

EE468: Integrated Public Economics, Development and Political Economics

Lecture 6: Education

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Outline

- The current stage of education, development and poverty
- A simple model of education investment, estimate return to education
- Learning from existing education interventions and implications

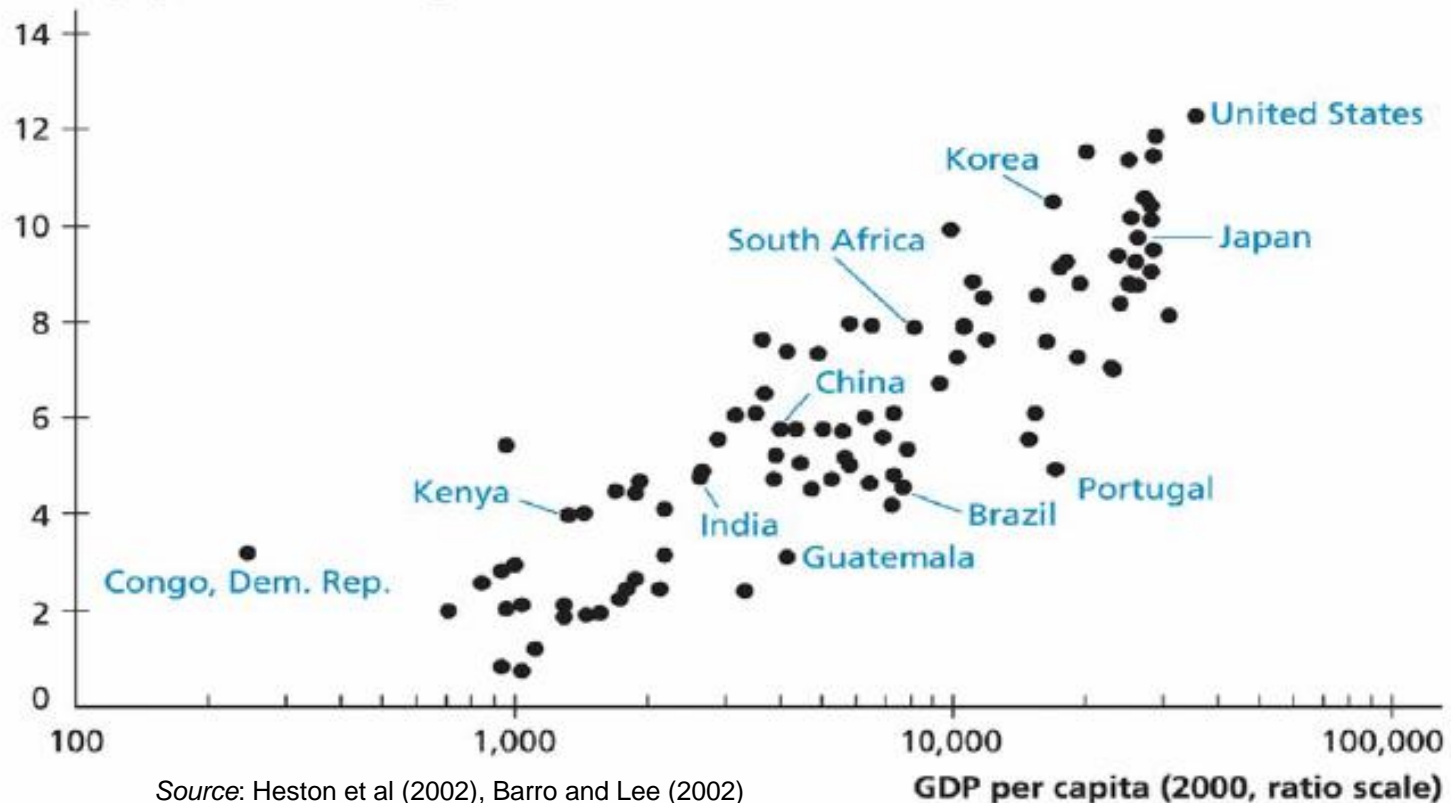
Motivating evidence and policy questions

- **Improvements in education are key to development**
 - Values on productivity/income and interaction with health/nutrition and other dimensions of development
 - Dynamic implications, intergenerational and could reinforce poverty trap
- **Enormous disparities in educational outcomes across and within countries**
 - Progress in primary school enrolment worldwide due to (MDG driven) supply-side interventions, BUT low and varying progress for outcomes
 - Education quality is consistently low with large variations in poor countries
 - Varying evidence of expected and disparities in return to education
- **Key policy questions**
 - How to explain low investment in education and disparities in outcomes?
 - Is education really worthwhile? How to rigorously estimate return to edu?
 - What can we learn from existing education intervention? What can be done to improve the next generation of education policy?

Education and economic development

- **Interaction between education and economic development ambiguous:**
- Education increases productivity, has positive effect on income and society
 - Higher income can allow more investment in quantity/quality of education

Average years of schooling, 2000

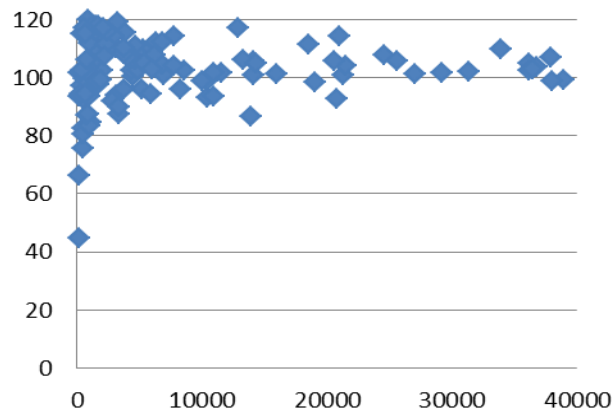


Source: Heston et al (2002), Barro and Lee (2002)

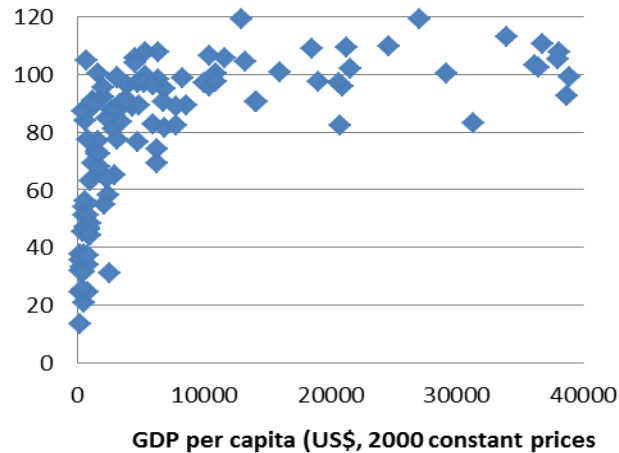
Cross countries disparities in enrolment and completion

- Enrolment do not imply completion. But both are highly correlated with income

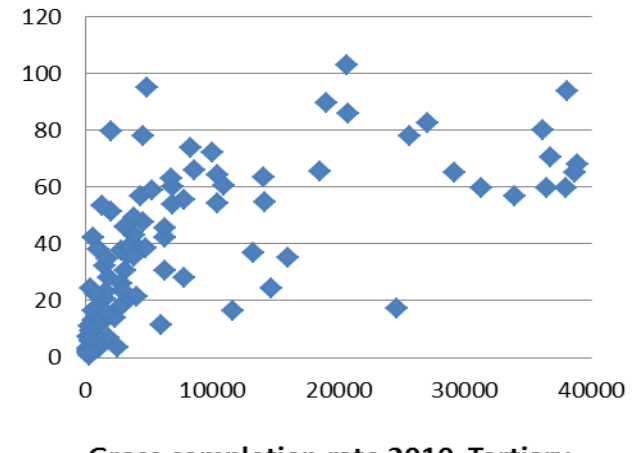
Gross enrolment rate 2010, Primary



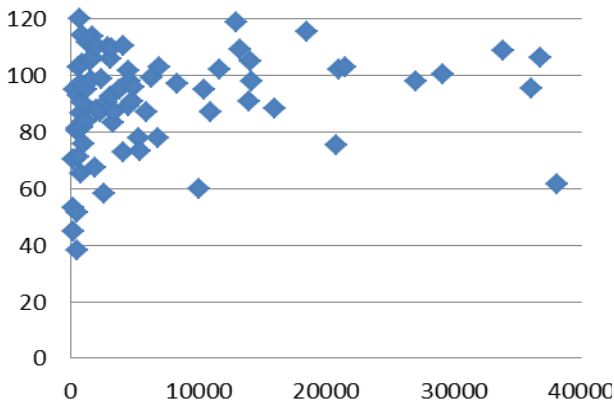
Gross enrolment 2010, Secondary



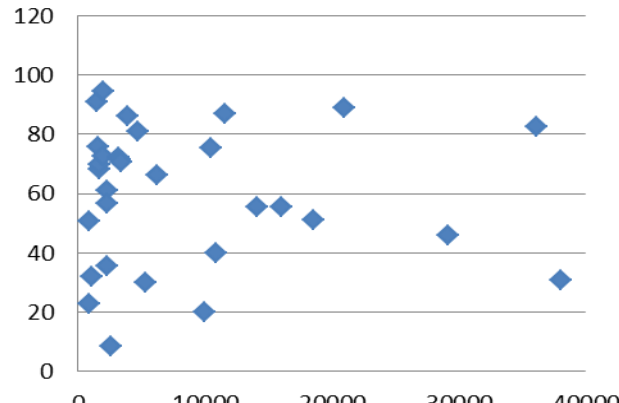
Gross enrolment rate 2010, Tertiary



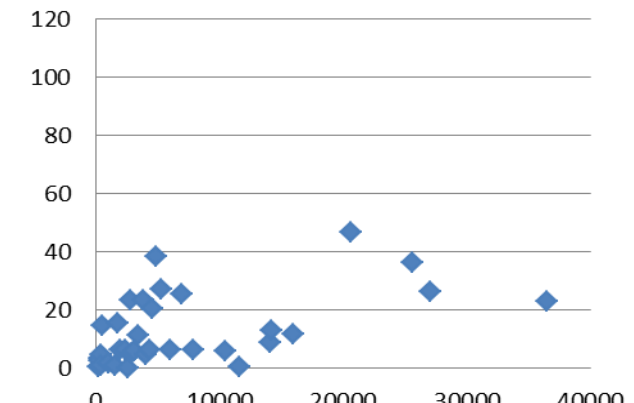
Gross completion rate 2010, Primary



GDP per capita (US\$, 2000 constant prices)



Gross completion rate 2010, Tertiary



GDP per capita (US\$, 2000 constant prices)

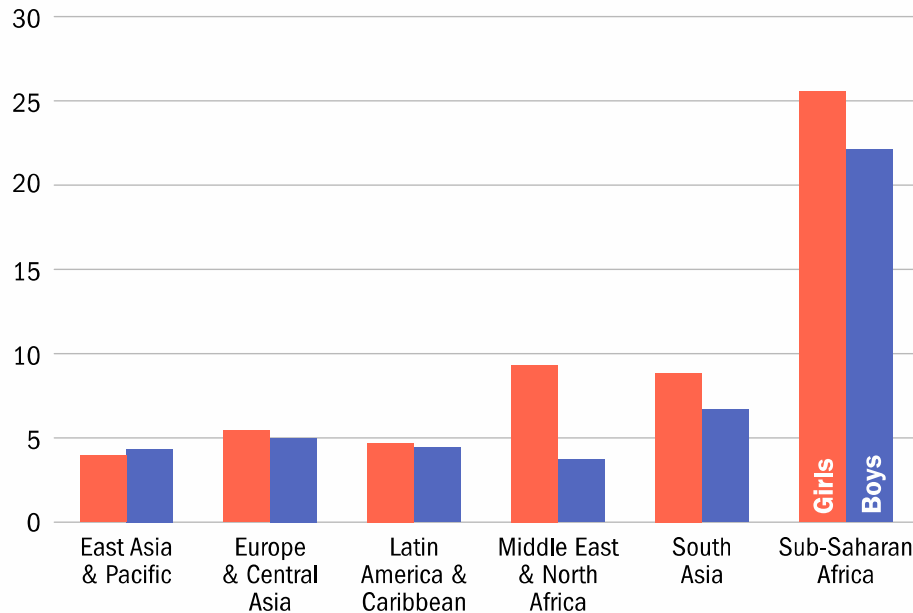
GDP per capita (US\$, 2000 constant prices)

GDP per capita (US\$, 2000 constant prices)

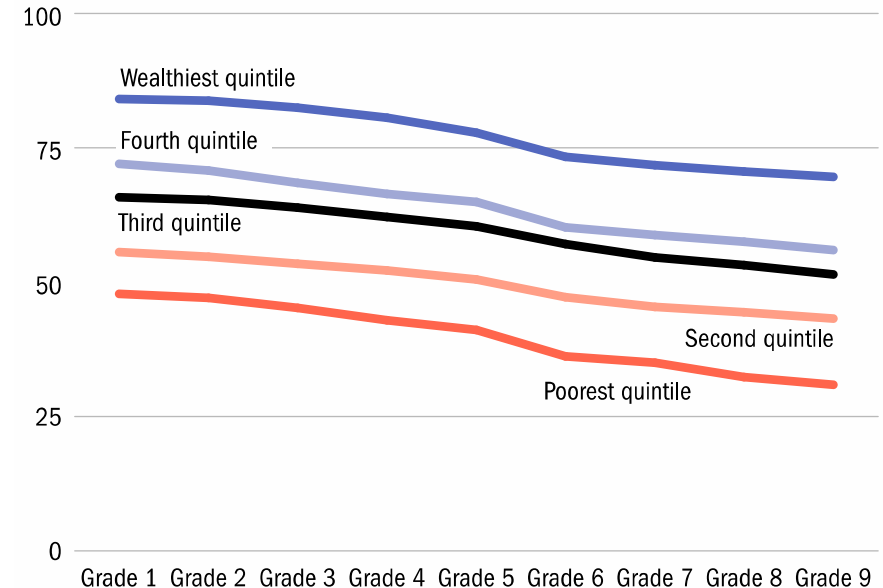
Disparities of outcomes across gender and income groups

- More girls than boys remain out of school in most regions
- Poor households are less likely to complete school at all level relative to the rich households → inequality in income is closely linked with inequality in educational outcomes!

Children not attending primary school, 2010
(% of relevant age group)

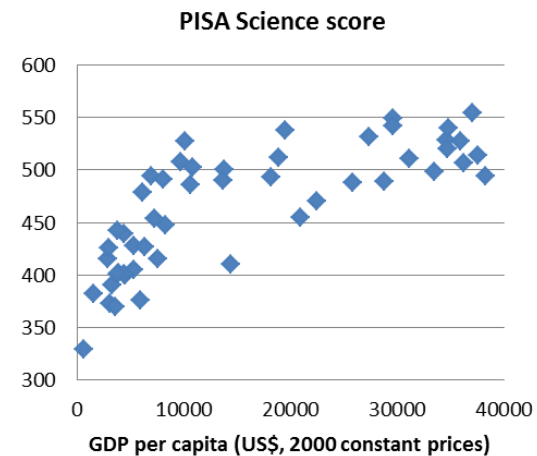
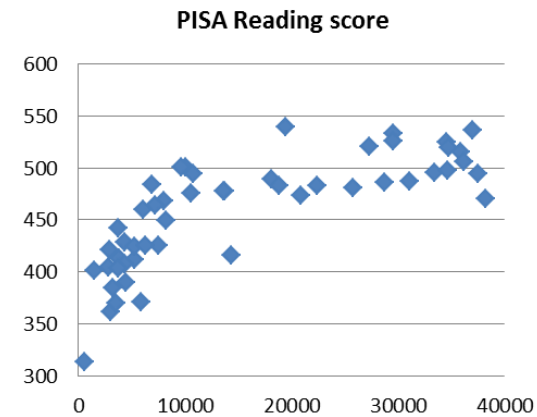
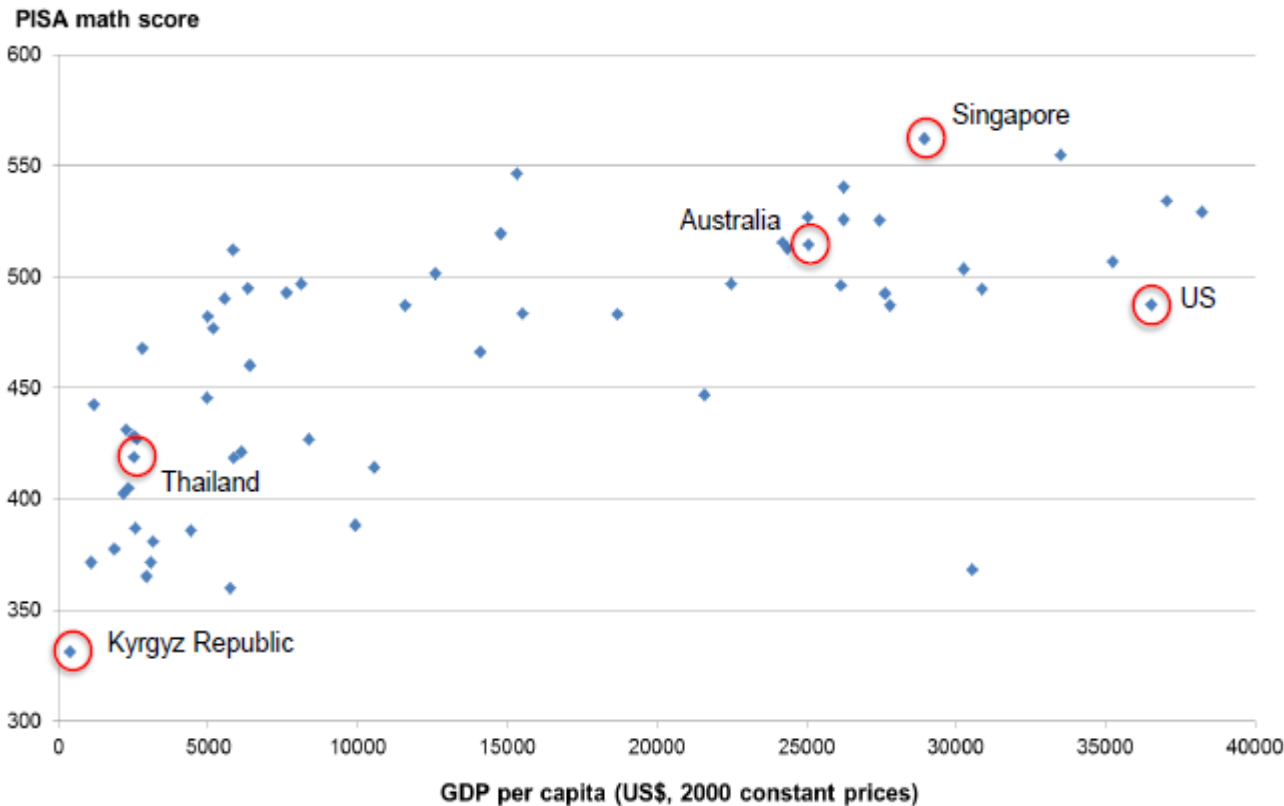


Share of people ages 10–19 completing each grade of schooling, by wealth quintile, 2010 (%)



Disparities in edu outcomes signal differences in quality

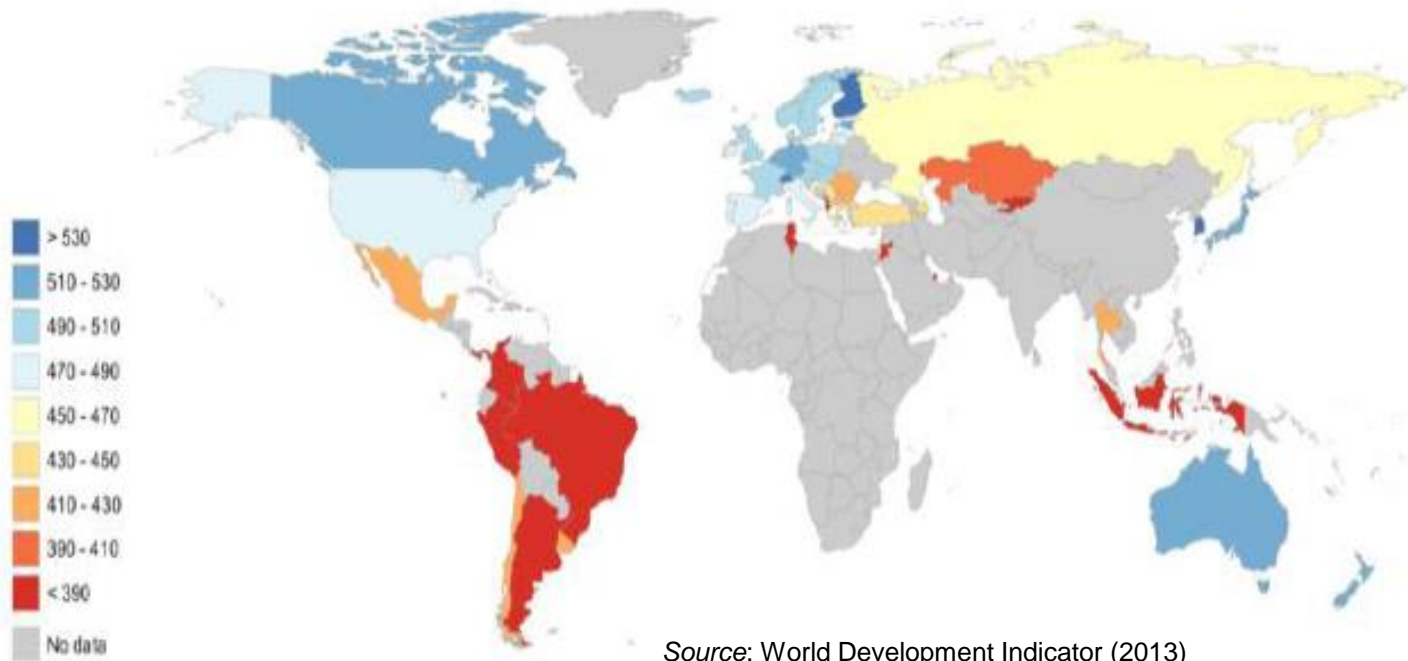
- PISA test scores for 15 year old students in 2009 provide strong evidence for all learning outcomes



Source: World Development Indicator (2013)

Disparities in edu outcomes signal differences in quality

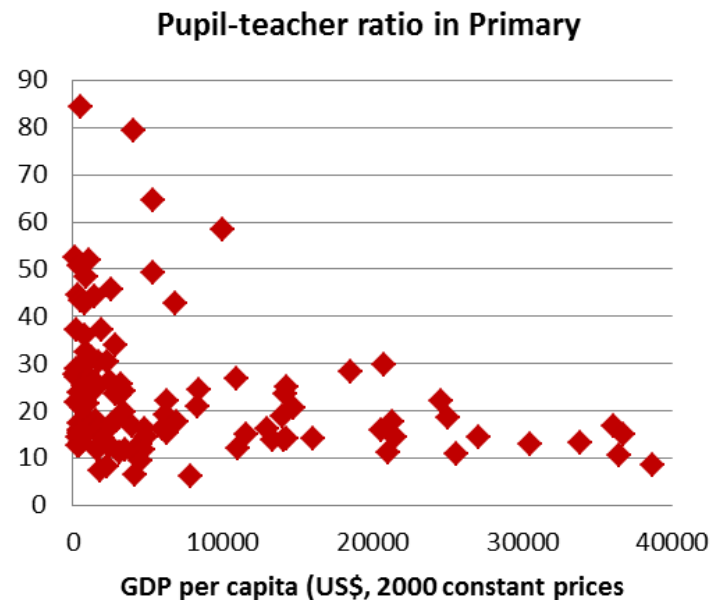
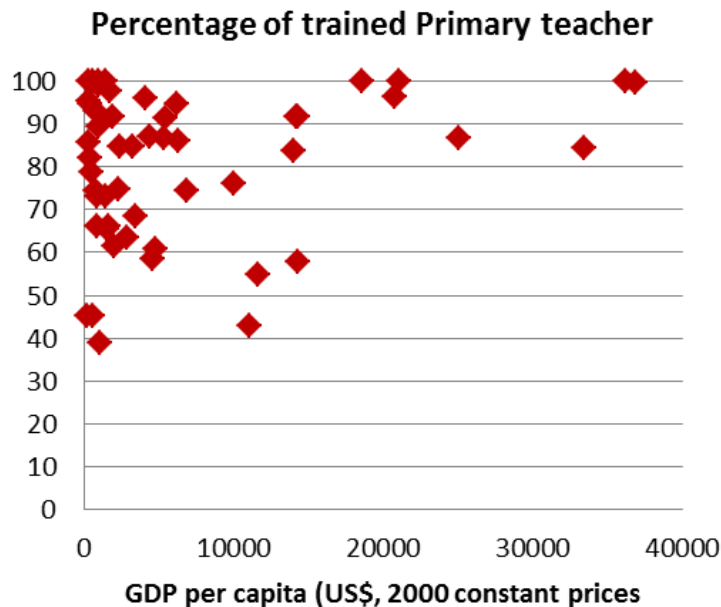
- Large disparities in PISA Math scores across countries



- ASER survey in India also found about 35% of children aged 7-14 years could not read grade 1 paragraph, 60% cannot read grade 2 story! And there is no progress since 2005...
- Similar results in Kenya, Pakistan and Uganda

Education quality is low and varying in the poor countries

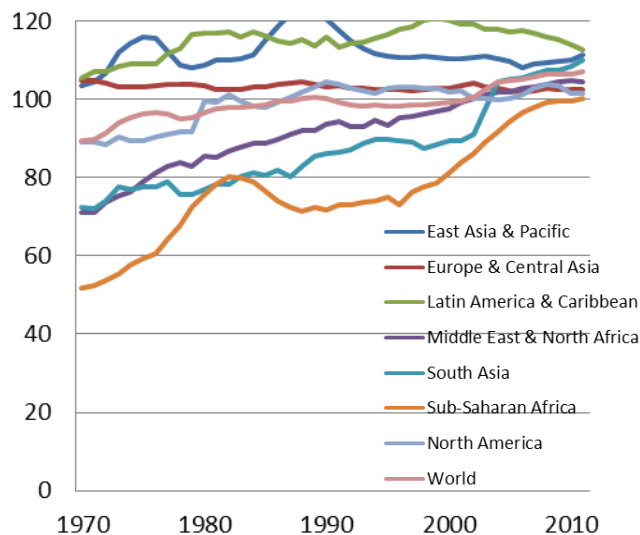
- Shortages of trained teachers, large class sizes and lack of infrastructures are common supply-side problems depressing edu quality
- Disparities in education quality are large across and within countries ...this potentially explain existing disparities in educational outcomes



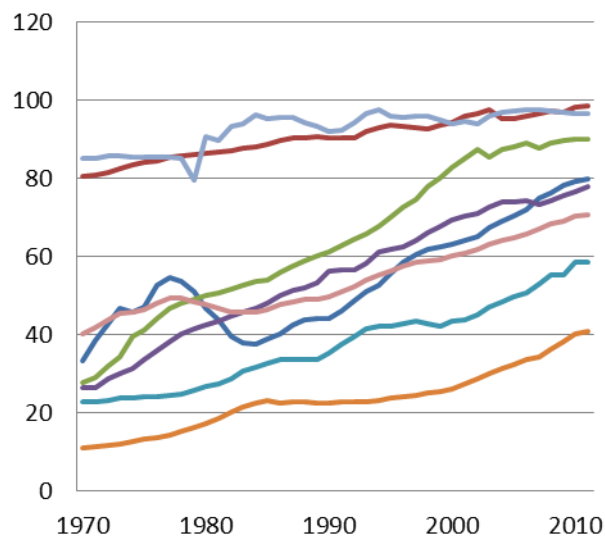
Progress in getting children to schools

- Good progress in primary school enrollment worldwide due to (MDG driven) supply-side interventions
- Smaller but quite steady improvement for higher levels
- Still large disparities across regions, with south Asia and Africa lagging behind
- How to explain these disparities in education investment?

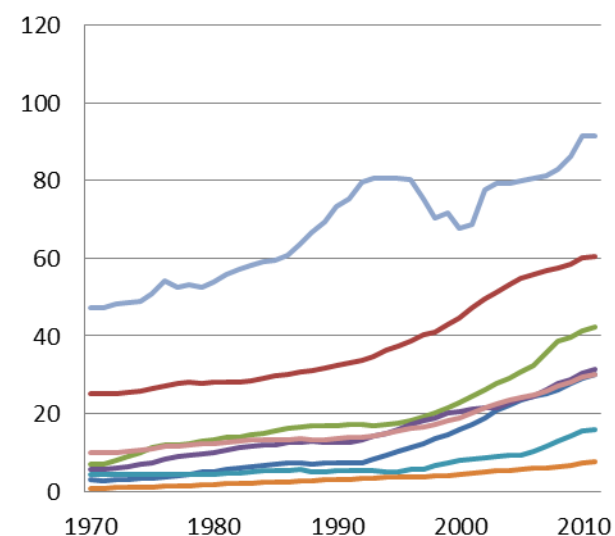
Gross enrolment rate, Primary



Gross enrolment rate, Secondary



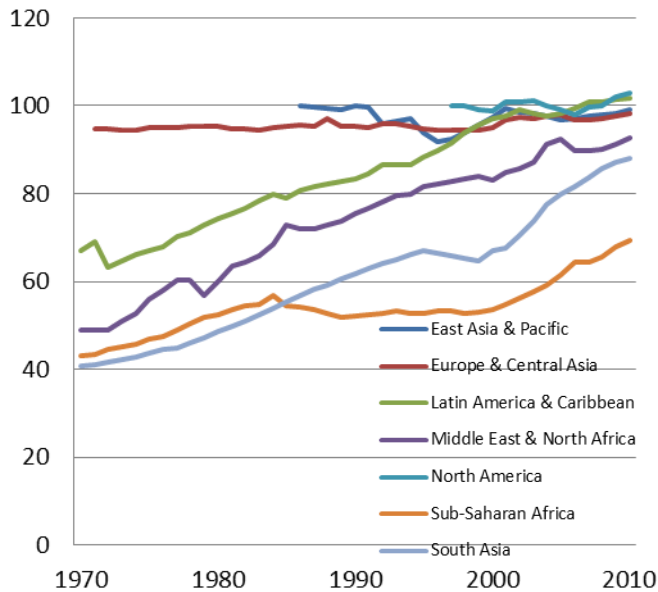
Gross enrolment rate, Tertiary



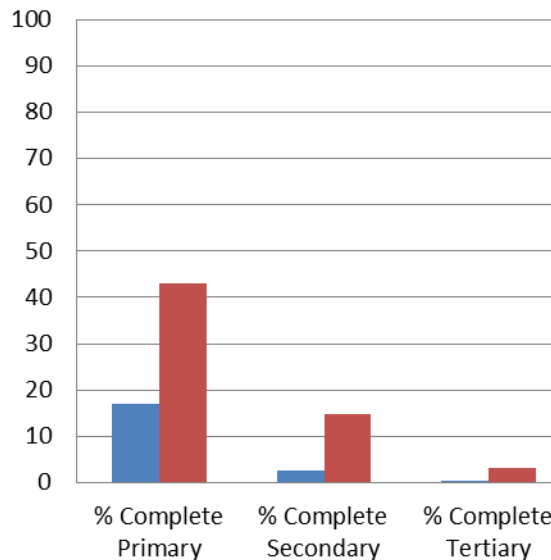
Progress in improving school completion

- Despite success in primary school enrolment, improving primary completion rates are still slow in some regions especially in Africa and south Asia
- Low progress in completion rates of higher education in developing countries
- Would these varying outcomes result from differences in education quality?

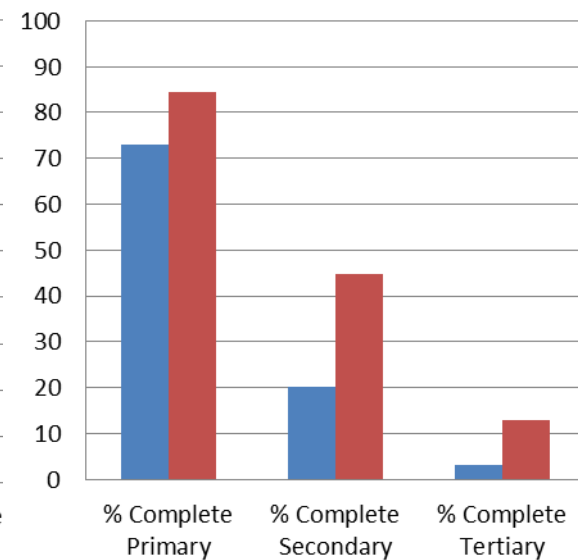
Primary school completion rate



Developing countries



Developed countries



Education, human capital and development

- **Education is the main component in human capital**
 - Knowledge, skills, on the job experience, ability to learn others
 - Cognitive vs. non-cognitive capacity
 - Increase productivity and capacity for technology

- **Positive externalities of education to other measures of human capital**
 - Impacts of education investment in health and nutrition
 - Effects of health/nutrition on school participation and cognitive development
 - So empirical analysis difficult due to endogenous relationship between health, nutrition and education

- **Education has important dynamic implications on long-run welfare**
 - Determine future stream of income, investment and return to other assets
 - Initial inequality in income → inequality in education investment and outcomes → persistent poverty and inequality
 - Education is thus important for “vicious cycles” of development

How do we measure education?

➤ **Inputs (a better signal of availability and access)**

- Binary: primary, secondary and higher education: enrolment vs. absentee vs. attainment (e.g., completion)
- Continuous: years of schooling

➤ **Outputs (a better signal of quality of education)**

- Quality of education outcomes
- Test scores

➤ **Unobservables**

- Inherent latent cognitive and non-cognitive abilities
- Recent work in this area focuses on returns to non-cognitive skills (personality traits – OCEAN: Openness, Conscientiousness, Extroversion, Agreeableness, Neuroticism)
- Measurement errors

What are returns to education?

➤ Estimating return to education common based on the Mincer model

$$\ln y_i = \beta_0 + \beta_1 s_i + \beta_2 X_i + \beta_3 X_i^2 + \varepsilon_i$$

where y_i is wage, s_i is years of schooling, X_i is experience

➤ But many problems

- Endogeneity bias (reverse causality, unobserved heterogeneity, omitted variable bias, measurement errors, etc.)
- Data quality
- Specification

➤ Would these problems

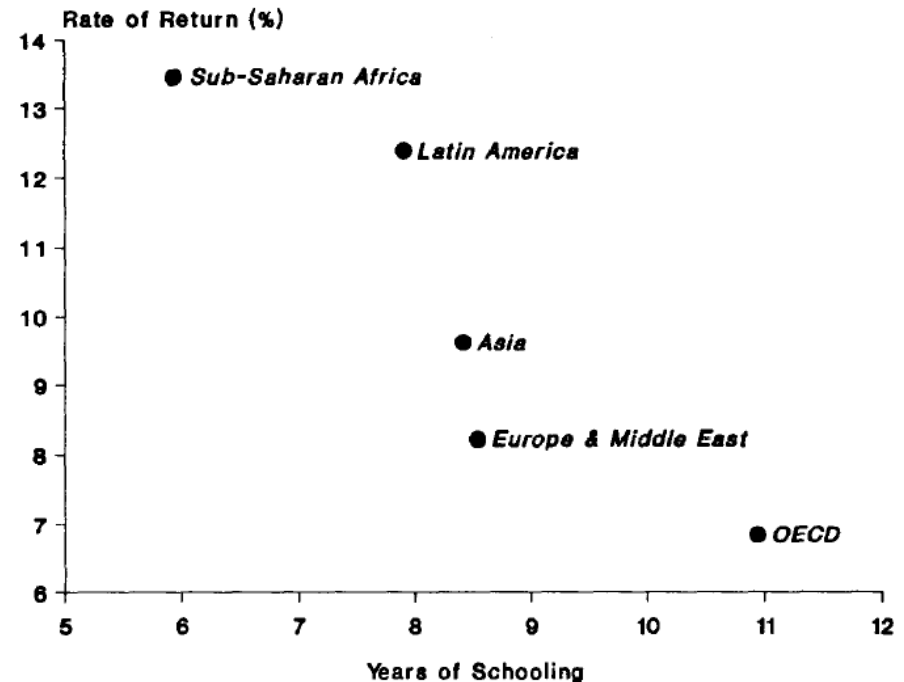
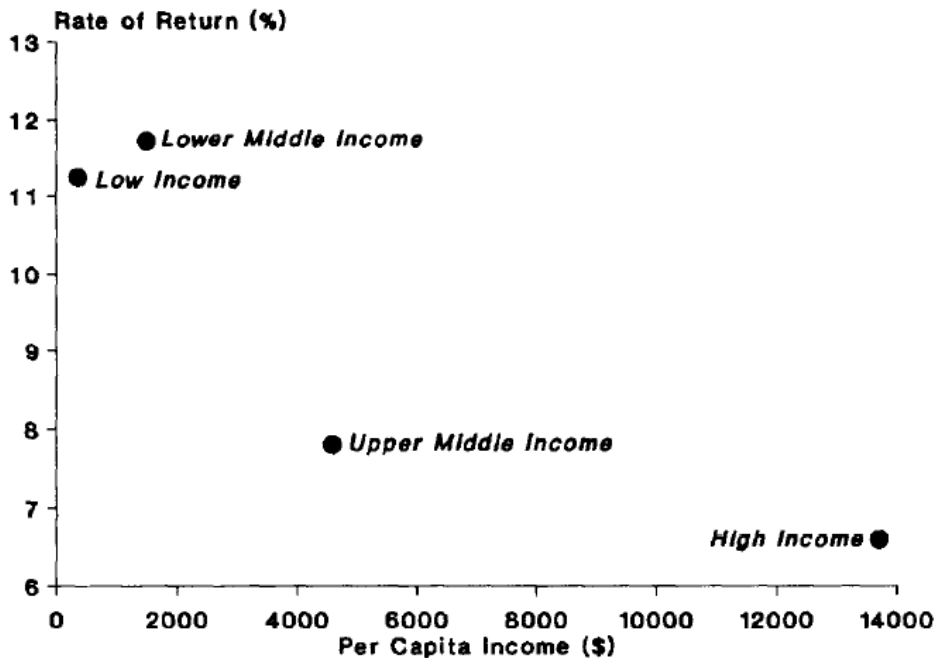
Lead the model to under
or over estimate the
return on education?

Returns to investment in education by level (percentage)

Country	Prim.	Sec.	Higher
Sub-Saharan Africa	41.3	26.6	27.8
Asia*	39.0	18.9	19.9
Europe/Middle East/North Africa*	17.4	15.9	21.7
Latin America/Caribbean	26.2	16.8	19.7
OECD	21.7	12.4	12.3
World	29.1	18.1	20.3

What are returns to education?

- **Psacharopoulos (1994) used Mincer model to estimate returns to education and compare across countries and groups**
 - He found that return to primary school is always the highest
 - Returns tend to decline by level of schooling and countries' per cap income



- To what extent can we trust these estimates?

What are returns to education?

➤ Recent empirical micro literature resolve endogeneity issues by exploiting natural experiments to identify return on education

- Natural experiments are events or interventions that have strong and significant effect on measures of education but are exogenous to the outcome variables (in this case is wage).
- So return to education can be estimated by 2SLS using exposure to the program/event as IV:

$$s_i = \gamma_1 Program_i + \gamma_2 Z_i + \varepsilon_i \quad (1^{st} \text{ stage})$$

$$\ln y_i = \beta_0 + \beta_1 \hat{s}_i + \beta_2 Z_i + \varepsilon_i \quad (2^{nd} \text{ stage})$$

- Ex) Duflo (2001) showed that exposure to large school construction program in Indonesia had strong effect on educational outcomes and affect wage through education. Using exposure to the program as IV, she found that each year of education increase wages by 8% on average
- Overall, they found strong evidence of positive return on education especially for the most disadvantaged groups. Yet, the estimated returns generally smaller than Mincer regression results!

Household's investment in education

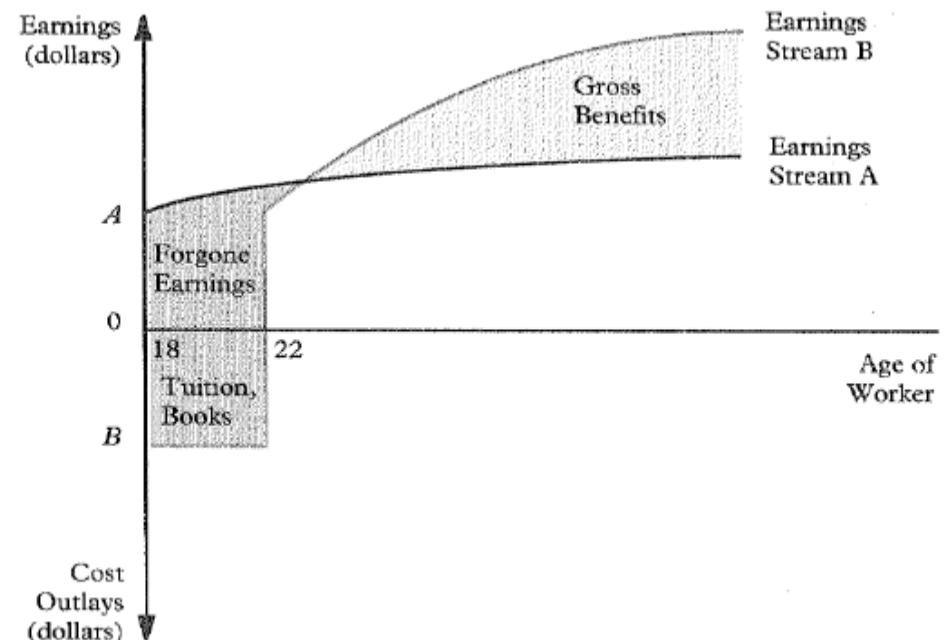
➤ Cost of education: parents incur cost of education today including

- Direct cost: tuition, uniform, transportation, etc.
- Opportunity cost: income foregone, e.g., child labor

➤ Benefit of education: is to be realised in the future

- Monetary: increasing the child's productivity and stream of future earnings
- Non-monetary: intrinsic (e.g., increase self satisfactory, etc.) and externalities through interactions with health/nutrition
- Social vs. private returns

➤ Optimal schooling choices (whether to go and stay in school) will have to take into account these intertemporal costs and benefits



A simple model of educational investment

- Parents make schooling investment decision for their child. Their utility depends on the future earnings of the child when he/she grows up y discounted at the rate δ and the child's schooling s : (how to make sense of this utility function?)

$$u(y, s) = \frac{1}{\delta} \ln(y) - h(s)$$

- Assuming that schooling only yield monetary benefit such that the future earning of the educated child follows:

$$\ln(y) = a + bs$$

where b is economic return to schooling (i.e., earning will increase by $b\%$ for extra year of schooling). Does linear return make sense? What if return is non-linear, e.g., s-shape similar to capacity curve?

- The cost (both direct/opp.cost) of extra year of schooling include constant unit cost r and extra cost increasing with s (is this convex cost assumption realistic?)

$$h'(s) = r + \theta s$$

A simple model of educational investment

- The parents' schooling decision can thus be obtained from

$$\max_s u(y, s) = \frac{1}{\delta} (a + bs) - h(s)$$

- The optimal schooling decision is thus

$$s^* = \frac{b - \delta r}{\delta \theta}$$

As expected, the optimal schooling will increase

- The higher the expected return to schooling b
 - The lower the discount rate δ
 - The lower the direct and opportunity cost of schooling r, θ
- Based on this simple, unconstrained model, parents' schooling decision will depend on the determinants of b, δ, r, θ

What determine returns to education?

➤ The market

- Demand and supply of educated labor determine market wage for the educated child
- How will return to education differ for boys and girls, urban and rural, rich and poor?

➤ The quality of education

- Resources: available trained teachers, textbooks, teaching facilities
- Curriculum and teaching methods: focus on learning not passing exams?
- Incentives: teachers, parents, students?

➤ The model simple ignore non-monetary benefit of education

- Intrinsic values, possible externality effect on health/nutrition investment

So if parents are indeed very sensitive to return to education, ensuring on the quality of education, availability of job and their perceived benefit will be critical to increase educational investment

What determine costs of education?

➤ **Direct costs**

- Tuition fees, books, uniforms, etc.
- Transportations (are there schools in the neighborhood?)

➤ **Opportunity costs**

- Income foregone, e.g., working as child labor
- Opportunity cost will be especially high among credit constrained households and when child labor is needed to cope with shocks

➤ **Ability to attend school**

- Is the child healthy enough to be able to go to school?

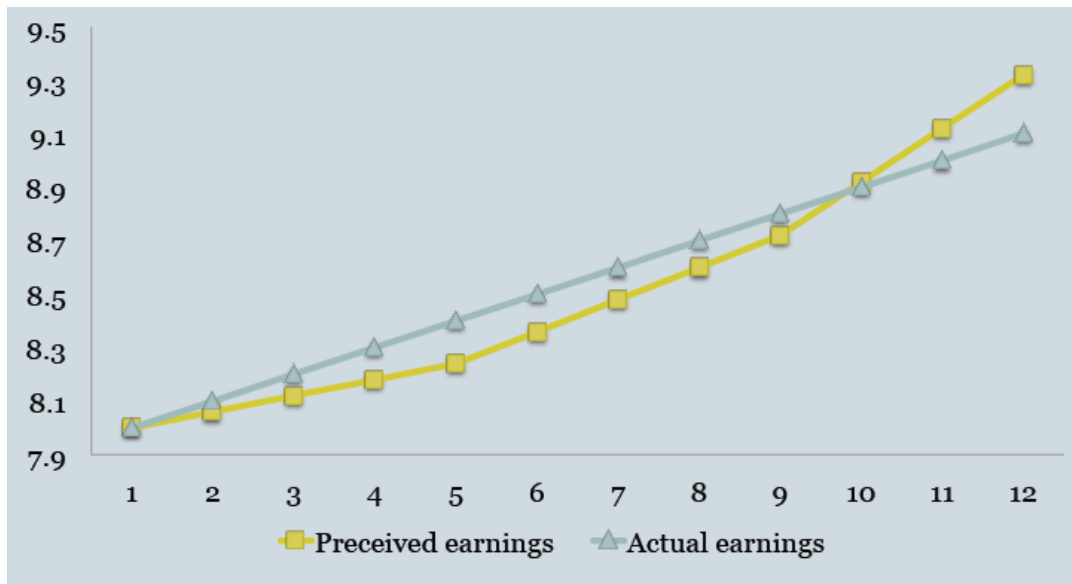
What determine households' discount rate?

➤ **Poor households tend to discount future extensively**

- Credit constrained, need to meet subsistent consumption

What happen if parents misperceive return to education?

- Literature show that returns to education appear to be linear (in $\ln y$)
 - Linear return \rightarrow there is positive return at all level of education
- What happen if parents perceive non-linear return (e.g., have 'elite bias' and so tend to underestimate return to lower level of education and overestimate return to higher level)?



Ex) Nguyen (2008) found this 'elite bias' perception in an experiment in Madagascar. On average, parents believed that returns are 6% for each year of primary school, 12% for secondary and 20% for tertiary

Educational investment with increasing return

- Non-linear return could be in the form of s-shape with locally increasing return to education. Let's consider a simple case (where $d > b$):

$$\ln(y) = \begin{cases} a + ds & \text{if } s \geq \bar{s} \\ a & \text{if } s < \bar{s} \end{cases}$$

- The optimal schooling investment is now

$$s^* = \begin{cases} \frac{d - \delta r}{\delta \theta} & \text{if } s^* \geq \bar{s} \\ 0 & \text{if } s^* < \bar{s} \end{cases}$$

with (actual or perceived) non-linear return, parents will not invest in education if they do not expect to be able to obtain higher education

- Increasing cost of education could have big disincentive effect on investment with increasing return comparing to the linear return case! How about interventions that reduce costs and/or increase benefit of schooling?
- Could s-shape return be illusive or real?
 - Is there benefit to primary schooling? Do children need to achieve higher education to realise high return? → so far no empirical evidence on this!

Educational investment with credit constraint

- Suppose that parents cannot afford to pay more than $h(s) = \bar{H}$
- Under linear return: $\ln(y) = a + bs$, the optimal schooling investment will be

$$s^* = \begin{cases} \frac{b - \delta r}{\delta \theta} & \text{if } h(s^*) \leq \bar{H} \\ s^{**} \text{ where } h(s^{**}) = \bar{H} & \text{if } h(s^*) > \bar{H} \end{cases}$$

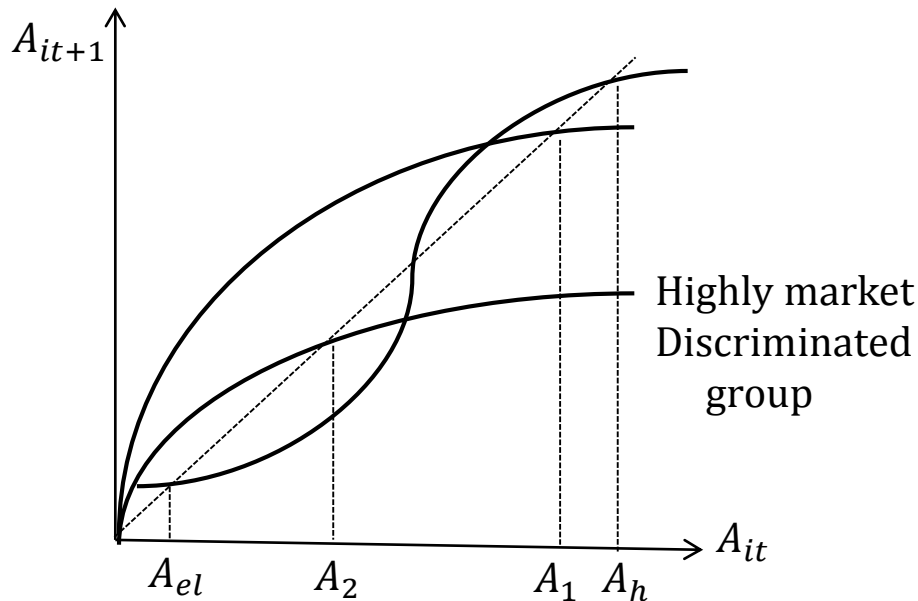
As long as benefit outweigh cost, constrained parents will under invest in edu

- Under increasing return: $\ln(y) = \begin{cases} a + ds & \text{if } s \geq \bar{s} \\ a & \text{if } s < \bar{s} \end{cases}$, and if $s^* \geq \bar{s}$

$$s^* = \begin{cases} \frac{d - \delta r}{\delta \theta} & \text{if } h(s^*) \leq \bar{H} \\ s^{**} \text{ where } h(s^{**}) = \bar{H} & \text{if } s^{**} \geq \bar{s} \text{ but } h(s^*) > \bar{H} \text{ and } ds^{**} > \bar{H} \\ 0 & \text{otherwise} \end{cases}$$

When high optimal edu investment exists under locally increasing return setting, constrained households who cannot afford to invest at the optimal level will not invest (substantially underinvest) in education ... multiple equilibria emerge!

Educational investment and poverty trap



Single convergence poverty trap

- Some groups with low return to education at all level due to market discrimination, etc. (what else?)

Multiple equilibria poverty trap

- Result from a combination of 1) feedback effect of education and income, 2) increasing return to education, 3) imperfect market

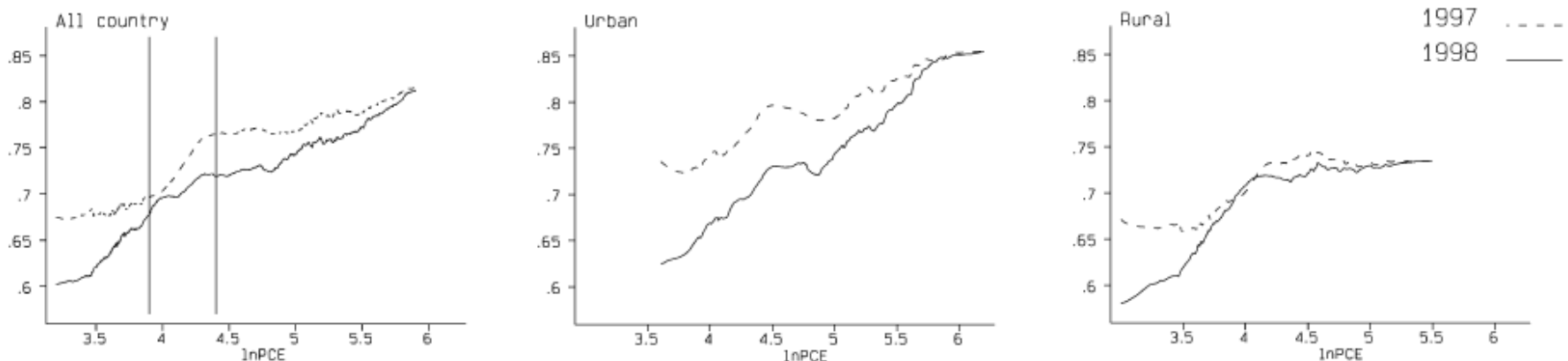
- Multiple equilibria \rightarrow persistent poverty and inequality are associated with disparities in educational investment
 - Wealthy households can invest in education, hence retain high and income
 - Poor households are unable to invest, hence unable to increase income to move out of poverty
- Multiple equilibria \rightarrow long-term impacts of shocks

Educational investment and shocks

Shocks can increase opportunity cost of educational investment and so affect education investment in two ways

- **First, shocks can directly force households to reduce expenditures**
 - In Indonesia, Thomas et al. (2004) found that investment in education declined after the 1997 financial crisis especially among the poorest

School Enrollments by per Capita Expenditure (Before/After 1997 FN Crisis)



Source: IFLS2/2+
Per capita expenditure (PCE) measured in 1997

Source: Thomas et al (2004)

Educational investment and shocks

➤ **Second, child labor are often used as coping strategies for uninsured hhs**

- In Tanzania, Beegle and Gatti (2006) found that child labor were used as buffer against unexpected crop loss among agricultural households

$$y_{ijt} = \beta_0 + \beta_1 X_{ijt} + \beta_2 shock_{ijt} + \beta_3 (shock_{ijt} \times assets_{ijt}) + \beta_4 assets_{ijt} + \varepsilon_{ijt}$$

Hours worked, income shocks, and assets

Dependent variable	(1) Hours worked	(6) Hours worked
Specification	FE	FE with cluster-time dummies
Sample restriction: land acres		1–25.5
Shock: any crop loss	6.08** (2.87)	7.50** (3.56)
Log per capita land value	0.47* (0.27)	0.87** (0.35)
Shock x log per capita assets	–0.47* (0.28)	–0.61* (0.35)
Per capita land value		0.02*** (0.01)
Shock/10 x per capita land value		–0.06 (0.23)
Mother dead		–0.36 (0.86)
Father dead		0.63 (0.89)
Observations	5591	4706
R-squared	0.38	0.42

- Availability of asset helped decrease the impact on child labor. So the poor with less asset would tend to use more child labor as buffer to shock
- Literature also found that in the face of risk (expected shocks), poor households with no access to effective insurance also tend to use child labor as income diversification against shocks

What interventions could work?

	Demand-side interventions	Supply-side interventions
Enhance return to education	<ul style="list-style-type: none"> - Create more jobs - Fix parents' elite bias perception: disseminate credible statistics of return? 	<ul style="list-style-type: none"> - Increase edu quality through resources (trained teachers, facilities, technology), focusing more on how students learn, fixing incentives
Reduce cost of education	<ul style="list-style-type: none"> - Reduce direct costs (tuition, uniforms, textbooks) - Financial incentives to off set opportunity costs (CCT, school meals) - Ensure available credit and insurance market to reduce impacts of shocks - Health/ nutrition programs to improve attendance 	<ul style="list-style-type: none"> - Make more schools available in rural remote areas and improve infrastructure (reduce transportation and related costs)
Credit constraints	<ul style="list-style-type: none"> - Make educational loan available to the poor? 	<ul style="list-style-type: none"> - Improve quality of public schools

Ex1) Are supply-driven education expansion useful?

- **Large scaled supply driven policies, e.g., making schools available, making school compulsory have been popular in many countries**
 - Free education in many African and Asian countries
 - Right to education in India
- **These have led to substantial increase primary school enrolment between 1999-2006**
 - From 54% to 70% in Africa and 75% to 88% in East and South Asia
 - Worldwide, the number of out-of-school children fell from 103 mill in 1999 to 73 mill in 2006
- **Are these (expensive) program worthwhile?**

For: since the programs reduce cost of schooling, these should at least get people to go to school

Against: these programs are useless as long as education quality are still poor. Over time parents will stop sending their kids to school even though it's free!

Ex1) Are supply-driven education expansion useful?

- **Duflo (2001): 62,000 schools were built from oil money in 1974-1978 (the INPRES program)**

TABLE 3—MEANS OF EDUCATION AND LOG(WAGE) BY COHORT AND LEVEL OF PROGRAM CELLS

	Years of education			Log(wages)		
	Level of program in region of birth			Level of program in region of birth		
	High (1)	Low (2)	Difference (3)	High (4)	Low (5)	Difference (6)
<i>Panel A: Experiment of Interest</i>						
Aged 2 to 6 in 1974	8.49 (0.043)	9.76 (0.037)	-1.27 (0.057)	6.61 (0.0078)	6.73 (0.0064)	-0.12 (0.010)
Aged 12 to 17 in 1974	8.02 (0.053)	9.40 (0.042)	-1.39 (0.067)	6.87 (0.0085)	7.02 (0.0069)	-0.15 (0.011)
Difference	0.47 (0.070)	0.36 (0.038)	0.12 (0.089)	-0.26 (0.011)	-0.29 (0.0096)	0.026 (0.015)
<i>Panel B: Control Experiment</i>						
Aged 12 to 17 in 1974	8.02 (0.053)	9.40 (0.042)	-1.39 (0.067)	6.87 (0.0085)	7.02 (0.0069)	-0.15 (0.011)
Aged 18 to 24 in 1974	7.70 (0.059)	9.12 (0.044)	-1.42 (0.072)	6.92 (0.0097)	7.08 (0.0076)	-0.16 (0.012)
Difference	0.32 (0.080)	0.28 (0.061)	0.034 (0.098)	0.056 (0.013)	0.063 (0.010)	0.0070 (0.016)

Ex1) Are supply-driven education expansion useful?

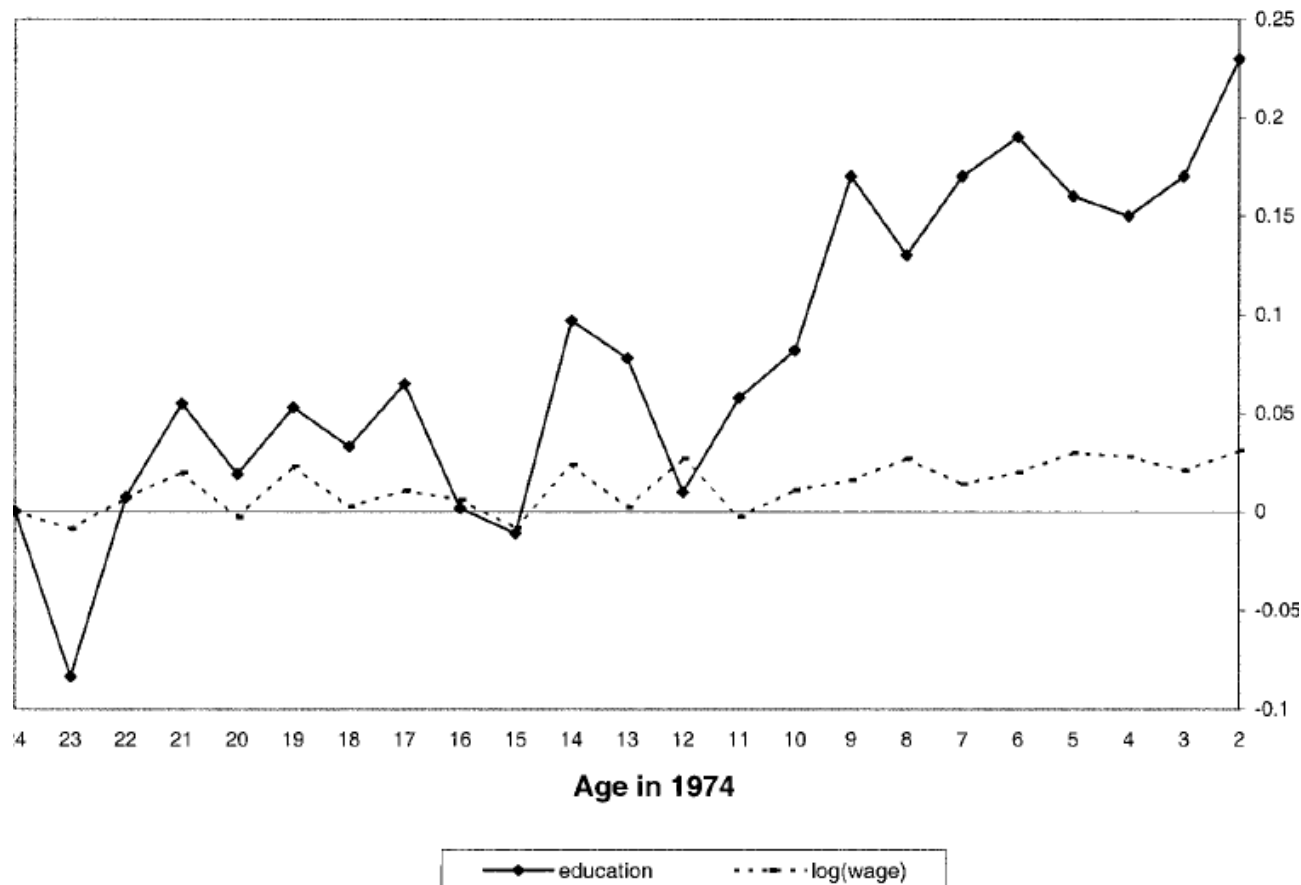
- Each primary school construction per 1,000 children led to an average increase of 0.12-0.19 years of schooling and 1.5-2.7% increase in wage!

TABLE 4—EFFECT OF THE PROGRAM ON EDUCATION AND WAGES: COEFFICIENTS OF THE INTERACTIONS BETWEEN COHORT DUMMIES AND THE NUMBER OF SCHOOLS CONSTRUCTED PER 1,000 CHILDREN IN THE REGION OF BIRTH

	Observations	Dependent variable					
		Years of education			Log(hourly wage)		
		(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A: Experiment of Interest: Individuals Aged 2 to 6 or 12 to 17 in 1974</i>							
<i>(Youngest cohort: Individuals ages 2 to 6 in 1974)</i>							
Whole sample	78,470	0.124 (0.0250)	0.15 (0.0260)	0.188 (0.0289)			
Sample of wage earners	31,061	0.196 (0.0424)	0.199 (0.0429)	0.259 (0.0499)	0.0147 (0.00729)	0.0172 (0.00737)	0.0270 (0.00850)
<i>Panel B: Control Experiment: Individuals Aged 12 to 24 in 1974</i>							
<i>(Youngest cohort: Individuals ages 12 to 17 in 1974)</i>							
Whole sample	78,488	0.0093 (0.0260)	0.0176 (0.0271)	0.0075 (0.0297)			
Sample of wage earners	30,225	0.012 (0.0474)	0.024 (0.0481)	0.079 (0.0555)	0.0031 (0.00798)	0.00399 (0.00809)	0.0144 (0.00915)
<i>Control variables:</i>							
Year of birth*enrollment rate in 1971		No	Yes	Yes	No	Yes	Yes
Year of birth*water and sanitation program		No	No	Yes	No	No	Yes

Ex1) Are supply-driven education expansion useful?

- Since the effects on wage track those of education, the program impact on wage must be through its effect on education → program could be used as IV to estimate return to education....



Ex1) Are supply-driven education expansion useful?

- **Other similar supply-driven interventions also result in positive effects**
 - Taiwan instituted compulsory scheme in 1968 for 9 years of education
 - This led to an increase in schooling of both boys and girls
 - Infant mortality also declined in regions where education increased the fastest due to the reform
 - Nigeria use oil money to build school (similar to Indonesia)
 - This led to a reduction in fertility in regions where schools were built

Ex2) Conditional cash transfer program - PROGRESA

- Large scale social program launched in 1997 in Mexico
 - In 2002 renamed Oportunidades
 - In 2006 about 5 million beneficiary families (25 percent of all families)
 - On average, beneficiary families receive about USD 31 a month
- Long run poverty alleviation through investments in human capital
- Short run poverty alleviation through (conditional) cash transfers
- Intervene in families with young children
 - Focus on education and health
 - Demand-side interventions: Cash transfers given to mothers
 - Supply-side interventions improve availability of schools and health centres
- Benefits are conditional on certain behaviour
 - School attendance and regular check-ups at health clinics
- **Research questions**: How might the program improve edu outcomes?

Ex2) Conditional cash transfer program - PROGRESA

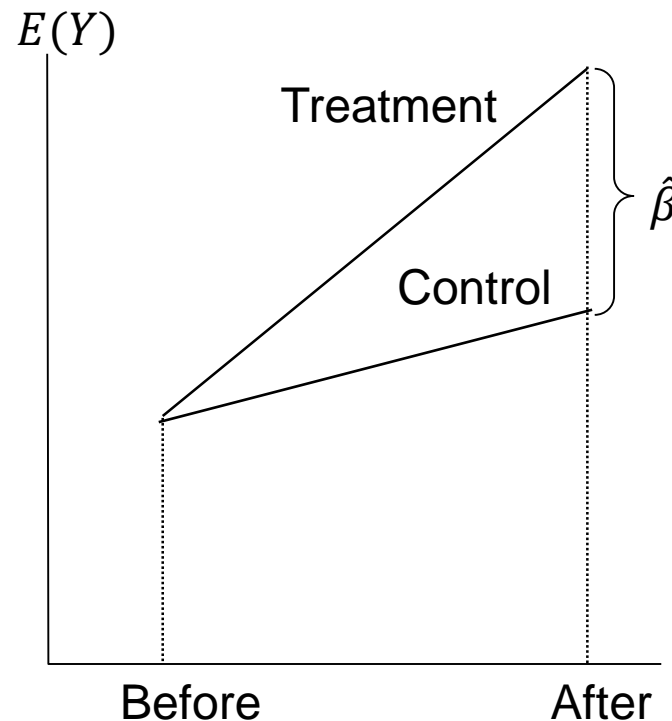
Experimental design

- Evaluation design was incorporated in program design
- Eligible villages selected at random in to different groups, which enter the program at different moments in time
 - Sample of 506 villages with 24,077 Households (78% beneficiaries)
 - 186 control (no PROGRESA) vs. 320 treatment (PROGRESA)
- Two stage selection process
 - Geographic targeting – random!
 - Within village household level targeting - Not random, but purposive targeting
 - Collect information on basic indicators for whole population
 - Use basic indicators to generate simple poverty score and select eligible based on poverty score
 - Important that population does not realize this! as they may change behaviour to be eligible for CCT
- Survey on sample: Pre-intervention (97), post (Oct 98, June 99, Nov 99)

Ex2) Conditional cash transfer program - PROGRESA

Evaluation strategy

	Treatment villages	Control villages
Eligible households	A	B
Non-eligible households	C	D

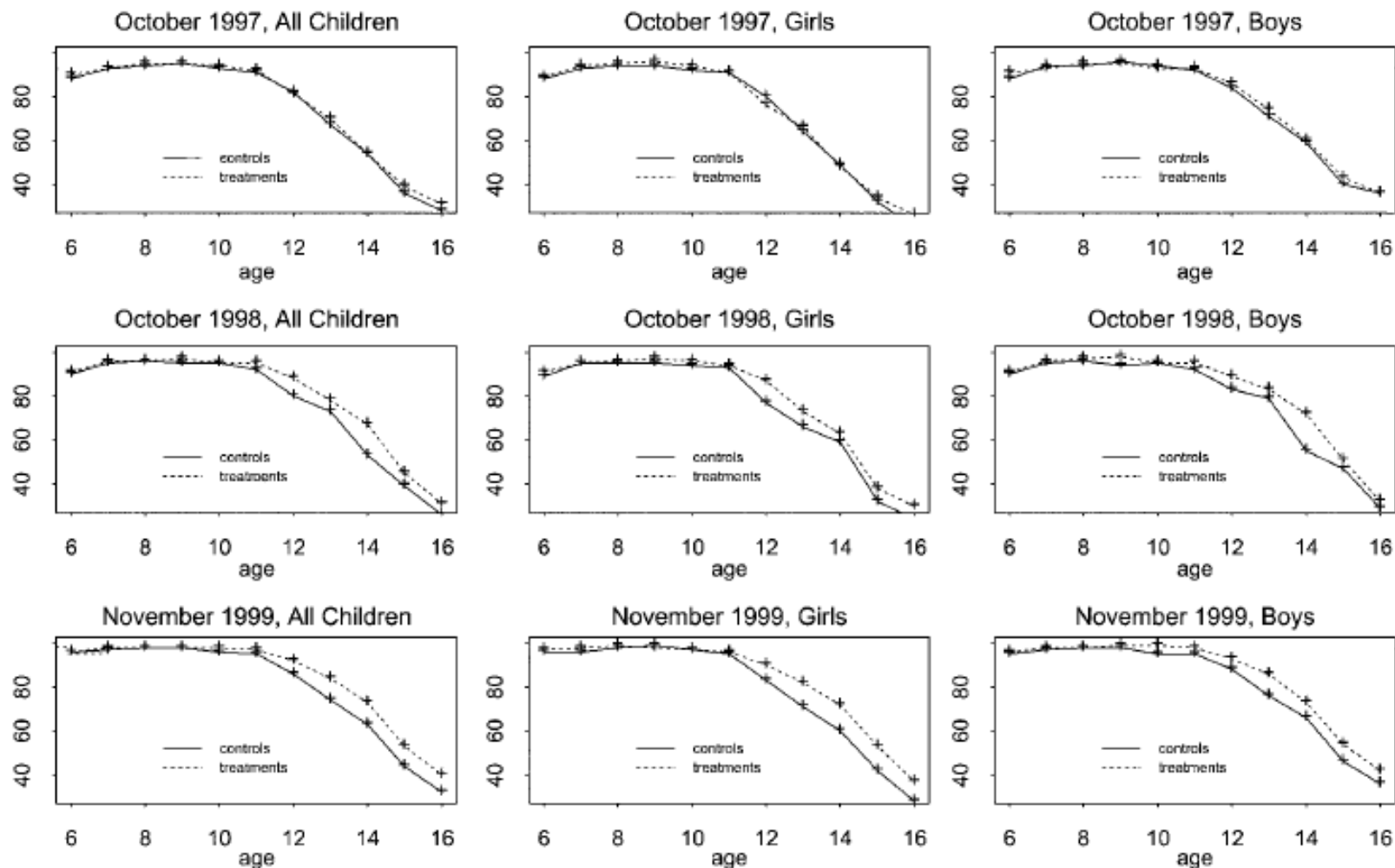


- Impact effect: $A - B$
- Spill-over effects: $C - D$

- Pre-program outcomes of treatment and control groups should be similar when we compare among eligible households (A-B) or non-eligible households (C-D)

Ex2) Conditional cash transfer program - PROGRESA

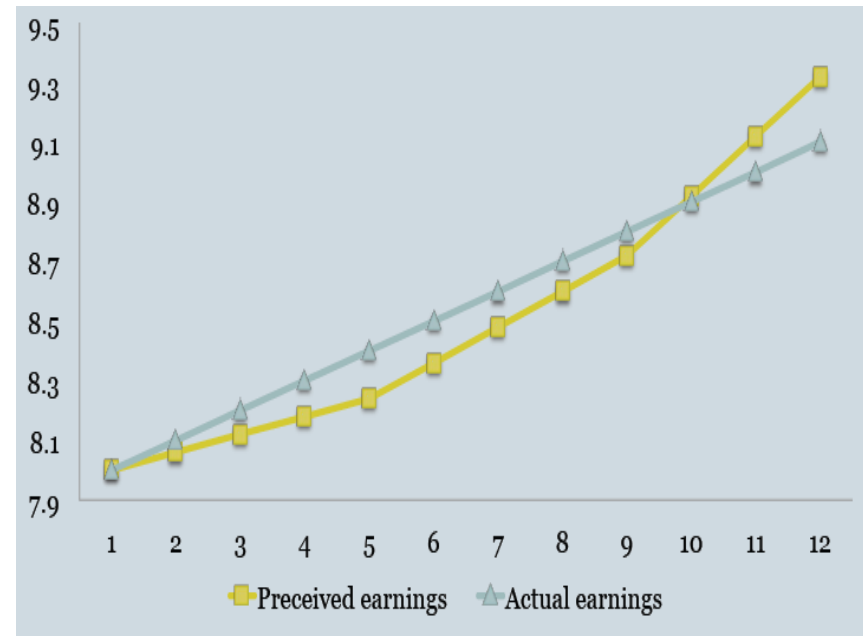
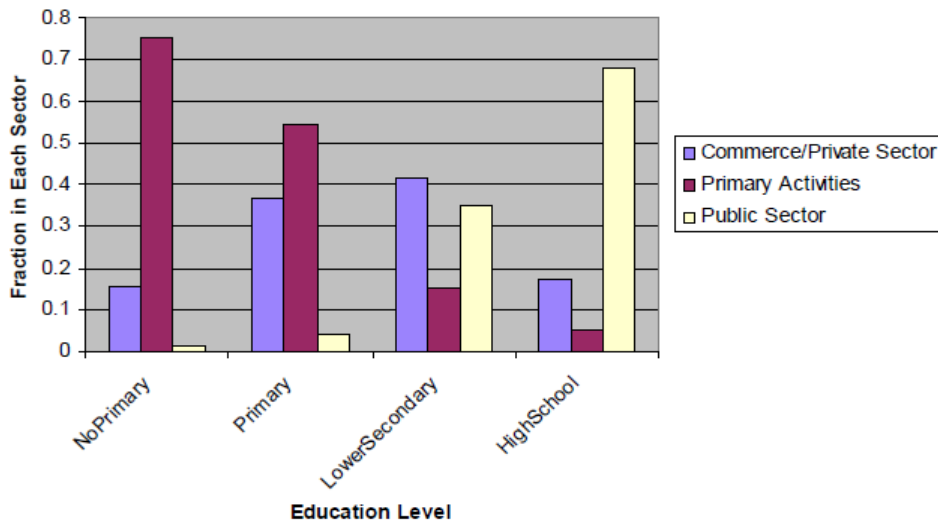
Behrman, Sengupta and Todd (2005) found positive impact on enrolment rate



Ex3) Fixing parents' elite bias' in returns to education

- Parents are sensitive to perceived returns to education when they make their education decision
- Nguyen (2008) ran some experiments in Madagascar and found that on average randomly selected parents tend to underestimate lower edu
 - When ask about their subjective expectation of jobs and returns for their child at different level of education:

Figure 2A: Baseline Beliefs of Job Types by Education



Ex3) Fixing parents' elite bias' in returns to education

- When the randomly chosen parents were shown actual statistics of return to education in a simple and credible way, parents who were initially overstating the returns reduced effort and those who were underestimating increased effort!

Ministry of Education

RETURNS TO EDUCATION IN MADAGASCAR 2005

This table presents the average monthly income (in ARIARY) of 25 year-old Malagasies, by gender and by different educational levels.





	Without any degree	Primary school with CEPE	Lower secondary school with BEPC	At least high school with BAC
Female	34 524 Ar	44 119 Ar	73 771 Ar	163 344 Ar
Male	47 637 Ar	60 877 Ar	101 793 Ar	225 389 Ar
Gain				

Table 7: Impact on Schooling Effort and Test Scores

	Attendance	Test Scores	Under-estimated ^(#)	Over-estimated
	(1)	(2)	(4)	(5)
Panel A				
AnyStatistics	7.846 (4.87)	0.202 (0.106)+	0.365 (0.156)*	-0.223 (0.17)
Observations	176	6297	2877	492

- Making credible statistic information on actual return to education could be low-cost and effective intervention in improving school investment!

Source : Calculations from the 2005 Household Survey

Ex4) Making more jobs available for the graduates

- Parents tend to be sensitive to job opportunities that education open
- Jensen (2010) ran RCE providing three years of recruiting services to help girls in randomly selected Indian villages who had English education to get job in business process outsourcing industry (BPO). He ran

$$y_{iv} = \beta BPO_v + \gamma X_{iv} + \delta_v + \delta_i + \varepsilon_{iv}$$

TABLE III. EFFECT OF THE INTERVENTION ON HUMAN CAPITAL

PANEL A. GIRLS	Round 2 Outcomes			Round 2 Outcomes		
	(1)	(2)	(3)	(4)	(5)	(6)
	Enrolled	BMI- for-Age	Height- for-Age	Enrolled	BMI- for-Age	Height- for-Age
Treatment	0.052*** (0.019)	0.24*** (0.070)	0.063 (0.066)	0.053*** (0.019)	0.23*** (0.069)	0.060 (0.063)
log (expend per cap)				0.025 (0.018)	0.11* (0.058)	0.147** (0.057)
Head's Education				0.005* (0.003)	0.017 (0.012)	0.008 (0.009)
Spouse's Education				0.008** (0.004)	-0.033* (0.018)	0.040 (0.014)
Family Size				0.002 (0.004)	-0.014 (0.014)	0.030** (0.013)
Child's Age				-0.002 (0.004)	-0.038*** (0.011)	0.265*** (0.092)
R ²	0.004	0.007	0.001	0.016	0.017	0.06
Observations	1,830	2,031	2,031	1,830	2,031	2,031

Availability of BPO recruitment increased girls education and also health outcomes

Improvement in labor market can indeed increase education investment!

How to improve education quality?

- So far we saw many interventions succeeding in getting children to schools, but less successful in improving learning outcomes (e.g., test scores)
- The first generation of programs aim to improve education quality focused on supply side by relaxing school's resource constraints... but disappointing results!
 - Textbooks: Kremer et al. and Gleww et al. (2002) distributed English textbooks to students in some randomly selected schools in Kenya
 - Only best students benefit as weaker ones could not even read English!
 - The intervention clearly not suitable and tailor to students' ability to learn
 - Class size reduction: Duflo et al. divided class sizes into half in some randomly selected schools in Kenya
 - There was no significant effect on test scores as long as students stayed with regular teachers ... same results also found elsewhere!
- What is common with these interventions?
 - Do not focus on how the resource can really help students' learning
 - Do not address teachers' incentive?

Ex5) Remedial education and computer-assisted learning

- Banerjee et al. (2007) conducted two RCEs in schools in urban India
 - A remedial education program for weak kids hired young women from the children's community with 10-12 grade education to teach basic literacy and numeracy skills 2 hours per day
 - Strength: Focus on child at current level of achievement, employs someone from the community, good incentive w/ short contract, reduce class size
 - Potential weakness: a much less educated teacher, little training
 - A computer-assisted learning program for every kids offered 2 hours of computer per week, during which they play games that involve solving math problems whose level of difficulty responds to their ability to solve them
 - Popular in India, computers can resolve shortage of trained teachers, tailored to child's current level of ability and also can make schools more attractive for kids
 - **Research questions:** How might these interventions improve learning outcomes (test score)?

Ex3) Remedial education and computer-assisted learning

Experiment design

- 98 schools in Vadorara and 77 schools in Mumbai
- School-level randomisation: in each city, schools are randomly assigned into group A or B, where students grade 3-4 were randomly assigned into treatment and control:

YEAR 1				
	GROUP A		GROUP B	
Grade 2	TREATMENT	A	CONTROL	B
Grade 3	CONTROL	C	TREATMENT	D

YEAR 2				
	GROUP A		GROUP B	
Grade 3	TREATMENT	A	CONTROL	B
Grade 4	CONTROL	C	TREATMENT	D

Impact in year 1:

For grade 2 = A-B

For grade 3 = D-C

Impact in year 2:

For grade 3 = A-B

For grade 4 = D-C

- Collect pre-test score before intervention and post-test score after

What might be advantages of this design? What could cause bias?

Ex3) Remedial education and computer-assisted learning

Simple difference of group mean (standardised) post-test score

Table II: Test Score Summary Statistics for Balsakhi and CAL Programs

		PRE TEST			POST TEST		
		Treatment	Comparison	Difference	Treatment	Comparison	Difference
		(1)	(2)	(3)	(4)	(5)	(6)
A. Balsakhi: Vadodara							
Year 1 (Grades 3 and 4)	Math	-0.007	0.000	-0.007 (0.059)	0.348	0.171	0.177 (0.070)
	Language	0.025	0.000	0.025 (0.061)	0.794	0.667	0.127 (0.076)
Year 2 (Grades 3 and 4)	Math	0.046	0.000	0.046 (0.053)	1.447	1.046	0.401 (0.078)
	Language	0.055	0.000	0.055 (0.058)	1.081	0.797	0.285 (0.071)
B. Balsakhi: Mumbai							
Year 1 (Grade 3)	Math	0.002	0.000	0.002 (0.108)	0.383	0.227	0.156 (0.126)
	Language	0.100	0.000	0.100 (0.108)	0.359	0.210	0.149 (0.102)
Year 2 (Grades 3 and 4)	Math	-0.005	0.000	-0.005 (0.058)	1.237	1.034	0.203 (0.107)
	Language	0.056	0.000	0.056 (0.054)	0.761	0.686	0.075 (0.061)

Ex3) Remedial education and computer-assisted learning

Simple difference of group mean post-test score

Table II: Test Score Summary Statistics for Balsakhi and CAL Programs

		PRE TEST			POST TEST		
		Treatment	Comparison	Difference	Treatment	Comparison	Difference
		(1)	(2)	(3)	(4)	(5)	(6)
C. Computer Assisted Learning: Vadodara							
Year 2 (Grade 4)	Math	-0.054	0.000	-0.054 (0.076)	1.129	0.810	0.319 (0.087)
	Language	-0.009	0.000	-0.009 (0.083)	0.719	0.709	0.010 (0.093)
Year 3 (Grade 4)	Math	0.125	0.000	0.125 (0.073)	0.813	0.232	0.581 (0.089)
	Language	0.116	0.000	0.116 (0.079)	0.118	0.014	0.104 (0.080)

Ex3) Remedial education and computer-assisted learning

Difference in difference estimate: $S_{ispost} - S_{ispre} = a + bT_s + \gamma S_{ispre} + \varepsilon_{is}$

Table III: Estimates of the Impact of the Balsakhi Program, by City and Sample

	Number of Observations	Dependent Variable: Test Score Improvement (Posttest - Pretest)		
		Math	Language	Total
	(1)	(2)	(3)	(4)
A. Pooling Grades and Locations				
Mumbai and Vadodara Together Year 1	12855	0.182 (0.046)	0.076 (0.056)	0.138 (0.047)
Mumbai and Vadodara Together Year 2	21936	0.353 (0.069)	0.187 (0.050)	0.284 (0.060)
B. Pooling Both Grades				
Vadodara Year 1	8426	0.189 (0.057)	0.109 (0.057)	0.161 (0.057)
Vadodara Year 2	11950	0.371 (0.073)	0.246 (0.061)	0.331 (0.070)
Mumbai Year 1 (Grade 3 Only)	4429	0.161 (0.075)	0.086 (0.066)	0.127 (0.067)
Mumbai Year 2	9986	0.324 (0.145)	0.069 (0.081)	0.188 (0.112)

Ex3) Remedial education and computer-assisted learning

Difference in difference estimate: $S_{ispost} - S_{ispre} = a + bT_s + \gamma S_{ispre} + \varepsilon_{is}$

Table IV: Impact of the CAL Program, by Year

	Number of Observations	Dependent Variable: Test Score Improvement (Posttest - Pretest)		
		Math	Language	Total
	(1)	(2)	(3)	(4)
A. Effect of the CAL Program				
Vadodara Both Years	11255	0.394 (0.074)	-0.025 (0.082)	0.191 (0.083)
Vadodara Year 2	5732	0.347 (0.076)	0.013 (0.069)	0.208 (0.074)
Vadodara Year 3	5523	0.475 (0.068)	-0.005 (0.042)	0.225 (0.051)

Ex3) Remedial education and computer-assisted learning

Difference in difference result: $S_{ispost} - S_{ispre} = a + bT_s + \gamma S_{ispre} + \varepsilon_{is}$

- Who gain from these programs?

Table V: Short- and Longer-Run Impacts of Programs, by Initial Pretest Score

Sample	Probability of assignment to balsakhi (1)	Program effect in Year 2:			Number of Observations (5)
		Math (2)	Language (3)	Total (4)	
PANEL A: Balsakhi, 2002-2003					
All Children	0.313	0.371 (0.073)	0.246 (0.061)	0.331 (0.070)	11950
Bottom Third	0.446	0.469 (0.088)	0.317 (0.074)	0.425 (0.084)	4053
Middle Third	0.341	0.374 (0.082)	0.240 (0.069)	0.339 (0.080)	3874
Top Third	0.162	0.229 (0.076)	0.174 (0.076)	0.216 (0.077)	4023
PANEL B: CAL, 2002-2003					
All Children		0.347 (0.076)	0.013 (0.069)	0.208 (0.074)	5732
Bottom Third		0.425 (0.106)	0.086 (0.089)	0.278 (0.102)	1962
Middle Third		0.316 (0.081)	0.005 (0.081)	0.183 (0.082)	1844
Top Third		0.266 (0.073)	-0.033 (0.081)	0.146 (0.078)	1926

Ex3) Remedial education and computer-assisted learning

What do we learn from these education quality interventions?

- These interventions seem effective in improving learning outcomes
 - The remedial education program increased average test scores of all children in treatment schools by 0.28 standard deviation. As local hired women were cheap, this could be cost effective intervention (\$0.67 per 1 standard deviation increase in mean children's test score)
 - The computer-based learning increased math scores by 0.47 standard deviation. These magnitudes are large by standard of education intervention
 - Overall, children at the bottom of test-score distribution gain the most!
- What might be behind these success? → focus more on students' learning?
- Is it possible to make progress at higher levels of education?
- Would the results be generalised to rural areas and in poorer environments? To other skills, e.g., reading?

Implications for the next generation of education policies?

- Supply driven school expansion could yield positive impact on getting children to schools and externalities on health and education BUT
 - Less likely to improve educational outcomes
- Need complement with programs to improve quality of education
- How to improve quality of education?
 - Just relaxing schools' resource constraints might not work (e.g., textbook, class size)
 - Need to focus on how the students can learn and how to address teachers' incentives
- Programs target to improve return to education, e.g., increase job availability, or fix parents' wrong perception on return to education could yield high impact
- Interventions that simultaneously address both supply and demand issues could also have high potentials, e.g., CCT