Lecture 4: Early Childhood Education. How Important?

Internal Rate of Return:

Say we have a project with the following cash flows over the project's lifetime:
$$-C_1 + R_2 + R_3 + R_4 + ... + R_{20}$$

NPV of the project is equal to where r=the bank rate of interest:
$$\frac{-C_1}{(1+r)} + \frac{R_2}{(1+r)^2} + \frac{R_3}{(1+r)^3} + \frac{R_4}{(1+r)^4} + ... + \frac{R_{20}}{(1+r)^{20}}$$

If the NPV of the cash flows is greater than 0, the project is profitable since it pays out at a rate of return higher than the bank rate of interest, i.e. you are making more than what you need to pay off the bank for a loan of $-C_1$.

Say we assume that r=6% and the NPV=200. If r increases to 6.05%, the NPV decreases to 175. If we increase r further to 6.38% and the NPV=0, we know that the r=6.38% is the internal rate of return, the breakeven interest rate for the project.

The bank rate of interest= $r_{real} + r_{inflation}$

The Marginal Rate of Return to Education:

Borjas paper: In this paper, Borjas tried to estimate the percentage change in wages from one more year of education.
To make this calculation, we focus on earnings at a specific age rather than a lifetime earnings profile. For example, the wage at age 30:

$$wage_{30,i} = \alpha_0 + \beta_0 (yrsofschooling)_i$$

In the 1970s, the return to each additional year of school was estimated at 7%. In the 1990s, 9%.

What if we adopted a one year policy intervention for people between the ages of 17 and 25? What about interventions at other ages such as very young children? Are the results very different?

Early Childhood Intervention:

Theory:
1. *Children have more plastic brains*. Their brains more easily form and reform neural networks than older people can. In other words, their neurons are more flexible and they have very few old neural networks to disrupt when learning
   Experiments on animals corroborate the theory:

-Observations of monkeys developing at various ages with and without maternal contact show very different behavioral outcomes.
-The damaged eye experiment
-Language development: Infants are capable of learning any language or even more than one while older people have a harder time mastering a language when they start learning it before infancy. However, evidence of the difficulty of learning certain language pairs together is not discussed.

2. *Learning is cumulative.* Cognitive and social skills at age X affect a person's ability to learn at age X+1.
Social skills affect learning because learning is often not done alone. It requires collaboration, interaction, dealing with frustration, and disruptions.

Testing the theory:
The data available is:
1) Test scores at 22 months
2) Test scores at 42 months
3) Test scores at 5 years
4) Test scores at 10 years
5) Record of educational attainment at age 26
6) Socioeconomic status of the parents (SES)

Test scores at 42 months should do a good job of predicting 5 year test scores, 10 year test scores, and educational attainment at age 26.

Test scores at 22 months should do a poorer job than test scores at 42 months of predicting because a child's brain is more plastic at 22 months and has more potential to change. However, a relationship still exists between test scores at 22 months and test scores at older ages.

Suppose low test scores at 42 months do a good job of predicting low educational attainment.
How do we explain this?

Knudsen, et al. argue:
Cognitive ability at 42 months is a function of experience and genetic differences. Experience encompasses all parent-child interactions language interaction, whether a parent reads to the child, whether the parent allows the child to ask questions. Experience is found to vary by socioeconomic status.

Therefore, low cognitive ability at 42 months can be explained by low quality of parental interaction with a child. It is safe to assume that it will continue to be of low quality in the future. Because socioeconomic status plays a role in child-parent interaction, socioeconomic status plays a role in cognitive ability development.

In the data, we need independent variation so we can separate the effects of the parent's socioeconomic status and test scores on educational attainment at age 26.

$$(Educational Attainment)_{26,i} = \alpha_0 + \beta_1(SES)_i + \beta_2(testscore)_{42,i} + \varepsilon_i$$

If our data only includes people with high test scores and high socioeconomic status or people with low test scores and low socioeconomic status then we have a case of multi-colinearity, where the independent variables are highly correlated.

How do we test the data?

At 22 months, the cognitive ability tests include cube stacking, language use, personal development I and II, drawing, gross motor development.

At 10 years, the tests include reading, math, picture/language, and the British Ability Scale.

These tests are only useful if we can compare earlier tests to subsequent tests so the tests at different ages must be boiled down into principal components to transform the variables.

Principal components:

$$F_{1,i} = a_1 CS_i + a_2 LU_i$$
$$F_{2,i} = b_1 CS_i + b_2 LU_i$$

Where both equations are weighted averages of the various tests. F1, F2 are a new set of axes for the testing data. F1 picks up most of the variation.

In sum, we use principal components to transform the many data points available for each child at each single testing date into one data point which ranks the children by percentile score. Then, we can compare the percentiles that individual children fall in across different years.