The Puzzle
The Estimated Returns to R&D are very high

- US firm level/industry data- social returns
  - Grilliches and Lichtenberg (1984) 71%
  - Terleckyj 1980, Scherer (1982) >100%
  - Griffith, Redding, Van Reenen (2004) 57%
  - Jones and Williams (1998) 28%

- X country
  - Coe and Helpman (1995) G7 123%
  - Van Pottlesberghe and Lichtenberg (2001) G7 68%

- And imply social rates of return far above private
  - Jones and Williams (1998): US should quadruple investment in RD
…and get higher with distance from the frontier

- **Two Faces of R&D** (Cohen and Levinthal 1989)
  - Invention
  - Learning/Catch-up
  - Poor countries should have much greater returns

- **Griffith, Redding, Van Reenen (2004)**

<table>
<thead>
<tr>
<th>Country</th>
<th>Dist. Frontier</th>
<th>RoR R&amp;D</th>
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<tbody>
<tr>
<td>USA</td>
<td>-.18</td>
<td>57%</td>
</tr>
<tr>
<td>UK</td>
<td>-.53</td>
<td>77%</td>
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<tr>
<td>Italy</td>
<td>-.73</td>
<td>88%</td>
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- What should the rate of return be for LAC? 200%? 300%?
But poor countries do generally less R&D than rich countries... Why?

\[
\frac{R \& D}{GDP} = \beta_1 \frac{GDP}{CAP} + \beta_2 \left[ \frac{GDP}{CAP} \right]^2
\]
R&D Superstars- Are they the only rational ones? Or inefficient (Young 1992)

\[
\frac{R & D}{GDP} = \beta_1 \frac{GDP}{CAP} + \beta_2 \left[ \frac{GDP}{CAP} \right]^2
\]
Estimating the Returns to R&D
Estimation

\[ \Delta \ln y_t = \beta_y \ln y_{t-1} + r_k \frac{I_t}{y_t} + r_{R&D} \frac{R&D_t}{y_t} + \beta_l \Delta \ln L_t + \varepsilon_t \]

But if, as in GRV (2004):

\[ r_{R&D} = \rho + \delta_2 \ln \left( \frac{A^*}{A} \right)_{-1} \]

or more complicated, need to allow parameters to vary
Data

- R&D- UNESCO Collection pioneered by Lederman and Saenz
- Other variables-Barro and Lee (2001)
  - Adjust for labor quality (Caselli 2004) $hL = \exp(\phi(s))$
  - $\phi(s)$ piecewise linear function with varying slopes.
- Both R&D and Investment- perpetual inventory
- 5 Year averages 1960-2000
Endogeneity?

- Simultaneity responsible for high ROR?
- Internal instrument (lags) (Hall and Mairesse 1995, GRV 2004)
- External instrument- IPRs (Ginarte and Park 1997)
  - Patent law coverage, membership 3 international agreements, enforcement mechanisms etc.
  - Composite index ranges between 0 and 5
  - Has a channel of influence through R&D
  - But driven by non-R&D/growth related factors. 1986- Trade agreements- US, Europe, Japan introduce IPRs as quid pro quo for market access in WTO, particularly with respect to Korea and Taiwan.
External Instrument: IPRs

- Link from IPRs to growth, or anticipation of growth unlikely
- Rodrik: “WTO rules on trade related intellectual property rights (TRIPS) are utterly devoid of any economic rationale beyond the mercantilist interests of a narrow set of powerful groups in the advanced industrial countries. The developmental pay-off of most of these requirements is hard to see (2001, P 27).” Also Maskus.
- However, still a potential link through trade.
- Run for just LDCs-same results.
Results
## Growth regressions and returns to R&D (Labor quality adjustment)

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<th>POOL</th>
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<th>PANEL</th>
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<td>No IV Internal External</td>
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<td>No IV Internal External</td>
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<tr>
<td>R&amp;D (Gross)</td>
<td>0.16</td>
<td>0.072 0.629</td>
<td>0.704*** 0.473 -0.177</td>
<td>0.704*** 0.781** 1.029**</td>
<td>[0.187]</td>
<td>[0.210] [0.488]</td>
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<td></td>
<td>[0.187]</td>
<td>[0.210] [0.488]</td>
<td>[0.219] [0.302] [0.799]</td>
<td>[0.263] [0.398] [0.507]</td>
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<tr>
<td>Investment</td>
<td>0.203*** 0.203*** 0.202***</td>
<td>0.277*** 0.278*** 0.281***</td>
<td>0.277*** 0.280*** 0.275***</td>
<td>[0.024] [0.024] [0.024]</td>
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<td>[0.029] [0.026] [0.026]</td>
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<tr>
<td>Labor Growth</td>
<td>0.454*** 0.435*** 0.558***</td>
<td>-0.242** -0.248** -0.265**</td>
<td>-0.242* -0.211* -0.208*</td>
<td>[0.094] [0.097] [0.138]</td>
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<td></td>
<td>[0.094]</td>
<td>[0.097] [0.138]</td>
<td>[0.110] [0.110] [0.115]</td>
<td>[0.132] [0.118] [0.119]</td>
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<tr>
<td>Initial GDP</td>
<td>-0.001 -0.001 -0.002</td>
<td>-0.053*** -0.052*** -0.048***</td>
<td>-0.053*** -0.046*** -0.046***</td>
<td>[0.001] [0.001] [0.001]</td>
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<td>[0.006] [0.006] [0.008]</td>
<td>[0.007] [0.008] [0.008]</td>
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<td>Observations</td>
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<td>F(Cragg-Donald)</td>
<td>39.36</td>
<td></td>
<td>13.74</td>
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Parameter Stability

Physical Investment

Labor Growth

Initial Income
Returns to R&D

No Instruments

Internal Instruments

External Instruments
Rates of Return-Country Indicative

[Graph showing rates of return for various countries over different periods, with a focus on the relationship between returns to R&D and distance to the economic frontier.]
What offsets catch-up effect—Complementary Factors?
Perceived Quality of Research Institutions

Quality

Distance to the economic frontier (1996-2000)

World Economic Forum (2010)
China and India: Wise or Wasteful?
Who’s doing R&D? Patents granted by the USPTO to inventors based in China

Branstetter 2012
China differs from Taiwan and Korea in the composition of their innov.surges

Branstetter (2012)
Pros and Cons

- MNCs providing eco-system: complementary factors
  - Most patents owned by MNCs
  - 50% are co-patented

- But will it maintain an autonomous innovative capacity?
Conclusions for LAC?
Conclusions for LAC

- Returns to R&D remain high
- But complementary factors likely to be essential; otherwise, returns could even be negative!

How much R&D should LAC do?
- MICs-in the “sweet spot” far from frontier, but with enough complementary factors
- Poorest maybe not so much. Focus more on upgrading, quality enhancement?

- Needs to be efficient, autonomous and demand driven.