

ECONOMICS OF EDUCATION

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Education production functions

How resources (inputs) can be transformed into
outputs?

Output = f (inputs)

What is output?

- Wage levels?
- Employment probabilities?
- Job satisfaction?
- Technical ability?
- Creativity?
- Basic skills?
- Attitudes?

- Test scores?
- Graduation rates?

- College attendance?
- Multiple outputs?

- Most studies use test scores.
- We have data for test scores.
- To use things that are measured while students are in school.

Test scores can be used different ways:

- levels: $A_{it} = X'_{it} \beta + u_{it}$
- gains: $A_{it} - A_{it-1} = X'_{it} \gamma + v_{it}$
- new level conditional on old level: $A_{it} = \alpha A_{it-1} + X'_{it} \gamma + \epsilon_{it}$

What are inputs?

- School inputs (manipulable)
- Non-school (not manipulable) inputs

School inputs (manipulable)

- expenditures
- student-teacher ratio
- class size
- teacher quality,
- peers,
- other school inputs

How can we measure teacher quality?

- Salaries?
- Experience?
- Teachers' test scores?

- Teaching methods?
- A good teacher would be one who consistently obtained high learning growth from students, while a poor teacher would be one who consistently produced low learning growth – teacher fixed effect models (control for all possible characteristics of teachers – even without measuring them – so long as those characteristics do not change over time).

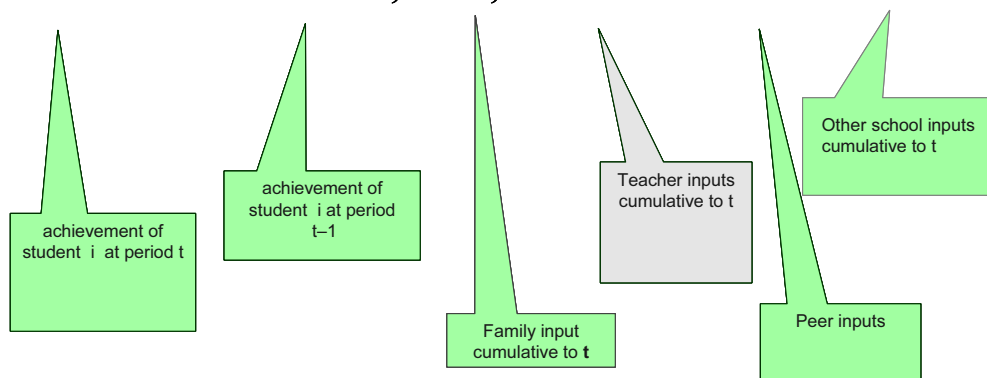
What is $f(\cdot)$?

- Linear?
- Non-linear?
- With interaction?

Education production function

(output conditional on old output)

$$A_{it} = f(A_{it-1}, F_{it}, TA_{it}, P_{it}, ISK_{it})$$



Measurement problems – a lot

- Endogeneity of school quality – is school quality positively correlated with wealth and social advantage? Are greater resources allocated to poorer areas?
- Omitted variables problem (e.g. teachers' motivation, parents' help, ability of children)
- Test measurement errors

Results of early education production functions

Estimated expenditure parameter coefficients from 147 studies of educational production functions (US)

Input	Number of studies	Statistically significant		Statistically insignificant		
		+	-	+	-	Unknown sign
Teacher/pupil ratio	152	14	13	34	46	45
Teacher education	113	8	5	31	32	37
Teacher experience	140	40	10	44	31	15
Teacher salaries	69	11	4	16	14	24
Expenditure/pupil	65	13	3	25	13	11

Source: Hanushek, E. A.: Education Production Functions. 1995

Estimated expenditure parameter coefficients of educational production functions for developing countries

Input	Number of studies	Statistically significant		Statistically insignificant
		+	-	
Teacher/pupil ratio	30	8	8	14
Teacher education	63	35	2	26
Teacher experience	46	16	2	28
Teacher salaries	13	4	2	7
Expenditure/ pupil	12	6	0	6

Source: Hanushek, E. A.: Education Production Functions. 1995

Recent results

- Use of large administrative datasets, panel data
 - Class size effects – mixed results
 - Teacher effects
- teachers matter in terms of student performance
- the differences are not closely correlated with measured teacher characteristics
- (Rivkin, Hanushek, Kain 2005; Rockoff, 2004; Nye–Konstantopoulos–Hedges, 2004; Rivkin–Hanushek–Kain, 2005; Aaronson–Barrow–Sander, 2007; Kane–Staiger, 2008; Slater–Davies–Burgess, 2009)