Lecture 8
Education

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Rutgers University

Spring Semester, 2009
Part I

Reading Assignments
Reading Assignments
Part II

Introduction
We have considered in depth the technology issue as an engine of growth
Introduction

We have considered in depth the technology issue as an engine of growth

- Role of technology
Introduction

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- Role of technology
- R&D and R&D history
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**Question**

What is skill biased?
What is Education?

Human capital is the result of education
Human capital is the result of education

- Formal = schooling
What is Education?

Human capital is the result of education

- **Formal** = schooling
  - Conventional schools (K – 12, College, etc.)
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  - **Vocational schools**
What is Education?

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  - Continuing adult education
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  - In-house training courses offered by businesses and agencies
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- **Informal = on-the-job-training, apprentices**
Formal education from schooling can be subdivided for analysis...
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- **Quantity of education**
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- **Quantity of education**
  - **Number of years of schooling attained**
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    - Scores on internationally comparable exams
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- **Quantity of education**
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    - Pupils per teacher
    - Gender ratio (female to male)
Formal Education

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- Quality of education
  - Gauged by...
    - Scores on internationally comparable exams
    - Pupils per teacher
    - Gender ratio (female to male)
    - Spending as percent of real GDP
An empirical model looked at the effect of education on growth for a number of countries in the context of other variables.
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\[ g_{it} = g(X_{it}) + \epsilon_{it} \]

where

- \( g = \text{CAGR} \)
- \( X = \text{list of explanatory variables for countries} \)
- \( i = 1, \ldots, n_t \text{ countries} \)
The $t$ represents 10-year periods for calculating the CAGRs, the dependent variable.
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- This is a panel with three time measures for each country
- A total of 246 ($= 81 + 84 + 81$) observations
- Estimation is by an extension of OLS rather than OLS to take advantage of the panel nature of the data
Panel data involve observations that possess both cross-section, and within-cross section (time series) identifiers.
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- Generally speaking, panel data correspond to data with large numbers of cross-sections, with variables held in single series in stacked form
### A generic panel structure

<table>
<thead>
<tr>
<th>Country</th>
<th>Period</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>i = 1</td>
<td>t = 1</td>
<td>data</td>
</tr>
<tr>
<td></td>
<td>t = 2</td>
<td>data</td>
</tr>
<tr>
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<td>...</td>
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<td></td>
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<tr>
<td>i = 2</td>
<td>t = 1</td>
<td>data</td>
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<tr>
<td></td>
<td>t = 2</td>
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<td></td>
<td>...</td>
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<td></td>
<td>t = T(2)</td>
<td>data</td>
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<td></td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>i = N</td>
<td>t = 1</td>
<td>data</td>
</tr>
<tr>
<td></td>
<td>t = 2</td>
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</tr>
<tr>
<td></td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>t = T(N)</td>
<td>data</td>
</tr>
</tbody>
</table>
Advantages of a panel

- Controls for store heterogeneity reducing risk of biased estimates
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Formal Education
(Continued)

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Disadvantages of a panel

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Formal Education (Continued)

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Disadvantages of a panel

- More complexity estimation methods
- More complex data structure
Independent variables
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- Log per capita real income (within-level of RGDP; also, squared)
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- Openness ratio
- \((\text{Openness ratio}) \times (\log \text{GDP})\) (real terms)
Independent variables

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- Male secondary and higher schooling
- Government consumption /GDP (real terms)
- Rule-of-Law index
- Openness ratio
- (Openness ratio) x (log GDP) (real terms)
- Inflation rate
Independent variables

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- (Openness ratio) x (log GDP) (real terms)
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- Log total fertility rate
Independent variables

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- (Openness ratio) x (log GDP) (real terms)
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- **Investment/GDP (real terms)**
Formal Education
(Continued)

Independent variables

- Log per capita real income (within-level of RGDP; also, squared)
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- Openness ratio
- (Openness ratio) x (log GDP) (real terms)
- Inflation rate
- Log total fertility rate
- Investment/GDP (real terms)
- Growth rate of terms of trade
The $R^2$ values for the three subperiods are very respectable...
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- $R^2_1 = 0.62 \Rightarrow 62\%$ of variation growth explained
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- $R^2_1 = 0.62 \Rightarrow \text{62\% of variation growth explained}$
- $R^2_2 = 0.50 \Rightarrow \text{50\% of variation growth explained}$
The $R^2$ values for the three subperiods are very respectable... 

- $R_1^2 = 0.62 \Rightarrow 62\%$ of variation growth explained
- $R_2^2 = 0.50 \Rightarrow 50\%$ of variation growth explained
- $R_1^2 = 0.47 \Rightarrow 47\%$ of variation growth explained
Generally, a higher ratio

\[
\begin{align*}
\text{Human Capital} \\
\text{Physical Capital}
\end{align*}
\]

generates higher growth
Generally, a higher ratio

\[
\frac{\text{Human Capital}}{\text{Physical Capital}}
\]

generates higher growth

- More human capital facilitates absorption of new, superior technologies from leading countries
Generally, a higher ratio

\[
\frac{Human \ Capital}{Physical \ Capital}
\]

generates higher growth

- More human capital facilitates absorption of new, superior technologies from leading countries
- We will discuss absorption/adoPTION later
There are two ways to measure or discuss human capital as previously discussed...
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- Quantity of education
There are two ways to measure or discuss human capital as previously discussed... 

- Quantity of education
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Quantity of Education...
Quantity of Education...

- This was measured in this study by the years of schooling attained by the population 25 and older.
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Question

Why not females?
Female education attainment was tried for secondary and higher levels but was found to be statistically insignificant.
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Possible interpretation
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  - Many countries follow discriminatory practices and do not exploit well-educated females in the economy
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  - Many countries follow discriminatory practices and do not exploit well-educated females in the economy
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- But – effect may be spurious
Better fit? Is effect really smaller? Outlier pulling line (?)
Quality of Education

Some believe the quality of education is more important than quantity. Quality can be measured by test scores. The test scores used in this study...
Quality of Education

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- The test scores used in this study...
  - Science
  - Math
  - Reading
Results...
Results . . .

- **Science** has a statistically significant and positive effect
Results...  

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- A 1 standard deviation improvement in scores would raise growth 1% per year!!
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- Reading is negative!!
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Overall, the test score variable is positive.
Figure 3. Growth Rate versus Test Scores
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- But we need to do better to explain how schooling affects growth.
- There is the possibility that the causality direction is reversed: growth affects schooling so we may be measuring the wrong thing!
Some studies have shown that 1960\textsuperscript{1} primary- and secondary-school enrollment rates are positively related with 1960-1985 growth in real GDP per capita.

- An increase in enrollment rates tantamount to one more year of attainment is associated with 0.30\% per year faster RGDP growth over 1960-1990 (standard error = 0.05\%).

\textsuperscript{1}Note: Study done in late 1990s so looked at a long period. This allowed a generation sufficient time to grow (30 years), be educated, mature and enter the work force.
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  - Big tech boom especially in 1970s, 1980s, 1990s

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