
The higher wage is therefore partially offset by the loss of leisure, so that real income (including psychic costs and returns, or utility) gain is less than measured pecuniary gain (e.g. doctors, foreign exchange traders). The returns are therefore **overestimated**, and the rate of return is **biased upward**.

3. If capital market is imperfect, then forgone earnings underestimate the time cost of human capital investment.

If there's capital market imperfection, then students often have to work more than otherwise \Rightarrow leisure less than what an equivalent worker can enjoy.

\downarrow leisure \Rightarrow Marginal value of time \uparrow for student. Therefore, if use real wage to evaluate time cost (value of time devoted to education / human capital investment), then **underestimate true cost**. (i.e. **overestimated the return**).

Empirical Analysis of Investment in Education



4. Pecuniary returns underestimate total returns

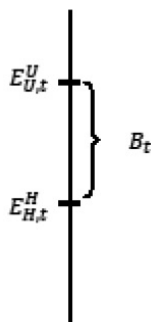
Measuring returns to education by earnings differential underestimate the true benefits because some returns, whether job-related or not, are non-pecuniary. Nonpecuniary fringe benefits, for example, are not included.

This would tend to **bias downward** the estimate of the rate of return.

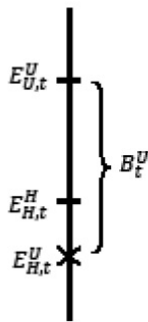
5. Selectivity bias in choice of education

There may be self selection in the choice of years of schooling. When ability is not one-dimensional, it might well be the case that high school graduates may be better at their jobs they are doing than university graduates, while university graduates are better in their jobs than high school graduates. People do what's relatively good for themselves. If you forced a high-school person to go through university, he/she may not earn as much as a normal university graduate. Result about the return to university education: downward bias for university graduates; and upward bias for high-school graduate.

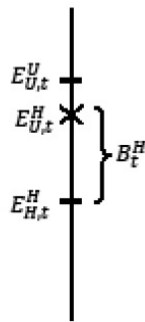
Empirical Analysis of Investment in Education



Actual



University persons
→ Underestimate return



High School persons
→ overestimate

Empirical Analysis of Investment in Education

Example

$E_{y,t}^x$ = earnings at period t of a graduate with x years of education attainment if he/she has chosen y years of education instead.

For $x = y \Rightarrow E_{x,t}^x$

$E_{U,t}^H$ = earnings at period t of a high school graduate if he/she has gone university education instead.

Benefit to university education

$$B_t = E_{U,t}^U - E_{H,t}^H$$

Empirical Analysis of Investment in Education

The correct way to measure benefit to university education for high school graduates

$$B_t^H = E_{U,t}^H - E_{H,t}^H$$

because $E_{U,t}^U > E_{U,t}^H$

We expect $B_t > B_t^H \Rightarrow$ estimate of returns of college education tend to overestimate value of education to high school graduates.

Empirical Analysis of Investment in Education

The correct way to measure benefit to university education for university graduates

$$B_t^U = E_{U,t}^U - E_{H,t}^U$$

because $E_{H,t}^U < E_{H,t}^H$, then $B_t^U > B_t \Rightarrow$ underestimate value of university education to university graduates.

Empirical Analysis of Investment in Education

If include non-pecuniary returns, would expect rate of return to investment education $>$ rate of return to investment in physical capital.

Reasons

- Liquidity
 - Higher rate of return on human capital reflects lack of liquidity
 - Lack of marketability (capital market imperfections) \Rightarrow supply of funds for human capital investment lower
- Uncertainty
 - Premium for human capital investment

Post-school investment: general and specific training

If education were the only form of human capital investment, then we would expect the earnings path to be flat, and even declining, as human capital depreciates with age.

observation: earnings path of most individuals is concave and increasing even after the completion of education \Rightarrow most individuals continue to accumulate human capital over his work life until quite late in life, i.e. when the remaining horizon becomes too short for investment to be worthwhile.

The actual shape and slope of the wage path, depend on the nature of the training \Rightarrow fixed costs of employment. Much training happens on the job: on-the-job training.

Post-school investment: general and specific training

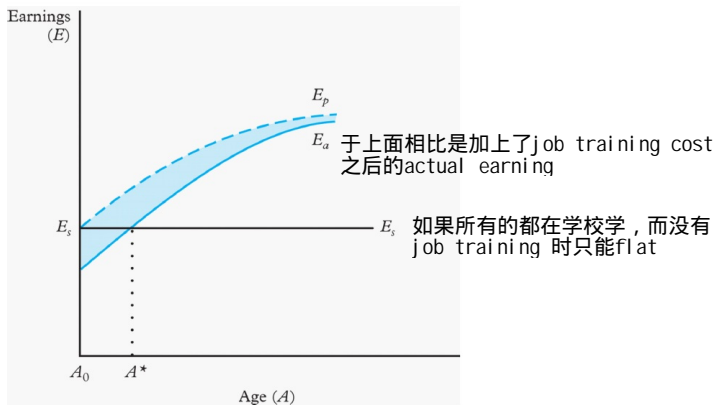


Figure 4: Investment in On-the-Job Training over the Life Cycle

Post-school investment: general and specific training

Complete schooling: earn E_s (no depreciation over time)

E_p (dashed line): earnings with on-the-job training, full potential

E_a : actual earnings

$E_p - E_a$: investment costs

Age $\uparrow \Rightarrow$ HK investment $\downarrow \Rightarrow$ E_a and E_p become closer. 越老越觉得没有那么多必要再投资training了

Age $\uparrow \Rightarrow$ HK investment $\downarrow \Rightarrow$ both E_a and E_p rise faster in earlier years. 由于你投资越少，所以增加的速度也相应变慢

Gender difference in investment in training

Given trained worker's earnings profile tends to be steeper than that of an untrained worker, there are also difference in gender.

1. Earnings profile of male workers

Regardless of marital status, male workers generally have more or less continuous experience in the labor force, or an uninterrupted career. The earnings of a male, and indeed any, worker depends on the amount of human capital accumulated at any time, as well as amount of new investment.

Gender difference in investment in training

2. Earnings profile of female workers

The labor market behavior of female workers are characterized by the following properties:

(a) Lower human capital investment

Women in general show lower labor force participation. As a result, they are less likely to invest in human capital that augments their market skills.

反正上班时间短，也不值得太多的往进投资

Gender difference in investment in training

(b) Lower labor force participation

Most women have interrupted careers: they move in and out of the labor force, often in response to family situations. In general, we can divide a married mother's career into 3 stages:

- ① a continuous spell until the birth of the first child;
- ② a period of intermittent participation, as permitted by freedom from childraising activities;
- ③ a period of more permanent re-entry into labor force for some after the youngest child reaches school age.

⇒ traditional role in child-bearing and child-rearing; reinforced by employers' behaviour.

Gender difference in investment in training

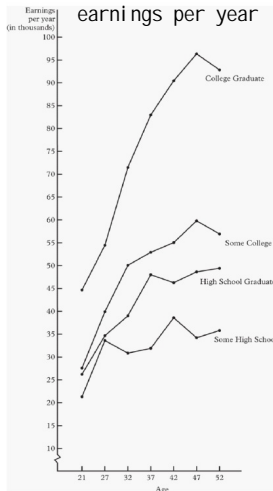
(c) Heterogeneity in labor force behavior of women workers

Some women never get married, and some married women never have children. These women are likely to have longer and less interrupted careers, and their investment behavior and earnings profile more resemble those of men.

woman之间的差距比较大

Note that gender difference in labor force attachment may result in difference in occupational choice, resulting in occupational segregation.

Gender difference in investment in training



差距在不断拉大

some是没有拿到学位的人

Figure 5: Money Earnings (Mean) for Full-Time, Year-Round Male Workers, 2008

Gender difference in investment in training

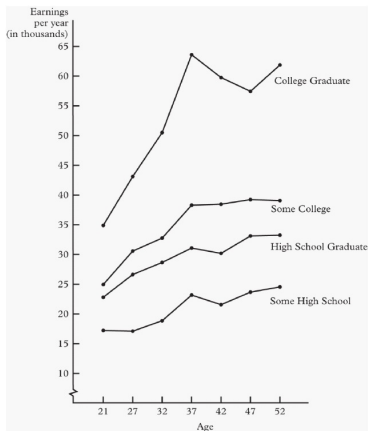


Figure 6: Money Earnings (Mean) for Full-Time, Year-Round Male Workers, 2008

Gender difference in investment in training

看斜率的大小就知道

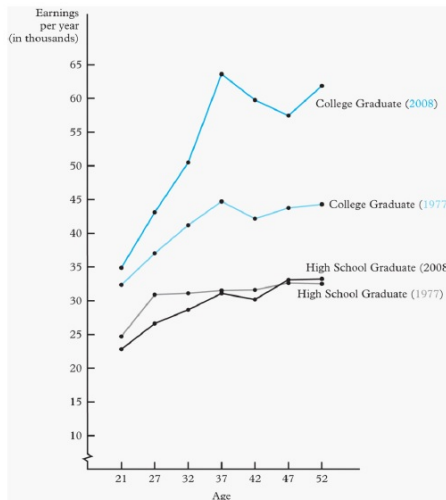
Male have more (general) training than females in earlier years of working, and related convexity in the earnings profile.

Females' profiles are less "fanned out" than males' profiles. fan out: 当岁数变大, 差距拉大

⇒ Within each gender, earnings differences across education levels tend to be more pronounced as they age.

- Average earnings of full time workers rise with the level of education;
- The most rapid increase in earnings occurs early in one's working life, thus giving a convex shape to the age/earnings profiles of both men and women; 在岁数小的时候增长速度很快, 投资也大
- Age/earnings profiles tend to fan out, so that education-related earnings differences later in workers' lives are greater than those early on; education的作用会越来越明显
- The age/earnings profiles of men tend to be more complex and to fan out more than those for women.

Gender difference in investment in training



30年的变化很大，much more compared with the 1977，而且这个的区别是在岁数大的时候产生的

变化不太大

Figure 7: The Increased Concavity of Women's Age/Earnings Profiles

Gender difference in investment in training

Percentages of Women among College and University Graduates, by Degree and Field of Study, 1971 and 2008				
Percentage of Women among:	Bachelor's Degree		Master's Degree	
	1971	2008	1971	2008
Total	43.4%	57.3%	40.1%	60.6%
Business majors	9.1	49.0	3.9	44.6
Computer science majors	13.6	17.6	10.3	26.8
Education majors	74.5	78.7	56.2	77.2
Engineering majors	0.8	18.4	1.1	22.9
English majors	66.7	67.9	61.0	67.0
Health professionals	77.1	85.4	55.9	81.1
First professional degree ^a			6.3	49.7

Figure 8: Percentages of Women among College and University Graduates, by Degree and Field of Study, 1971 and 2008

Gender difference in investment in training

Labor Force Participation Rates, Part-Time Employment Status, and Hours of Work in the United States, by Gender (2009)		
	Women	Men
Labor force participation rate, age 20 and over	59.2%	72.0%
Percent of employed who worked full-time	73.5%	86.8%
Average weekly hours of full-time workers, by occupation:		
Management, business and financial	42.3	45.9
Professional specialty	40.3	43.5
Office/administrative support	39.3	40.9
Sales	40.8	44.7
Installation and repair	41.1	42.0

Figure 9: Labor Force Participation Rates, Part-Time Employment Status, and Hours of Work in the United States, by Gender (2009)

Signaling/screening hypothesis

↑ education \Rightarrow ↑ worker productivity.

↑ education of A \Rightarrow ↑ productivity of B.

because social benefit > private benefit \Rightarrow externalities.

Other screening device, i.e. finding out who is productive, not enhancing worker productivity. 不会增加 productivity 而是帮助 employer 找到合适的人选

不是因为你去了 school 你增加了 human capital 而是因为你去了学校，有了 signal 说明你是 capable

Employers look at indicators such as age, experience, education ...

Some indicators are immutable, e.g. age

Other indicators can be acquired by worker, e.g. education \Rightarrow signals.

Signaling/screening hypothesis

e^* : years since high school, e.g. university degree
at e^* , wage jumps to W_2 .

Schooling/education \neq productivity.

Signaling/screening hypothesis

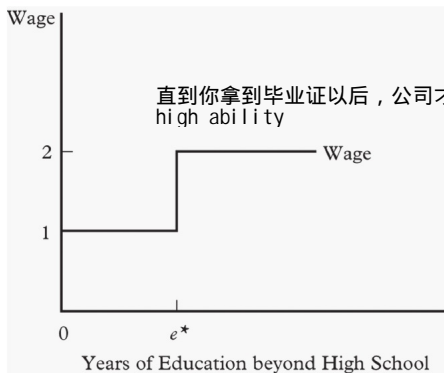


Figure 10: The Benefits to Workers of Educational Signaling

Signaling/screening hypothesis

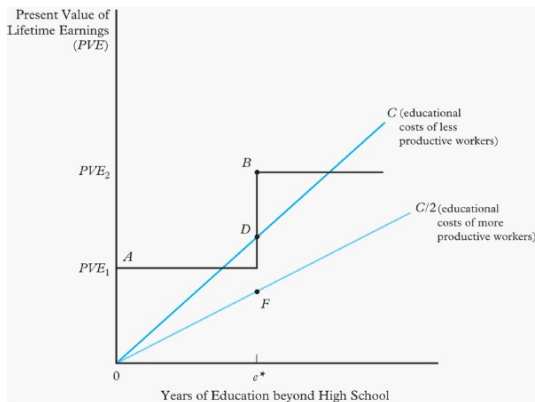


Figure 11: The Lifetime Benefits and Costs of Educational Signaling

For “less able”, $BD < AO$, so university degree is not worthwhile; for “more able”, $BF > AO$, so university degree is good.

Signaling/screening hypothesis

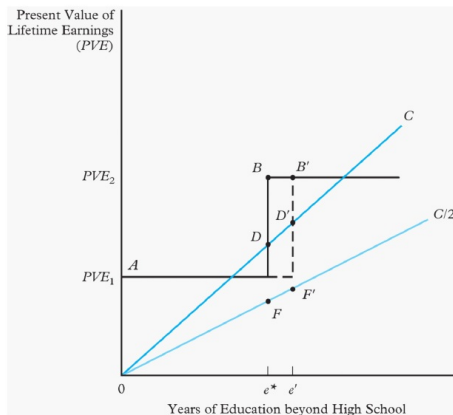


Figure 12: Requiring a Greater Signal May Have Costs Without Benefits

Signaling/screening hypothesis

Requiring higher critical education does not affect the decision of the two types of workers but increase the cost for high ability workers. So it's socially undersirable in this care here.

Human capital or signaling?

Not important for individuals but yes for society.

- Ehrenberg and Smith (2015) *Modern Labor Economics: Theory and Public Policy, Chapter 8*