

## Lecture 13

### Compulsory Schooling, Dropout Behavior, and Alternatives to the Human Capital Model

Compulsory school laws mandate the minimum length of time a child must spend in school before having the option to leave. These laws have been around for a long time. Many industrialized countries introduced them more than a hundred year ago, and since then, they've been updated often. Most recently, for example, many states have implemented or are considering raising the minimum school leaving age to 18. A number of papers have used compulsory schooling as an instrument to measure the causal effects of education. They seem to be potentially good instruments in that they seem likely to be correlated with schooling (by definition, they are intended to raise school attainment) and not be correlated with ability or other cost factors, since they are imposed on everyone, whether or not they want to leave school early.

There are two types of compulsory school law instruments.

#### 1) Day of birth

Angrist and Krueger (1991) exploit differences in school starting ages together with a fixed minimum school leaving age to identify potentially exogenous variation in the minimum exposure to class time. In states with a December 31<sup>st</sup> cutoff for starting school, children born near the end of a year enter school at 5  $\frac{3}{4}$  while students born near the start of the year enter school around 6  $\frac{3}{4}$ . Students are typically allowed to leave as soon as they reach their 16<sup>th</sup> birthday. Therefore, students differ in the minimum length of time they must spend in school before having the option to leave (between 0 and 12 months).

Figure 1 of Angrist and Krueger JEP Fall 2001 shows nicely their identification. They estimate Mincerian returns to education of about 8 – 10%

#### 2) State/regional dropout ages

Changes to the dropout age may also provide an instrument for estimating causal effects of education. If all states raised the dropout age at the same time, we would have a discontinuity in education restrictions, but might have a hard time discerning whether changes or trends in schooling and earnings around the time of the increase were actually due to the law changes or something else.

Luckily, many states change the school laws at different times, allowing controls for time fixed effects and state fixed effects.

Angrist and Acemoglu have used US variation in state compulsory school laws to estimate returns to education ranging from about 7 to 10%.

A number of recent papers have now branched off and used these instruments to examine outcomes other than earnings:

Llearas Muney: mortality

Lochner and Moretti: likelihood of ending up in jail.

I started my project wondering whether I could detect an effect of education on subjective well-being ('happiness').

No luck with General Social Survey: results too imprecise, and only had current state of residence rather than residence of birth.

I heard about Harmon and Walker's paper that estimated returns to education off of a compulsory school law change in Britain, and knew there were happiness data available with the British Data.

Amazing first stage!

Figure 1, 2, 3 Old Version

IV results also hold up, even for 'happiness'

Table 2, 3, 4

Specification checks hold up very well too:

Tables A3 A4 A5

Rather than turn the paper into a 'returns to education on happiness', it occurred to me that there was a more interesting point to all of these results.

What is the LATE from these estimates? Who are those affected by compulsory schooling? We're really looking at the returns to compulsory schooling.

If the instrument is valid, compulsory schooling identifies the effects of additional schooling for individuals that otherwise would not have continued on.

Who are these people that prefer not to continue?

Consider in the context of a human capital model:

In year zero, an individual must decide whether to dropout,  $s=0$ , or not,  $s = 1$ . Assuming her period consumption utility is  $\log C$ , her lifetime utility, extending to year  $T$  and conditional on school choice is:

$$(1) \quad V(S) = \max_{C(t)} \left\{ [\log C(0) - \varphi(S)] + \sum_{t=1}^T \delta^t [\log C(t) + \theta(S, t)] \right\}$$
$$= \max_{C(t)} \left\{ [\log C(0) - \varphi(S)] + \sum_{t=1}^T \delta^t \log C(t) + \theta(S) \right\},$$

where  $[\log C(0) + \varphi(S)]$  is period 0 utility, and  $\varphi(S)$  is the individual's distaste for high school.

$\theta(S) = \sum_{t=1}^T \delta^t \theta(S, t)$  represents possible nonpecuniary gains to schooling, discounted over the

individual's lifetime at the time preference discount rate  $\delta$ .

Suppose an individual can borrow or lend freely at a fixed interest rate  $r$ . Also, simplify the earnings-age profile to depend on schooling only in terms of levels. Year  $t$  earnings are  $y(S, t)$ , dependent on schooling  $S$ . Then, the intertemporal budget constraint is

$$(2) \sum_{t=0}^T R^t c(t) = \sum_{t=S}^T y(S, t) R^t = y(0) 1(S=0) + \sum_{t=1}^T y(S, t) R^t,$$

where  $R^t = \frac{1}{(1+r)^t}$ .  $y(0)$  is earnings in 0 if  $S=0$  ( $1(S=0) = 1$  if  $S=0$ , 0 otherwise). If the effects of

schooling are known, the individual simply compares utility under both situations and chooses to take the extra year if  $V(1) > V(0)$ , otherwise she doesn't invest. Define  $X'(S) = X(1) - X(0)$ . The first order conditions are:

F.O.C.:

$$\frac{1}{C(t)} \delta^t - R^t \lambda = 0$$

$$\theta'(S) - \varphi'(S) - \lambda y(0,0) - \lambda \sum_{t=1}^T \frac{\partial y(S, t)}{\partial S} R^t > 0$$

Using the budget constraint,  $\lambda = \frac{\sum_{t=0}^T \delta^t}{\sum_{t=S}^T y(S, t) R^t}$ . Note that this implies, if  $\delta = R$ , annual consumption is

just the average of present value income:  $C(t) = \sum_{t=S}^T y(S, t) R^t / \sum_{t=0}^T R^t$

An individual prefers to drop out if:

$$(*) \quad k + \frac{\varphi'(S)}{\lambda} > \sum_{t=1}^T \frac{\partial y(S,t)}{\partial S} R^t + \frac{\theta'(S)}{\lambda}$$

Where  $k = y(0,0)$  is forgone earnings from staying in school. By dividing by  $\lambda$ , the expression monetary units.  $\frac{\varphi'(S)}{\lambda}$  is the disutility from staying in school, relative to a marginal increase in utility from an extra dollar of consumption. An increase in forgone earnings by \$1 has the same value attached to it as an increase in  $\frac{\varphi'(S)}{\lambda}$  by 1.

Note, if there are no non pecuniary gains or costs from attending school, and we approximate earnings as fixed over the lifecycle so that  $y(S,t) = y(S)$ , and we let  $T \rightarrow \infty$ , then we arrive at the condition:

$$\text{Drop out if: } \frac{y'(S)}{k} < r$$

<draw graph showing area differences in PV, with and without earnings growth – reasonable approximation>

Compulsory schooling prevents drop out behaviour. In the context of our human capital model above, compulsory schooling compels individuals for which (\*) holds to go from  $S=0$  to  $S=1$ . Since they are already optimizing, compulsory schooling should lower lifetime utility.<sup>1</sup> From a human capital perspective, compulsory schooling is a very strange policy to advocate and enforce! Very little has been said in economics about this policy that has been around for at least a hundred years. I've come across only 2 papers that acknowledge the welfare decreasing implications of compulsory

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<sup>1</sup> In Chiswick's (1969) words, 'while those compelled to over-invest [in school] experience an increase in their annual post-investment income, they experience a decrease in their marginal and average internal rates of return'.

schooling under a human capital model, but note that it may still reduce earnings inequality (even at the expense of lowering welfare). Another paper mentions this anomaly can occur in the presence of education externalities.

Why were compulsory school laws introduced in the first place? Why do people continue to advocate raising the school leaving age? Motivations behind this policy often relate to paternalistic assumptions that children wishing to leave school early are, in fact, better off from staying on, or that positive externalities exist from raising a population's overall education attainment.

It occurred to me that this instrument might provide an interesting way to test the human capital model. Rather than estimate annual returns to schooling,  $\frac{y'(S)}{k}$ , why not instead estimate

$\sum_{t=1}^T \frac{\partial y(S,t)}{\partial S} R^t$  in (\*). This would give us a lower bound of the present value benefits from an additional year of high school, assuming no additional non-pecuniary benefits (which could also be high). We could then predict the minimum amount costs would have to be, in monetary terms, for an individual to prefer to dropout.

Figure 5, Figure 6

Table 5

What could be going on?

1) liquidity constraints

Suppose the individual cannot borrow in year 0, the year she must decide whether or not to continue school.

$$V(S) = \max_{C(t)} \left\{ u[y(S,0)] - \varphi(S) + \sum_{t=1}^T \delta^t u[C(t)] + \theta(S) \right\} \text{ subject to:}$$

$$-\frac{1}{\lambda'} \frac{\partial u(y(S,0))}{\partial S} + \frac{\varphi'(S)}{\lambda'} > \sum_{t=1}^T \frac{\partial y(S,t)}{\partial S} R^t + \frac{\theta'(S)}{\lambda'}$$

The equation is very similar, but the individual's marginal cost from an additional year of school now includes her disutility from less consumption instead of disutility from foregone earnings.

<evidence of credit constraints>

Table 8, Census data shows 90% of 17 year old dropouts still living at home and 50% not working.

## 2) Uncertainty

Heckman suggests the reason why returns to education are higher than the interest rate is because an education investment is risky. Analogous to other financial investments, risk leads to a higher return demanded. To see this in the context of our model, suppose the time preference discount factor,  $\delta$ , equals the financial discount factor,  $R$ . This assumption leads to the well-known result that a student attempts to smooth consumption over her lifetime. Suppose also that the student is liquidity constrained at the time the school choice is made. Annual income after period 0 is  $y(S,t) = y^p(S) + \sigma(S)\varepsilon$ . The uncertain component,  $\varepsilon$ , has mean zero and variance 1, and is multiplied by a standard deviation factor that depends on school attainment. Expected lifetime utility is:

$$EV(S) = \left\{ [u[y(S,0)] - \varphi(S)] + \sum_{t=1}^T \delta^t u[y^p(S) + \sigma(S)\varepsilon] + \theta(S) \right\}$$

Assuming the function,  $u[y^p(S) + \sigma(s)\varepsilon_i]$ , may be approximated by a second-order Taylor series around the point,  $\varepsilon_i = E(\varepsilon_i) = 0$ , the lifetime utility function can be reformulated as:

$$EV(S) = \left\{ [u[y(S,0)] - \phi(S)] + \sum_{t=1}^T \delta^t u[y^p(S)] + \sum_{t=1}^T \delta^t u''[y^p(S)] \frac{\sigma^2(s)}{2} + \theta(S) \right\}$$

Maximizing with respect to  $S$ , the condition for preferring not to continue school is:

$$(A3) \quad -\frac{\partial u(y(S,0))}{\partial S} + \frac{\partial \phi(S)}{\partial S} > \sum_{t=1}^T \delta^t (U' + U''\sigma(s)) \frac{\partial y^p(S)}{\partial S} + \frac{1}{2} \sum_{t=1}^T \delta^t U'' \frac{\partial \sigma^2(s)}{\partial S}.$$

Using the assumption that  $\delta^t = R^t$ , and defining,  $\lambda^* = U' + U''\sigma(s)$ , the condition satisfying a drop out decision can be rearranged as:

$$(A4) \quad -\frac{1}{\lambda^*} \frac{\partial u(y(S,0))}{\partial S} + \frac{1}{\lambda^*} \frac{\partial \phi(S)}{\partial S} > \sum_{t=1}^T R^t \frac{\partial y^p(S)}{\partial S} + \frac{1}{2\lambda^*} \sum_{t=1}^T R^t U'' \frac{\partial \sigma^2(s)}{\partial S} + \frac{\theta'(S)}{\lambda^*}.$$

This equation is comparable to before, except for the second component on the right-hand-side. If a student is risk-averse ( $U'' < 0$ ) and additional schooling increases risk ( $\frac{\partial \sigma(s)}{\partial S} > 0$ ), the decision to drop out becomes more likely than the case when future earnings are certain. When using ex-post future earnings to convert income-streams into present value, researchers often correct for uncertainty with a discount rate higher than the risk-free rate.

The appropriate financial discount rate to use is similar to that for treating education as an investment decision. A better depiction of the school-choice model involves choosing between alternative earnings distributions. If a student is risk-neutral, then only differences in expected returns matter and a risk-free financial discount rate to convert future expected returns to present value should be

used. If a student is risk-averse, higher expected returns from additional schooling may matter less if the variance in expected earnings is also higher.

A small literature that measures riskiness of education involves comparing variances of log earnings among different education groups for students with similar characteristics. The previous literature focuses on whether earnings uncertainty increases when extending schooling beyond high school (e.g. Levhari and Weiss, 1974 and Chen, 2002). The uncertainty from extending a student's minimum education attainment level by one year, however, is not comparable with these earlier estimates since additional high school is unlikely to contribute to human capital specialization.

I find evidence that additional high school is less risky than without. I also find dropouts that faced more restrictive school-leaving ages are less likely to be unemployed. Among 15 and 16 year olds not in school from the 1950 U.S. census, less than half recorded are in the labor force (41 percent) and 89 percent still live with parents. Fifty years later, the pattern has not changed much. Among 17 year-olds not in school in the 2000 U.S. Census, for example, 90.4 percent lived with parents, and 45 percent were not in the labor force. The results support a preference for using a risk-free financial discount rate to make present value comparisons. For sensitivity analysis, I consider a range of possible rates: 3 percent, 5 percent, and 8 percent. All three assumptions generate similar conclusions. But there doesn't seem to be any strong reason for a case that additional high school leads to high probability of lower wages.

### 3) Hyperbolic Discounting: $0 < \beta < 1$

Students value the future, but when making decisions, they value the present temporarily more. Following Laibson (1997) and O'Donoghue and Rabin (1999), one way to incorporate immediate impatience into the school choice model is to add a second discount rate placing more relative weight on the current period versus all other periods:

$$V(S) = \max_{C(t)} \left\{ [\log C(0) - \varphi(S)] + \beta \sum_{t=1}^T \delta^t \log C(t) + \beta \theta(S) \right\}.$$

A student discounts all consequences beyond the first period from the school choice decision by the factor  $\beta$ . If  $\beta < 1$ , this quasi-hyperbolic discount factor changes the discounting of this period relative to the entire future. If students could make school choice decisions before facing any imminent opportunity cost, they would place less weight on these costs than when facing them at the time the decision is actually made. Preferences under such behavior are time inconsistent. The condition for dropping out is if:

$$k + \frac{\varphi'(S)}{\lambda} > \sum_{t=1}^T \frac{\partial y(S,t)}{\partial S} R^t + \frac{\beta \theta'(S)}{\lambda}.$$

$$\lambda = \frac{1 + \beta \sum_{t=1}^T \delta^t}{\sum_{t=S}^T y(S,t) R^t}$$

The more the individual discounts the future, the larger the weight placed on her disutility from effort at school. Furthermore, a hyperbolic discount rate also lowers the significance placed on the non-pecuniary portion of education's relative benefits.

#### 4) Identity, peer effects:

Deviating from behavior common to one's social group may evoke anxiety and discomfort in one's self and in others, even if such behavior, without considering self-image, would raise lifetime utility. Let  $\Phi(S, E(S|I))$  be a student's utility (or disutility) from attaining school level  $S$ , relative to the education attainment she perceives is expected of her by those she identifies with,  $E(S|I)$ .

$$V(S) = \max_{C(t)} \left\{ [\log C(0) - \varphi(S)] + \sum_{t=1}^T \delta^t [\log C(t)] + \theta(S) + \Phi(S, E(S|I)) \right\}$$

Then, she prefers to drop out of school when:

$$k + \frac{\varphi'(S)}{\lambda} > \sum_{t=1}^T \frac{\partial y(S,t)}{\partial S} R^t + \frac{\theta'(S)}{\lambda} + \frac{\Phi'(S, E(S|I))}{\lambda}$$

A student whose social group considers dropping out acceptable (and even expected) is more likely to drop out in the identity model for two reasons. First, deviating from her social group's expectations and attitudes would likely generate an immediate disutility. Second, she may perceive this disutility to continue in the future.

If the discomfort a student gets from exceeding her social groups' school attainment norm predominates her reason for dropping out, then raising the minimum school leaving age may increase her lifetime utility. She no longer would receive discomfort from her decision, since her social group's school attainment norm would also adjust from the law change. Her peers would also face the new dropout age. Increasing the school leaving age would also prevent her from projecting her current state over her future. A student that would choose to continue schooling, where it not for concerns over how doing so affects her self-image, would be better off under a higher minimum school leaving age policy.

##### 5) Misguided Expectations:

$$k + \frac{\varphi'(S)}{\lambda} > \sum_{t=1}^T \frac{\partial \hat{y}(S,t)}{\partial S} R^t + \frac{\theta'(S)}{\lambda} + \frac{\Phi'(S, E(S|I))}{\lambda}$$

where  $\frac{\partial \hat{y}(S,t)}{\partial S} < \frac{\partial y(S,t)}{\partial S}$ . Thus, expectations are not correct.

Students may systematically mispredict expected gains from additional education. Students may not make correct present value calculations of future returns, or may underestimate the real gains from school. Dominitz and Manski (2000) find substantial variation among high school students in

earnings expectations conditional on a bachelor degree. While expectations about the returns from a degree were positive, it seems questionable whether would-be-dropouts can anticipate lifetime gains from one more year of school. The annual gains may seem insignificantly small and ignored when comparing them to a large initial burden from staying in school (Rubinstein, 1988). Guidance from parents who themselves dropped out or peers that do not care for school may also lead to misguided expectations of returns to school.