Design and Evaluation of Fiscal Incentives for Business Innovation in Latin America: Lessons Learned After 20 years of Experimentation

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Abstract This chapter presents the most important recent trends with regard to the design and evaluation of fiscal incentives for the support of business innovation in LAC. Several countries in the region have been experimenting with these policies since early 1990s, in many of these cases with technical and financial support from the Inter-American Development Bank. In contrast with the OECD countries, the LAC's business innovation support framework is clearly biased toward direct transfers to the private sector. Just a few countries have more recently started to experiment with tax incentives. However, in comparison with the international best practices, the fiscal budgets allocated to these programs are rather meager. To some extent, business innovation policy in the region is still in its infancy. Despite this, many of these pilot programs have already been assessed and this chapter takes advantage of the existent wealth of studies in order to provide a qualitative meta-analysis of the most pioneer programs in operation since early 1990s. They main conclusions are rather straightforward: There is clear evidence of a positive impact on investments (input additionality). In other words, fiscal incentives have been effective at the moment of increasing firms' investment in innovative projects and not only that they have been also effective in leveraging private resources for this investment. However, the studies also found that different financing mechanisms have varying impacts on different group of beneficiaries. Although it seems that the risks of crowding-out private investments are lower in the case of programs based on subsidized loans or tax incentives, matching grants seems to be more effective in the case of new innovators or at the

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moment of fostering linkages between firms and universities. An important policy recommendation from the different studies is that matching grants programs are a very powerful tool, which impacts might be maximized when they focus in these activities. With regard to output additionality, impacts also seem to be positive whenever enough time has elapsed since the support was approved. Indeed, the different studies that looked at output additionality suggests that positive impacts in labor productivity might be significant—in the range between 5 and 25 %—but that results start to show up only after three to five since the start of an innovation project. The chapter also indicates that the main considerations of design should be taken into consideration at the moment of increasing the efficiency of these programs and at the same time minimizing problems of moral hazard.

1 Introduction

Since the beginning of the 1990s, several Latin American countries have witnessed a systematic growth of public programs aimed at enhancing firm-level innovation and technological upgrading. The overarching justification for these programs is that the market has failed to provide the incentives needed to reach an optimal level of private investment in innovation activities.[1] Therefore, Latin American firms have failed to adopt modern technologies and business practices that would have helped them to improve their productivity and competitiveness.

In this context, several Latin American countries have introduced various types of fiscal incentives to stimulate innovation activities and to strengthen the linkages among firms and other agents in the National Innovation System (NIS).[2] The first of these fiscal incentives program was started in Chile in 1991 and since then they have spread throughout the region in the extent that nowadays about 70 % of the countries in LAC have put in place some form of fiscal incentive program for innovation.

Almost 20 years have already elapsed since then and pari passu with the experience accumulated with the actual implementation of these policies, a systematic amount of evidence and methodological learning has been produced

[1] Investments in innovation activities include both tangible (machinery and equipment, computer hardware, etc.) and intangible components (research and development, design, software development, etc.).

[2] Metcalfe (1995) states that NIS is "that set of institutions that jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store, and transfer the knowledge, skills, and artifacts, which define new technologies. The element of nationality follows not only from the domain of innovation policy but also from elements of shared language and culture that bind the system together and form the national focus of other policies, laws, and regulations that condition the innovative environment."

with regard to the effectiveness of these incentives to alleviate the different market failures that hinder innovation and productivity in the region. The aim of this paper is to carry out a qualitative "meta-analysis" of these programs (and their respective impact evaluations) in order to take stock of the learning achieved so far and provide specific recommendations of how public policy should be better designed in order to maximize additionality and productivity impacts.

This chapter is structured around the following sections. Section 2, after this introduction, provides the context of this chapter by presenting a short overview of the regional innovation performance over the last 20 years. Section 3 summarizes the different rationales that justify public policy intervention with regard to business innovation. Section 4 presents the landscape of different policies interventions in the region and describes their main characteristics with regard to how they have actually been implemented. Section 5 presents a "meta-analysis" by making a comparative analysis of the most recent evaluations done so far. Section 6 concludes with a summary of the emerging issues with regard to the design of future innovation policies.

2 Innovation at a Glance: The Regional Landscape

On average, Latin American and Caribbean countries underperform other developed and developing countries in terms of productivity growth. This poor productivity outcome explains why the region has shown very modest economic growth in the last 30 years and why, despite unusually favorable international conditions over the last half decade, the region still lags behind other regions in terms of economic growth. Indeed, the top left panel of Fig. 1 shows the evolution of the productivity gap between the typical LAC country and the USA. Taking into consideration that the productivity gap has been normalized to one in 1960, the figure clearly indicates an increase in this gap since then. In other words, the productivity gap of the region with regard to the USA—which is normally taken as the proxy for the best practice frontier—is today about 60 % higher of what it was in 1960 (IDB 2010a). This situation is pretty unique to the LAC region, as other regions in the world have managed either to keep track with the best practice frontier or to catch up with it.

Innovation broadly defined as the introduction of new products or processes by firms has been credited as the ultimate engine of productivity growth by a vast amount of economic literature.[3] The entrepreneurs, motivated by profit, look for better—meaning more efficient—ways of doing things that can be commercially viable, and in the process they come up with new routines, production arrangements, materials, or machinery that saves costs and/or improves output's quality.

[3] The OECD defines innovation as "new products, business processes and organizational changes that create wealth or social welfare" OECD (2005).

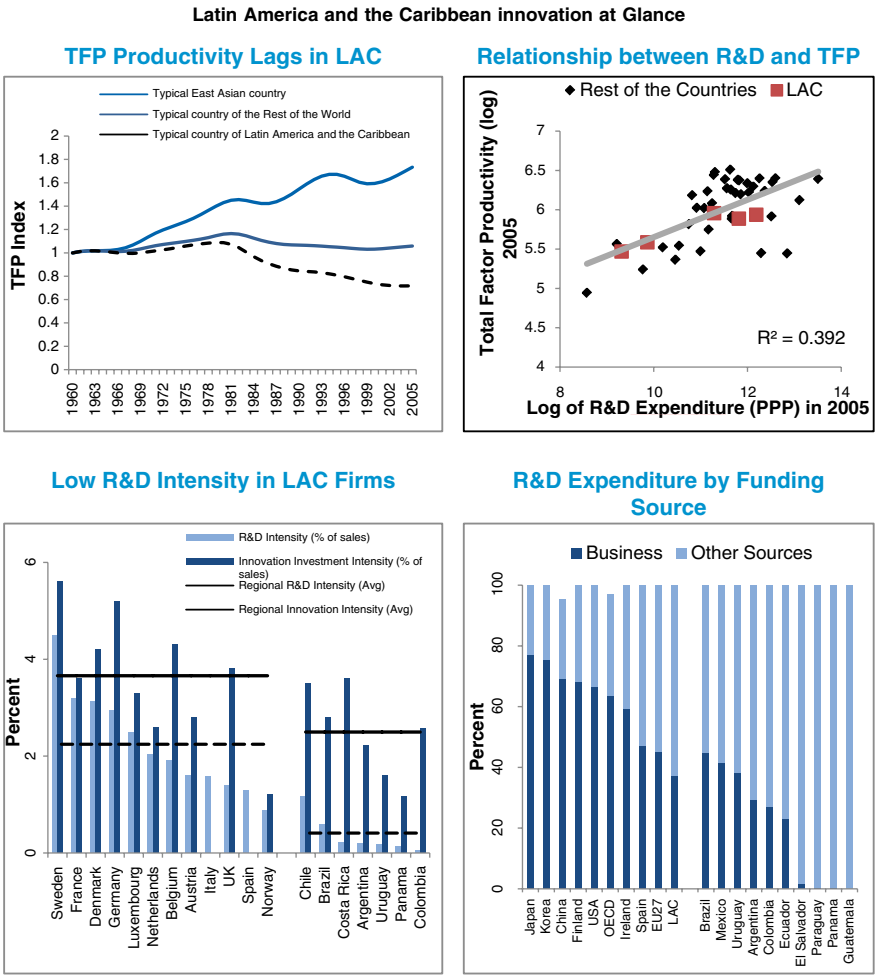

Fig. 1 Latin America and the Caribbean innovation at Glance. *Source* IDB (2010b)

In fact, the top right panel of the Fig. 1 shows that there is a positive and statistically significant correlation between productivity and investments in R&D across a large cross section of countries, the strength of this correlation suggests an investment with high social return rates, and indeed, about 40 % of the variations in productivity in the sample are due to variations in investments in R&D.

Yet it is also a well-established fact that firms in Latin America register what appear to be sub-optimal levels of investment in innovation (both the tangible and intangible components). Certainly, the bottom left panel of Fig. 1 compares the business innovation investment rates across a sample of OECD and LAC countries where information is available and internationally comparable. The figure also shows the average investment rate for these two regions, suggesting two clear

findings: (1) average innovation investment rates are clearly lower in LAC than in OECD countries and (2) that the investment gap among these two regions is particularly severe in the case of the intangible component of that investment—which is R&D.[4]

Figures available at the macro-level indicate not only that the general level of expenditure in innovation is low by international standards, but also, notoriously, that most of the innovation investment in the region (about two-thirds of it) is directly performed by the public sector (see the bottom right of Fig. 1). This is in stark contrast with OECD and successful catching-up economies, where about two-thirds of innovation investments come from private sources. This is also confirmed by micro-evidence that suggest that, more often than not, innovation is not a preferred path for many Latin American firms, in their search for profitability, the opening of new markets or the consolidation of advantages relative to competitors (IDB 2010b). Such a weak propensity to engage in innovation activities by the private sector is all the more noteworthy given that studies that have looked closely at the profitability of innovation in Latin American firms show consistently positive returns (Crespi and Zuniga 2011). Such a reluctance of the private sector to invest in innovation has been traced to a set of ailments that hinder the private returns of these investments at the firm level.

3 The Rationale for Innovation Policies

The fundamental premise for innovation policies is that government intervention would be necessary if profit-driven actors underperform with regard to the production and/or exchange of technological knowledge from a social welfare perspective (Steinmuller 2010). The economics of innovation literature has provided several rationales as to justify that indeed this is the case. Broadly speaking, the rationale for public policy in this field can be articulated around the following considerations:

1. *Spillovers and the "public good" nature of knowledge*.

Since the seminal works by Nelson (1959) and Arrow (1962), scientific and technological knowledge has been regarded as a non-excludable and non-rival good. In the extent that private benefits associated with knowledge creation are not fully appropriable by the innovators, this creates a wedge between the private and social returns of knowledge investments, leading to a rate of investment in knowledge

[4] Although it is true that R&D investments are normally more oriented to the introduction of innovations with a high level of novelty—in other words, they are targeted to innovations that push the technological frontier—there is also an important consensus in the literature that a minimum level of R&D is also necessary in order to create enough absorptive capacities as to search for, adopt, and adapt already existent technologies to the local contexts. The concern is that not even this minimum level is reached in the region.

that will fall short from socially optimum levels. This rationale applies not only to the *levels* of innovation efforts but also to the *direction* of these efforts. Certainly, the "public good" rationale of knowledge applies more strongly in the case of *scientific* rather than *technological* knowledge.[5] In the extent that the latter is more applied, predictable and linked to firm specific assets, it is more likely that innovators will be able to collect a larger share of the value of innovation to society, and so that private sector investments in technological knowledge would be closer—though not equal—to the optimum social levels.[6]

2. *The problem of asymmetric information.*

The economics of information literature (Stiglitz and Weiss (1981) makes clear that asymmetric information in market transactions (due to the problems of adverse selection and moral hazard) can affect firm innovation from two different perspectives. From the perspective of investment theory, innovation projects have several peculiar characteristics, which differentiate it from ordinary investment (Hall and Lerner 2010). *First*, innovation projects are riskier than physical investment projects. Consequently, external investors might require a higher risk premium for the financing of innovation activities. *Second*, because of the problem of spillovers, innovators are themselves reluctant to share information about their projects with potential outside investors furthering worsening the asymmetric information problem. *Third*, the difficulty of using intangible assets as collaterals also leads to increased costs of external capital in the form of a higher risk premium. In summary, asymmetric information would lead to a wedge between the opportunity cost that private innovators require to their innovation investments and the capital cost that external investors are willing to charge to finance innovation projects, the result will be that privately (and eventually socially) profitable innovation projects will not materialize due to the fact that financing costs are simply too high.

The second perspective on how asymmetric information affects innovation concerns to knowledge dissemination and it relates to the fact that private actors do not have "perfect information" on technology or production possibilities. In the same way, adverse selection and moral hazard problems also extend to the (imperfect) operation of technology markets. This claim is consistent with two empirical findings: (1) that there exist persistent differences in the technological performance between countries and so that catching-up is very far from being an automatic process consistent with the idea of knowledge as a global public good

[5] On the other hand, projects with a significant component of basic research are unlikely to produce results with commercial application in the short run. Although this may discourage private investments, the projects could still have a high social return because of the skills and knowledge produced during their development, apart from their final achievements.

[6] The applied nature of technological knowledge also made it more likely of being protected by intellectual property rights. However, this by no means implies that firm investment in technological knowledge will be socially optimum, appropriability problems also exists in the case of this knowledge as the coverage offered by intellectual property rights protection is usually limited.

(Fabegerber and Verspagen 2002) and (2) that the process of technology diffusion, even within narrowly defined industries, is very sluggish leading to a persistent firm heterogeneity in productive performance (Disney et al. 2003).

3. *The pervasiveness of coordination and institutional failures.*

A key contribution of the innovation systems literature is that knowledge has non-negligible tacit components and as such innovation is the result of feedback and interaction involving numerous actors (Lundvall 1992). Although many of these interactions are market mediated, a large proportion of them are governed by non-market institutions. *Because the efficiency of this process at the macro-level depends on the behavior of individual actors and the institutions that govern their interaction, coordination problems might arise* (Soete et al. 2010). A nice example where these coordination problems could emerge refers to the setting of standards that regulate producer–user interactions in the case of General Purpose Technologies (GPTs). GPTs are a set of technologies that spread out across different economic activities leading them to innovate as well. Progress in the adopting sectors feeds back into GPTs developers, generating a process of sustainable growth (Bresnahan and Trajtenberg 1995; Aghion et al. 2009). It is also clear that the way about how these technologies contribute to growth is not only through the development of GPTs intensive sectors per se (the supply side) but also, and even more critically, through the development of the *complementary* innovations that facilitate their wider adoption across the *other* sectors of the economy, which start to innovate as a consequence of this. This requires the solution of coordination problems. The solving of the coordination problem requires not only putting attention to the linkages among the actors but also to their absorptive capacities (Cohen and Levinthal 1989). The concept of absorptive capacities is a key ingredient of the new literature of innovation, in particular from the perspective of catching-up economies. Following Steinmueller (2010), the concept of absorptive capacities refers to fact that new knowledge might not be employable without heavy co-investments by the users in corresponding human capital and learning; furthermore, it also implies that the new knowledge might not be reproducible without the direct assistance of the originator.

In the extent that human interactions are governed by institutions, the innovation systems literature puts a strong emphasis on institutional governance and change. These refer to institutional design arrangements that foster public–private interactions and at the same time minimize problems of moral hazard. Institutional change interventions refer also to arrangements that build linkages between the different actors involved in the innovation process (such as universities, public research organizations, technology producers and users, and consumers) either by defining new roles to already existent institutions (such as allowing the patenting of university research in order to encourage technology transfer) or by creating clubs or consortiums that regulate interactions between the agents (Steinmueller 2010). These sorts of arrangements may lead to a better equilibrium either because innovation costs are not duplicated in separate efforts that lead to identical results or several externalities are internalized. In this case, public intervention is often

required to reduce the transaction costs that may hamper the formation of the joint venture and to regulate their activities in order to achieve the desired balance between cooperation and competition.[7]

4 The Implementation of Innovation Policies in LAC

The previous analysis offers different conceptual frameworks that justify the implementation of innovation policies based on the idea that profit-seeking agents will produce both a level and direction of knowledge investments, which will fall short from socially desirable outcomes. Following David et al. (2000), broadly speaking public policy has suggested two main approaches in order to solve the under provision of innovation efforts by private firms: (1) direct production of knowledge in public institutions (laboratories and public research institutes) and (2) fiscal incentives for a greater amount of private investment in knowledge generation. Without ignoring the importance of government investments in public research organizations, the issues related to the governance, funding incentives, and productivity impacts related to the operations of these organizations are enough complex as to require a far more specific focus than the scope of this chapter. Regardless to this, in this chapter, we will specifically focus on the second class of policy designs, in particular given their growing importance in the LAC region. In particular, we will focus on two particular classes of fiscal incentives: direct subsidies and tax incentives, without ignoring that other types of incentive designs are also available (such as adoption subsidies, technology acquisition policy, signaling strategies, information diffusion policies, thematic funding, and entrepreneurship programs); however, the empirical evidence and learning accumulation on the impacts of these other designs in the region is far more limited.[8]

Both direct subsidies and tax incentive schemes have been in place in the LAC region since early 1990s and more countries seem to be eager to adopt them. Figure 2 summarizes the degree of penetration of fiscal incentives for innovation in LAC, and it compares it against the OECD countries. In the OECD, almost 80 % of the countries have implemented a matching grants system and 66 % have also implemented a tax incentive, with 45 % of the countries having both of them. The degree of penetration is somehow lower in LAC. Indeed, only 65 % of the countries have put in place a matching grants mechanism and just about 30 % have tax incentives. Moreover, just 30 % of the countries have both systems in place, while 35 % have none of them. On the other hand, in the OECD there is no country without some sort of fiscal incentive for business innovation.

[7] The regulation may allow and encourage firms to coordinate their R&D investment during the first stage of a project (e.g., the basic research stage) and then force them to engage in Cournot or Bertrand-type competition in the second stage (e.g., prototype development). On this topic, see among others Martin and Scott (2000).

[8] For some references, see Steinmueller (2010) and IDB (2010a).

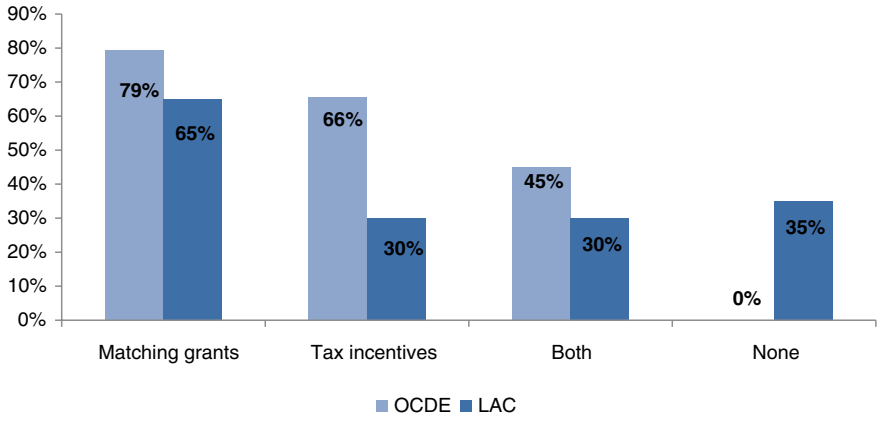

Fig. 2 Percentage of countries with fiscal incentives for business innovation. *Notes* Own elaboration using UNESCO and IDB database "Politicas e Instrumentos en Ciencia, Tecnologia e Innovacion en America Latina y el Caribe" and Table 7 of chapter Evolution of the Public Institutions of Science, Technology and Innovation in Chile: 1990–2012 of "OECD Science, Technology and Industry Outlook 2010." OECD refers to 29 countries that outside LAC present either full members or in open discussions for accession. The list includes Australia, Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Poland, Portugal, Russian Federation, Slovenia, South Africa, Spain, Sweden, Turkey, the UK, and the USA. In the case of OCDE, matching grants comprises R&D subsidies and competitive grants schemes. LAC comprises Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, Paraguay, Salvador, Trinidad and Tobago, Uruguay, and Venezuela

From a practical point of view, it is worth to emphasize the main differences between the direct subsidies and tax incentives and also their main pros and cons with regard to implementation:

1. **Direct Subsidies**: Subsidies are a type of *direct support* for business innovation which is *project-specific based*. So, they modify the firms' marginal cost of capital and may raise the private marginal rate of return of the innovation investment by, for example, inducing collaboration with other actors with complementary assets. Because they are project based, subsidies allow public agencies to target projects with perceived high marginal social rates of return. Given the problem of asymmetric information between the public agency and the beneficiary, direct subsidies might suffer from opportunistic behavior and moral hazard problems. Indeed, while the public agency might want to maximize firm's innovation efforts, private entities might aim at maximizing the size of the innovation project (and of the subsidy). However, although not fully eliminated, the moral hazard problem implicit in a direct subsidy could be controlled for by a design that considers the two following key attributes:

   (a) Subsidies are normally allocated under a *matching grant* approach with *maximum* limits and list of eligible expenses; in other words, the subsidy

never covers the full costs of the supported project.[9] It is expected that using this approach there will be a better alignment between the goals of the public agency and the firm, somehow controlling for the potential problem of moral hazard. In order words, if the beneficiary wants to increase the size of the innovation project in order to extract a higher subsidy, it will have to pay also a higher cost. Related to this, a nice feature of this cost-shared approach is that public agencies can also adjust the amount of the co-funding according to the main characteristics of the projects or the beneficiary. Indeed, in the case of innovation projects, the share of the subsidy might increase when the project implies the participation of more than one beneficiary due that is expected that projects that involved more than one firm or a firm collaborating with a university might lead to higher spillovers. Sometimes subsidies might target the fixed capital component of an innovation project (for example, the R&D laboratory or the CAD system) under the assumption that when these capabilities are available they might reduce the innovation costs of future innovation projects. Alternatively, there might be an increase in the subsidy component when the project's beneficiary is a small firm under the assumption that the intensity of market failures faced by SMEs is also higher.[10] Finally, the operation of the co-funding mechanisms is normally implemented through the ex-post reimbursement of the approved expenditures that qualify for the subsidy.

(b) Subsidies are also normally allocated using a competitive *call for proposal process*. The competitive process allows the public agency to identify the best proposals (selection based on merit) and to allocate the resources among them according to some evaluation score normally set by external evaluators or peer-reviewers. In some cases, on the top of a technical evaluation, a social cost-benefit evaluation might be carried out in order to identify the economic relevance of the project. In order to allocate the subsidies the public agencies normally put in place an adjudicatory commission formed with representatives from government, private, academic, and civil society organizations, increasing transparency and reducing the risks of capture.

However, the above-mentioned counter balances come to some costs. The main problem with the direct subsidy schemes is that they need important institutional capacities in the executing agency and when these capacities are not present the

[9] Although there are important variations in the sorts of expenditures that are eligible for the subsidy, the typical matching grant program normally pays for research variable costs (researchers' salaries, research inputs and the costs of outsourced R+D); however, in some cases, a fraction of the fixed costs of laboratory and testing equipment is also included. Some programs also include among eligible costs those expenses related with either the acquisition of intellectual property rights such as the purchase of a license or patent/trademarks application costs.

[10] Co-funding normally varies between 20 and 70 % of the overall project costs.

efficiency of the whole operation dramatically decreases. The building of these capabilities requires that two additional conditions need to be met: First, the system needs to be quite predictable in order to allow for policy experimentation, monitoring, and evaluation to take root and second that some critical mass of human capital in the executing agency and the support system is available (evaluators, peer-reviewers, etc.).[11] On the top of this, additional costs of administrating grants disbursements also should include compliance with the often-complex regulation of public fund disbursements (Steinmueller 2010). For this reason, implementation has been normally done by either newly created specialized institutions (such as innovation agencies) or by augmenting the scope of already existent institutions (such as national research councils).

A second problem with the matching grants is that, as subsidies are paid ex-post against receipts, they do not seem to be very suitable for the promotion of entrepreneurship. Indeed, if it is the case that the (new) entrepreneur is credit constrained, this type of funding may be of little help. Some designs are trying to correct for this through the inclusion of partial advanced funding provisions for new firms, but even in this case this advanced cash needs to be covered with guarantees.[12] A third problem with the matching grants approach relates to the competition process, unless several competitions are open during the year, companies might have to wait for several months until they can apply for funding, this could make the scheme less interesting in particular for firms where the market lead is a key competitive assets.[13] Finally, a fourth a key issue, when direct subsidy schemes are implemented in weaker context is that their success depends on firm's ability to identify an innovation opportunity that can be codified into a coherent project proposal. The presence of these sorts of capabilities on the demand side of the scheme is not something that can be taken for granted. Some schemes in the region are trying to mitigate for this problem by complementing the scheme with the support of small grants for project formulation or through the establishment of two-step competitions (a call for concept notes and then a call for full proposals).

[11] When these capacities are not met, the outcome might be high administration costs. This is very clear at the early stages of policy experimentation when it is not uncommon to find that hurdles to apply are high, the speed at which applications are processed are too slow and the opportunity costs of applying forbidding in particular in the case of SMEs and start-up firms.

[12] An important caveat here is that as soon as public agencies act as a screener, conveying the technical knowledge that the financial markets lack or are willing to develop, they should also reduce the usual asymmetry of information problem between the financial sector and the innovative firms. By this way, and in some extent, granted subsidies based on externally and technically evaluated projects might "signal" a good innovation idea that might later on be funded by the financial markets (more on this in the next section).

[13] In order to relax this constraint some agencies also operate an "open window system" where firms could apply at any time. In this case, project proposals are still evaluated from a technical point of view and, sometimes, from a cost-benefit point a view; and also the project, if it passes the cut-off score still needs to go to the adjudication board for approval. The main difference with the call for proposals system is that in this case competition is weaker as firms that file their proposals earlier are more likely to be funded.

The direct subsidies programs in the region have also followed a clear evolution over time. Since a pure horizontal approach, they have gradually moved toward a more targeted approach focused on particular sectors or technologies. There are two main rationales for this (1) to avoid dispersion of the limited resources available for innovation support and so the need for reaching some sort of critical mass to have impact and (2) that the policy learning achieved during the horizontal phase might have allowed the policy markets to learn about main market failures and other constraints that firms face in order to innovate, leading them to the development of more tailored made innovation policies.

Another interesting evolution has been with regard to the coexistence of matching grants with subsidized or conditional loan program lines. At the beginning of the 1990s, several countries experimented with these sorts of loans. In this approach, loans could be partially or even totally forgiven on the basis of three criteria: the success or the failure of the project, the nature of the beneficiary, and the level of project technological risk. However, the coexistence of the loans with similarly oriented matching grants program lines led to competition between both interventions and a very little interest by the firms on the conditional loans. So, over time the conditional loans schemes were phased out, and the overall system of direct transfers was simplified.

More recently, there has been a re-emergence of subsidized loans in some countries, now with a more clear focus on funding the adoption of innovative technologies by the firms (in particular technologies embodied in machinery and equipment). However, it is important to take into consideration that the rationale for this is in some extent different from that normally used for the support of investments in intangible assets such as R&D or design. In the case of the adoption of embodied technology, the subsidy is normally based on the potential spillovers that this technology generates to the rest of the sector or the economy, so it is an asymmetric information problem what is being targeted, once this demonstration effect is operation, the subsidy should stop. Obviously, actual implementation of the scheme requires a severe fine tuning by the implementing agency on what it should or it should not be considered an innovative technology. Despite these problems, a nice feature of the subsidized loans is that in the extent that the subsidy is small and it does not reduce the capital cost below the opportunity costs of the firm's internal funding, it becomes a very powerful tool for self-selecting potential innovators that do face liquidity constraints rather than plain rent-seekers.

2. **Tax Incentives**: Different for the direct subsidies, tax incentives are based on *firm-level* innovation activities rather than projects, so allowing the firms to get support for their whole portfolio of innovation activities without having to submit a project proposal for each one of them, this reduces dramatically firms' compliance costs and agency's administration costs. Strictly speaking, tax incentives operate through different approaches: tax credits, enhanced allowances, and accelerated depreciation of intangible investments. Tax credits allow for a direct deduction from the payable tax, while enhanced allowances and accelerated depreciation represent a deduction (above the normal

deduction rate of 100 %) from the taxable income of the company. The main difference between the two mechanisms is that the former directly reduces the tax liability, while in the latter the reduction in the tax liability depends on the effective tax rates.

In developed countries, tax incentives normally applies to the corporate income tax; however, some, in particular, developing countries have also experimented with other variations such as reductions in tariffs for imported research machinery and equipment, deductions in the value added tax and discounts in the social security and employers' contributions on the payroll of researchers' salaries. Similar to the case of the direct subsidies, the actual implementation of tax incentives requires giving some particular consideration to the following design issues: (1) the definition of a target group (the tax incentives can be made available to all firms or the support can be made more generous for SMEs or some specific sectors), (2) the regulatory labeling of the innovation activities (countries normally applies some variations of international standards following the OECD's Frascati and Oslo Manuals), and (3) the qualification of those activities eligible for the tax incentive (these might be salaries of R&D personnel, R&D expenditures—salaries plus research inputs costs—and capital R&D expenditures). On top of this, a decision needs to be made on whether the scheme will be based on the volume (deductions based on the total amount of previous qualified expenditures) or increment of the investment (based on the growth of qualified expenditures, in which case it is necessary to define the base amount upon which the growth will be calculated) (Van Pottelsberghe et al. 2009). Although the fiscal costs of increment-based tax incentives are normally much lower, they are also far more difficult to implement and monitor.

As in the case of the direct subsidies, tax incentives are also subject to the similar problems of moral hazard in the extent that firms might claim activities that they would otherwise conduct or have been conducting as innovation expenditures.[14] Averting this hazard requires the establishment of nominal limits, an auditable definition of innovation activity and active enforcement by both the innovation agency and the tax authority. So, in principle, the higher administration and compliance costs of the direct subsidies need to be compared with the higher policing costs of the tax incentive.

However, when analyzing a tax credit system several caveats need to be considered. *First*, the actual impact of the tax incentives on the marginal cost of capital of innovation activities depends on the general fiscal environment of the economy as fiscal incentives are less effective in a country with low taxes. In fact, this is one of the main reasons on why the empirical literature has normally found that tax incentives are less effective as a stimulus for innovation in SMES rather than in

[14] Tax incentives normally end up making the tax system more complex leading toward a higher degree of uncertainty with regard to the interpretation of legal regulation, requiring more auditing resources from the administration authority and to greater opportunities to manipulate the tax system generating more room for evasion and avoidance (De Luis 2010).

large companies (Harris et al. 2009). SMEs simplified tax treatments normally imply that corporate tax rates are lower in the case of this group of firms.[15] *Second*, the impact of the scheme also strongly depends on the tax position of the firm and on its ability to make profits; this does not seem to be the case for start-up firms that have just entered the market, so a priory, the power of this policy tool to promote entrepreneurship is limited. This limitation can be in some extent ameliorated through the inclusion in the scheme of carry-over provisions that allow unused portions of the credit to be carried forward to the next fiscal years. In some developed countries with, even more generous schemes, carry-forward provisions are combined with direct cash refunds, in which case the tax incentives become a grant (these are the cases in France and the Netherlands for example) (Criscuolo 2009). *Third*, and most importantly, under a tax incentive scheme is the firm who choose those innovation projects that will be implemented, so in some extent it is a mechanism that is more market-friendly than the direct subsidy and this rests under the assumption that normally the firms should have better information about what project should be pursued. An important contradiction with this rationale is that in a world with market failures, market-friendly mechanisms might not be the best channels as to guide resource allocation. In other words, giving complete freedom to the firm to choose does not guarantee that the selected projects will be also those with higher *social* return rates or those with a higher risk. So, at the end additionality could be lower as funded projects could be similar to those that would be funded by the firm anyway. Some countries have tried mitigating this problem through the introduction of differentiation with regard to the type of expense that is eligible for the tax incentive. For example, some designs increase the rate of the tax credit for in the innovation activities outsourced to universities or implemented in collaboration with other firms.

From an evaluation point of view, tax incentives also pose important challenges in comparison with the direct support. In first place, for the purpose of policy assessment, firms cannot be legally excluded from a tax incentive to which they are entitled. This removes the possibility of evaluating tax credits by constructing a control group using randomization techniques. Even the implementation of quasi-experimental techniques might be difficult when all the qualifying firms (firms that do R&D for example) receive the incentive. For this reason, one of the favorite approaches for the impact evaluation of R&D tax credits schemes resides in the utilization of structural modeling techniques (Hall and Van Reenen 2001; OECD 2010), which makes the evaluation results even more dependent on critical assumptions on firm behavior, preferences, and production technology, but that could be weaker to solve the attribution problem.

[15] However, this needs to be balanced against the fact that the final impact of the tax incentive on capital costs depends also on how the investment is going to financed. If financing is done with debt, some schemes—in particular in Latin American—allow for the deduction of interest paid for this, de facto reducing the firm's taxable base. Because large and established firms are more likely to get external financing, so this rebalance the expected impact of the tax incentive toward SMEs and new firms (if they actually make profits) (Roca 2010).

Finally, it is important to emphasize that although both types of fiscal incentives have "gross" fiscal costs in terms of either cash transfers or forgone revenues, the final "net" fiscal costs will depend on the effectiveness with which each instrument is able of increasing firm investment on innovation, on how efficient in terms of productivity this investment is and on how much tax revenues would be generated as a result of this productivity increase. With regard to the fiscal costs, a nice feature of the direct subsidies is that this cost can be incorporated into the budget process with high certainty. This might not be the case for tax incentives, as soon as the actual amount of forgone revenues could also depend on a series of endogenous decisions taken by the firms with regard to how to finance this investment or through the setting of price transfers between related companies. Moreover, in the extent that carry-forward provisions exist, incentives by the administrating agencies are toward being comparative more relaxed with regard to the approvals in the extent that the fiscal costs will be absorbed by the future administrations.[16] Although there are few studies regard to the "net" fiscal costs of innovation (mainly R&D) tax incentives, the results for developed countries suggests that the "net" costs is actual negative—or in other words that the fiscal authority recovers the costs through higher revenues (Griffith et al. 2001). However, recent evidence also shows that this might not be the case for least developed regions (Harris et al. 2009).

As it was mentioned above, several LAC countries have established innovation tax incentives during the last 15 years (Argentina, Colombia, Brazil, Mexico—recently discontinued—and more recently Chile and Uruguay). The typical LAC tax incentive presents some important differences with regard to the standard approach in developed countries. Given their importance, sometimes indirect taxes are also included among the deductions (such as the value added tax or import tariffs). But even more important is that the implementation of the scheme is mostly project based. That is in order to qualify for the tax incentive, firms are normally asked to submit a project proposal to the public agency that will review whether the project qualifies as an innovation project and it will recommend the approval of the eligible expenditures to the tax authorities who will issue a tax credit certificate. The rationale for this approach is to have a tighter control of the fiscal costs of the scheme. In addition to this, in many cases the allocation of resources is done following a competitive process where resources are allocated according to the merit of the project, until the overall budget for the program is achieved. The trade-off is that many of the administration and compliance costs of the matching grants schemes reappear, sometimes without the benefits of the matching grants system as the decision-making power mainly remains in the firm (if the firm has submitted a project proposal that under the law qualifies as an innovation project, the agency is obliged to issue the tax credit certificate, even when social returns

[16] The fiscal costs of tax credits in developed countries in terms of forgone revenues have systematically increase over the last twenty years with values in the range between 0.06 % of the GDP in the case of the UK up to 0.29 % of the GPD in the case of France (OECD 2010). For a typical developed country that spends about 2 % of the GDP in R&D of which 60 % is done by the business sector, R&D tax incentives represent a significant part of the this effort (OECD 2010).

of the project are low and not very different from the private ones. Merit-based competition and the setting of fiscal quotas can alleviate this problem).

The remaining section of this chapter will focus on the main results emerging from the evaluation of the different programs that support business sector innovation in LAC. However, before this, we will summarize the main issues with regard to the impact evaluation of fiscal incentives for innovation.

5 Empirical Results Emerging from Impact Evaluations of Fiscal Incentives in LAC

5.1 Some Methodological Considerations

As it is clear from the above discussion, although innovation policies might be justified because the presence of many different market, coordination and institutional failures; successful implementation makes strong demands on governments' ability to design programs that would rectify the identified failures. In real life, governments face informational constraints that may be as or more severe than those of firms. Firms and innovation projects are highly heterogeneous. This means that a policy that is optimal in the strict sense of achieving Pareto efficiency should vary not only from firm to firm, but also from project to project. This puts administrating agencies under a severe informational stress (Toivanen 2009). In summary, although there might be a strong case of innovation policies, actual implementation could easily lead to the wrong results or in other words public support could lead to crowding out of private funding.

One of the first issues to be defined in an impact evaluation is how and when to measure the effects of the program, i.e., the outcomes of interest. In the spirit of the CDM model (Crepon et al. 1998), a distinction can be made between innovation input indicators and economic performance indicators. Innovation input indicators are the indicators more directly affected by the intervention. For instance, for a fiscal incentives program, an innovation input indicator is total investment in innovation by the beneficiary. While the relationship between the subsidy and the total investment seems in principle almost tautological, our previous discussion clearly highlight that this is not necessarily true (see, e.g., David et al. 2000). In other words, in the extent that innovation policies are able of changing the firm's marginal cost of capital and to the extent that investment decisions react to this change in the cost of capital we might be able of identifying the extent to which innovation policies generate *input additionality*.

However, just assessing whether innovation efforts increase as a consequence of a subsidy is not enough for policy evaluation purposes. The whole portfolio of innovation projects held by the firm is normally affected. As a result of this, projects with different productivity might be executed, while others might be postponed. So, assessing the outputs of innovation investments is also important (*output additionality*).

Innovation outputs are variables where the concrete realization of innovation activities is observed and their impacts on economic performance materialize. So, in particular in the case of business innovation programs, important output variables to measure *output additionality* are, for example, productivity growth, employment, wages, and exports to just cite a few.

We close this section with a short consideration to the issue of when impacts should be measured. Normally, input additionality is measured in the short term, which is while the innovation project is being implemented. However, in the case of output additionality, a "time to build" period is necessary as to find impacts. More generally, the impact of different programs may display very different patterns over time. An intervention may generate a one-shot increase in the outcome and may have strong impacts that fade out progressively with time; the impact of a program may only appear after a certain period or may even generate an initial drop in the outcome that is later overshot by increases in subsequent years. As a result, a proper consideration of the timing of the effects is crucial in an impact evaluation setting, and failures to account for these issues may lead to misleading conclusions and policy recommendations. A clear distinction should be made between short-run and long-run effects to properly evaluate the costs and benefits of a public program.

Even after carefully considering and selecting the relevant outcomes and indicators, evaluating the impacts of public programs is not a trivial task, especially when the interpretation of the relationship between program participation and the outcomes of interest is to be causal. In impact evaluation, the main definition of causality is based on the concept of *counterfactuals*. For instance, suppose a firm receives a subsidy for innovation investment, and suppose we observe the value of a given outcome of interest for that firm. Then, the public subsidy is said to have a causal effect if the outcome of the firm in the absence of subsidy, but *holding everything else equal*, would have been different. In other words, the program or "treatment" has a causal effect if the observed outcome when the firm receives a subsidy is different from the *counterfactual outcome*, i.e., the outcome that would have been observed if the firm did not receive the subsidy. While this definition of causality is relatively simple and intuitive, it introduces a serious problem from an empirical point of view, because the counterfactual outcome, by definition, is never observed. In other words, if a firm receives a subsidy, it is impossible to know with certainty how this firm would have done it without it. This problem can be approached by setting a control group of firms that did not receive support from the program (and from any other program) selected in a way as to minimize all the observable differences among both groups.

Each one of the evaluations that we review in this chapter is based on a unique dataset where both primary sources of information on beneficiaries are linked to secondary sources of information such as innovation and industrial surveys. This procedure allowed to exactly identifying the specific firms that participated in each evaluated program. In addition, in all the cases, the control group was constructed using a sample of firms that did not receive any other comparable treatment in order to maximize the accuracy of the impact estimation. Moreover, all the evaluations tried to identify comparable treated and non-treated firms in order to minimize the

effect of potential "selection biases" on the evaluation results. A control group was identified using a number of different methods: propensity score matching procedures, difference-in-differences estimation, fixed effect panel data estimation, and instrumental variables methods.[17] All the evaluations are done at the beneficiary level rather than at the project level.

5.2 A Meta-analysis of Evaluation Results

We first summarize the results on input additionality by looking at the impacts of the different programs on firm's innovation investment and we try inferring the extent to which there might be crowding-in or out effects on private investment. We also provide some information on the impact evaluation methodology actually being used. After this, we focus our attention on the impact on output additionality and in particular the extent to which over a longer time period any impact on productivity can be observed. As a caveat, it is important to say that the heterogeneity of available information and data sources did not allow the studies reviewed here to adopt identical estimation techniques for all impact evaluations. As a consequence, results are sometimes not fully comparable across the different cases.

5.3 Input Additionality

Similarly to other regions, the evaluation of input additionality has been the preferred approach for impact evaluation in LAC. Table 1 summarizes the results of 13 impact evaluations done so far in the region. In seven of the studies (summarized in the top half of the table), the main impact indicator variable is the absolute value of firm's innovation or R&D investment (in log). In five of these cases, the main dependent variable is private R&D or innovation investment; in other words, the impact indicator is investment net of the subsidy, while in the two remaining cases the studies looked at total investment in innovation or R&D.[18] The bottom half of the table, on the other hand, summarizes six studies where the main indicator of interest is innovation intensity, that is innovation or R&D expenditures as a fraction of sales or total investment. In two of these cases, the results refer to innovation intensity efforts net of subsidy. In the remaining ones, the results look at the impacts in total innovation efforts.

[17] For more details, see Hall and Maffioli (2008) and Crespi et al. (2011).

[18] In these two cases, the crowding-in/out analysis is less precise. In this case, some assumptions need to be done with regard to the potential way on how the subsidy might it have been disbursed for a representative plant and also with regard to the project duration. In these cases, the assumed project duration relates to the one specified in the grant contract. This approach will surely underestimate the actual length of the typical innovation project.

Table 1 Input additionality—testing for crowing-in/crowding-out effects

Country	Evaluation period	Program name	Intervention	Beneficiaries	Indicator	Impact	Crowding in/out	Method
Argentina (1)	1994–2001	FONTAR-TMP1	Subsidized loan	Firms	ln (Total R&D)	0.15**	In	FE-IV
Argentina (2)	1998–2006	FONTAR-ANR	Matching grants	Firms	ln (Private InnovExp)	0.18*	In	FE-CS
Panama (3)	2000–2003	FOMOTEC	Matching grants	Firms	ln (Total R&D)	0.15**	No evidence	FE-CS
Uruguay (4)	2000–2006	PDT-I	Matching grants	Firms	ln (Private InnovExp)	0.84**	In	FE-CS
Mexico (5)	2004–2007	EFIDT	R&D tax credit	Firms	ln (Private R&D)	0.25**	In	FE
Colombia (6)	2000–2002	Tax Incentives	R&D tax credit	Firms	ln (Private R&D)	0.06**	In	SM
Argentina (7)	1995–2001	FONTAR CFF	R&D tax credit	Firms	ln (Private R&D)	0.13***	In	FE
Argentina (8)	2001–2004	FONTAR-ANR	Matching grants	Firms	(Total R&D intensity) %	0.18**	No evidence	DID-PSM
Brazil (9)	1996–2003	ADTN	Subsidized loan	Firms	(Private R&D intensity) %	0.66**	In	PSM
Brazil (10)	1999–2003	FNDCT	Matching grants	Firms and UNIV	(Private R&D intensity) %	1.63**	In	PSM
Chile (11)	1998–2002	FONTEC	Matching grants	Firms	(Total R&D intensity) %	0.74*	Partial out	DID-PSM
Panama (12)	2006–2008	SENACYT	Matching grants	Firms	(Total R&D intensity) %	0.13**	In	PSM
Colombia (13)	2002–2003	COFINANCIACION	Matching grants	Firms and UNIV	(Total R&D intensity) %	1.20*	In	PSM

Source fixed-effects, instrumental variable (*FE-IV*), fixed-effects and common support (*FE-CS*), fixed effect (*FE*), structural modelling (*SM*), difference in difference–propensity score matching (*DID-PSM*), propensity score matching (PSM). (1) Chudnovsky et al. (2006), (2) Lopez et al. (2010), (3) Maffioli et al. (2011), (4) Lopez and Rossi (2010), (5) Calderón (2010), (6) Mercer-Blackman (2009), (7) Binelli and Maffioli (2006), (8) Chudnovsky et al. (2006), (9) De Negri et al. (2006a), (10) De Negri et al. (2006b), (11) Benavente et al. (2008), (12) Crespi et al. (2011), and (13) Crespi et al (2011). In the case of the evaluation of SENACYT-Panama, total R&D intensity is computed as R&D as a fraction of total innovation sales. *** 1 % significance level, ** 5 % significance level, and * 10 % significance level

Several clear results emerge from Table 1. In first place, the evidence across the different studies is that fiscal incentives clearly stimulate innovation or R&D investments in the LAC region. In all the cases, and regardless the main indicator variable, it was obtained a positive and significant average treatment effect on the treated. In other words, firms that received some sort of fiscal support did increase their innovation investments. Based on the arguments made earlier, this implies that the programs in general are well focalized in the extent that they seem to be targeting firms with either serious appropriability or financial constraints problems or both. So whenever these constraints are relaxed, firms react favorably increasing their investment in innovation. Furthermore, there are seven evaluations where the main impact indicator is the private investment in innovation or R&D, and the results for this variable are also positive and significant, suggesting that companies that receive fiscal support also react increasing their own investment in innovation. As it was mentioned above, this result might be the consequence of the operation of many different transmission mechanisms. In first place, fiscal support might be targeting riskier projects, and so this might induce private finance for follow-up less risky investments. On the other hand, public support might be targeting infrastructure projects, so reducing the subsequent capital costs of any subsequent project. Finally, the fiscal incentive might have a signaling effect on the quality of the project and the research team, so allowing the firm to leverage additional resources from the financial markets. Moreover, qualitative interviews that were part of the evaluation of the Chilean FONTEC, suggest that this signaling effect was indeed important (see Benavente et al. 2007).

With regard to the differences between instruments, it is also observed that the only three cases where there was no evidence of crowding-in (in two cases, there was no evidence on crowding-in nor out, while in just one remaining case there was some weak evidence of partial crowding-out) correspond to variations of the matching grant scheme. Indeed, it seems that subsidized loans or tax credit schemes are clearly more able of generating multiplier effects on private investments. So, there is some evidence that in the extent that matching grants programs provide financing a zero costs this might reduce the potential multiplier effect of the fiscal scheme. However, an important qualification is needed in this case. There are two cases where the matching grant designs have had the highest positive impact on investment—even in comparison with the other instruments—and also the largest multiplier effect with regard to leveraging private investment in innovation. These are the cases of the Brazil's FNDCT and Colombia's Cofinanciacion programs where the main characteristic is that in both cases the scheme provides conditional funding for firm–university collaboration. So, it seems that matching grants programs are particularly well suited to also encourage the building of linkages among the different actors of the innovation system. This particular feature of these two programs could have contributed to the addressing of both financial and technical constraints (lack of human resources, lack of own specialized research infrastructure, and lack of technical knowledge, among others). The relaxation of these other technical constraints might have led to a multiplier effect in private funding.

One important limitation in particular during the earlier evaluations was that sample size did not allow for assessing the extent to which impacts were heterogeneous according to different sub-groups of firms. However, in the case of the Argentina's FONTAR-ANR program, the sample size was large enough has to assess whether there was impact heterogeneity according to firm's experience with managing innovation projects. The evaluators found that although the program does not provide evidence of a multiplier effect at the aggregate level, the data indicate that new innovators have seen a substantial increase in their private investment in R&D. On the other hand, the effect of the matching grants is smaller in the case of more experienced innovators, for which some evidence of displacement of resources was found. In other words, although very limited, the evidence seems to point out toward a favorable impact of matching grants on firms with limited experience on the formulation and execution of innovation projects (Chudnovsky et al. 2006).

Finally, the different evaluations do not find any systematic differential impacts between the other two instruments: tax credits and subsidized loans. In both cases, there are crowding-in multiplier effects and the total the impacts on the firms' total innovation investments are rather similar. As it is possible to infer from Table 1, the majority of the studies make use of propensity score-based techniques in order to find similar treatment–control pairs and select a common support for the impact evaluations. This allows assessing which the main determinants that affect the probability of being selected into any of these programs are. Across many of the studies, it seems that firms with higher levels of human capital or some previous experience in managing R&D and innovation programs are more likely to be selected. In some extent, this is expected, given that in all the cases agencies' technical evaluators highly weighted these two indicators at the moment of scoring each proposal. The problem of an excellence-based selection system is that it is highly meritocratic and what it might be seen as a good result in the short run, it could trigger unexpected dynamic effects in the longer term. Indeed, a heavily meritocratic evaluation system might lead to the selection of only very good candidates, candidates that might be selected again in future competitions. This might trigger a sort of "Matthew Effect" dynamics that might end up affecting competition and inequality through the formation of powerful elites. More research is needed in order to assess whether these endogamy effects are present or not, but this is an issue that requires some follow-up in the near future. In other words, it is important to keep clear exit strategies in the different schemes and to make it transparent to the firms that support has a ceiling. This ceiling should be located just at the right level as to foster excellence but at the same time without compromising variety. The matching grant instrument seems to be particularly well suited to keep the right balance between excellence and diversity.

Are the LAC results very different from the international evidence? Several reviews done on the impacts of fiscal incentives on business innovation investments tend to also reject the full crowding-out hypothesis. David et al. (2000) and Klette et al. (1999) provide a comprehensive review of the main empirical studies measuring the impact of public funding on firms' investment in innovation

during the 1990s in developed countries. According to David et al., two-thirds of the studies report that public R&D funding did not substitute private R&D investments. In the last decade, this kind of analysis has proliferated, thanks to the increasing availability of data, providing some additional insights into the effectiveness of public support of private innovation. Aschoff (2009) provides an updated review of the most significant results. Most of them confirm the absence of full crowding-out effects, and some also show evidence of multiplier effects on private investments. In summary, the LAC region compare quite well with regard to the international evidence on the effectiveness of fiscal incentives on input additionality.

5.4 Output Additionality

At the international level, fewer studies analyze the effect of public support on innovative output (patents, numbers of new products, and sales of new products) and firm performance. Although some positive effects are detected, the results are less conclusive. The main difficulty in this case is that a longer time horizon is required to detect these effects. In fact, while crowding-out or multiplier effects can be detected almost in conjunction with the receipt of public financing, other effects are detectable only after the innovation, learning process and the intra-firm diffusion of the technology have come to an end. This implies that rigorous impact evaluations of these effects may require panel data for a minimum period of at least five years after the receipt of public financing. LAC evaluations do not escape to this problem either. In many of the evaluations carried out by the IDB between 2005 and 2007 (IDB 2007) and summarized by Hall and Maffioli (2008), the studies do not find consistent effects on patents or new product sales and the evidence on firm performance is also mixed with positive results in terms of growth but little corresponding impact on measures of productivity. As it was mentioned before this could be due to the fact that in many if these evaluations output additionality is asked with reference to the same time period during which the innovation project is taking place. So, the time span for evaluating output additionality might have been too short.

In order to fill this knowledge gap, the IDB is currently re-assessing many of the programs mentioned in Table 1 over a longer period and looking at what sorts of impacts these interventions have had in labor productivity growth. The following programs have already been re-assessed: COFINANCIACION (Crespi et al. 2010), FOMOTEC (Maffioli et al. 2011), and two for Chile FONTEC and FONDEF (Alvarez et al. 2011). The implementation of these longer-term evaluations required a close articulation with National Offices of Statistics. Indeed, one of the drawbacks of the previous evaluations was that the same were based on linking beneficiary data with innovation surveys. However, even though innovation surveys are important tools to gather information on innovation investments (and so to assess input additionality), sampling is normally based on repeated cross sections of randomly selected firms. This makes the following of firms over longer time periods almost impossible.

In order to lift these data constraint problem, the evaluators have been working with national statistics offices and linking beneficiary data with business registers data, a process that allows following firms for a very long time period. One limitation of this approach is that data linking can only be done on already existing data registers. So, in this case, the results are somehow restricted to the analysis of manufacturing firms and firms with more than 10 employees.

The results for the four evaluated programs are summarized in Table 2. In this case, all the programs were evaluated using the same methodological approach with the main output indicators being labor productivity. In all the cases, the main dependent variable is in log. The results suggest an important impact of the fiscal incentives on firm performance with increases in labor productivity between 13 % in the case of Panama (which corresponds to the shortest time period) and 15 % in the case of the Colombian program. The results are significant to the standard levels. The two Chilean programs are in between with productivity increases between 9 % in the case of FONTEC and 12 % in the case of FONDEF. Having two programs in the same country is also interesting because it allows for making a closer comparison among them. In particular, we could explore whether there are important synergies among the two programs. In order to explore this, in the sample there is a small but still important group of beneficiaries that make use of both programs. So, we re-explored the analysis for Chile, taking into consideration the existence of three treatments or interventions: (1) firms that applied only for FONTEC, (2) firms that applied only for FONDEF, and (3) firms that made simultaneous use of both programs (FONTEC + FONDEF). We found strong evidence as two suggests there are important synergies among the two programs. Indeed, companies that received the FONTEC only treatment showed productivity increases of 6 % (and not significant), while firms that made use of the FONDEF only approach showed productivity increased of 10 % (and significant). On the other hand, firms that used both programs had a productivity growth of 24 % and significant.

In order to explain the differences between FONTEC and FONDEF, we need to consider the main characteristics of both programs. In the case of FONTEC is the typical matching grant scheme for business innovation projects and where projects are selected based on an open window system. In the case of FONDEF, we are facing a program that gives grants to support university–firm collaboration and where the selection is based on competition.

We systematically found that FONDEF firms have had a higher impact on productivity than FONDEF firms, this could be due to either the incentives for collaboration (that reduces other market failures in addition to lack of finance), or the nature of the competitive process used for the allocation of the resources. We also found evidence that there are important complementary effects among both programs and that FONTEC produces its higher return when it is implemented together with FONDEF. In other words, we found that a combination between an incentive for U-I collaboration (that might be targeting a coordination failure) with an incentive to the firm (that could be targeting an appropriability or financial constrain problem) seem to be the best combination.

Table 2 Output additionality—testing for productivity impacts

Country	Evaluation Period	Program name	Intervention	Beneficiaries	Indicator	Impact	Method
Colombia (1)	1995–2007	COFINANCIACION	Matching grants	Firms and UNIV	Labor Productivity	0.15***	FE-CS
Chile (2)	1998–2006	FONTEC	Matching grants	Firms	Labor Productivity	0.09***	FE
Chile (2)	1998–2006	FONDEF	Matching grants	Firms and UNIV	Labor Productivity	0.12***	FE
Chile (2)	1998–2006	FONTEC only	Matching grants	Firms	Labor Productivity	0.06	FE-CS
Chile (2)	1998–2006	FONDEF only	Matching grants	Firms and UNIV	Labor Productivity	0.10***	FE-CS
Chile (2)	1998–2006	FONDEF + FONTEC	Matching grants	Firms and UNIV	Labor Productivity	0.24***	FE-CS
Panama (3)	2000–2003	FOMOTEC	Matching grants	Firms	Labor Productivity	0.13*	FE-CS

Source fixed-effects and common support (*FE-CS*) and fixed-effects (*FE*). (1) Crespi et al. (2011), (2) Alvarez et al. (2011), and (3) Maffioli. *** 1 % significance level, ** 5 % significance level, and * 10 % significance level

In the cases of COFINANCIACION and FOMOTEC, it was also possible to track the impacts along time by looking at the time since exposure to the treatment. The results provide evidence that these effects remain and, in some cases, increase over time, with these effects becoming more significant between three and five years after the firms started being treated. These findings suggest that longer-term impact evaluations enable the detection of impacts on some of the most relevant variables of interest. This does not necessarily mean that final impact evaluations should be carried out five years after the project's execution. Evaluations could focus instead on the first cohorts of treated firms, so that by the end of a program, some results on performance could also be assessed. This is precisely the approach taken by the US Congress for the evaluation of the Small Business Innovation Research (SBIR) program. The moment the program was approved in the early 1980s, Congress asked the Small Business Administration (SBA) to ensure that beneficiaries of the first three cohorts be followed up over the next decade (Lerner 1999).

6 Conclusions and Emerging Issues

This chapter presents the most important recent trends with regard to the design and evaluation of public policies for the support of business innovation in LAC. Several countries in the region have been experimenting with these policies since early 1990s. In contrast with the OECD countries, the LAC's innovation support framework is clearly biased toward direct transfers to the private sector. Just a few countries have more recently started to experiment with tax incentives. And even in the case of the most important direct support instrument such as the matching grants, the fiscal budgets allocated to these programs are rather meager. In some extent, business innovation policy in the region is still in its infancy.

Many of these pilot programs have already been assessed, and this chapter takes advantage of the existent wealth of studies in order to provide a qualitative meta-analysis of the most pioneer programs in operations since early 1990s. The main conclusions are rather straightforward: *there is a clear evidence of a positive impact on input additionality*. In other words, fiscal incentives have been effective at the moment of increasing firms' investment in innovative projects, and they have been also effective in leveraging private resources for this investment. The studies also found that different financing mechanisms have varying impacts on different group of beneficiaries. Although it seems that the risks of crowding-out private investments are lower in the case of programs based on subsidized loans or tax incentives, matching grants seems to be more effective in the case of new innovators or at the moment of fostering linkages between firms and universities, which suggests the need for focusing these programs on these two issues. With regard to output additionality and productivity, impacts also seem to be positive whenever enough time has elapsed since the grant was approved. Indeed, the different studies that looked at output additionality suggests that positive impacts in labor productivity start to show up only after three to five years since the start of an innovation project.

The previous review also raised several questions with regard to the actual design and implementation of business innovation programs. We close this chapter with a short reference to these emerging issues.

1. The multilevel governance of business innovation policies.

Several LAC countries—in particular the largest ones—are taking important steps toward the decentralization of policy decision making toward provincial and local governments. Indeed, these are the cases of countries such as Argentina, Brazil, Chile, Colombia, and Mexico. In these countries, fiscal incentive programs that operate at the local level are starting to coexist with national or federal level programs. This coexistence of multilevel innovation interventions is also characteristic of some territorially big developed countries such as Canada and the USA. Based on the OECD experience, although in principle sub-national innovation fiscal incentives increases the overall generosity of the support provided to the firm and so they seek to increase the innovation investment performed by local firms, the overall effect is not clear, in particular whether the net effect would still be positive after taking into consideration the decreasing innovation performance in neighboring regions (OECD 2010). In other words, the overall result might not be the expected one. For example, there has been a proliferation of R&D tax incentives among the US states during the last 20 years. Wilson (2009) analyzes the impacts of these state-level schemes and finds that although these incentives are effective in increasing in-state R&D, almost all of such increase is due to R&D being drawn away from other states suggesting a zero-sum game in the aggregate (a gain in one state would be off-set in another state). The risks of ending up in a similar situation in LAC countries should not be ignored. So, more research needs to be done and better data collection needs to be put in place in the region in order to tackle this multilevel governance issue.

2. Can the current set of innovation policy instruments foster entrepreneurship?

There are number of obstacles that might hinder the use of innovation policy instruments in the promotion of entrepreneurship. One is that subsidies are normally paid ex-post against receipts. If it is the case that entrepreneurs are credit constrained, this type of funding may be of little help for them. Second, the speed at which decision making is normally done within the region's innovation agencies may be too slow for a start-up (Toivonen 2009). Previous evidence from developed countries finds that subsidy application costs decline with the size of the firm. And in the case of tax credits even when the application costs are lower, the fact that many start-up firms do not have taxable income yet might also reduce the effectiveness of a tax-based incentive for these types of firms. Despite these limitations, there are two potential advantages of direct subsidies for the support of entrepreneurship. On the one hand, in the extent that direct subsidies are assessed on project basis this could trigger a signaling effect on the quality of the innovative idea for the financial sector, relaxing the severity of the financial constraints (Lerner 1999). On top of this, the implementing agencies might design the matching grants targeting collaboration between large firms and universities with new technology-based firms, linkages

that could also help reducing the development constraints faced by start-up firms. On the balance, it is an empirical matter the extent to which direct subsidies might stimulate entrepreneurship as well; however, the very limited evidence on this emerging from the FONTAR-ANR program reviewed above suggests that matching grants might have some potential for new innovators.

Finally, even when they could have some effectiveness, it could be that matching grants might not be the first best intervention to foster entrepreneurship in the extent that, perhaps the main constraints are the lack of an entrepreneurial culture (and related human capital) at it seems it is the case in many developing countries or the lack of sufficient financial instruments (such as guarantee funds or venture capital funds). In some extent, the effectiveness of the matching grant instrument to foster entrepreneurship will depend on the complementarities among them and all the other set of financial and human capital instruments.

3. The consideration of special characteristics of the service sector.

Although services dominate economic activity, they have long remained under-researched by analysts of innovation policies. During the last ten years in developed countries, however, there has been an increasing interest in understanding innovation in services. Results emerging from this research suggest that services innovate differently than in manufacturing (e.g., less based on R&D and more based on informal arrangements, the adoption of ICTs and user–producer interactions) and that "one fits all" theories on innovation in services might be misleading in the extent that they are a diverse group of sectors both with regard to production and innovation (Tether 2003). In contrast with this evolving body of knowledge, there are no systemic studies of innovation in services in LAC yet. The imperative for understanding the determinants of innovation in services and assessing those market failures that might hinder innovation in these sectors is clear as the service sector employs a significant proportion of the workforce, but its under-performance has been identified as pulling down aggregate productivity levels (IDB 2010a, b). The innovation policy dilemma is clear, if services innovate differently from manufacturing, proper support, and encouragement for innovation in this sector may necessitate new policy designs and programs. Filling the knowledge gap on the determinants of innovation and productivity in services requires improving in data collection efforts. Although some countries in the LAC region have just started collecting data on innovation in services, this emerging evidence has not been yet properly assessed.

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