Econ 463 R. Butler 2005 Lecture 14

I. Human Capital--returns to schooling estimated two ways

A. Internal rate of return estimates of human capital investments

Friedman and Kuznets considered the problem of comparing two types of homogeneous groups of people one of whom goes on to complete more years of schooling than the other: lets call these "high school" and "college" types of people. Let Y_t be the income of high school people "t" years after high school, and Z_t be the income of the college people "t" years after high school.

types of people:	year=0	year=1	year=2	....	year=n
high school	Y_0	Y_1	Y_2	....	Y_n
college	Z_0	Z_1	Z_2	....	Z_n

Now to find the return to extra investment in schooling undertaken by the college types, we find ñ such that the present value of the two income streams are equalized:

$$1)\ 0 = \sum_{t=0}^{n} \frac{Z_t - y_t}{(1+\rho)^t}$$

Suppose that the income streams are given as in the chart below.

types of people:	year=0	year=1	year=2	year=3	year=4
high school	100	105	110	115	120
college	30	100	140	160	180

If we let ρ=.10, then the sum in equation (1) would be 25.04, so that at an internal rate of return of 10 percent, the college investment was better than the high school investment. If we let ρ=.30, then the sum in equation (1) would be –14.60, so that at an internal rate of return of 30 percent, the high school education is the better investment (since future income gains from college are discounted more heavily). The internal rate of return that equalizes these streams is 20.87 percent.

In their empirical comparisons of the earnings streams of doctors and dentists (this study was done in the 1940s), the calculated ρ was much greater than the market rate of interest. This led them to conclude that the supply of doctors was probably restricted (through medical schools?) to level below that which would prevail in a free market. (Why did they conclude this?)

B. <u>The earnings function approach</u> (developed by J. Mincer and G. Becker)
This assumes that all individuals are alike with respect to ability and their rate of discount. In which case, the present value of the difference between high school and

college careers must be exactly enough to offset the costs of the additional schooling (why can't it be greater?). Everyone invests until the rate of time discount is equal to the market rate of interest (why will this be true when everyone is identical), so letting

r=rate of interest
E_t=potential earnings t years after school starts (age 6)
C_t=schooling investment cost in t^{th} year after school starts
k_t=cost to potential earnings in the t^{th} year ($k_t=C_t/E_t$)
E_0=potential earnings in the absence of schooling

Then the potential earnings of an individual after one years worth of schooling will be

$$E_1 = E_0 + rC_0$$
$$= E_0(1+rk_0)$$

(Do you understand what we have done here?) After two years of schooling, potential earnings would be

$$E_2 = E_1(1+rk_1)$$
$$E_2 = E_0(1+rk_0)(1+rk_1)$$

And if we repeat this for T full years of schooling we find (by recursion) that

$$E_T = E_0(1+rk_0)(1+rk_1)(1+rk_2)...(1+rk_{T-1})$$

Now we use a few tricks about logarithms, namely that log(AB)=logA+logB, and log(1+z)=z when z is a small number ("close" to zero, i.e., if |z| is less .2 then its a pretty good approximation). Taking natural logs of both sides of the last equation, and using the tricks we get that

2) $$\log(E_T) = \log(E_0) + \sum_{t=0}^{T} rk_t = r\sum_{t=0}^{T} k_t = rS$$

where S is the number of years of schooling, and the last equality depends on a couple of key assumptions holding. What are those assumptions? From 2 its clear that if actual earnings in year equals potential earnings, E_t, then the rate of return to schooling can be estimated by the following simple regression

3) $$\text{Log(earnings)} = \beta_0 + \beta_1 \text{ education}$$

What will the intercept and slope coefficients of this regression estimate? Often 3 is expanded by making a few more assumptions about equation (2) terms (what are these assumptions?) to get

4) $$\text{Log(earnings)} = \beta_0 + \beta_1 \text{ education} + \beta_2 \text{ job experience}$$

This last equation is the most common regression in economics, and paid for the orthodontic work of many a labor economist's children. (Often this equation is estimated with a few other controls thrown in, like age, gender, occupation, industry and whatever else is ringing the researchers bell at the moment).

II. Conceptual Problems with Estimating and Interpreting Schooling Model Output

In this section, we discuss three alternative potential difficulties with interpreting the schooling model: unobserved ability differences, sample selection, and life-cycle considerations for the human capital model.

A. The Rosen critique (what happens if unmeasured ability also determines earnings) Simplify to the problem of the optimal harvest time (how long to go to school), assume that get a constant wage income stream, W, once you graduate from school:

5) Max V(s) = $\int_S^T W\, e^{-rt}\, dt = \frac{W}{r}[e^{-rS} - e^{-rN}]$

6) subject to W=f(S,A)

where

W=wage income
S=years of schooling completed
T=end of earnings career
r=market rate of interest
A=ability

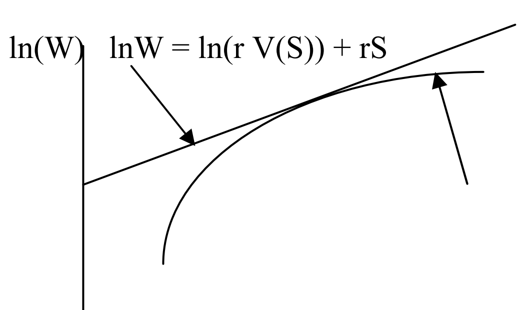
Let N get large enough so that the last term on the rhs of equation (1) can be ignored, and we have:

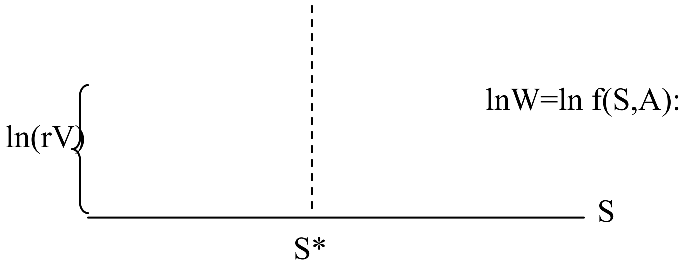
7) V(S) = $\frac{W}{r} e^{-rS}$

which we want to maximize subject to the wage constraint given in equation 2. We assume that ln(W) is a concave function of S (a very sensible assumption—simply that "there are diminishing returns to investments"). Taking logs of equation (7) and rearranging we get

8) lnW = ln(r V(S)) + rS

which is maximized subject to lnW=ln f(S,A):



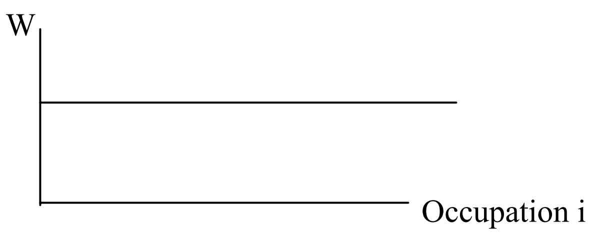


Note that r enters both the intercept and slope of the objective function, and that ability, A, is a constraint on the amount of schooling that can be achieved.

If r and A vary across individuals, than the market would actually be throwing out a bunch of observations like:

from which it would be hard to identity any structure from a single equation estimate.

So what does this mean for the Mincer schooling equation? That all individuals are alike with respect to r and A, so that the relative supplies of labor to alternative occupations must be perfectly elastic, with the shift in supply curve determined only by entry costs:



So supply factors adjust relative wages in each occupation so that the present value of the associated earnings stream are equalized everywhere. Hence,

9) $V(S) = \frac{W}{r} e^{-rS} = V_0$ for all S.

Then equation (8) becomes

10) $\ln W = \ln(r V_0) + rS$

And the Mincer model becomes a structural equation.

B. Roy Selection Model

We observed that in the previous section that differences in unobserved ability (or in rates of return) made interpretation of the Mincer schooling model difficult. Here, we look at how sample selection may also bias the estimated returns to schooling. To keep it simple, we consider individuals making schooling choices in junior high (the last time that they were rational, before they started to color their hair with jello): Each individual is assumed to be faced with the decision to continue schooling after high school or not. We assume that they consider their best choice among grades 9 through 12 (highest wage choice), and compare this with their best choice among grades 13-22), where "wage" is "net wage" after adjusting for the cost of schooling. (Maybe for Dick, it would be dropping out at the end of the junior year in high school OR getting a MBA with two additional years of graduate training, which is intellectually about the same as dropping out of high school—and the choice set for Dick would be "11,18".)

Their wage function is

$\text{Ln}(\text{wage}^h) = \beta_0 + \beta_1 S^h + \varepsilon^h$ if they stop at high school, and

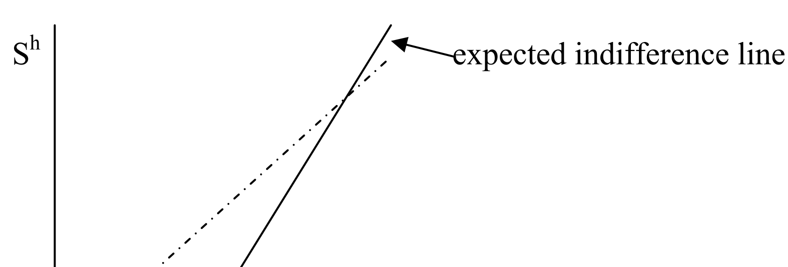
$\text{Ln}(\text{wage}^c) = \alpha_0 + \alpha_1 S^c + \varepsilon^c$ if they continue on for at least some college.

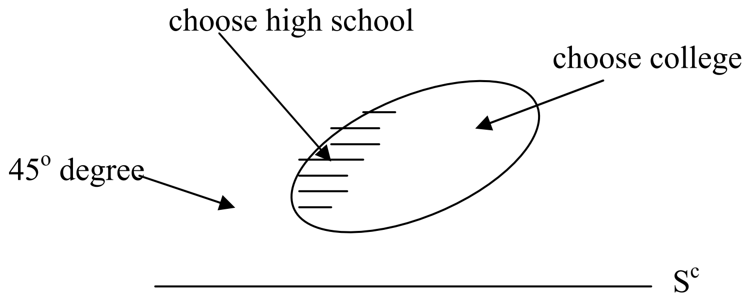
where the ε-terms are unobserved influences on the wages, not affecting the schooling choice (so, for example, they would not include the "ability" of the last section). So each individual has a potential pair of wages (with associated schooling levels) to choose from: $\ln(\text{wage}^h)$ or $\ln(\text{wage}^c)$. They choose high school as long as

$\ln(\text{wage}^c) < \ln(\text{wage}^h)$ or as long as $\alpha_0 + \alpha_1 S^c + \varepsilon^c < \beta_0 + \beta_1 S^h + \varepsilon^h$. A worker will be indifferent between high school and college as long as or as long as $\alpha_0 + \alpha_1 S^c + \varepsilon^c = \beta_0 + \beta_1 S^h + \varepsilon^h$, or whenever

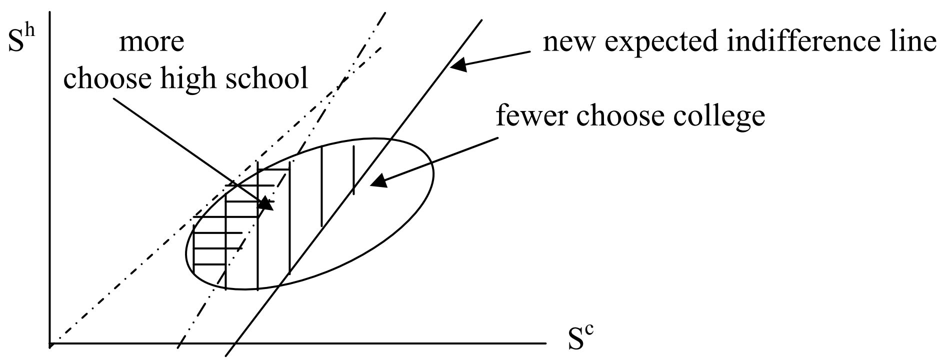
$S^h = [\alpha_0 - \beta_0]/\beta_1 + (\alpha_1/\beta_1)S^c + [\varepsilon^c - \varepsilon^k]/\beta_1$

This is just like a regression equation, with and the slope term being the relative returns of college to high school. Since the errors have zero mean, then $E(\varepsilon^c - \varepsilon^h)=0$, then the expected value of the line of indifference in education (the "expected indifference line", $E(S^h)$) would look line:



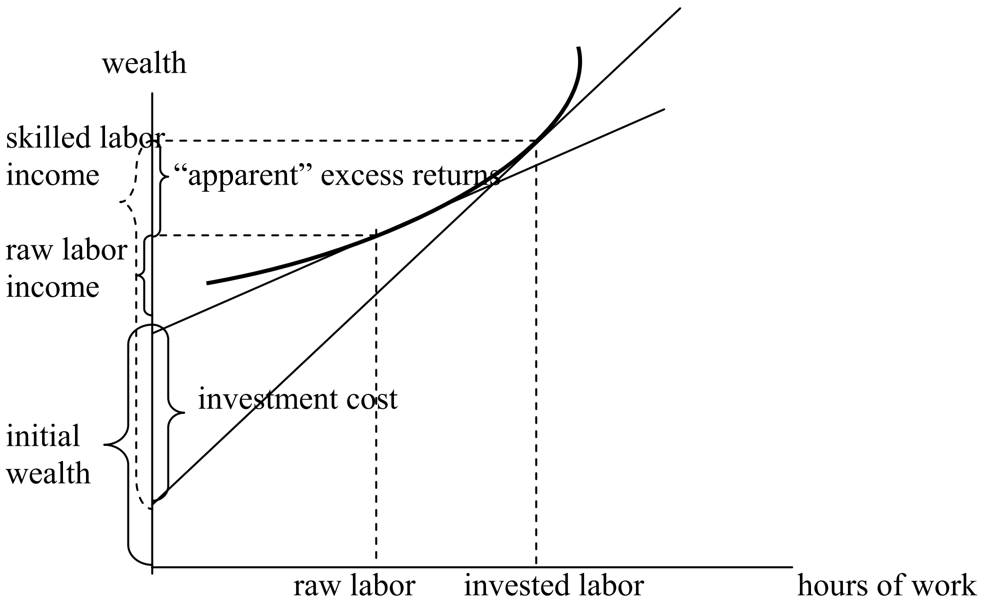


given the distribution of potential schooling pairs for each individual is distributed in the pictured "oval" pattern, and where we have assumed that the return to college education is greater than the return to high school (so the indifference line has a slope greater than one). If the returns to college education were to drop, then the slope of the expected indifference line would fall, and the optimal choice of schooling would change for some individuals—fewer would choose to continue on to college:



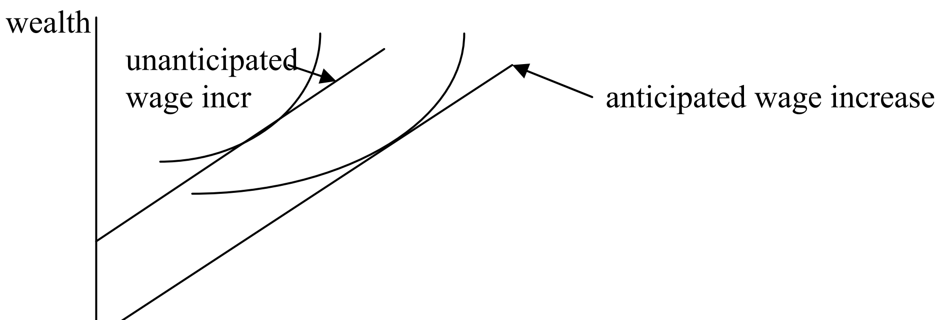
More choose to stop at a high school education, when the relative returns to college falls. So the sample of college going workers is conditioned on the returns to college education. We never see anyone both stopping their education at the high school level *and* going on to college. It is either one or the other. If we could make parallel universes, and in one have everyone go to high school and then would, we could estimate the high school education tradeoff without bias. In the other parallel universe, we would send everyone off to college and do the same. However, in our universe we have a sample selection problem. More individuals end up going to college (and appearing in our sample) when the relative returns to college education is higher. So sample inclusion depends on the value of the independent variables, as it did for female labor supply. This could lead to biased estimates in our schooling model (because choice of schooling is endogeneous, just was it was in the Rosen model).

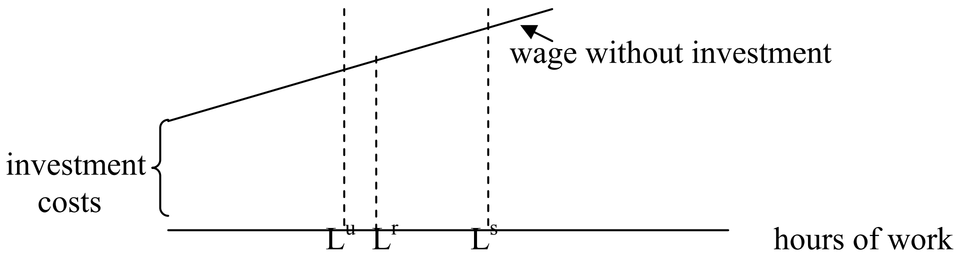
C. The Lindsay critique(C.M. Lindsay, JPE, Nov. 1971)--even if all of the assumptions of the Mincer model are correct (identical ability and preferences), the estimates of returns to schooling will tend to be biased (Lindsay critique): Unlike other forms of capital where a change in the value of the capital assets comes through a change in the income stream associated with the asset (and hence such changes represents only wealth effects), <u>human</u> capital is different (recall lecture seven). A change in the value of one's human capital is a change in price (namely, the wage) also induces a substitution effect between leisure and goods. This induced substitution effect creates a bias in the estimated returns to schooling. Namely, an increase in the value of the HK asset can only be realized in a change in the wage rate—but a change in the wage rate induces a substitution effect Assuming that there are only two professions, one requiring no HK investment and the other requiring some substantial HK investments on the part of the worker:



The observed earnings differential between skilled and raw labor is the difference is between the small, raw labor income amount, and the much larger (dashed line) skilled labor income. The difference between incomes seems to involve an excess returns to the skilled position (by the amount "'apparent' excess returns"); but in fact, the worker is just compensated enough to make him indifferent between the two professions. The "'apparent' excess returns" is, in fact, a premium that just compensates the worker for giving up additional hours. That is, the income difference between skilled and raw labor has a return to investment component, and a hours-premium component.

A final note on the differences between unanticipated and anticipated differences in the wage rate. In Lindsay's model, anticipated changes generate no income or wealth effect, only a substitution effect so that hours of work always increase with an anticipated change in the wage. There are wealth effects only when the wage changes are unanticipated—only in this case can you get a backward bending labor supply function. This is illustrated as follows:




wage without investment
investment costs
L^u
L^r
L^s
hours of work