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)

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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)

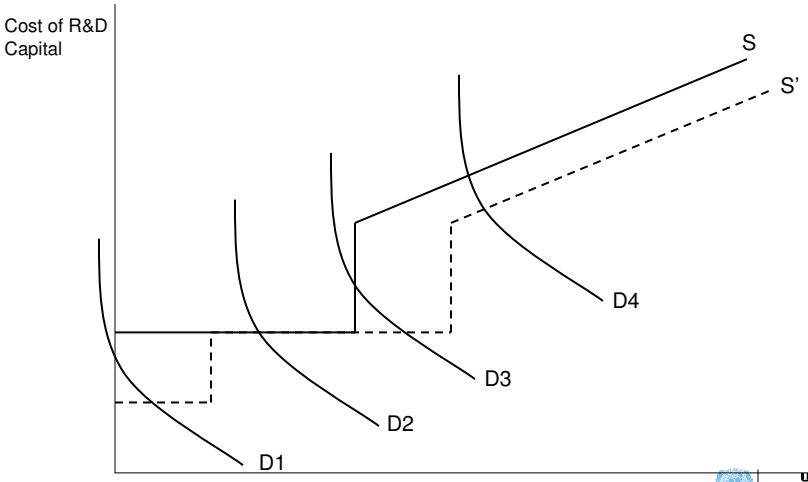
Policy instruments

- 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

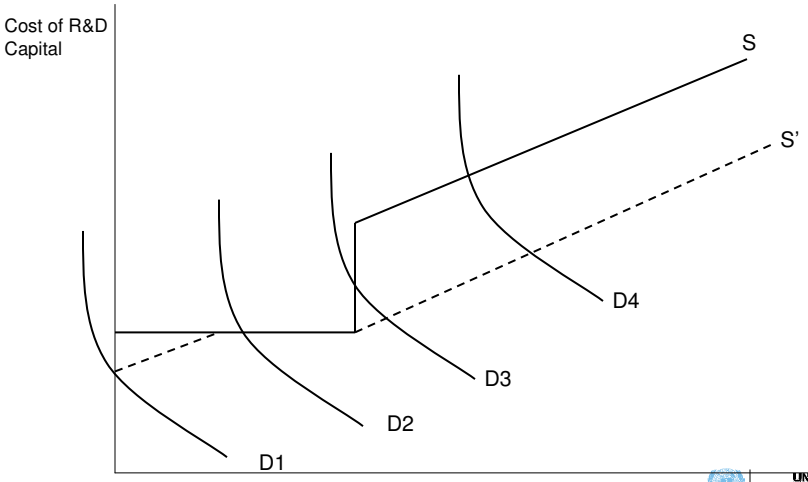
Grant



Grant

- 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



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

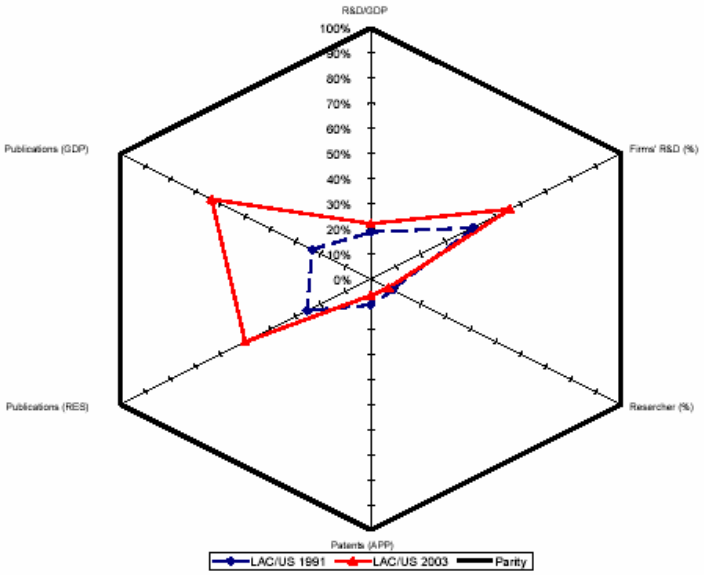
Conclusion

- 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

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



Source: Authors' calculations on the basis RICYT

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

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

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Indicators and Data Sources for TDF Impact Evaluation

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

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} = R&D if firm participates

Y_{it}^{C} = R&D if firm does not participate

D_i = Dummy for participation

Δ = effect of participation.Then we have

$$\Delta = E[Y_{it}^{T} \mid D_i = 1] - E[Y_{it}^{C} \mid D_i = 0]$$

$$= E[Y_{it}^{T} - Y_{it}^{C} \mid D_i = 1] - E[Y_{it}^{C} \mid D_i = 0] + E[Y_{it}^{C} \mid D_i = 1]$$

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

Solutions

- Identify a control group of firms, then
  - Propensity score matching
    - match firms whose likelihood of participation conditional on characteristics is equal.
  - Difference in differences estimation
    - difference both treated and control firms before and after, then take the difference between the two changes – like including firm and year dummies.
  - Fixed effect panel estimation
    - similar to previous if year effects are included, but other *X*s can be controlled for.
  - Instrumental variable estimation
    - need an instrument for selection (difficult to find)

Results of the evaluations

	Input additionality		Behavioral additionality	Innovative output		Performance		
	Cr. out	Multi-plier		Patents	New prod	Sales	Prod	Exp-orts
FONTAR-TMP1 (AR)	No	Yes						
FONTAR-ANR (AR)	No	No+			NS (+)	NS (+)	NS (-)	NS (-)
ADTEN (BR)	No	Yes		NS (+)*		+	NS (-)	
FNDCT (BR)	No	Yes		+** NS (-)*		NS (+)	NS (+)	
FONTEC (CH)	May be	No	+	NS (+)*	NS (-)	+	NS (+)	+
FOMOTEC (PN)	No		+		+	NS (+)	+	

+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.