“The Effectiveness of Innovation Policies in MICs:

Main findings from Evaluation studies”

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Motivation

- Building innovation and technological competences in MICs
- What do we know about the effectiveness and impact of innovation funding programs and tax incentives?
- Implications for design and targeting, and venues to improve impact and uptake

Outline

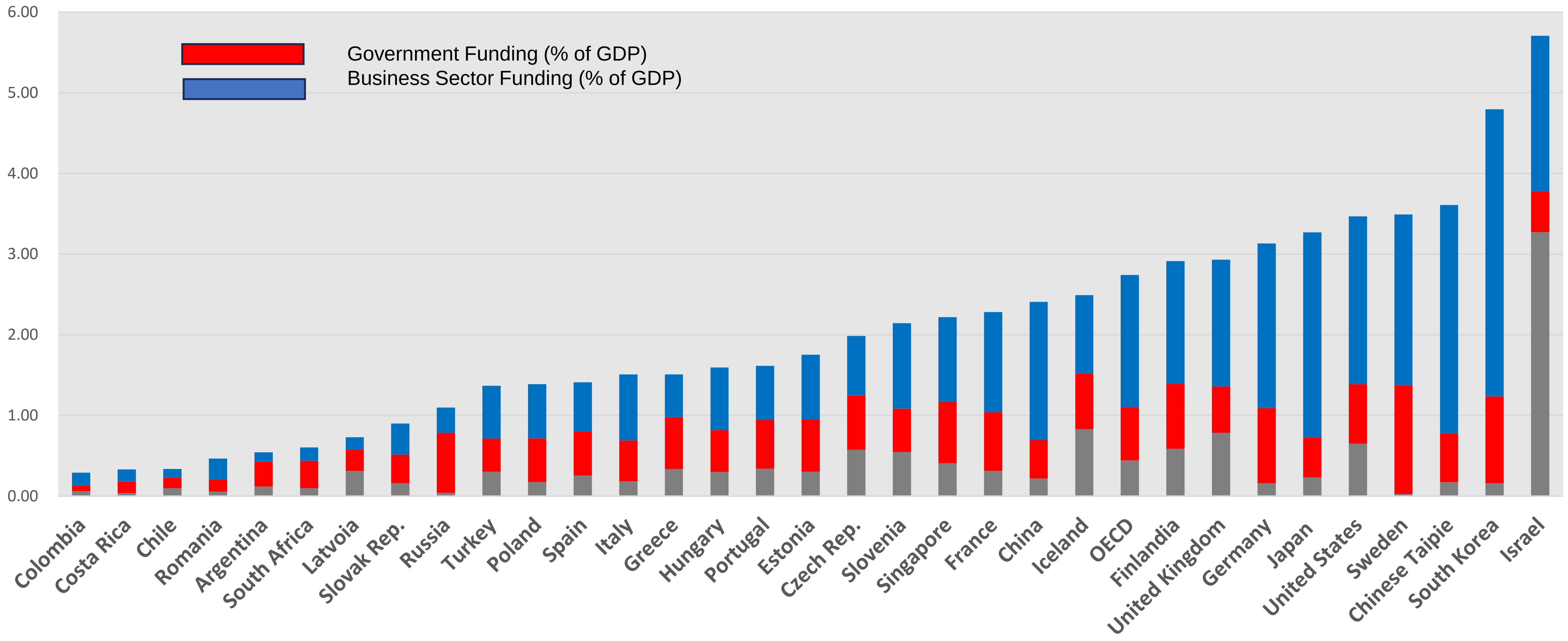
- Main concepts and rationale
- Instruments
- Evaluation, effectiveness, and Impact
- Findings from evaluation studies (MICs)
  - Direct Impacts
  - Indirect Impacts
  - The role of Competition
- Policy implications and future research

Concepts and Rationale

The value of innovation

- Innovation as key motor of long-run growth and development.
- Productivity growth drives income-level transition: Two thirds of the variation in income levels and growth rates among countries is due to differences in TFP (Hall and Jones, 1999).
- And investments in innovation explain a large part of TFP growth and firm productivity differences:
  - R&D explains up to 75 %of the differences in TFP growth rates, once externalities are accounted (Griliches, 1979)
  - The productivity gap between innovative and non-innovative firms is higher in MICs than HICs: 70% (LAC) vs. 20% in HICs (IDB, 2013).
- The innovation paradox: large social returns to R&D in developing countries; and the highest levels in MICs (Goni & Maloney, 2017).

R&D investment and business sector contribution



Innovation Policy (IP) Rationale

- Appropriability of ideas –lower returns to innovation investment
- Market failures –(asymmetric information and risk)
- Coordination Failures -several (complementary) competences required for innovation –across the NIS or within sectors, etc.

- Interventions to promote individual & system integration (Teubal, 1999).
- IP requires institutional capabilities (Cirera et al., 2020)
- A minimum of absorption and managerial capabilities in firms (MICs) and public sector research and technological capabilities (institutions).

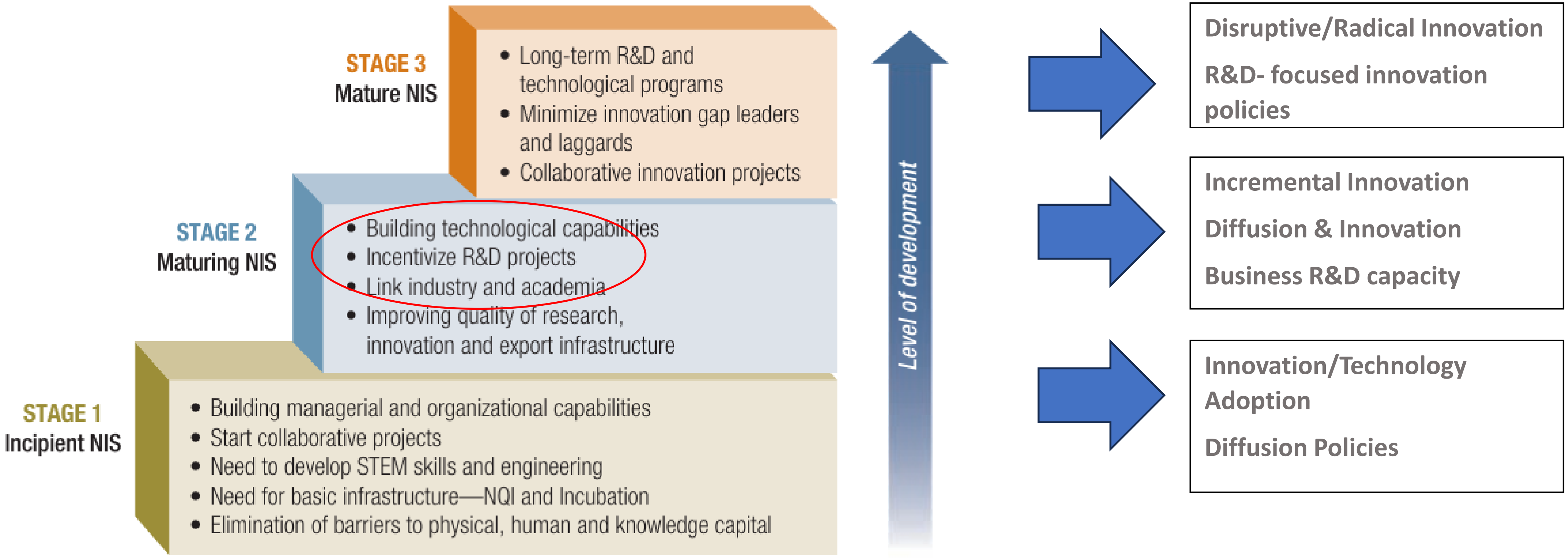
Definition

The OECD Oslo Manual:

"Innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations (OECD, 1992; OECD & Eurostat, 2005)".

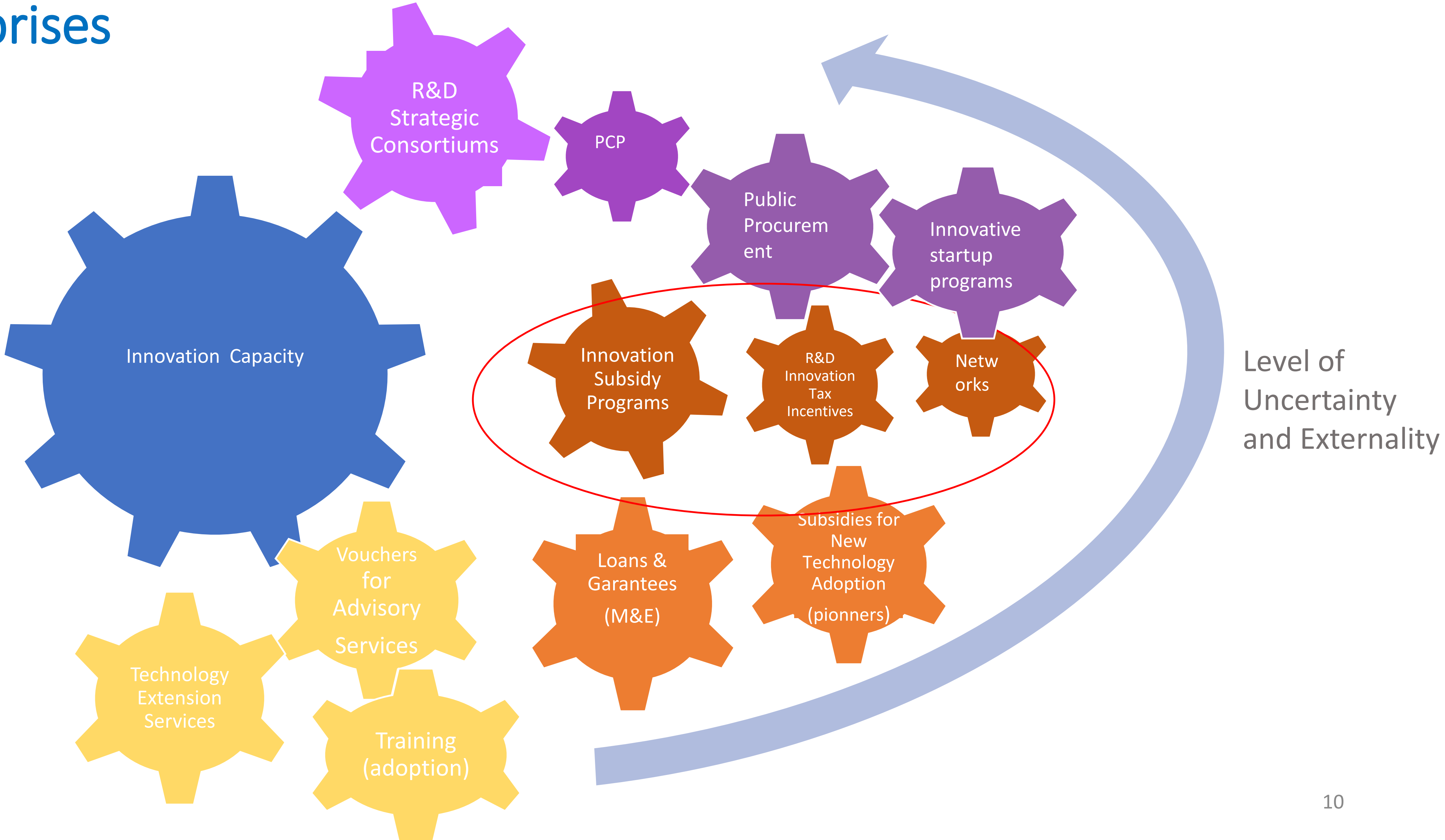
- It is about creation and adoption/diffusion
- Technological or non-technological forms (e.g., business models)
- New to firms or new to markets (incremental or radical)

Fitting with development: An evolving approach



Source: Cirera and Maloney (2017) and Cirera et al., (2020)

A vast array of instruments to support innovation capabilities in enterprises



Evaluation, Impact and Effectiveness

Innovation Funding (Subsidy) Programs

- Co-financing or Grants; mostly transversal in early years.
- Mostly targeting applied R&D and investments associated with technological developments (including prototype development, PoCs, testing) for product/process innovation & complementary capabilities.
- Two types:

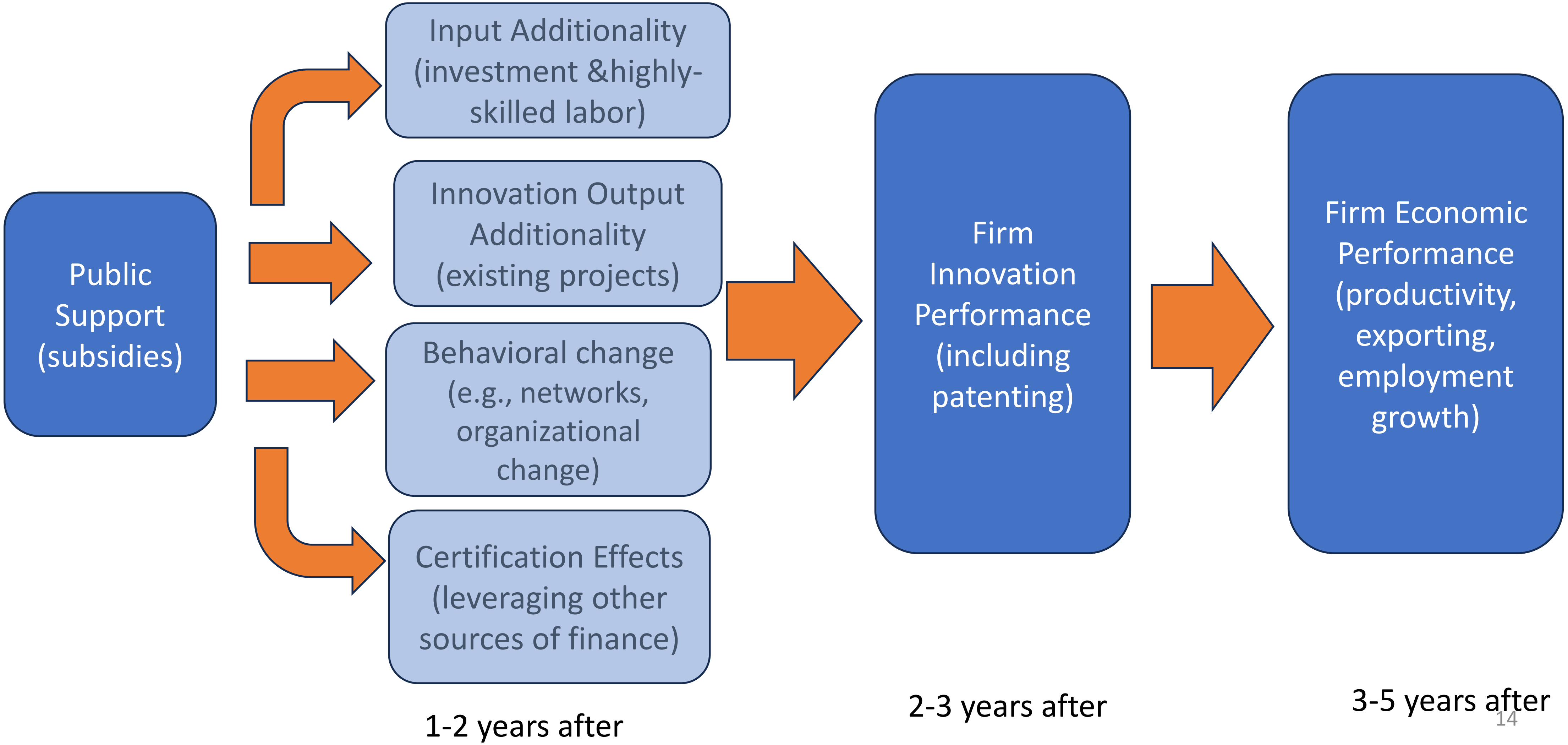
  1) Business Innovation projects : with the goals of developing or improving new or significantly improved products, processes, or organizational innovation, as well as the adoption of new technologies to support innovation targets.

  2) Research-oriented collaborative programs: More research-oriented and involving public S&T actors and university partners.
- Competitive Process (eligibility criteria and panel evaluation)
- Other advantages (directionality, adaptability to sector-focus..)

Policy Impact and Effectiveness

- *First order question*: How much did the policy leverage firm investments after intervention?
- How much the firm would have invested if she had not received public support for innovation projects? (e.g. Lach, 2002; David and Hall, 2000).
- *Second-order objective*: How much the policy intervention helped improved innovation results and contributed to firm sales, employment, & productivity?
- *Ultimate goal:* how the intervention promoted innovation and productivity improvements beyond beneficiaries through knowledge spillovers.
- *Net effectiveness*: Full cost-benefit analysis; including operating/compliance costs ("average additionality") (Lachj, 2002; Hall, 2001), spillover and welfare effects.

Public support (subsidy) affecting performance through different channels: "direct effects"



Why innovation subsidies might not work?

Effective (Crowding-in)

- Reduces the costs of investment and encourage firms expand efforts (extensive margin)
- Reduces costs of entry into R&D/innovation - (intensive margin)
- Enable private finance: “signaling” or “certification effects” of firm projects (Feldman & Kelley, 2006).
- Enable access to specialized research expertise and public S&T infrastructure.

Crowding-out or null impact

- Agency risk aversion -favoring strong performers (low risk/most innovative projects–which may have been undertaken even without support)
- Potential substitution due to higher costs of research inputs entailed by increased demand (HC fixed in the short run).
- Problem of political capture (see China evidence by Fang et al., 2018).

What do we know from HICs?

- Recent research more unanimously rejects crowding-out; but varying impacts across countries (Zuniga-Vicente et al., 2014; Becker, 2015; OECD, 2019).
- Average additionality (per public dollar) close to 1 (Appelt et al., 2019).
- Mixed findings regarding innovation outputs, but recent research points to additionality effects in radical innovation (collaborative programs)
- Medium and long-term effects
- Inducing effects (intensive margin) especially in technologically-weak regions, low R&D performers and low/medium high-tech sectors (EU)
- Stronger effects in SMEs and young firms (e.g. Appelt et al., 2019; 2022).
- More effective programs are those having complementary support (e.g. advisory services, training..).

Risks of lack of impact in MICs –

- Institutional capabilities in maturation or lagging
- Jumping into second- or third-stage level policies without first-stage capabilities (absorption capacity)
- Uptake limited by lack of skills and complexity of procedures
- Risk of capture by S&T communities (in collaborative approaches) and leading firms –mostly because of policy/innovation experience
- Weak work on bridges between public S&T and private sectors

Impact Evaluation studies in MICs

- A voluminous literature for HICs available; more limited for MICs but expanding.
- For this report, we focused on empirical studies with the following features:
  - ➢Studies from mid-2000s dealing with sample selection and endogeneity of treatment; and if possible, unobserved heterogeneity.
  - ➢A total of 42 evaluation studies between the years 2006-2022. Most of them use innovation surveys, or firm surveys matched with list of beneficiaries.
  - ➢A combination of short-term studies (two-three years span) and panel studies; but the latter are more limited.
- Difficult to conduct a meta-analysis (MRA) (differences in outcomes –some evaluate investments, some others evaluate outputs; not enough obvs. per group)
- Limitations of country-level approaches (context, implementation capabilities..)

Evaluation challenges and methods

- Identify causal effects; dealing with endogeneity and selection bias – i.e., allocation of subsidies is not a random process (Klette et al., 2000; David et al., 2000).
- Quasi-experimental methods including matching methods, regression discontinuity designs (approaches a natural experiment), IV and endogenous treatment models, and panel methods.
- Counterfactual analysis allows comparison with comparable firms (control groups) while helping with selection bias whereas fixed effects address unobserved heterogeneity.

Findings from Impact Evaluations

Innovation subsidies in MICs

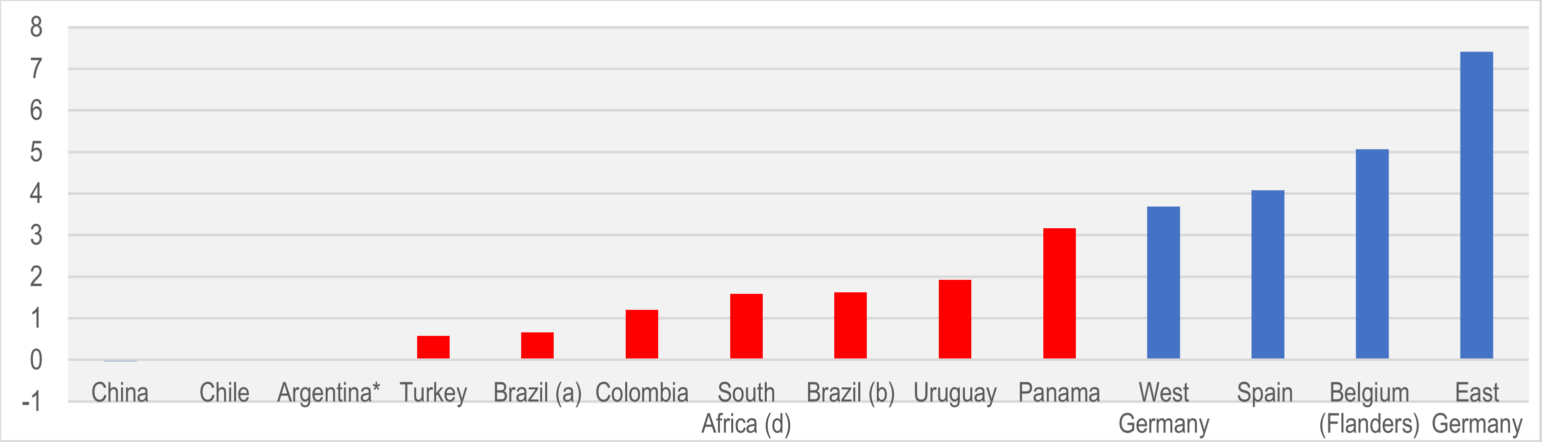
Do they leverage private investments –after intervention?

- Evidence of crowding-in effect ("input additionality") more predominant than "crowding-out" or null effect (15/23 studies) especially in recent research.
- Evidence of "behavioural" change (but few studies available): increased collaborative linkages with exernal actors (e.g. Chile, Argentina, and Poland); increased use of external knowledge, new partnerships, etc.
- More mixed evidence for China and Poland (no significant impact or crowding-out effects): Boeing (2016); Cheng & Chen, 2006).
- Impact at the extensive margin stronger (entry of new performers).

Input Additionality from public funding support for innovation : 15 out of out 23

Type of Study	Papers	Methods	Private R&D investment/ intensity	Total Private Innovation Investment/Intensity
Counterfactual Analysis/ DID estimation	10 papers Crowding-in (+)	PSM /Single Differences	• Brazil (FNDTC/ADTN) • South Africa • Panama	• Uruguay • Panama • Paraguay
		PSM and Conditional PSM DID estimation (with PSM)	• Argentina • Turkey • Brazil	• Panama • Argentina
	3 papers crowding-out (-)	PSM/DID DID	• Chile (services) • China (Listed)	-----------------
	3 papers: No sig. impact	Fixed Effects/DID with PSM	• Argentina • Poland	• Argentina
Structural Models/IV-Instrumental	2 papers	2SLS and Matching (PSM)	• Central Eastern European firms • Colombia	----------------
	3 Papers Crowding-in	GMM/Arellano&Bond	• China (R&D personnel)	• Turkey and Poland • Colombia
	1 Crowding-out	GMM/IVs	• China (R&D investment)	-----------------
	No impact (1 paper)	IV/2SLS		• Poland (only significant in non-exporters)

Figure 3: Impact of R&D subsidies on private R&D intensity (PSM estimates) -short run impact
(*one or* two years)- percentage points difference between treated and control



Sources: Estimates from PSM estimation (first difference) are reported or coefficients from fixed effect regresion (with PSM); evlauations are conducted within the first and three years after intervention. Estimates for Argentina refer to private innovation investment. Estimates for China and Chile are non-significant.

Impacts (ATTs) on R&D (intensity) are significant but smaller than HICs.

For MICs, R&D looks more difficult to leverage than other forms of innovation investment (capital and machinery, technology purchasing..).

Note: Comparison of ATTs across countries –with care (periods differ; policy mix differ, etc.).

Output additionality: findings in MICs

- Evidence of innovation output additionality (product and process) -mostly taking place in the medium-run.
- Predominance of “process” innovation over “product” innovation.
- Weak or no-significant impact on patenting - few exceptions (e.g., Poland: Bruhn and McKenzie, 2019; China: Chen & Cheng, 2016).
- Positive impacts reported on firm productivity, employment growth, and new product lines in panel data studies : Colombia, Brazil, Poland, CEE, Costa Rica, and Chile -- impact taking place between the third-fifth year after intervention (Castillo et al., 2020).
- Some evidence on exporting propensity (e.g. Costa Ria and Colombia).
- Mixed results (productivity) for China (Branstteter et al., 2019).

Collaborative Programs with S&T institutions

- Address the need for more complex knowledge and technology by facilitating access to research expertise and infrastructure at public S&T institutions
- Examples: FONDEF (Chile), FNDTN (Brazil), PROPyME Fund (Costa Rica), (Poland)
- Although they are more difficult to set-up, they are particularly relevant for promoting knowledge transfer from public institutions to private sector.
- Main findings:
  - More lasting effects on productivity than traditional innovation subsidies programs (see Alvarez et al., (2012); Crespi et al., (2020), Monge, 2015).
  - Promote spillovers more than individual projects given the more basic nature of R&D (Chile: Crespi et al., 2020).
  - Associated with new product introduction and more radical innovation) and patenting in EU countries (see Bruhn and McKenzie (2019) for Poland).

Firm heterogeneity

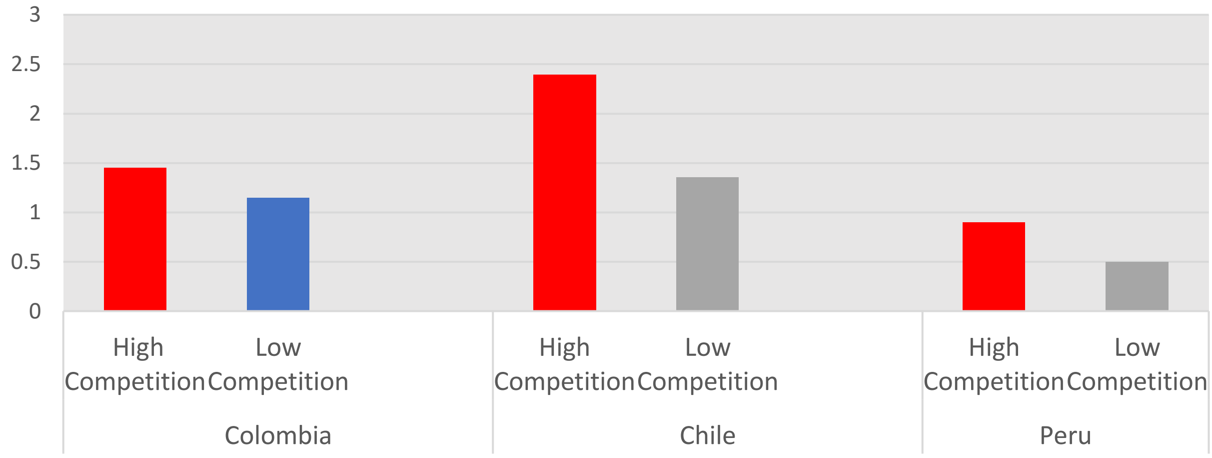
- The effectiveness of innovation policies in leveraging additional R&D and innovation investment may differ across different types of firms.
- Pros and Cons : Large firms – concentration risks vs. spillovers opportunities (Bloom et al., 2013) plus product innovation capacity.
- Interventions are found more effective in fostering crowding-in effects in firms with higher financial constraints –in SMEs and young firms –but research still limited (e.g. difficulties to evaluate sub-groups -DOF).
    - Small Firms: Turkey (Ozcelik and Taymaz, 2008), Israel (by Lach, 2002), and China (Boeing, 2016; Guo *et al.,* 2016; Cheng and Cheng, 2016),
    - Young firms: For Argentina, crowding-in effects only appear in small and young firms (<7 years) – and the response in young is the highest (Pereira et al., 2018;)

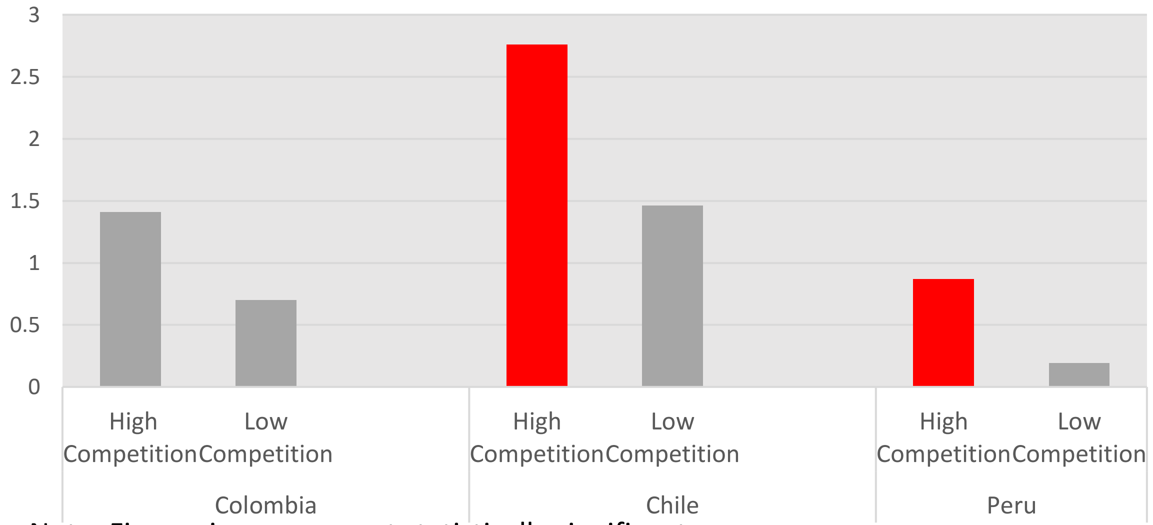
Does competition matter to policy effectiveness?

Should market context be taken into consideration in policy design?

- Innovation-incentives from competition -neo-Schumpeterian growth models (Arrow, 1962; Aghion and Howit, 1992; Aghion et al., 2005) –up to a point.
- Innovation incentives decrease with distance to the frontier (Aghion et al., 2009).
- Competition may help promote innovation and technology adoption due to technology spillovers –especially in new technologies (e.g., cloud computing in Ben Yousseff et al., (2015) or solar panels (Hancevic and Sandoval, 2023).
- Competition may leverage impact of interventions (Ackigit et al., (2018) on the impact of R&D tax credit in the early 1980s in US). Three mechanisms central to firm R&D decision in open markets: (i) a “defensive” innovation motivation; (ii) market expansion effects (which increases returns to R&D), and (iii) technology spillovers.

High Competition vs Low Competition: ATT effects on Innovation Investment per employee (log) (PSM/DID) - Lerner Index Definition (Kernel Matching (a) and NN-1 (b))





Note: Figures in grey are not statistically significant.
Sources: Benavente and Zuniga (2021) and initial results for Colombia (Holguin and Zuniga, 2024).
Datasets: Innovation Surveys 2015-2020 (Colombia), 2013-2018 (Chile).

- Preliminary evidence suggests that in Colombia, Chile and Peru, the impact of innovation funding programs is larger or only significant in high-competition sectors (Lerner Index).
- A similar finding reported with alternative matching methods, and competition indicators, including HHI and entry rate.

Indirect impacts : Spillovers

- Empirical research still limited (in both HICs and MICs)
- Methodological challenges
- Externalities can be positive or negative:
  - Negative: –Business stealing effects (Bloom et al., 2003) & price effects.
  - Positive: -inducing innovation and performance in others: Knowledge spillovers from mobility of personnel (Moen, 2005; Foster-McGregor and Posch, 2018) and market linkages.
- Understanding the potential of mechanisms through which they develop and how policies can maximize positive externalities (social returns) and limit negative ones (e.g., competition law) is key

Some emerging evidence- with converging points:

- **Substantial spillovers through mobility of personnel** towards non-supported firms (employment, productivity and exporting)-: Argentinian firms (Castillo et al., 2020).

- **Vertical spillovers more than horizontal spillovers (intra-sector sectors).**
  - Supplier sectors –especially from high-tech services (China: Guo & Haochen, 2022).
  - Downstream sectors -no effects from intra-sector support (HICs: Appelt et al., 2023).

- **Spillovers more likely to develop from "collaboration" programs**; evidence from Chile (FONDEF): spillover impact from support only significant when coming from collaborative public-private collaboration (Crespi et al., 2020).

- **How to promote spillover impact?**

Other findings from recent research: instrument complementarities

- Joint reinforcing effects of policies has been reported for the use of innovation subsidies and loans (see Huergo and Moreno, 2017).
- Combining "supply-side" support measures (funding) and "demand-side" (e.g., for Eeastern European firms see Stojcica *et al.*, 2020).
- Also, higher additionality effects when firms are engaged simultaneously in collaborative (technology oriented) programs and business innovation programs (e.g. Fontec and Fondef in Chile).
- Complementarities between advisory services and innovation subsidies (Caloffi et al., 2022).

Policy implications and future research

Key messages (1)

(i) Innovation funding programs can support the building of innovation capacity and firm performance and are especially more effective at the extensive margin.

➔Attention to entrants and support measures to new performers (i.e. linking with S&T actors; project support, etc.).

➔ complementarities with other capacity building programs/advisory

(ii) Spilllover-dimension and supportive policies for externalities:

➔ Projects with large externality potential: collaborative schemes with S&T institutions

=> promotion local productive/vertical linkages, fluidity in markets, development of knowledge and technology services markets.

Key messages (2)

(iii) Size-oriented interventions. Are these results conclusive? Non.

- Difficult to diagnose financial constraints –and other failures exist.
- It may be not the size (small size) what matters, but the innovative potential of young (small) firms –
- Spillover considerations and market allocation effects to investigate.

(iv) Evidence on tax incentives more mixed but still limited for MIC

- Less suitable for entry in R&D/innovation –but can be attractive for young (technology-based) firms -with enabling design

Final comments: Scale matters for impact and spillovers. Despite their potentialities and impact opportunities, innovation funding and collaborative programs remain tiny in most MICs.

Thank you!

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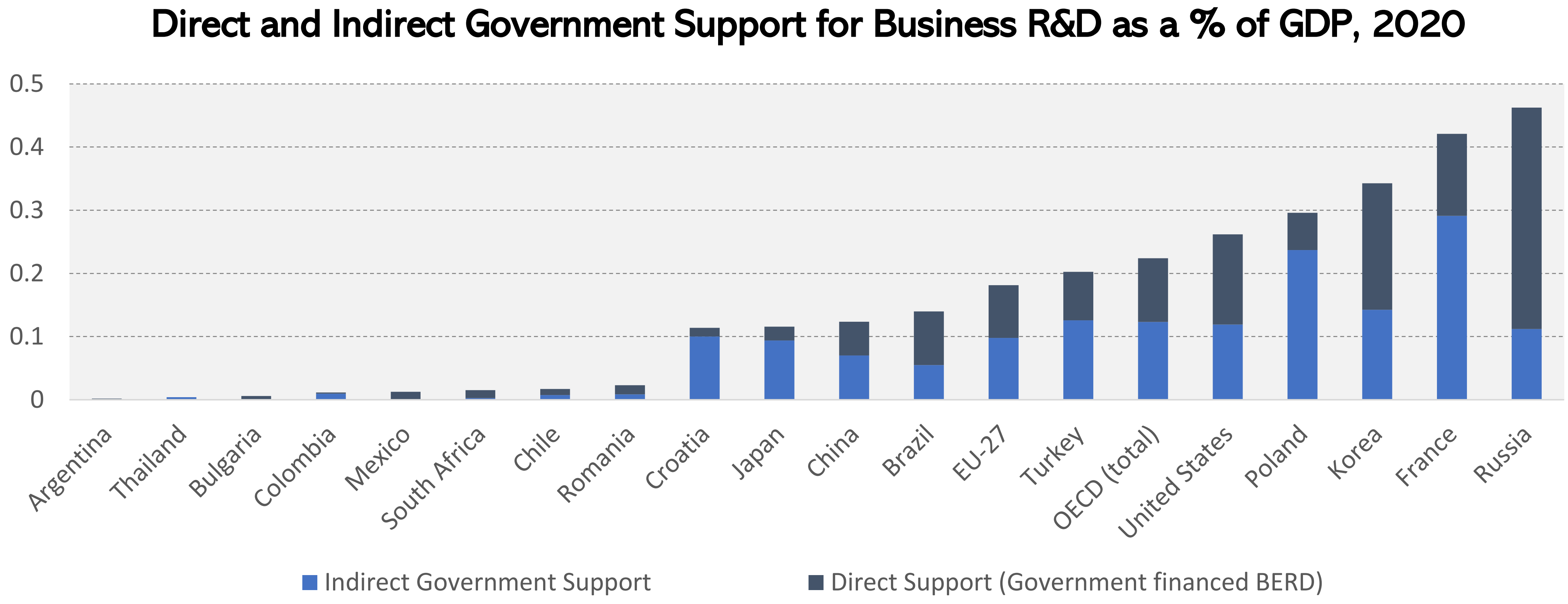


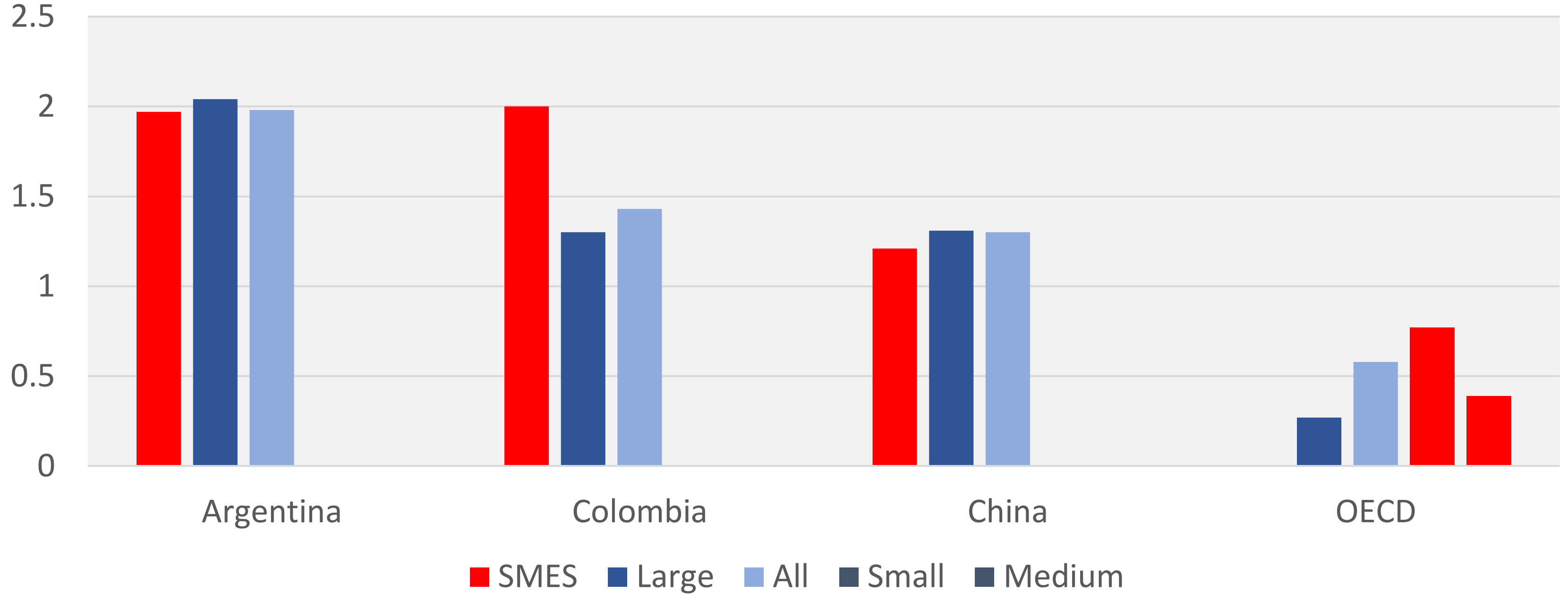
Direct and Indirect Government Support for Business R&D as a % of GDP, 2020
0.5
0.4
0.3
0.2
0.1
0
Argentina
Thailand
Bulgaria
Colombia
Mexico
South Africa
Chile
Romania
Croatia
Japan
China
Brazil
EU-27
Turkey
OECD (total)
United States
Poland
Korea
France
Russia
Indirect Government Support
Direct Support (Government financed BERD)

Additional slides

At the end..

- Public support for business R&D and innovation remains tremendously small in MICs (almost peanuts –less than 0.025% of GDP in Mexico, South Africa, Romania, Thailand, etc.- as opposed to 0.22% of GDP in HICs), with exception of Brazil, Poland, Turkey and China.
- Majority of subsidies in MICs goes to the acquisition of machinery and capital assets for which other types of instruments could be used given their lower risk (loans and guarantees).
- Supported firms through funding programs do not have a sufficient scale for impact (less than 100 firms supported in Colombia)

Figure 3: User cost elasticity for R&D Investment (long-run): Differences across firm sizes



Sources: Argentina (Crespi et al., 2016); Colombia (Mercier-Blackham, 2008), OECD (Appelt et al., 2020), and China (Chen et al., 2016).

Note: The studies for Argentina, Colombia and China use data for manufacturing firms while the study of OECD uses data for all economic sectors. The study of OECD (2020) uses firm-level data for 20 OECD countries. The estimates for Argentina refer to investment in total innovation (R&D plus expenditures in machinery, equipment, software, etc.).

R&D/innovation tax incentives: main findings

- Still experimental in MICs, policy implementation and design challenges
- Low uptake, biased to large firms: limited applicability to small and young firms (Brazil, Chile), tax control avoidance by firms.
- Mixed findings but quite few studies
- Argentina: Limited impact on R&D but high response in capital investments
    - A weak elasticity of private R&D with respect to user cost (lower than -1) in: Turkey, Brazil, Taiwan, Argentina, and Ecuador. But superior to one in Colombia and China.
    - A high elasticity in tangible investments (machinery) to user tax costs–evidence from Argentina and Ecuador (Crespi et al., 2017)
    - Multiplier effects low (Taiwan & Turkey: <than 0.5) (1in HICs).

Responsiveness to R&D/innovation tax incentives: Mixed Evidence but much less research

<table>
<tr><th>Type of Study</th><th>Methods</th><th>No. of studies</th><th colspan="2">Findings per category</th><th>Countries</th></tr>
<tr><td rowspan="2">Counterfactual and DID estimation</td><td rowspan="2">Conditional PSM
DID or DID with PSM</td><td rowspan="2">7 papers
(cross-section/short panels)</td><td>R&D investment
R&D intensity</td><td>(+ sig.)
(5 papers)</td><td>• Brazil
• Turkey
• India</td></tr>
<tr><td>Hiring of Researchers/innovation personnel</td><td>(+ sig,)
(3 papers)</td><td>• Mexico
• Brazil</td></tr>
<tr><td rowspan="3">User-cost elasticity studies
(Structural Modelling)</td><td rowspan="3">IVs and GMM</td><td rowspan="3">4 papers
(panel)</td><td rowspan="2">User-cost elasticity (R&D)</td><td>>|-1| (absolute value of elasticity)
(2 papers) (sig.)</td><td>• Colombia (1.43)
• China (1.3)</td></tr>
<tr><td>< |-1|
(4 papers) (sig. in 3/4)</td><td>• Ecuador (R&D)
• Argentina (R&D),
• China (High Tech)
• Taiwan</td></tr>
<tr><td>User cost elasticity (Innovation or Capital Investment)</td><td>>|-1| (2 papers) (sig.)</td><td>• Argentina, total and M&E (1.5);
• Ecuador (1.3)</td></tr>
</table>

Fiscal Incentives for R&D in in MICs

- Market-driven instrument; less room for policy direction on the nature of projects; more suitable for existing performers.
- R&D tax incentives seek to promote R&D activity by reducing the user cost of R&D and encouraging private companies to increase their innovation efforts.
- Different formats: credits, discounts, allowances, accelerated depreciation or amortization, etc. that apply to incurred expenditures (or outputs).
- Growing use in MICs: China, India, Thailand, Russia, Brazil, Chile, Argentina, Colombia, South Africa, Turkey, among others.
- In MICs , tax incentives apply to both internal and external R&D and other forms of innovation investment such as technological equipment acquisition and hiring of S&T/innovation specialists associated with R&D.

16. R&D/innovation tax incentives: the findings

- Low or moderate marginal effects on private R&D investment but large responsiveness (crowding-in or higher elasticity rates) in terms of overall innovation investment.
- A weak elasticity of private R&D with respect to user cost -i.e., lower than one -, has been found in several empirical studies (Turkey, Brazil, Taiwan, Argentina, and Ecuador) but superior to one in Colombia and China. A lower multiplier effect has been found for Taiwan and Turkey.
- In OECD countries this elasticity is larger than one; see Appelt et al., (2020); Guceri et Lou (2016) and Dechezlepettre et al., (2018), with a multiplier effect of 1 (one additional $ dollar in private investment per public $).
- In contrast, a very high elasticity of tangible investments (M&E) to user costs –has been reported for Ecuadorian and Argentinian firms (Crespi et al., 2017).
- Evidence that R&D tax incentives can encourage and help firms to employ highly skilled workers, which helps enhance firm innovation performance (e.g. for Brazilian firms see Kannebley et al., 2013; Gama e Colombo & Noguera da Cruz, 2021; for Mexican firms see Chávez, 2020)
- Policy implementation and design challenges in MICs –low uptake; policing and auditing.

Empirical evidence on the interplay competition and innovation policy effectiveness

- In cross-country studies, empirical research tends to confirm the existence of complementarities between market competition (e.g., proxied by product market regulation or market indicators) and the impact of innovation policies in fostering R&D and patenting (e.g. Criscuolo et al., 2014; Andrews et al., 2015).
- For Chinese firms: Evidence that industrial policies are more effective when they induce or support greater competition -according to research by Aghion et al., (2018), and especially when targeting younger firms.
- For EU firms, more mixed evidence by Freitas et al., (2015) and Murin and Sasmarin (2021).
- For LAC countries: The impact (crowding-in) of innovation subsidies on firm private investment in more competitive sectors is found two times larger he impact in less competitive sectors or only significant in these sectors – in a counterfactual study (Zuniga and Benavente, 2021).