Evaluating the Impact of Technology Development Funds in Emerging Economies: Evidence from Latin-America

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Overview

- Survey evaluations of recent tech policy initiative in Latin American countries
- Simple analytic framework for evaluation of R&D subsidies
- Latin American context
- Evaluation methodology
- Evaluation results for 4 countries (Argentina, Brazil, Chile, Panama)

March 2008
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Rationale for R&D subsidies

- Arrow (1962) and Nelson (1959)
  - Externalities (failure of appropriability)
  - Uncertainty and risk
  - Financing problems due to asymmetric information and moral hazard
- Evolutionary scholars
  - Dynamic, collective and uncertain nature of the innovation process
  - Linkages among and absorptive capacity of agents of the National Innovation System (externalities)

Policy instruments

- This paper:
  - public subsidies - grants and matching grants
  - targeted credit
- Other instruments – possibly less effective in a developing country context:
  - tax incentives
  - intellectual property system
What do we expect?

- Rate of return to R&D should fall, not rise, based on the argument for having a policy in the first place
- Rent-seeking may be important, especially if funds are completely fungible (lack of additionality)
- The two instruments (grants and credits) are slightly different in their impact

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**Grant**

![Diagram of R&D spending and capital costs with curves D1, D2, D3, D4, S, and S']

- Cost of R&D Capital
- R&D Spending

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- Firm 1 – induced to undertake R&D
- Firm 2 – no change, substitutes grant funds for its own
- Firm 3 – moderately constrained, increases R&D by almost the amount of the subsidy
- Firm 4 – heavily constrained, increases R&D a small amount

Subsidized credit

Graph showing the relationship between cost of R&D and capital.
Subsidized credit

We assume that the subsidy makes credit cheaper than internal funds over some range.

- Firm 1 – no change in behavior
- Firm 2 – no change in R&D, uses some of the subsidized funds instead of its own
- Firm 3 – increases its R&D
- Firm 4 – increases its R&D by more

Conclusion

- Grants have a greater impact on firms that do no R&D at present
- Subsidized credit has more impact on firms that are financially constrained
  - Do R&D, have a high return, but little access to funds
- Firms that use only internal funds for R&D investment are the most likely to see no additionality
Latin American S&T

- **Surveys:** IDB 2001, ECLAC 2004, Velho 2004, and Hall 2005
- S&T sector in Latin America growing in absolute terms but falling behind in relative terms.
- **R&D expenditure:**
  - LAC share of world expenditure: 3.1% in 1997; 2.6% in 2003
  - R&D/GDP ratio increased from 0.49% in 1991 to 0.57% in 2003, but...
    - East Asia (1.2%) and Eastern Europe (0.97%)
- Business R&D share also lower than in other similar countries

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**Figure 1** – R&D input and output: evolution of the gap between LAC and US (1991-2003)

*Source: Authors’ calculations on the basis of ICTY.*

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Why?

- Lederman and Maloney 2003, De Ferranti 2004, and Benavente et al. 2005:
  - Rate of return to R&D is high, higher than for capital investment
- Lederman and Maloney 2003 and De Ferranti 2004 identify the following factors:
  1. Short planning horizons due to persistent macro volatility
  2. Financial constraints
  3. Weak intellectual property rights
  4. Low quality of research institutions
  5. Very unequal distribution of education
  6. Failure to mobilize government resources
  7. A rentier mentality due to a long history of passive natural resource exploitation

Policy response

- Import substitution phase (1970s-1980s):
  - Linear model of innovation
  - Focus on funding public research
  - Project choice centered on govt interests, state-owned firms (supply side focus)
- 1990s to present – move towards the market, supported by IDB:
  - Innovation resources targetted more towards industry
  - Project choice shifted towards demand side – dictates of market and firms, although social-private return gap could enter into choice
  - Remaining public research resources channeled directly to scientists based on quality
Technology Development Funds Evaluated

<table>
<thead>
<tr>
<th>Country and period</th>
<th>Name</th>
<th>Tools</th>
<th>Mechanism</th>
<th>Beneficiaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina (AR) 1994-2001</td>
<td>FONTAR-TMP I</td>
<td>Targeted Credit</td>
<td>Open Window</td>
<td>Firms</td>
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<tr>
<td>Argentina (AR) 2001-2004</td>
<td>FONTAR ANR</td>
<td>Matching Grants</td>
<td>Call for Proposals</td>
<td>Firms</td>
</tr>
<tr>
<td>Brazil (BR) 1996-2003</td>
<td>ADTEN</td>
<td>Targeted Credit</td>
<td>Open Window</td>
<td>Firms</td>
</tr>
<tr>
<td>Brazil (BR) 1999-2003</td>
<td>FNDCT</td>
<td>Matching Grants</td>
<td>Open Window / Call for proposals</td>
<td>Firms and Research centers</td>
</tr>
<tr>
<td>Chile (CH) 1998-2002</td>
<td>FONTEC – Line 1</td>
<td>Matching Grants</td>
<td>Open Window</td>
<td>Firms</td>
</tr>
<tr>
<td>Panama (PN) 2000-2003</td>
<td>FOMOTEC</td>
<td>Matching Grants</td>
<td>Open Window</td>
<td>Firms</td>
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</tbody>
</table>

Indicators and Data Sources for TDF Impact Evaluation

<table>
<thead>
<tr>
<th>Evaluation (horizon)</th>
<th>Evaluation Questions</th>
<th>Indicator</th>
<th>Sources</th>
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</thead>
<tbody>
<tr>
<td>Input additionality (short term)</td>
<td>Does public financing crowd out private resources?</td>
<td>Amount invested by beneficiaries in R&amp;D</td>
<td>Firm balance sheets; Innovation and industrial surveys</td>
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<tr>
<td>Behavioral additionality (short/medium term)</td>
<td>What is the impact of the TDF on the innovative behaviour of beneficiaries?</td>
<td>Subjective indicators on product innovation, process innovation, linkages with other agents in the NIS</td>
<td>Innovation surveys</td>
</tr>
<tr>
<td>Innovative outputs (short/medium term)</td>
<td>What was the impact on the innovation capacity of beneficiaries?</td>
<td>Patents; Sales due to new products</td>
<td>Patent databases; Innovation surveys</td>
</tr>
<tr>
<td>Performance (medium/long term)</td>
<td>What was the impact on competitiveness of beneficiaries?</td>
<td>Total factor productivity; Labor productivity; Growth in sales, exports, employment</td>
<td>Firm balance sheets; Innovation surveys; Industrial surveys; Labor surveys</td>
</tr>
</tbody>
</table>
The evaluation problem

- Selection into a program is endogenous, because firms choose to apply for funds.
- All the analyses tried to use the well-known quasi-experimental or treatment effect approach
  - In some cases, data availability prevented full quasi-experimental approach

Estimating program effects
(R&D example)

\[ Y_{it}^T = \text{R&D if firm participates} \]
\[ Y_{it}^C = \text{R&D if firm does not participate} \]
\[ D_i = \text{Dummy for participation} \]
\[ \Delta = \text{effect of participation. Then we have} \]
\[ \Delta = E[Y_{it}^T | D_i = 1] - E[Y_{it}^C | D_i = 0] \]
\[ = E[Y_{it}^T - Y_{it}^C | D_i = 1] - E[Y_{it}^C | D_i = 0] + E[Y_{it}^C | D_i = 1] \]

The last two terms are the selection bias — difference between firms that choose to participate and those that do not.
Results of the evaluations

<table>
<thead>
<tr>
<th></th>
<th>Input add.</th>
<th>Behavioral add.</th>
<th>Innovative output</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cr. out</td>
<td>Multiplier</td>
<td>Patents</td>
<td>New prod</td>
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<tr>
<td>FONTAR-TMP1 (AR)</td>
<td>No</td>
<td>Yes</td>
<td></td>
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<tr>
<td>FONTAR-ANR (AR)</td>
<td>No</td>
<td>No</td>
<td></td>
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<td>ADTEN (BR)</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>FNDCT (BR)</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>FONTEC (CH)</td>
<td>Maybe</td>
<td>No</td>
<td></td>
<td></td>
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<tr>
<td>FOMOTEC (PN)</td>
<td>No</td>
<td></td>
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*Yes for new innovators  *Patent grants  **Patent applications
Summary of results

- Impacts are positive, but become weaker as we are further away from the instrument:
  - R&D is not crowded out, and usually increases, net of subsidy
  - Where measured, linkages to the NIS improve
  - Innovative output increases, but in some cases not significantly (timing?)
  - Performance in terms of growth and productivity improves in some cases, but not all
- Timing of evaluation may be a problem

Grants versus credits

- As predicted,
  - Matching grants more effective for new innovators, also for industry-public research cooperation
  - Targeted credit more effective in general
    - A signal to financial markets of firm technical capacity and ability to innovate (Argentina and Chile surveys)
Recommendations (1)

- Longer run impact of the programs need to be monitored, given possible time lags
- Identify firms’ constraints beyond those of financial nature
  - Shortage of skilled labour could significantly affect firms’ innovation strategy and plan (e.g., Chile)
  - Consider inclusion of services that complement the financial support of innovation activities, e.g., access to skilled human capital (univ-firm interaction)

Recommendations (2)

- Future programs should contain evaluation design:
  1. Assess the rationale behind the particular policy tool adopted
     - describe the specific market failures that the instrument would be addressing
     - rationale for the targeting of the instrument
  2. Identify short, medium and long run expected outcomes
  3. Periodically collect primary data on the programs’ beneficiaries and on a group of comparable non-beneficiaries
  4. Evaluate impacts on the same sample of firms repeatedly so long-run impacts can be clearly identified
  5. Evaluate impacts on new samples of firms in order to identify possible re-targeting of policy tools
Recommendations (3)

- Promote more systematic cooperation between the programs’ administration and National Institutes of Statistics
  - significant share of information needed can be generated at a low cost by simply including specific “policy evaluation” sections in the industrial and innovation surveys periodically collected in many LAC (and other) countries.