PUBLIC

DOCUMENT OF THE INTER-AMERICAN DEVELOPMENT BANK

INNOVATION, SCIENCE AND TECHNOLOGY
SECTOR FRAMEWORK DOCUMENT

COMPETITIVENESS AND INNOVATION DIVISION

November, 2014

This document was prepared by the project team consisting of: Jose Miguel Benavente (IFD/CTI) Division Chief; Juan Carlos Navarro (IFD/CTI); Gustavo Crespi (CTI/CUR); Gabriela Martinez (IFD/CTI); Liora Schwartz (IFD/CTI); Alison Cathles (IFD/CTI); Blanca Torrico (IFD/CTI); Bertha Briceño (KNL/KNM); and Maria del Pilar Jimenez (LEG/SGO). The team appreciates the contributions of: Agustina Calatayud and Joan Prats (IFD/CMF); Antonio Garcia Zaballos (IFD/ICS); Fabrizio Opertti (INT/TIU); Roberto Manrique (IFD/IFD); Pedro Martel and Cesar Falconi (INE/RND); and Susana Garcia-Robles (MIF/MIF). Inputs from all VPP units were channeled through VPP/VPP.

CONTENT

Abbreviations

BRIK	Bank Repository of Institutional Knowledge
CATI	Centros de Apoyo a la Tecnología y la Innovación
CFE	Fondo Sectorial para Investigación y Desarrollo Tecnológico en Energía de México
CMF	Capital Markets and Financial Institutions Division
COLCIENCIAS	Departamento Administrativo de Ciencia, Tecnología e Innovación, Colombia
CONACYT	Consejo Nacional de Ciencia y Tecnología, México
CORFO	Corporación de Fomento de la Producción, Chile
CORPOICA	Colombian Corporation for Agriculture and Farming Research
CTI	Competitiveness and Innovation Division
DEM	Development Effectiveness Matrix
DIA	Development in the Americas
ECLAC	European Commission for Latin America and the Caribbean
ESW	Economic and Sector Work
EU	European Union
FIA	Fundación para la Innovación Agraria, Chile
FINCYT	Fondo para la Innovación y Tecnología, Perú
FINEP	Financiadora de Estudos e Projetos, Brazil
FIP	Fondo de Investigación Pesquera, Chile
FONSOFT	Fondo de Promoción de la Industria del Software, Argentina
FONTAR	Fondo Tecnológico Argentino
GDP	Gross Domestic Product
ICM	Programa Iniciativa Científica Milenio, Chile
ICT	Information and Communications Technology
IFI	International Financial Institutions
IIC	Inter-American Investment Corporation
iLab	Innovation Lab
INT	The Integration and Trade Sector
INTA	Instituto Nacional de Tecnología Agropecuaria, Argentina
IPEA	Instituto de Pesquisa Económica Aplicada, Brazil
IPES	The Politics of Policies: Economic and Social Progress
IPR	Intellectual Property Rights
ITAM	Instituto Tecnológico Autónomo de México
KIBS	Knowledge Intensive Business Services
LAC	Latin America and the Caribbean
MIF	Multilateral investment Fund
MINCYT	Ministerio de Ciencia, Tecnología e Innovación Productiva, Argentina
MSTI	Main Science and Technology Indicators
NIS	National Innovation System

NSG	Non-sovereign Guaranteed Operations
OECD	Organization for Economic Co-operation and Development
OMJ	Opportunities for the Majority
OVE	Office of Evaluation and Oversight
PBL	Policy Based Loan
PCR	Project Completion Report
PCT	Patent Cooperation Treaty
PDL	Performance Driven Loan
PISA	Programme for International Student Assessment
PPP	Purchasing Power Parity
PSO	Private Sector Operations
R&D	Research and Development
RES	Department of Research and Chief Economist
RICYT	Red de Indicadores de Ciencia y Tecnología
S&T	Science and Technology
SCF	The Structured and Corporate Finance Department
SCL	The Social Sector
SGO	Sovereign Guaranteed Operations
SME	Small and Medium Enterprises
SO	Sovereign Operations
SPD	Office of Strategic Planning and Development Effectiveness
STEM	Science, Technology, Engineering and Mathematics
STI	Innovation, Science and Technology
UNCTAD	United Nations Conference on Trade and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
VC	Venture Capital
WIPO	World Intellectual Property Organization

I. THE INNOVATION, SCIENCE AND TECHNOLOGY SECTOR IN THE CONTEXT OF THE IDB'S SECTOR STRATEGIES

A. The Innovation, Science and Technology Sector Framework Document as it relates to existing regulations

1.1 The document "Strategies, Policies, Sector Frameworks and Guidelines at the IDB" (GN-2670-1) established that the Sector Framework Document (SFD) should "provide flexible guidance to accommodate the diversity of challenges and institutional contexts faced by the Bank's 26 borrowing member countries, and at the same time should be narrow enough to provide meaningful guidance to project teams and provide a clear sense of what the Bank seeks to accomplish in a given sector". This SFD addresses the GN-2670-1 mandate for the Innovation, Science and Technology sector, establishing a framework for the Bank's work in the sector, including operations, research and dialogue with countries. This SFD is sufficiently detailed to be able to offer clear guidance for work in the sector, yet it can and should be adapted to suit the particular conditions or preferences of each country and project.

1.2 As indicated in paragraph 1.25 of GN-2670-1, once the Innovation, Science and Technology Sector Framework Document is approved, the following sector policies will cease to be in effect: Use of Intermediate or Light Capital Technologies (OP-705); Information Age Technologies and Development (OP-711); Industrial Development (OP-722); Telecommunications (OP-732); and Science and Technology (OP-744). This SFD reflects and updates, as current good practices and policy evidence allow, the technical and aspirational aspects. No normative content that would be useful to maintain in effect was identified in such policies. Similarly, once this SFD is approved, the Science and Technology for Development Sector Strategy (GN-1913-2) will also cease to be in effect. As required by GN-2670-1, the material of such sector strategy that continues to be germane has been incorporated into this SFD, thereby achieving an updating and strengthening of its content.

1.3 Innovation, science and technology (STI) have a pervasive and growing presence in all human activity. Accordingly, many sectors in which the Bank works in Latin America and the Caribbean (LAC) are expected to incorporate innovation and technology as an expanding part of their investment and reform programs; energy production and consumption, environmental protection, agricultural production, transport, commerce, public administration, education, health care and social policy constitute just a partial list. Such development reflects well established worldwide trends toward increasing knowledge and innovation density in national economies.

1.4 This SFD recognizes that governments in borrowing member countries play a critical role in enhancing competitiveness by directly encouraging business innovation, by establishing an enabling environment for firm innovation and technology-based entrepreneurship, as well as providing complementary public goods such as scientific knowledge and advanced human capital. Policies and programs that address market and coordination failures and support the development of national innovation systems seek to raise productivity and strengthen competitiveness. The ultimate goal of public policy in this sector is thus to enhance business productivity and competitiveness in the LAC region by facilitating the creation and growth of dynamic firms with the capacities and tools to innovate and compete in international markets. Putting together the architecture of scientific, technological, regulatory and connectivity pre-conditions of such enhancement is also a key part of what the Bank does and this document covers.[1] In providing guidance toward this goal, the Innovation, Science and Technology SFD is in line with the mandate of the Ninth General Capital Increase (GCI-9) and supports private sector development.

B. The Innovation, Science and Technology Sector Framework Document as it relates to the Institutions for Growth and Social Welfare Sector Strategy

1.5 This SFD is consistent with the Institutions for Growth and Social Welfare Sector Strategy (GN-2587-2), which responds to the call in the GCI-9 to focus on strengthening private sector entities such as Small and Medium Enterprises (SMEs)[2] through bolstering public institutions. The strategy highlights the role of innovation and technological development institutions in fostering increased SME competitiveness and private sector growth. It describes the need to build innovation capacity, increase access to technology and improve linkages between the key actors in the innovation system in order to upgrade firm performance and productivity levels. This SFD provides critical insight as to the best practices internationally, and highlights specific examples from the region regarding policy and program design and implementation in the sector. By nature, the Innovation, Science and Technology sector is transversal and so therefore elements of the sector appear in all of the different sector strategies. As a consequence, the framework set forth in this SFD is expected to be supportive of innovation,

---

[1] Discussing science and technology policy in the same context of innovation policy is standard in the literature. The main source of reference for the modern definition of innovation, OECD's Oslo Manual (2005), defines innovation policy as "an amalgam of science and technology policy and industrial policy. Its appearance signals a growing recognition that knowledge in all its forms plays a crucial role in economic progress, that innovation is at the heart of this `knowledge economy`" (p. 6).

[2] As long as this SFD touches upon the needs of SMEs in LAC and the respective policy responses, it must be understood as complementing the Support for SME and Financial Access and Supervision SFD (GN-2768-3). Also relevant in this context, are the Sector Guidelines for SME Finance and Development Programs (GN-2615) which supports the strategy and provides more narrowly defined action regarding four target areas: expanding access to finance for productive SMEs; improving the business climate and generating incentives for formalization; improving firm level programs and policies; and generating policy-relevant knowledge. This SFD provides support for the strategy and therefore also supports the sector guidelines, though it is not specific to SMEs.

research and technology-related priorities and concerns that are found across those strategies.[3]

1.6 This document has been structured into five sections that seek to address the seven elements that the document GN-2670-1 outlines for SFD documents. This section places the Sector Framework Document in the context of existing regulations and existing institutional strategies. Section II presents the international empirical evidence on policies and programs in Innovation, Science and Technology and provides the basis for defining this sector's framework; LAC's experience with STI policy-making provides a major source of such evidence, but state of the art analytical and assessment literature focused on other regions of the world is also abundantly used when relevant. Section III includes an analysis of the challenges faced by the region and, in light of current research, identifies priority action areas for the IDB. Section IV synthesizes previous the Office of Evaluation and Oversight (OVE) reports, summarizes the latest results of the Development Effectiveness Matrices (DEMs) and the main lessons learned from the IDB projects in the sector, commenting on the strengths the Bank has as provider of financing and technical assistance in STI policy. Section V presents the sector´s vision, mission, goals and dimensions of success for the IDB's work in the sector over the next three years, which is the period of time for which the approved framework will be in effect.

II. INNOVATION, SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT AND ECONOMIC GROWTH

A. Innovation and knowledge as key to productivity growth and economic development

2.1 Innovation is the transformation of new ideas into economic and social solutions. Innovation can be the execution of a new way of doing things more efficiently (a more effective use of resources), a new or significantly improved product (good or service) or process, a new marketing practice, or a new organizational method in business practices, workplace organization or external relations (OECD and Eurostat, 2005). For firms and countries, innovation is at the heart of

---

3 Developing broadband infrastructure, now the focus of a specific Bank initiative, and building regional research and innovation areas appear in the Sector Strategy to Support Competitive Global and Regional Integration (GN-2565-4); knowledge generation, innovation, closing the digital gap and accelerating broadband deployment appear as common themes in the Sustainable Infrastructure for Competitiveness and Inclusive Growth Strategy (GN-2710-5); support of technology transfer mechanisms, research, green and new technology are repeatedly mentioned in the Integrated Strategy for Climate Change Adaptation and Mitigation, and Sustainable and Renewable Energy (GN-2609-1); and in the Strategy on Social Policy for Equity and Productivity (GN-2588-4), the need to invest in human capital throughout the lifecycle and that test scores in Math and Science (PISA) at a young age (15 year-olds) have implications for a nation's economic performance.

sustainable competitive advantage, increased productivity, and economic progress.[4]

2.2 At the firm level, innovation means transforming ideas and knowledge into economic advantages such as higher productivity growth, new markets, and higher market shares. Hence, firms are the agents in charge of transforming knowledge into new economic solutions for their own benefit and the economy as a whole.

2.3 Endogenous growth models emphasize that Research and Development (R&D) expenditures should be seen as an investment decision affected by the institutional and market conditions of each particular economy (Romer, 1990; Aghion and Howitt, 1992). These models suggest that by affecting these factors, governments can encourage R&D investment decisions and economic growth.

2.4 Beyond the simple accumulation of labor, physical and human capital, innovation is a key determinant of long-term growth by improving the ways in which capital and labor combine and consequently improving the yields for the same level of productive factors. Empirical evidence shows that about half of the variation in income levels and growth rates among countries is due to differences in total factor productivity (Hall and Jones, 1999). Previous research found that R&D[5] explains up to 75% of the differences in total factor productivity growth rates, once externalities are taken into consideration (Griliches, 1979). Evidence from OECD countries points to the fact that investment in R&D causes productivity growth and not the other way around (Rouvinen, 2002). In other words, investment in innovation is a critical input in long-term growth, rather than simply a result of that growth.[6]

2.5 Consistent with previous findings, social returns on investment in innovation tend to be higher than the opportunity costs (returns on physical capital). For developed economies, social rates of return on R&D have been estimated at 40% or more (Hall, Mairesse, and Mohnen, 2009). In addition to generating new knowledge, investments in innovation also have a direct effect on the creation of absorptive capacity. Innovation activities, particularly R&D investment, are fundamental for the development of new competencies and skills needed to seek, acquire, and adapt existing technology. In other words, innovation activity is a

---

[4] A key implication of this definition is that innovation is not a synonym of the words scientific research or technology. In practice, it is often associated with them, but there is plenty of non-technologically based innovation, as well as a lot of scientific results and even technology that does not necessarily translate into innovation. Innovation happens in the firm, and it is about new ways of doing things that add value. In contrast, invention is showing that doing something is feasible and how.

[5] R&D investment is commonly used as a proxy for investment in innovation because it can be relatively well measured and, conceptually, it constitutes a measure of the financial effort that countries do to incorporate new ideas in their economies. More precise measurements of innovation beyond R&D figures have only recently become available for a limited number of countries.

[6] The main point made here is not intended to imply that there is absolutely no effect of growth on innovation. For nuances in this regard see Griliches (1986); Hall and Mairesse (1995) and Goñi and Maloney (2014).

key driver of catching up (Rostow, 1960; Cohen and Levinthal, 1989).[7] In fact, advanced economies returns to R&D investment tend to increase with distance from the technological frontier (Griffith, 2004).

2.6 Even more importantly, social rates of return on innovation exhibit the same pattern in developing economies (Benavente et al., 2005) and some estimates find them to be even higher. Lederman and Maloney (2003) found that the social returns on R&D for countries in Latin America are quite substantial. For medium-income countries, such as Mexico and Chile, they found an average return of around 60%. For relatively poorer countries, such as Nicaragua, some estimates put the average return closer to 100%. More recent research has introduced some caveats, finding that rates of return to R&D follow an inverted U pattern (see Annex, Figure 1), increasing with distance to the frontier and then falling after a certain point, turning negative for the poorest countries, a phenomenon attributed to the absence of a critical mass of complementary inputs for innovation such as adequate human capital, weak scientific infrastructure, weak private sector development and sophistication and overall poor coordination of the innovation system (Goñi and Maloney, 2014).

2.7 Many signs point to the fact that such important contribution of knowledge and innovation to growth is expanding at an accelerated rate. Today's economies are increasingly becoming knowledge economies. The ability and speed with which societies can absorb new technologies, access and share global information, and create and disseminate new knowledge have already become a major determinant of their ability to function and compete. Traces of these trends are everywhere: investment in knowledge-related activities and intangibles has been growing faster than capital investment in advanced economies for at least a decade (OECD, 2013). The knowledge content of products and services is on the rise all over the world. The labor market shows a growing "skills bias" both in developed and developing economies, signaling that jobs growth will be in those occupations that involve sophisticated handling of symbols, information, and analysis. The most dynamic industries are those that can be classified as knowledge intensive, and all economic activities, even the most traditional, are increasingly influenced by technology and innovation, and this has been the case for the better part of the past two decades (Rand, 2007; OECD, 2000).

2.8 A key driving force behind the creation of a knowledge economy is the exponential growth in the volume and speed of information generated by the expansion of Information and Communications Technologies (ICT).[8] Indeed,

---

7 The importance of knowledge and technological capabilities for catching up has been extensively documented (Griffith, Redding, and Van Reenen, 2004). This was the case not only for Japan in the early 1930s (Johnson, 1982) but also for the newly industrialized economies in Asia, notably South Korea (Kim, 1998; Nelson and Pack, 1999; Kim and Nelson, 2000). In both cases, catching up is associated with previous concerted efforts to build technological capacity (Kim, 1997).

8 A recent estimate indicates that there was an 18 fold increase in Internet traffic across borders between 2005 and 2012 (McKinsey, 2014).

given that ICT substantially lower the cost of information storage and transmission, their diffusion throughout the economy reduces the uncertainty and transaction costs associated with economic interactions. ICT increase the organizational capacity of firms to codify knowledge that otherwise would remain hard to store, organize, transmit and use, accelerating learning and reducing problems related to "organizational forgetting" (Foray, 2007). Production processes can be more easily decentralized, locating different components of the same processes in different countries based on the comparative advantages of each economy, resulting in major reconfigurations of global value chains (Lach, 2005). On the demand side, the ICT revolution facilitates a higher degree of customization, opening up new possibilities for developing countries to exploit emerging niches through e-commerce technologies. ICT shorten the distance between producers and users: buyers and sellers located in different cities, regions and countries can share information on their needs and products, reducing information asymmetries and entry costs in markets (Perez, 2008). This, in turn, leads to an increase in the volume of transactions, generating more output from the same set of inputs. In other words, ICT have become a trigger for higher productivity levels (Spence, 2001; Chen and Dahlman, 2005).

2.9 Yet, for all the development and potential of contemporary connectivity, the fact remains that innovation takes still a very long time to spread to most firms in developing countries. Recent experience indicates that one thing is to have the technology available, and quite another to have it incorporated into the productive process. Not only does the public good nature of knowledge stand in the way of a smooth and rapid catching up in terms of technology (more on this below): although new ideas and inventions are reported ever more rapidly in today's interconnected world, it is a well-established fact that mere availability and sometimes even awareness of how better to produce or organize things is far from a sufficient condition for the actual adoption of new ideas and know-how in practice, in production and the economy. Elusive but very real factors prevent efficient dissemination of innovations. The adoption and absorption of existing technological innovations is an uncertain and risky process that is costly for firms and requires accumulation and assimilation of both physical and human capital (Nelson and Pack, 1999). In addition, a significant share of knowledge important for the economy and development is tacit, meaning that it cannot be codified, explicitly documented, or transmissible outside direct personal interaction. It consists of competencies without formal comprehension, which represents often overlooked and formidable obstacles to knowledge diffusion.

2.10 The result is a widening productivity gap between advanced and developing economies –a generalization fully valid for LAC (IDB, 2010)[9]– and the uncontested fact that global innovation is highly concentrated in a small number of nations around the world –and Latin American and Caribbean countries are not part of that short list. The remaining part of this section discusses how better to frame and understand this problem and how government responses have fared in tackling its causes and improving the state of innovation in our region. The argument proceeds step-by-step from the systemic nature of innovation, and the foundations of the ability of public intervention to influence innovation, down to what to do, what is being done, and to what effect, in matters of innovation policy and its close relative, science policy.

B. Innovation as a systemic process: The determinants of innovation

2.11 The growing literature on innovation systems also provides deeper insight into the determinants of the innovation process (Freeman, 1987; Lundvall, 1992). This literature recognizes that innovation is not a simple linear process that flows smoothly from research to application (see Annex, Figure 2a); rather, it is a collective process involving interactive learning among several actors (researchers, firms, users, etc.) and requiring multiple inputs (research, training, production facilities, engineering, problem-solving at the plant level, marketing) (see Annex, Figure 2b). An innovation system is defined as the set of economic agents, institutions, and practices that perform and participate in relevant ways in the process of innovation. Actors in a "national innovation system" (firms, universities, public agencies and governments, financial systems, and markets) contribute to the generation of knowledge, its diffusion, its use and exploitation, its adaptation, and its incorporation into production systems and society (Freeman, 1987; Metcalfe, 1995). As such, the National Innovation System (NIS) approach provides the framework within which governments form and implement policies to influence the innovation process (Kline-Rosenberg, 1986).

C. Left to their own devices, markets produce a sub-optimal level of innovation.

2.12 **Knowledge as a public good.** A businessman will invest less than optimally in figuring out a new productive process or in improving technical skills of his personnel if the competitor next door can easily steal his ideas or human resources without having invested in bringing them about. Ever since the seminal works by Nelson (1959) and Arrow (1962), knowledge has been considered a non-excludable and non-rival good. When innovators cannot take advantage of all the benefits associated with knowledge creation, a gap arises between social and

[9] In The Age of Productivity (IDB, 2010b), the Bank, through a comprehensive research project, firmly established the severity of the productivity gap affecting LAC (see in particular chapter 2, Daude and Fernandez-Arias). The fact that innovation, scientific and technology deficits have become a major factor behind widespread slow productivity growth across the region was explicitly addressed in the mentioned volume (see Navarro et al. chapter 10). The point was later further confirmed and explored in Crespi and Zuñiga (2010).

private returns from related investments and, therefore, there is less investment in knowledge generation than is socially desirable. The natural response to this issue: the establishment of a system of property rights that maximizes the social returns of knowledge production and dissemination is essential, but designing and enforcing it is an extremely difficult task.[10] Yet, the public good nature of knowledge is only one of several market failures associated with innovation, as it turns out.

2.13 **Asymmetric information.** The economics of information literature (Stiglitz and Weiss, 1981) indicates that asymmetric information in market transactions (owing to problems of adverse selection and moral hazard) can influence business innovation in several ways. First, innovation projects have unique characteristics that exacerbate the typical problems of asymmetric information that hinder the financing of all investments (Hall and Lerner, 2010). In the first place, innovation projects are riskier than most other projects.[11] Second, because of the inherent difficulties to avoid leakages in the created knowledge, innovators themselves are reluctant to share information about their projects with potential outside investors. This further magnifies the problem of asymmetric information. Third, it is difficult to use intangible assets as collateral. In summary, a gap tends to exist between the normal opportunity cost faced by private sector innovators and the minimum capital cost that they are charged by external investors in order to finance their innovation projects. Since this is a pervasive and multifaceted problem, the result is that a good share of all potentially profitable innovations falls by the wayside.

2.14 Additionally, private actors, both producers and users, do not have perfect information about the possibilities that a new technology offers. Normally, the one providing the technology has more information about its potential than the person about to acquire it. Given the problems of adverse selection and moral hazard associated with the asymmetric information that affects technology transactions, their distribution ends up being slower than it might otherwise have been. This concurs with two findings of remarkable empirical robustness, already introduced in the previous section: (i) there are persistent differences between countries regarding technological performance, meaning that keeping up to date is far from being the automatic process that the idea of knowledge as a public global good might suggests (Fagerberg and Verspagen, 2002); and (ii) the process of technological dissemination, even within narrowly defined industries is very slow

[10] Typically, the incidence of this type of failure increases when knowledge is more generic and it decreases when knowledge is more applied, since a good share of productive knowledge is idiosyncratic to any particular firm. The general trend goes in the direction of more serious underinvestment in science and pre-competitive research than in development within firms. Given a considerable degree of complementarity between both types of knowledge creation, this trend constitutes a major rationale for science policy.

[11] Beyond risk, there is inherent uncertainty attached to innovation projects, understood as the unfeasibility of attaching probabilities of future events associated with the outcomes of investment. This operates as a powerful deterrence for potential funding sources for innovation initiatives.

and produces persistent differences with regard to firms' productive performance (Disney et al., 2003).

2.15 **Institutions are the key: coordination failures.** The most recent literature on innovation systems emphasizes that the knowledge that underpins any innovation always has critical tacit components, and it is therefore very difficult for innovation to emerge without the necessary feedback and close interaction among various actors (Lundvall, 1992). Although many of these interactions occur as a result of market transactions (for example, when a firm purchases new machinery and receive technical assistance services from the supplier for its setup), others interactions are governed by different institutions, thereby giving rise to potential coordination problems (Soete et al., 2010). A good example of this kind of problem is the development of software applications for SMEs, which usually requires close interaction between the developer and the user because of the limited absorption capacity of the user (Cohen and Levinthal, 1989).[12] In a scenario in which scale is limited and clients highly heterogeneous, transaction costs can end up hampering the emergence of a software service market oriented toward SMEs. By establishing user consortia to coordinate demand and regulating minimum product standards, this limitation might be alleviated. In more general terms, putting a new technology into practice in any productive environment will very often find a serious obstacle if appropriate regulations and coordination indispensable for joint investment on complementary assets (specific human capital, distribution chains and others) are absent (Bresnahan and Trajtenber, 1995; Aghion, David, and Foray, 2009).

2.16 **The innovative firms that fail to exist.** Current literature provides ample support and empirical evidence for the notion that (as will be described in paragraph 3.2) entrepreneurship is important to private sector development and economic growth. In addition, recent research has shown that fast growing firms could have a significant impact in terms of productivity and job creation (Haltiwanger, Jarmin and Miranda, 2010; Kane, 2010; Ács and Audretsch, 1989; Audretsch and Keilbach, 2003; and Holtz- Eakin and Kao, 2003). These studies suggest that the existence of dynamic entrepreneurship generates innovations, facilitates knowledge spillovers, creates jobs and leads to higher economic growth. The latest developments in information technology and communications have made these issues more prominent than ever for decision makers. Traditional thresholds to business development in key areas such as entry costs, access to talent, suppliers, clients, marketing channels and means of payment have been lowered, and business models globalized and radically transformed through access to broadband communications and software applications. Firms located anywhere can have global aspirations and very rapid growth in a way unthinkable just two decades ago. Yet, due in part to the same kind of market failures identified above and a series of governmental and regulatory obstacles, dynamic, high-growth,

[12] Absorption capacity refers to the likelihood that, before exploiting new knowledge, users must jointly invest in human capital or seek direct help from the originator (Steinmueller, 2010).

technology-based entrepreneurship does not flourish spontaneously (Wagner, 2014). Worldwide, however, the type of entrepreneurship born out of the identification of market opportunities rather than out of plain need for income (or self-employment) is becoming a major focus for both private investors and public policy (Lerner, 2012).[13]

2.17 **Special issues in the market for innovation in developing countries.** To the list of market failures outlined above, particular obstacles get in the way of innovation in developing economies: (i) weak linkages between firms or poor performing intermediary companies create huge information gaps and compromise the quality of the value chain as a whole; (ii) markets and firms tend to be smaller than they should optimally be, which prevents them from taking advantage of economies of scale (just to mention one example, larger firm size is highly correlated with larger investments in R&D); (iii) scarcity of complementary products in many markets create unnecessary high uncertainty about the ability of firms to produce and market new goods (Greenwald et al., 1989); (iv) scarcity of specialized technicians and engineers well versed in certain industries or technologies make it difficult to diversify the economy or to take firms to the next level in terms of product sophistication and quality; and (v) the emergence of new innovative firms is constrained by the weak market incentives that exist to overcome obstacles to innovation such as those listed above.

2.18 Still another issue that is particularly hard to deal, within developing countries, is directly related to the lower degree of institutionalization they have as compared to centuries-old public and private institutions, typical of advanced economies. In a weak or incomplete institutional environment, getting the most out of investments in innovation becomes a challenge. Furthermore, acting and getting results in the area of institutional change is often relatively more difficult and slow-paced in developing countries than in developed economies.

2.19 Finally, social issues such as poverty, social exclusion, access to education and health care are especially prominent in most developing countries, so much that they might leave little room for innovation as a sector of public policy worthy of investing scarce resources. Serious long-term competitiveness and productivity issues run the risk of being neglected. A response to this state of affairs has been the notion of social innovation, which points to the potential of technology and non-technology based innovations to address and provide solutions to social issues. Mostly based on the application of open innovation platforms and methods to social issues directly relevant for the base of the pyramid, several programs

[13] The literature has come to designate these two varieties of entrepreneurship as necessity-driven and opportunity-driven. The most common form in LAC is by far the necessity-driven type, comprising most of what is usually understood as the vast informal sector in most economies in the region. All references to entrepreneurship issues in this SFD belong rather to the opportunity-driven kind, since, when productivity growth through innovation is the focus of either public policy or private investment decisions, only high quality ventures with high potential for fast growth harbor a real possibility of contributing to economic growth and significant employment creation (Shane, 2009).

around the world and in LAC in particular –see the case of *Ideas para el Cambio in Colombia*, a COLCIENCIAS program– are turning innovative thinking into the source of practical solutions for the poor and excluded. This addresses widely felt problems themselves with a renewed perspective and helps spread the word that technology and innovation are important not just for firms and research institutions, but also for society at large. This, in turn, has the potential to impact public decision making in the direction of wider and more consistent support for STI policy in the long run, a major issue in the policy-making process in the sector, as explained below (see paragraphs 3.26 and 4.34).

D. Public policies are required in order to achieve efficient levels of innovation in the economy, and evidence shows they can be effective

2.20 Market failures associated with innovation activity represent, worldwide, a compelling rationale for public intervention aimed at fostering productivity growth through the encouragement of firm innovation. Under the market conditions typical of developing economies, as characterized in the previous section, knowledge gaps regarding specific market distortions create the need for a deliberate, policy based, search process (Hausmann et al., 2008) and suggest a strong case for active innovation, science and technology policies (IDB 2014). Such policies can address market failures by developing programs in areas such as incentives to business innovation, value chain upgrading, business incubators and accelerators, venture capital market development, industrial cluster strengthening or talent acquisition (highly skilled migration) promotion. The combination of innovation and trade policy also belongs to this discussion: according to the existing literature, there are significant feedback effects between innovation on one hand and export and investment on the other (Aw et al., 2007; Girma et al., 2008).

2.21 Two general modalities of intervention exist: directly encouraging investment in innovation at the firm level – either individual firms or a group of firms linked in a value chain or a cluster, or addressing framework conditions (for example, by improving the availability in the economy of key inputs for innovation) that lead to increased levels of innovation activity in the economy as a whole, which are consistent with higher and sustained productivity growth. Both firm-oriented and framework-enhancing policies can be horizontal, if they apply to the whole economy, or vertical is they concern a particular economic sector, value chain or industrial cluster. Table 1, below, illustrates the quadrants resulting from this typology, and provides a partial list of policy interventions included in each quadrant. Allowing for the particular circumstances of each economy, all four groups of interventions are potentially relevant for LAC (IDB, 2014). A brief discussion of the main policy instruments involved follows.[14]

[14] Space limitations prevent this document from presenting a full-fledged discussion of the whole set of instruments, design and implementation issues and the evidence pertaining to their effectiveness and impact. For an extensive discussion, see IDB (2014), particularly chapters 3, 4 and 7.

Table 1. Innovation, Science and Technology Policy in Four Quadrants

		TYPE	
		Horizontal	**Vertical**
Scope	**Public Good**	Higher education/Training. Support to scientific research. Intellectual property rights. Research infrastructure. Human capital immigration. Labor training. Competition policy. Regulation. Technology transfer organization. Entrepreneurship education. IPR and bankruptcy legislation and regulation. Innovation climate. Improve deal flow through technology transfer. Tax policy.	Technological institutes (agriculture, industry, energy, fishing, etc.) Standardization. Thematic funding. Signaling strategies. Information diffusion policies (extension systems). Technological consortiums. Contests. Industry specific training programs.
	Market Intervention	R&D subsidies. R&D tax credits. Financial measures (guarantees for technology investments, intangibles, values, etc.) Adoption subsidies. Public financing of seed, angel and venture capital, directly or through private Venture capital (VC) funds. Generic business incubators and accelerators. Tax incentives.	Public procurement. General purpose technologies (ICTs, biotech, Nano-tech). Strategic sectors (semiconductors, nuclear energy, electronics, etc.). Defense sector. Business incubators and accelerators focused on a particular GPD (ICT or biotechnology).

Source: IDB (2014)

2.22 **Influencing firm behavior through horizontal interventions.** Support for firm innovation is a generally accepted governmental practice around the world. In OECD countries, between 10% and 45% of manufacturing firms[15] receive public support for innovation in any given year, through a variety of channels that include direct transfers and tax credits. Fiscal incentives for innovation are an established practice in a few countries of Latin America (Colombia, Brazil, Chile and Uruguay are examples) (see Parra, 2011 for details), but the instrument of choice across the region tends to consist of innovation funds, that allocate funds to private firms for innovation projects on a competitive basis. A long list of reasons derived both from innovation policy itself (better targeting and additionality, accessibility to SMEs, transparency and others) and fiscal policy (simplicity of tax code, moral hazard,) speak of the superiority of direct subsidies over fiscal incentives, yet international –and Latin American– experience indicates that a good design of tax exemptions for R&D activity can minimize its risk and costs relative to alternatives, so that it can become a part of a good policy mix (Crespi, 2012).

[15] Focus on manufacturing innovation at this stage of the discussion, reflects only the far better availability and comparability of data for the case of manufacturing firm`s innovation processes and outcomes, a bias shared by data bases available both in LAC and the OECD. It should not obscure the fact that innovation in the service and natural resources sectors are equally relevant for the discussion, and the generalizations made here apply to them too. More on innovation in those areas of economic activity appear further below in this document (see paragraphs 2.40 to 2.42).

2.23 Direct subsidy programs are often described as demand based interventions, since the government does not pick and choose which particular firms to support, but waits for the firms to reveal their demand for innovation and then awards the funds; as a standard design feature, they operate requiring that beneficiary firms provide matching funds. An ample set of evidence supports this type of policy intervention as consistently effective in Latin America. Past IDB evaluations have shown that innovation funds that have direct subsidies as their typical policy instrument are effective (Hall and Maffioli, 2008; see Lopez, 2009 for a comparative discussion of 13 evaluations of programs of this kind in LAC). In particular, these studies found that public funding does not crowd out private investment and in many cases has a positive effect on the firm-level intensity of R&D and innovation. A 2011 panel data based study of the effects of this type of funding on SMEs in the case of Colombia over the medium term (Crespi, Maffioli, and Melendez, 2011), showed that COLCIENCIAS' funding not only had a positive impact on firms' investment in innovation, but also had a significant impact on their performance. It provided evidence that these effects persisted and, in some cases, increased over time (see Annex, Graph 1).[16] Beyond their impact on productivity, innovation funds have proven to be rewarding in a fiscal sense, allowing for an increase in tax revenue because of expanded revenue generated by innovative firms which is usually larger than the total cost of the government funds supporting innovation policy (Lopez, 2009; Rivas, 2009).

2.24 Of particular interest are the effects on productivity. Between 1995 and 2007, COLCIENCIAS funding had an average impact on the introduction of new products and labor productivity of 12% and 15% respectively with these effects becoming more significant between three to five years after the firms received the funding (Crespi et al., 2011). These findings imply not only that beneficiary firms become more efficient, but also that they grow more and gain a larger market share than the control group. The result is that economic resources are being reallocated towards more productive firms, hence impacting productivity in the aggregate. Castillo et al., (2014) found ways to estimate the spillover effects of innovation grants to Argentinian firms in the context of the FONTAR program, showing that not only firms that became direct recipients of the subsidies but also firms that in time hired personnel leaving the beneficiary firms improved their productivity, thus providing the ultimate rationale for public intervention, the presence of positive spillovers (see Annex, Graph 2).

2.25 In sum, innovation funds that subsidize private sector innovation are one of the most consistently effective public policies when it comes to making firms more knowledge intensive. Experience indicates that this is a kind of policy instrument that can be mastered and competently handled even in a context of weak

[16] Considerable attention has been paid lately to the relative advantages of direct subsidies vs. tax credits as alternative channels of public support for firm innovation. The current trend in advanced economies is to favor tax credits, although policy research tends to find that direct subsidies have clearer and stronger effects on firms (OECD, 2013).

institutions, to the point that the recurrent dilemma of requiring strong institutions in order to have efficient policies that are not distortionary or captured in developing countries can be considered almost a non-issue.[17]

2.26 **Tiptoeing away from horizontal policies.** A more recent development, in which Brazil, Mexico and Argentina have a good deal of experience already and other countries in LAC are quickly catching up, is to provide some strategic direction to innovation funds by dedicating at least some proportion of the funds available to firms active in some industries (energy, agriculture, electronics) or technology areas (information technology, biotechnology) deemed vital or of high potential in the economy, creating some variation of sector-specific innovation funds. This evolution in policy is the result of internalizing the fact that most of public inputs needed for innovation are also sector specific (e.g. there is no such a thing like a "generic" engineer). When implemented, vertical policies are generally being done while preserving the demand-based approach, thus mitigating risks of capture or inefficient ¨picking the winners¨ approach. Recent impact evaluations (IDB, 2014) suggest that impacts on technology exports and employment can be positive, although probably not immediate, and avoiding capture by research institutions can be a challenge.

2.27 Programs organized around the notion of clusters often focus also on technology and innovation and are increasingly combined with efforts to strengthen regional and municipal innovation systems. The growing space that innovation and technology occupies in almost any industry and product makes this a trend that is easy to understand. Deliberate attempts at integration in global value chains are not new as public policy in Latin America –consider the "*maquila*" industrial zones–, and have had a measure of success, but they have also shown themselves to have very limited results in terms of knowledge transfer to the local economies. Global value chain upgrading has more recently been attempted through deliberate attempts at moving up towards value added stages beyond physical production –that turns out to be the lower value added phase–, which means strengthening areas such as engineering, design, distribution and logistics, marketing, servicing of manufactured products and R&D. These types of innovation policies include a role for direct foreign investment in R&D, as well as domestic supplier strengthening through investments in technological upgrades for firms. They also involve some deliberate effort to concentrate public support to certain clusters or value chains that have some "desirable" properties in terms of their potential to become springboards to enter more dynamic and knowledge intensive sectors, which represents still one more step in the direction of vertical policies for the support of firm innovation and productivity.[18]

---

[17] See chapter IV section C, for a review of the Bank experience that supports this point.

[18] The development of vertical instruments clearly places the methodological issues involved in identifying the economic sectors worth supporting on the forefront of policy. For an extensive discussion, see IDB (2014). See also Hausmann, Hidalgo et al. (2011) and Kim and Nelson (2000).

2.28 **The special case of support for entrepreneurship.** Beyond public programs aimed at encouraging innovation in established firms, governments around the world are also deploying a wide variety of interventions aimed at providing finance for the appearance and growth of dynamic entrepreneurs and high growth ventures. Seed, angel and venture capital funds have mushroomed over the past decade, as a response to the striking achievements of these instruments in the Silicon Valley experience. That case and a few other success stories speak eloquently about the role that government's intervention plays in making them possible (Lerner, 2009), yet the difficulty in replicating them in spite of sometimes very large investments by several countries suggest that both design (in short, derived from the difficulties that public sector agencies have in adapting to the flexibility characteristic of new ventures) and implementation issues (poor supervision, cumbersome processes in providing financing and others) are not easy to get right, as it has been the case in the Latin American experiences in spite of some partial achievements (Lerner, Leamon & García-Robles, 2013). One lesson learned is that success in setting up a financial framework for dynamic entrepreneurship critically depends on the financing interventions that have been complemented by non-financial support programs (training, incubators, accelerators, adequate intellectual property rights (IPR), tax and technological resources in the environment). These programs, in turn, are complex in their design and quite often - small details in the incentives implicit in a particular program can make a difference when it comes to results, as a recent impact evaluation of CORFO's incubators program in Chile shows (Navarro, 2014).

2.29 **Investing in the inputs for innovation and the role of science policy.** In contrast to demand-side interventions aimed at encouraging firm innovation, supply-side policy instruments focus on the generation of new scientific knowledge, both basic and applied, and the formation of human capital as well as in the necessary infrastructure for the practice of science and the advancement of technology and its applications. Most LAC countries have supply-oriented policies on their agendas today (examples include scholarship programs and direct funding for research institutes). This policy approach was the main component of science and innovation policy from the 1950s until the mid-1980s (Sagasti, 2011).

2.30 The traditional instruments for promoting scientific research include funds for science and research grants (which evolved almost everywhere into a competitive, peer reviewed process, along the lines of the National Science Foundation in the US). The creation of centers of excellence is also attracting interest. Centers of excellence seek to position the country or the region's research institutions among the top ranking research institutions worldwide, in a selection of fields that are lent priority and relevance for the national economy. Their creation frequently involves a combination of resources, subsidies, and grants from both federal and local budgets. Two examples of this are the *Programa Iniciativa Científica Milenio* (ICM) in Chile, and the *Centro de Excelencia en Genómica* in Colombia. They can be understood as a vertical supply side intervention in contrast with the horizontal nature of the traditional peer-reviewed research projects.

2.31 **Infrastructure for science and technology.** In the area of infrastructure, policies include developing university and public research centers with the right infrastructure in a variety of scientific disciplines but, most importantly in the areas of general purpose technologies (bio, nano and ICT) that underpin work in a wide range of more specific fields. There is extensive experience and a well-established good practice in the area of how to design and implement policy for scientific infrastructure and equipment, emphasizing relevance, adequate utilization of capacity, inter-departmental and inter-institutional sharing of sophisticated equipment, and provisions for maintenance and cost-recovery when possible. Often, universities turn out to be the beneficiaries of these policies.

2.32 **Human capital for science, technology and innovation.** In the case of human capital for innovation, science and technology, policy instruments include undergraduate, graduate, and post-graduate scholarships, scholarships for doctoral and post-doctoral studies abroad, and educational programs in technical areas, among others. In recent years, policy in this area has evolved substantially. Worldwide, national talent acquisition strategies have become proactive. Traditional strategies in this area, usually focused on scholarship programs, are being complemented by a more deliberate and wider search for talent. More attention is being paid to the development of domestic graduate and research programs that will be able to accommodate new Ph.Ds. returning from abroad. Additional steps are also being taken to manage talent flows across borders by designing specific policies directed at preventing brain drain and attracting the scientific diaspora. Thus, countries such as Argentina, Colombia, Ecuador and Uruguay have put in place well-funded initiatives aimed at attracting and connecting with the scientific diaspora. “Brain circulation” terminology has replaced the old language of “brain drain”, thanks to the unprecedented mobility of people and ideas made possible by increased facility of transport and communication technology over the past couple of decades. Gradually, the notion that LAC countries must attract highly skilled human capital –not only scientists, but also engineers and entrepreneurs– is gaining traction: the celebrated Start-Up Chile program aims at attracting entrepreneurs from around the world in the hope that their presence in Chile will help transmit tacit entrepreneurial knowledge to local entrepreneurs in a way that would be impossible through traditional training and scholarship programs. Still another new set of programs targets the industry insertion of researchers, by subsidizing the hiring by industry of engineers and scientists with advanced degrees, subject to a gradual phasing out of the subsidy until, after a few years, the firms will bear all the costs of the highly qualified personnel.

2.33 **Focusing on mission-oriented research: vertical science and technology policies.** In general terms, as far as science policy is concerned, a better balance between applied and basic research in science funding and education programs constitutes a necessary first step toward a better matching of investments in research and industry needs. This does not mean completely excluding basic research, but rather striving to balance discovery-driven research and more mission-oriented research. Initiatives to support the creation of specialized research centers addressing industry needs are again expanding in the region. In some countries, these centers were created as far back as the 1930s, but are lately being re-launched, and in some cases re-structured, so that their governance and mission can be better aligned and receive stronger funding. INTA in Argentina and CENIS in Colombia are two examples. In Colombia, the Colombian Corporation for Agriculture and Farming Research (CORPOICA) seeks to generate and transfer scientific knowledge and technological solutions to the agriculture sector. Its aim is to become the leader in research and innovation and to contribute to the articulation of the national innovation system and the integration of local teams with international networks in Science and Technology (S&T).

2.34 The rise of policy programs targeting specific technologies and/or industrial sectors is a response to the view that world-class economic competencies are a product of knowledge-intensive efforts in activities that promise high impact. Some sectors have industries or technologies in which the country's competencies are still embryonic but the sector is deemed strategic for future economic performance (e.g., semiconductors and nanotechnology). FONSOFT software in Argentina and CT-BIPOTEC in Brazil are examples of such programs. Other policy programs target sectors in which countries have a competitive advantage but need to improve their performance through knowledge and innovation. Among the instruments promoted in this approach are sectoral and technology funds (e.g., INCAGRO-FTA in Peru (agriculture); FIP (fishing) and FIA (agriculture) in Chile), and other programs targeting crosscutting areas.[19]

2.35 Programs to support crosscutting areas include the creation of funds for sustaining technology development in technologies or sectors that have an impact throughout the economy and society (e.g., ICTs and environmentally friendly technologies). Some programs established to support crosscutting sectors include CT-AEREO and CT-ENERG in Brazil, and the Sectoral Fund for Technology Development in Energy by CFE-CONACYT in Mexico.[20] Priority area programs are designed to support S&T activities for social development. Activities include the mobilization of human and financial resources for R&D, which is frequently done by specialized national research centers, and the dissemination of cost-effective technologies that have broad application in society. Some examples are the

[19] This SFD does not expand on the particulars of the important area of innovation in the agricultural sector, even though most of the discussion on market failures applies in full to that sector. A more detailed discussion can be found in the Agriculture and Natural Resource Management SFD, which is focused on promoting rural development through the creation of effective policy interventions, technological innovation policies being one of them.

[20] Brazil has two important horizontal funds: VERDE AMARELO, whose aim is to strengthen R&D linkages between universities and firms, and FUNTTEL, for the development of telecommunications.

FINEP-PROSOCIAL and FINEP-HABITARE in Brazil, and the Sectoral Fund for Research and Development in Water CONAGUA-CONACYT in Mexico.[21]

2.36 All these constitute examples of vertical public goods-oriented science and technology policies. It is too soon to be able to see concrete results from the use of these types of instruments. However, some interesting recent examples provide grounds for optimism. Successful sector policy initiatives are found in Brazil and Argentina in the area of agricultural exports, as well as the software industry in the case of Mexico`s Prosoft (ITAM, 2012). These efforts have emphasized collaborative processes between public research institutions, technology transfer, extension services, export promotion, and industry.[22] A similar synergy is developing in the emerging agricultural machinery industry in Argentina (Lengyel, 2009).

2.37 **From a good business climate to a good innovation climate.** Beyond investment in inputs to innovation in the form of physical and human capital, ongoing developments in innovation policy emphasize the need to build a cultural, regulatory and institutional environment that breeds innovation. The "innovation ecosystem", an expression once reserved for the financial framework needed for technology-based entrepreneurship (comprising seed capital, angel investors and venture capital), is now been applied in a more comprehensive way to refer to efforts that include anywhere from business accelerators and incubators to contests and prizes to outstanding innovators. In between lay the key institutions needed to solidify links among the main actors in the innovation systems, such as capabilities in intellectual property rights management, technology transfer offices at universities, science and entrepreneurship education in K-12 and higher education and all of them are mostly dependent on public policy. This type of policy approach goes beyond the traditional business climate reforms –as represented by the World Bank's Doing Business index–, that leveling the playing field by creating a favorable business environment, no matter how important it is and how well is done, will not take an economy very far in terms of sustainable competitive advantages and closing productivity gaps: that will require active productive development and innovation policies as well as the right environment for high productivity companies to exist and prosper (Halward-Driemier, Pritchett, 2011; Acs, 2012; DIA, 2014).

2.38 Technology transfer programs that use public funding to help bridge the gap between ideas and prototypes originated in universities and the market are an important member of this family of policies. So are institutions and programs whose mission is to help firms that are lagging behind technologically to catch up.

---

[21] Significantly, most of these programs bear the name of the specific economic sector for which they are intended to be relevant, signaling the very embodiment of the notion of mission oriented research as contrasted with curiosity oriented research.

[22] See, for instance, in connection with technology transfer initiatives that try to link firms, government and academia for the purpose of technology commercialization, the experience of WIPO with CATI (*Centros de Apoyo a la Tecnología y la Innovación*) in http://www.wipo.int/tisc/es/.

This is especially true of SMEs, which are frequently disadvantaged relative to larger firms in terms of access to technology and human resources in S&T. Technology diffusion centers (typically funded through public resources or combinations of private and public contributions) provide technology extension services that can help strengthen capacity in firms. They provide expertise and services including, but not limited to: prospective studies, adaptation of foreign technologies, engineering services and development (i.e., testing of new products, calibration, and quality tests), and training and networking services (i.e., with providers of technology and customers and with other industries).

2.39 Insofar as institutions govern the coordination of human interactions, the latest literature on innovation places great emphasis on good governance and institutional reform. For example, the literature favors the innovation of institutional designs that promote public–private interactions and that connect the different actors participating in the innovation process (e.g., firms, universities, a variety of public agencies, producers and users of new technologies, and consumers). This greater coordination can be achieved either by defining new roles for existing institutions (e.g., allowing universities to claim intellectual property rights over the research they conduct or regulating new contract models that support the emergence of a risk capital industry) or by creating organizations to regulate interactions between actors (e.g., by creating governing boards that induce coordination among a variety of public sector ministries or agencies and the private sector, competitiveness councils, university technology transfer and IPR offices, technical and quality standards-setting agencies and public–private technological development consortia) (Steinmueller, 2010). These kinds of arrangements can lead to more innovation and high productivity growth because innovation policy becomes streamlined and better coordinated; investments are not wasted on duplicate efforts that lead to overlapping results. Ultimately, at the firm level, products and services are more likely to be coordinated and more compatible across industries and within each industry's value chain. Thus, externalities become internalized and it becomes more likely that joint investments turn out to be complementary.

2.40 **The special case of innovation in services and ICT.** Worldwide, the prominence of services is being observed and studied as one of the most drastic changes in the economic structure since the emergence of the industrial revolution (Rubalcaba, 2007). Despite being often considered as an innovation-averse sector, evidence from countries of the OECD shows a strong relationship between innovation and productivity in services firms. Moreover, some types of services are more knowledge intensive and innovative than manufacturing firms (OECD, 2009). The majority of firms in LAC work in the service sector, and by far most of the employment is concentrated in this heterogeneous set of economic sectors (from retail to transportation and from finance to consulting) grouped in national accounts as ¨services¨. Yet, traditionally most of the discussion and research about innovation usually has manufacturing as the focus of attention and analysis. The standard Oslo Manual definition of innovation includes innovation in productive processes, organization and marketing, which represents a recognition that innovation in services can happen and can be potentially important. Although innovation in services is still in the early stages as a subject of systematic study (see Annex, Box 1 for recent IDB research on the topic), it is generally recognized that: (i) it is less dependent upon R&D than innovation in manufacturing; (ii) it is often focused on business models and business strategy, and therefore rather low-tech; (iii) when it comes to technology the most important modern technology for the service sector tends to be ICT applications to businesses, leading the literature to characterize ICT as the general purpose technology for the service sector (Savona and Steinmueller, 2013); and (iv) this is particularly important, and by no means exclusive, of the services known as 'Knowledge Intensive Business Services', or KIBS, such as consulting, engineering and design.

2.41 As in other areas of technology diffusion and adoption, ICT does not spread throughout the business landscape, and particularly among SMEs, as smoothly and rapidly as desirable, keeping the productivity of the service sector at abysmal levels, on average, as recently emerging research shows (IDB, 2011; IDB, 2014). Firms face several obstacles in adopting ICT technologies. First, they incur high fixed costs associated with purchasing and maintaining hardware and software and adapting it to production processes, disrupting normal business processes. Second, poor telecommunication infrastructure and inadequate regulatory frameworks lead to high connectivity costs. Third, limited ICT literacy (i.e. lack of knowledge and trust in ICT) prevents firms from adopting them and fully realizing their potential benefits. Finally, services provided online and the coordination between them and transport and mail infrastructure are still limited and their regulation is embryonic, consequently reducing the attractiveness of ICT adoption. Business analytics, the use of social media for marketing and customer relations, the intelligent management of inventories and deliveries, just to mention a few examples, are rarely known or practiced in most SMEs in developing countries and LAC economies are not the exception. Broadband deployment, essential as a requirement for most of these advanced uses of ICT in business, lags behind all across the region.

2.42 **The special case of innovation in natural resource industries**. LAC countries are heavily natural resources (NR) endowed. The traditional view in development has been that NR abundance tends to be a mixed blessing, creating potentially large risks as well as opportunities. In spite of having a rich tradition of applied research and technology diffusion, the agricultural sector, in particular, has been associated with backward production methods and slow productivity growth. Yet, the recent decade of structural transformation has increased the importance of NRs in the majority of LAC countries (CIEPLAN, 2013). Since early 2000s the terms of trade of commodities have increased by more than 40% above its long term trend (CEPAL, 2013) and in several LAC countries this price boom has led to substantial investments to expand the production frontier of natural resource based sectors (both renewable resources such as in agriculture as non-renewable resources as in mining). This is partially due to excellent external conditions as the growing demand for raw materials from China and India and the boom in commodities resource based sectors. These productivity gains have been, to a large extent, driven by the impact of ICT in the reconfiguration of NR value chains at the global level, as well as by the introduction of product, process and business model innovation directly related to NR anchor firms and the network of SME that act as suppliers of service and technology to them (see Annex, Box 2 for details). The dynamics of innovation in sectors such as agriculture and mining is still not fully documented or understood, but its relevance for LAC makes by necessity a major focus of STI policies.

E. On the policy mix

2.43 Lessons from programs in STI in different countries worldwide suggest that it is important to achieve a balance between supply-side policies and demand-side policies. In particular, a clear focus on enhancing business productivity and innovation has to be carried out while maintaining a keen awareness of the fact that efforts to establish a critical mass of scientific and engineering capacity must remain well funded. Policies should target these two dimensions, and strive for coordinating and developing them in close proximity. For instance, the necessary space for curiosity-oriented research should allow for a priority for mission-oriented research, one that is undertaken having in mind its relevance for business development and finding solutions to social problems.[23] Well-established programs such as the United States Small Business Innovation Research have proven that public procurement, if designed in a way that facilitates technology transfer and innovation, can be a powerful tool in focusing research in practical and high economic and social impact fields.

2.44 A major consideration in figuring out the best policy mix for a given country in a given moment of its economic development has to do with designing policy and deciding about public interventions bearing in mind that, even if market failures are endemic, it cannot be taken for granted that the process of addressing them will succeed (IDB, 2014). Positive externalities may fail to materialize, or their size might be lower than expected. Public services run the risk of being privately captured, or incursions in vertical innovation or science policy may run the risk of being shaped or implemented in ways akin to old fashioned and distortionary industrial policies. The institutional –bureaucratic, technical, political– capacity to execute a policy instrument that looks optimal on paper may very well not be in place. More generally, rather different policy design and implementation provisions will be in order according to how sophisticated the particular economy at hand was to begin with and how far its firms are from the technological frontier. Table 2 aims to illustrate, in connection with the distinction made above

[23] By definition, mission-oriented research has to be primarily defined according to the specific problems and circumstances of each country. There is room, however, for some common denominators to be found in issues such as understanding and mitigating the effects of climate change for the whole LAC region, in which case research acquires the form of a regional public good. The IDB could play a role in supporting this kind of mission-oriented research through its own instruments for the support of regional projects.

between types of programs that constitute market interventions and those that produce public goods (see paragraph 2.21), how some types of policies could be different in the case of national economies operating at different distances from the technological frontier, with those policies in the first row having the uniform characteristic of being less demanding in terms of public sector institutional capacity or private sector sophistication. This, of course, remains a rough approximation to the careful effort that needs to be made in designing appropriate STI policies in the case of each particular economy: the size of the domestic market and the prospects of foreign markets for each industry, the availability of basic inputs, both human and physical, industry-specific technology trends, global competition, local connectivity conditions, local institutional traditions and regulations, and still other factors need to be weighted in order to maximize the positive impact of interventions.

2.45 Last but not least, other political economy risks are normally worth considering, since innovation policy-making involves several potentially important agency problems that may lead to loss of accountability and undermine policy effectiveness. Given the long time horizons required for innovation and scientific investments to mature, dynamic inconsistency tends to be a major problem facing policy-making in this area.

Table 2. Tailoring Interventions to Specific Country Conditions

		TYPE	
		Market Intervention	**Public Good**
Technological Frontier	**Far**	Innovation funds, technology diffusion programs and institutions. Business incubation. Incentives for ICT adoption in business. Entrepreneurship education. Business climate reforms.	Enhancement of engineering education and technical post-secondary programs. Basic technological infrastructure: broadband, standards and quality systems, metrology laboratories. Early stages of competitive scientific research funding.
	Close	Public/private financing of seed, angel and venture capital. Business accelerators. Sector innovation funds. Innovation climate reforms (technology transfer programs, IPR development initiatives and regulations).	Advanced degree scholarships. Advanced talent acquisition strategies. Research institutions in General Purpose Technologies (Biotechnology, Nanotechnology, ICT).

2.46 In closing, and as an illustration of how the policy mix is conditioned by the type of economy in which it takes place, it is worth considering recent trends in innovation, science and technology policy in advanced economies. Concerns and instruments such as those described below may very well not fit in the right policy mix for LAC economies, or they may be beyond reach for lack of institutional capacity, yet they express responses to concerns that may arise in developing country contexts too, and therefore be nevertheless useful:

i. There is an increasing interest for the promotion of collaboration among the different actors of the system, which is done by the introduction of designs that stimulate university-industry collaboration, firm-firm collaboration, innovation networks and technological consortiums. In some extent, there is a growing concern by policy makers in promoting schemes that precisely foster the internalization of spillovers and the solving of coordination failures.

ii. There is a growing interest in paying more attention to the framework conditions. During earlier stages of STI policy, and not unlike the case of LAC countries, attention was principally focused on investment in large science projects, which mostly included programs for financing scientific research and provision of human capital. Nowadays, it has expanded to include issues such as regulation, competition and labor market policies.

iii. There is an increasing focus on supporting technologies rather than sectors. Or, if a sector needs to be supported the justification is provided based on the idea that this sector generates multiple spillovers that expand across the rest of economic activities (such is the case of general purpose technologies –nano, bio and ICT). Within this sector and while focusing in these technologies, the interest has gradually moved from the technology supply side to its adoption and use along wide economic sectors

iv. There is a growing attention being paid to the complementarities among the four different quadrants and to the policy sequencing among them. For example, the success of an R&D subsidies scheme –a typical program in the bottom-left quadrant in Table 1, above– will depend on several of the interventions included in top-left quadrant –the framework conditions. Most of R&D subsidies programs stimulate the demand for advanced human capital and engineers by the private sector. To succeed they depend on a positive supply response from the education system. The effectiveness of R&D subsidies is very likely that will depend on the effectiveness of competition policy. Indeed, competition pressures or entry threats force companies to innovate in order to escape competition. So, companies in relatively competitive markets are the ones willing to innovate and thus the ones facing the sort of market failures that justify R&D subsidies. On the other hand in monopolistic markets, R&D subsidies might end up being used by incumbent firms for other purposes or to erect barriers to entry (Aghion et.al., 2009).

III. THE REGION`S CHALLENGES

3.1 In almost every relevant dimension of the STI landscape, LAC countries differ greatly from more advanced economies. Overall, LAC countries display substantial underperformance with respect to OECD and EU countries and to emerging economies such as China, India, and some Central European countries.

(IDB, 2010). The following paragraphs explore the main aspect of these differences, since most of the issues affect all LAC economies. The discussion is developed, however, having in mind the fact that some countries in the region –such as Argentina, Brazil, Chile and Mexico– have begun to evolve toward developing a technological profile closer to that of advanced economies, and can count today with an arsenal of policy instruments and both public and private sector resources still not available to others in LAC.

3.2 The low technological intensity of Latin American economies is particularly evident in the list of leading export sectors that have represented the largest share of economic structure in the region, which has remained mostly unchanged over the past 50 years. A comparison of the evolution of the economic structure of Latin American economies and South Korea (see Annex, Graph 3) –a paradigm of innovation led economic development– over that 50 year period shows how, while the Korean economy changed its economic structure in favor of more technologically sophisticated industries, and diversified the number and nature of its productive specialization, for the most part LAC kept its economic structure heavily concentrated in primary exports and low-tech products, with a low technological profile and limited diversification in its economic structure (DIA, 2014).[24] Given the close links between investment in innovation and productivity growth, it can be asserted that the slow growth in productivity that characterizes the majority of economies in the region is due in part to unresolved and considerable challenges in the innovation, science and technology sector. The most salient of them are presented in what follows.

A. Low public and private investment in STI

3.3 **Highlighting the diversity of initial conditions as a premise.** Innovation systems in the LAC region find themselves at diverse stages of development in the STI sector. In connection with the previous discussion (see paragraphs 2.44 and 2.45, as well as Table 2, above), programs aimed at enhancing the sector will naturally be customized to reflect such differences. Thus, countries that have already built a substantial scientific research capability may need programs emphasizing the maintenance of such capability and, above all, approaches that focus the effort in connecting such capabilities with the productive sector. Those economies that cannot count on such capabilities as a premise will most likely have to emphasize the creation of the basics of science and innovation policy

[24] Along a similar line, Katz (2001) and then Cimoli et al. (2006) argue that the LAC economy has even accentuated such concentration in low-tech sectors in recent times. By analyzing structural change in the economic structure of Latin America between 1970 and 2000 and comparing it to South Korea, Finland, and the United States, they found that growth in South Korea and Finland is associated with a change in the economic structure in favor of knowledge-intensive sectors, which have a role in disseminating technology throughout the whole economy. In contrast, in Latin American countries, evidence shows a reduction in the participation of high-technology sectors in favor of natural resource-intensive sectors. The recent worldwide boom in commodities has probably added pressures that reinforce trends like the one described in these studies.

(such as the mainstreaming of peer-reviewed, competition-based selection processes for research and firm innovation projects) and the acquisition of a minimum critical mass of human capital for innovation. From an institutional point of view, countries with a tradition of science and productive development policy may have to invest primarily on coordination and the overall coherence of their institutional settings, while those with little institutional precedent may want programs that invest in a wide variety of instruments that are not very demanding in terms of implementation capacity, but allow for a quick learning process in both the public and the private sector.[25]

3.4 **Low overall investment in STI.** Yet, no matter their important differences, most Latin American countries underperform with respect to other countries with comparable income levels in terms of R&D intensity (see Annex, Graph 4). Under-investment in STI is a constant across countries in the region, and differences between countries reflect their heterogeneity but they are matters of degree, with low knowledge intensity clearly acting as a common denominator. Within LAC economies, the R&D gap with respect to their potential, measured in terms of expected R&D intensity relative to national income, has been smaller in Chile, Uruguay, Costa Rica, and Brazil (between 40% and 50%) and greater in countries such as Guatemala, where the gap is nearly 100% (IDB, 2010b). In contrast, European innovation champions such as Denmark, Sweden, and Finland appear frequently as dramatic outperformers, with R&D intensities above what their income level would predict (Lederman and Maloney, 2003; IDB, 2010b; IDB, 2014).

3.5 The gap with advanced economies is not closing. R&D expenditures as a share of Gross Domestic Product (GDP) (R&D intensity) has grown consistently in advanced economies establishing a solid base of STI investment, whereas improvements in LAC countries have been modest on average: R&D investment in the region in 2011 represented 0.78% of GDP compared to 0.56% in 2001. During the same period, OECD countries increased R&D intensity from 2.2% to 2.4% (OECD MISTI, accessed July, 2014). In addition, in contrast to the rather uniform increased investment in most developed economies, efforts to improve R&D investment in LAC were concentrated in a handful of countries. Over 60% of R&D expenditures in the region in 2011 occurred in Brazil, where R&D intensity has reached 1.21% of GDP, the highest in LAC, and heavily focused on energy and agricultural research (RICYT, 2014).

3.6 Beyond simple comparisons like these, available in depth analyses confirm the existence of an innovation shortfall in LAC economies: low technological intensity cannot be exclusively attributed to a particular kind of economic

[25] Clearly, the path to a knowledge-intensive highly productive economy is far from unique or linear (see Annex, Box 4), so these descriptions of different kinds of STI investment programs tailored to a diversity of levels of development is intended primarily as an illustration of how the Bank might respond in practice to such diversity, rather than as a prescription to be applied in all cases.

structure biased in favor of natural resources. On the contrary, empirical evidence suggests that even correcting for that factor, the conclusion of low innovation intensity holds (Maloney and Rodriguez-Clare, 2007; IDB, 2010).[26] LAC´s economies are low-tech not only because they are invested for the most part in low-tech industries, but also because, when they invest in any industry, they tend to operate that industry in ways considerably distant from the technological frontier.

3.7 **Low private sector investment in STI**. Another characteristic of the LAC region is scant private sector participation in innovation efforts (see Annex, Graph 4). The financing of R&D continues to be highly concentrated in public institutions (government agencies and universities), averaging roughly 58% of the total effort, compared to 35% in OECD countries in 2011 (RICYT and OECD MSTI, 2014).

3.8 Firms in LAC have a very different profile in terms of innovation activities compared to firms in advanced economies. A salient characteristic is the low level of expenditure and intensity of effort in R&D. On average, firms' R&D intensity (expressed as a percentage of sales) is below 0.4%, considerably lower than the 1.61% European or the 1.89% OECD averages. In all economies, R&D expenditure is highly concentrated in the largest firms. This is also true in LAC, but the disparities between the top 5% of firms and the rest is far more acute, clearly suggesting that a particular challenge is not only to raise the overall level of private investment in R&D, but to dedicate special efforts to technology diffusion across the vast majority of SMEs that operate a long distance from the technological frontier.

3.9 The differences between LAC and OECD countries in terms of intensity of innovation investment by firms are less pronounced given the broad definition of innovation activities adopted in current surveys.[27] In this context, the concentration of innovation effort in LAC firms occur in innovations that can be considered new for the firm, rather than for the national or global market, and on the purchase of capital goods and equipment related to innovation activities. Expenditure on these items represents between 50 and 80% of total expenditure on innovation, while the corresponding share in non-LAC OECD countries varies

---

[26] Analysis focused on the use of technology in particular sectors confirms this finding. Comparing Chile and Australia in the mining sector, and Chile and Finland in the paper pulp sector, Benavente and Bravo (2009) found that lower R&D investments in Chile accounts for much of the difference in productivity.

[27] Following the Oslo Manual, innovation activities include the acquisition of technology embodied in capital goods and equipment, hardware and software, the contracting of R&D services, technology transfer activities such as acquisition of disembodied technology (licensing and buying of intellectual property, know-how and other technical services), and training, engineering, and consulting services, among others (OECD and Eurostat, 2005).

between 10% and 40%. In OECD countries, R&D expenditure is frequently the main item of innovation investment.[28]

3.10 **The view from the firm.** Innovation surveys provide further insight into the way in which firms finance innovation. Information revealed by firms indicate that internal sources account for more than 70% of total financing of innovation, followed by commercial bank financing (between 10 and 20%). Public financing is a minor source of financing for firms in LAC, and tends to be used more intensely by relatively larger firms (Chrisney and Monge, 2013). According to innovation surveys, less than 6% of manufacturing firms in LAC receive public financing for innovation activities, figures that are dwarfed by non-LAC OECD averages. It is clear that direct subsidies and tax incentives put in place by governments across the region in order to encourage business innovation have, albeit effective in its own terms, stopped short of reaching a critical mass of potentially innovative firms (see Annex, Graph 5). Hence, their economy-wide impact on competiveness and productivity remains modest. Thus, in LAC, market failures in the market for knowledge are compounded by government failures in the form of sub-optimal funding of market-correction measures.

3.11 Innovation surveys also reveal problems related to market size, suggesting that a lack of integration of the regional market can also be an obstacle to innovation (Rovira et al., 2012). Lack of economic integration confines many businesses to their domestic –often small– markets. Should this be the case, it would imply diseconomies of scale for innovation projects, many of which require relatively large investments upfront and longer time horizons to realize a profit. Reduced mobility for entrepreneurs, incompatible firm-related or intellectual property rights legislation may also be limiting incentives for innovation, although this is an area where considerable research is still to be undertaken.

B. A deficit of inputs and weak framework conditions

3.12 **A shortage of human capital for innovation.** The differences with respect to human capital are similarly large. According to the data available, in 2011 there were only 1.11 researchers per 1,000 in the labor force on average in LAC (RICYT, accessed July, 2014). This number is seven times lower than the OECD average and eight times lower than in the United States (OECD MISTI, accessed July, 2014). There are substantially fewer Ph.Ds. in science and technology per capita. There were also substantially fewer doctoral graduates per capita in the

[28] The combination of low R&D efforts and high investment in technology embedded in machinery could signal problems (IDB, 2010). Even though acquiring technology by buying equipment and sophisticated machines can be an important step in catching up and advancing toward the technological frontier, the impact of embedded technology at the firm level is limited if internal absorptive capacity (in the form of R&D investment or human capital dedicated to innovation activities) is absent. This type of innovation activity tends to be a step in the right direction, yet one that generates fewer externalities than innovations that are new to the market, which normally come attached to human capacity building and the creation of valuable intangibles such as intellectual property at the firm level.

LAC region in 2011 compared to the United States and Spain. On average, there are 3.5 Ph.Ds. per 100,000 inhabitants in LAC and only 1.7 of those are in science and engineering, whereas in the United States and Spain there are 22.02 (in 2009) and 18.9 Ph.Ds. per 100,000 inhabitants, respectively and in Spain, 10.9 are in science and engineering (RICYT, accessed July, 2014).[29] Moreover, serious issues persist in terms of incorporating female researchers into the academic profession.[30]

3.13 Fewer researchers are employed in business (24% on average) in LAC than in OECD countries, where 59% of researchers work in firms (RICYT and OECD MSTI, accessed July, 2014). This low participation is explained by a combination of factors, including inadequate mechanisms for market insertion, the orientation of research competencies in many cases toward basic research, a mismatch between supply and demand (i.e., lack of relevance or applicability of specialties to industry needs), and particularities of institutional settings that preserve the separation of research and education systems from the private sector (i.e., lack of incentives for mobility). Another problem is that industries fail to recognize the importance of research for learning and innovation. Companies in LAC have systematically favored innovation strategies that focus on purchasing existing technology rather than promoting the endogenous generation of new ideas, neglecting the importance of developing research capacity for the absorption of technology. Consequently, the region's universities produce ideas, researchers and skills that are not used in industry.

3.14 **Progress in scientific production, but still lagging behind in patenting.** Scientific performance in LAC countries continues to lag behind developed countries. There are fewer than 200 scientific publications per million inhabitants in LAC, as opposed to over 1,500 in OECD economies (Calculations based on Scimago, accessed July, 2014). The picture is somewhat more nuanced, particularly if one looks at the figures for Brazil, Mexico, Argentina, Chile and Colombia countries that rank among the top 50 in the world in terms of scientific publications with rankings of 13, 31, 40, 46 and 49, respectively out of 225 countries in 2012 (Scimago, accessed July, 2014).[31] On a normalized scale of 170 countries, between the mid-1990s and the mid-2000s, the region improved its

[29] Flight of highly skilled human capital key for innovation activities is known to be a particularly serious challenge in the case of the economies of the Caribbean region (Docquier & Schiff, 2008).

[30] The past few years have seen a rush of governmental activity across the region aimed at addressing the highly skill human capital shortage. Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador and El Salvador have launched flagship scholarship programs of unprecedented funding and coverage, mostly focused on sciences and engineering. Other countries in LAC are rapidly following suit.

[31] These rankings are very sensitive to weighting the data by either population or GDP. Brazil, for example, accounts for over 50% of the publications in the region, yet if the country's publications are weighted by population Brazil's rank drops to 76 out of 206 countries; and Chile with almost 8% of the publications in the region becomes the region's frontrunner at 57 out of 206 countries when rankings are weighted by population. When rankings are weighted by GDP as they are by the Global Innovation Index (WIPO/INSEAD, 2013), the rankings change to Chile (52), Brazil (59), Argentina (77), Colombia (97), and Mexico (100).

position slightly. With respect to the growth rate of publications from Latin America, which has tripled over the past decade and a half, LAC has outpaced some other regions and consequently reducing the gap in this regard (IDB, 2010). The nature of research in LAC economies is also different from that in OECD countries. There is less applied research, notably in engineering and technology. The share of researchers working in those fields as a percentage of total researchers is between 10 and 30% (RICYT, accessed July, 2014), whereas in countries such as Singapore, Japan or Korea this figure is 60% (UNSECO accessed July, 2014 and IDB, 2010).

3.15 Yet, even if becoming a leading source of new knowledge in a particular scientific field or industry is beyond reach for a given LAC country, the need to adapt processes, machinery and products and to acquire skills to customize or use them is rapidly becoming an innovation intensive activity. A key question has become whether a given developing economy has put in place the basic conditions –a minimum of scientific skills, trained labor force, advanced equipment, communications infrastructure and business and governmental sophistication- to identify, obtain, adapt and use already existing knowledge in a context of accelerating technological change. The answer tends to be negative in the case of most economies in LAC (Rand, 2007). The challenge in this area seems to be one of sustaining the effort in leading countries, while spreading a minimum of scientific capability across all economies in the region, which are likely to require basic scientific capabilities to keep apace of the multiple applications of science in fields of critical economic importance such as energy, environmental protection, transportation, telecommunications, agriculture and still others. In this regard, R&D should be seen as both a source of original ideas and a source of absorptive capacities to search for and adapt existing ideas to local conditions.[32]

3.16 Despite such achievements in scientific performance, the technological performance of the LAC economies has remained extremely poor. The LAC region's ranking in number of patents has fallen (on a scale of 0-10, LAC fell from 6.3 to 5.4 in about a decade) (IDB, 2010). Between 1 and 5 out of 100 firms in any given LAC economy hold a patent, compared to between 15 to 30 European countries. When looking at trends in patenting and trademarks, it is clear that most of the world is moving in the direction of newer technological fields and, generally speaking, the LAC region is not increasing its patenting productivity at the same pace as its scientific productivity. A particularly serious cause for concern is that domestic firms in LAC seem to have little use for the patent system, as evidenced by the fact that foreign companies requests several time over the number of patents in LAC markets than national, resident firms. This points to another source of government failure in LAC, one that has to do with inadequacies in allocation of property rights that prevent firms from turning

[32] Even more, given the strong natural resource base of the productive structure of many LAC countries and the specificities this generates, it is necessary some degree of local R&D in order to exploit comparative advantages more efficiently.

their ideas into value, a key component, if there is any, of a modern knowledge economy.[33, 34]

3.17 **A weak innovation climate.** The fact that some measure of progress can be observed in terms of its scientific capabilities (as evidenced by gains in the scientific productivity over the years) has not necessarily translated into proportional improvements in commercializing ideas and improvement along other innovation indicators such as patents[35] suggest that are still significant weaknesses in the linkages between the actors in the innovation system. Thus, even if increasing scientific productivity reflects a relative strengthening of the university or academic pillar of the system, new knowledge and technical capabilities remain boxed inside laboratories and research centers, since collaboration between the universities and industry remains weak. New knowledge inputs are not necessarily translated in innovations and productivity gains in firms. Innovation surveys show that Latin American firms most often establish technological cooperation agreements with clients and suppliers. Universities and institutes of technology tend to be less important as partners for innovation activities (IDB, 2010b; Anllo and Suarez, 2009).[36]

3.18 The importance of this issue has led several countries in the region to develop explicit mechanisms of cross-sector coordination in innovation policy, such as industry roundtables and innovation workshops on shared research agendas, all of which have been introduced as a deliberate attempt to improve coordination and

---

[33] In 2013, the top 5 technological categories of Patent Applications Filed under Patent Cooperation Treaty (PCT) were (1) electrical machinery, apparatus, energy; (2) digital communication; (3) computer technology; (4) measurement; and (5) medical technology. In 2012, the patents granted in those categories in the LAC region were less than 1% of the number patents granted to high income economies in all 5 categories. The technology category among the top 5 in which the most patents were granted in the LAC region was medical technology with 341 patents awarded in 2012, whereas only 44 patents were awarded in the Digital communication category (WIPO, accessed July, 2014). The only fields in LAC in which some upward trends seem to be gaining momentum in terms of patenting are those directly related to natural resources such as mining and agriculture; both, large private companies and public research and technology entities (EMBRAPA, INTA, INIA), are behind this trend.

[34] In terms of trademarks, the top 5 applications by trademark class via the Madrid System in 2013 were: (1) computer & electronics; (2) services for business; (3) technological services; (4) clothing, footwear, headgear; and (5) pharmaceuticals & medical preparations. LAC applications in 2012, in all 5 classes, were less than 1% of those by high income countries. The class in the top 5 with the most trademark applications from the LAC region was technological services with 147 applications compared to over 100,000 from the high income countries (WIPO, accessed July, 2014).

[35] Or improvement in rankings along a composite indicator of innovation (which accounts for market and business sophistication and high and medium-tech exports and other innovation output and input related indicators).

[36] Several countries in the region have developed programs specifically aimed at improving the links between universities and firms, in some cases through additional incentives for projects contemplating collaboration (the case of FINCYT in Peru), sometimes through supporting the creation and functioning of specialized offices in Universities and other research institutions charged with cultivating links with private businesses (see MINCYT, Argentina). Although these programs have received favorable evidence-based assessments, innovation surveys do not seem to register a clear impact among firms at the national level (Navarro and Vargas, 2014), most likely due to their relatively small scale.

encourage pooling of resources and sharing of priorities among the key actors of the innovation system (Avalos, 2002). The same can be said for a few countries that have encouraged the institutionalization of mechanisms and incentives for university-business links. Most of this, however, is still tentative when compared with the magnitude of the challenge (Arza, 2010; Cimoli et al., 2010).

3.19 A particularly important and complex enhancement of the innovation climate that cannot be taken for granted, given its complexity, has to do with making the financial system sophisticated enough to handle the particular needs of technology-based rapid/growth new companies. Venture capital (VC) in Latin America is orders of magnitude below the one for developed economies, and also below China and India (Stein and Wagner, 2013). Still, the VC market has been growing rapidly over the last decade. In the case of Latin America, Brazil, Mexico and Chile, have accumulated experience in this area, and Uruguay is well advanced in putting together a complete cycle of venture finance, including seed, angel and venture investing. Other economies of the region are moving forward quickly. Valuable lessons have been learned, both regionally and globally, that provide a solid platform for accelerated catching up in this area (Lerner, Leamon and Garcia-Robles, 2013).

3.20 A good innovation climate, however, goes beyond having an adequate venture capital cycle.[37] Given the strong interactions between innovation and competition, and despite the progress made in several LAC countries in order to improve competition regulation, there still a lack of coordination between competition and innovation policies.[38] Basic components of the national innovation system that advanced economies take for granted, such as quality certification, metrology and a variety of technological services to industry are weak or absent in several LAC countries. Intellectual property rights are often less than adequately regulated from the perspective of encouraging innovation. Intangible assets such as personal relationships and trust, business and knowledge networks, global connections, entrepreneurial culture, legal and management awareness and savvy, and other forms of know-how that consist primarily of tacit knowledge are increasingly being identified as important innovation ingredients that can help to make an innovation system to function better. From the standpoint of a systemic notion of the innovation system, knowledge ends up being adapted, created or traded in the context of interactions that resemble a market for ideas. Such market (the market for patents or designs) involves inventors, firms willing or in need to try new approaches to processes, products and business models and a variety of intermediate agents such as those mentioned above that are in extremely short supply in LAC. As an outstanding exception to this generalization, the drive of

[37] In this regard, there are indications pointing to the fact that embryonic attempts of setting up VC markets in LAC countries have found an almost impossible hurdle in the weak “deal flow”, namely the scarce availability of ideas that are worth supporting coming out of new entrepreneurs, researchers and inventors.

[38] Most of the decisions regarding innovation policy in LAC are made without lending serious consideration to the industrial organization of the sectors where the innovation policy is supposed to impact, which is likely to have a detrimental effect on their impacts (Aghion et.al., 2009; Hsieh and Klenow, 2009).

the city of Medellin to become a leading innovative city has led to a variety of novel programs in areas that constitute, taken together, an attempt at tackling the systemic deficiencies of the innovation environment as a whole, most of them around Ruta N.[39] Other localities are starting to work along the same lines. The novelty of programs in this area calls for further research and impact evaluation.

C. The challenge of weak institutional capacity

3.21 In the end, the arsenal of policy tools available to LAC countries promoting innovation is not very different from the one available to governments in advanced economies. However, the similarities conceal some significant differences, the most salient of them being wide gaps in institutional development. Advanced economies have long ago established an institutional framework that has considerable built-in policy setting and management capacity. In such cases, the key elements of institutional best practice in the sector, particularly strong public-private dialogue, strong intra-government coordination and clear distinction among strategy setting, policy-making and policy implementation agencies and instances, are consolidated (Rivas, 2010). Yet such a framework is still in the early stages of development in most LAC countries.[40] Lack of well-developed institutions exposes policy to the risks of a deficit of dynamic consistency, poor coordination and capture. Reforms over the last decade in several LAC countries suggest a keen awareness at the top policy-making levels of the need to advance on the institutional front of STI policy. Success stories of institution-building exist, yet in most countries the institutional landscape remains in flux, still removed from an efficient and stable framework (Rivas, 2014).[41]

3.22 More specifically, and beyond the larger institutional and governance arrangements of innovation policy, countries in LAC face important challenges in terms of institutional capacity. Among the pending challenges are: (i) the need to sustain policies over the long term. The effectiveness of some innovation policies, notably on the supply and demand sides, is only seen in the medium and long run, but it takes time to build a critical mass of human resources in S&T and R&D capabilities in private firms; (ii) the need to strengthen institutional capacity to formulate, monitor, and evaluate innovation policies: evaluation and oversight are weak in most LAC countries and should become a central part of the new culture

[39] See De Leon (2014) "A review of the IDB agenda on intellectual property rights" for information about the limited but instructive precedents of work in the IPR area and the Bank.

[40] One after the other, comprehensive assessments of LAC´s innovation systems highlight the conclusion that enhancing the institutional setting responsible for science, technology and innovation policy must be considered a top priority. See for example, for Chile (OECD, 2007); for Mexico (OECD, 2009a); for Colombia (OECD, 2014); for Dominican Republic (UNCTAD, 2013); for Peru, both OECD (2011) and UNCTAD (2011); for Ecuador (IDB, 2014); for El Salvador (UNCTAD, 2012); and for Trinidad and Tobago (Compete Caribbean, 2014).

[41] The transformation of some countries into leading knowledge economies has been in all cases accompanied by substantial processes of institution building in STI policy. See Annex, Box 4 for a synthesis of the experience of Finland, Israel and South Korea in this regard.

of innovation policy practice; and (iii) the need to develop information infrastructure to monitor STI-financed projects, and build it into planning and -ideally multiannual- budgets.[42]

D. A new generation of challenges

3.23 **The particular challenges of ICT adoption and use.** Access to new information and communication technologies (ICT) by Latin American and Caribbean countries has been late and partial, as illustrated by all available indicators, such as the number of personal computers, Internet access, and access to broadband.[43] This lag is particularly important when analyzing the effects of innovation on productivity, since ICT is a general purpose technology that has a cross-sectional impact on all economic sectors. As stated above, advanced uses of ICT have not spread throughout the vast majority of SME in LAC. Two specific issues are worth highlighting in this regard: first, the fact that severely underdeveloped broadband infrastructure and regulation constitutes a major constraint to productivity growth in the region, particularly in the service sector, which is critically dependent on ICT for innovation; second, that such advanced uses of ICT have a serious difficulty in reaching a critical mass in any economy in the absence of a well-developed software industry, one that, with the exception of a few success stories in a limited number of digital hubs in Argentina, Brazil, Mexico, Uruguay and a few others, has not taken place in the LAC region.

3.24 The level of only one ICT adoption indicator is excellent in Latin America: the market penetration of cell phones, which has reached saturation levels among the adult population across LAC. This sector has benefited from accelerated technological innovation and costs reductions in the industry worldwide, and more advanced and private-sector friendly regulation, but marketing and business model innovations, such as the use of pre-paid phone time, are widely considered to have made the difference in the rapid rate of adoption. Even if success in access to critical mobile communication technology so far has failed to translate to other ICT areas, the growing importance of mobile services and applications and their

[42] According to a comparative study of 11 institutions managing S&T and innovation policy in Latin America (Ventura, 2010), these agencies in the region have weaknesses in terms of management and operations. Technological modernization is needed, notably information systems infrastructure and their adequate use, as well as policy delivery and monitoring. Another key issue is the limitations in recruiting, developing and managing talent, which typically leads to a serious gaps in agency capacities vis-à-vis their counter parts both in the private sector and sometimes in the science sector, with negative effects on effective implementation. In countries where public resources have dramatically increased budgets, agencies organization, internal processes and delegation have not always been revamped leading serious bottlenecks regarding budget execution.

[43] Several specific factors hamper the spreading of broadband use, and are worth mentioning: lack of coverage, high prices, low quality and lack of skills among individuals, firms and public agencies to use related services.

economic impact on almost every sector of the economy provide a key platform for innovation in the region.[44]

3.25 Some exceptions among large firms that have followed good overall approaches to adopting ICT show that it is possible for Latin American and Caribbean countries to exploit the potential of ICT (Alves de Mendonca, Frietas, and de Souza, 2008). But, in general, a lack of infrastructure and relatively high costs of adoption are producing a mix that is not beneficial. The end result is that LAC economies have been largely deprived of one of the main engines of productivity growth in the rest of the world, a deficit that is particularly serious in the case of the service sector, which exhibits the most serious productivity deficit. This is particularly the case compared to certain Asian economies, which undertook selective but highly significant early investments in ICT, including support for the local ICT industry, with enormous payoffs.

3.26 Policy responses to this state of affairs have also had important limitations. Several countries have put together ambitious national digital agendas (Colombia is a particularly recent and outstanding model), but for the most part current ICT policies in the region show a strong bias toward the development of e-government, particularly in the areas of financial management, procurement, and the management of tax and revenue systems, at the expense of a lack of necessary focus on the need for programs that enhance the capacities of the private sector to adopt and use ICT technologies. Among them: improving the supply of specialized human capital for the ICT industry and ICT-based business services, government assistance to SMEs in the area of incorporating advanced applications of ICT to business, investments aimed at improving the population`s level of digital literacy, and investment in broadband infrastructure, so that all the rest of policies can bear fruit.

3.27 **Making innovation relevant for social issues.** Beyond the competitiveness and productivity agenda, lie, in the case of LAC, a crowded and compelling need to address deficits in; social inclusion of people with disabilities, poverty reduction, access to health care and education, gender equality, re-integration of displaced communities and environmental protection. Recent diffusion of open innovation platforms has renewed interest among policymakers in the potential of applying design thinking, crowdsourcing and digital media to accelerate the rate in which social problems are identified, and high concept solutions are found and applied, while in the meantime enlarging the pool of potential participants (both in the identification and the solution sides of the process).Several countries have already

[44] The IDB has seen the development of broadband infrastructure, in particular, as a priority not only in the context of business innovation, but also in terms of its impact in health care, education, e-government and other public sector applications, and has channeled this vision within the framework of the Broadband Initiative. In the Andean Region in particular, a combination of technical cooperation and lending programs have allowed the Bank to support the development of the regulatory framework governing broadband, as well as to contribute to infrastructure expansion and broadband adoption and use by individual citizens, government institutions (such as schools and hospitals) as well as firms and the private sector.

experimented with internet-based or mobile-based platforms that prompt information from isolated or excluded populations, allowing these populations to prioritize the problems identified. Online platforms then publicize the list of priority problems to research centers, consulting and technology companies and universities, creating a competition for the best, least expensive, and more sustainable solutions to be designed and implemented. Many private firms, along with governments, are innovating to increase social inclusion and address social costs. The use of social innovation platforms has been used to develop business models that support base of the pyramid populations, while Social Investment Bonds are expanding private solutions to social goods provision.[45] A considerable challenge remains, however, in mainstreaming social innovation into the traditional practices of ministries, agencies and the private sector, so that it can live up to its potential.

3.28 **The policy-making process of STI and the new challenges.** A low level of investment in STI has been a constant across LAC for half a century, a period distinctive, worldwide, for a flourishing of innovation and technology revolutions, and for the emergence of leapfrogging economies based precisely on unprecedented investments in innovation, science and technology. When these traditionally low levels are contrasted with the very high rates of return to this kind of investment consistently found in every analysis carried out so far (see chapter 2), one conclusion is that the very modest flow of resources channeled to the sector must have causes deeply rooted in the policy-making process of STI across the region.[46] Another conclusion is that a correction is overdue. There are already signs that indicate that the correction is starting.

3.29 Recent developments in some countries of the region suggest that the trend to underinvest in STI is starting to be reversed. Natural resource royalties in countries such as Chile, Colombia and Peru have been recently directly channeled to research and development, regional innovation systems, massive scholarship programs for scientists and engineering or the build-up of research capabilities in

---

[45] As an example, efforts by CONFAMA in Colombia, a private non-profit entity funded by public and private sector employees, suggests that public-private partnerships are a means to develop practical, business-led social innovation.

[46] If a low level of investment –presumably sub-optimal– in STI persists in an economy in the long run, and it is not fully attributable to the economic structure of that economy –as in the case of most if not all countries in LAC– an explanation might be found in the peculiar policy-making process of the sector in the region.

universities and technology parks.[47] These developments have made available unprecedented levels of funding for STI activities, while creating a whole set of institutional and policy challenges of their own –plainly, how to use the additional resources efficiently. The new level of funding has placed a renewed focus on the deficit of institutional capabilities to deal with rapidly growing resources for STI, as well as on the very nature of the policy-making process in the innovation, science and technology sector (Benavente et al., 2010; Navarro, 2014). Such new and augmented flows of resources have been accompanied by the entrance of two new influential actors in the STI policy-making arena, the subnational governments, and the private sector, actors that, in turn, have the potential to engage in direct interaction among them, as the experience of Bolivia indicates.

3.30 For a long time, only two dominant actors counted in the policy-making process of STI policy in LAC: the government –for the most part the finance and planning ministries that have considerable control over budget allocations and spending priorities- and the scientific community. These actors have wielded veto power in matters of STI policy.[48] Yet they are normally at odds in terms of their understanding of the key goal of STI policy –contribution to economic development vs. contribution to knowledge–, and time horizon –short term vs. long term results. Economic authorities typically feel that, once they allocate the budget to the sector, they will lose control of the specific details of their use and will be, in particular, unable to align their use for the benefit of the economy and development goals. Scientists, in turn, lack the authority or political power to impose an increase in public funding, but they do retain their autonomy in the management of research and reject as intrusion any intervention not directly motivated by principles of academic excellence. In the absence of a well-developed institutional framework that puts a limit to the damaging effect of this kind of policy-making process, the result has been a consistently low level of investment in STI, well below what would be considered socially efficient levels.

[47] In Colombia, according to Articles 360 and 361 of the Constitution, 10% of revenues of the General Royalties System Fund will be directed to Science, Technology and Innovation. In Peru, according to Article 6.2 of Law No. 27506, 25% of the Canon funds –royalties from the exploitation of different natural resources– must be allocated to the regional government where the natural resource is exploited, of which 20% are exclusively for public investment universities for scientific and technological research that promotes regional development. Also, through the Law No. 28258, Law of Mining Royalties, it was established that 5% of these should be for universities. In Chile, the Law No. 20,026 establishes a specific tax on mining activity, which was created in the spirit of allocating 20% of its revenue to innovation funds. Despite the above, because of the existence of the principle of No Allocation of Taxes, Article 19 No. 20 of the Constitution, which states that all taxes, regardless of their nature, must enter the equity of the country and cannot be channeled to a specific destination, it is impossible to determine if the budget for innovation comes from the specific tax on mining.

[48] Three key characteristics of the interaction of these two actors are critical: asymmetries of information and agency problems undermine the ability of both of working together constructively and trusting each other; their preferences are, for the most part, not aligned; and their conflicts are not mediated or nuanced by the presence of the private business sector as a major player, which constitutes a stark contrast with the political economy of STI in advanced economies.

Traditionally, for the most part, the private sector has lacked the inclination or interest to become a part of the process.

3.31 Very recently, however, the private sector has become more vocal and proactive in demanding that innovation becomes a top governmental priority.[49] And national governments have paid attention. In addition, some significant voices are also being raised from the subnational levels of government. Given that that the exploitation of minerals that originates the royalties being channeled to innovation are usually concentrated in a number of states or provinces, the authorities of these regions are being very proactive in demanding participation in the decision-making process of innovation policy. A good number of cities in LAC are, at the same time, pledging to become innovation hubs and starting to invest heavily in technology and innovation.[50]

3.32 The -still work in progress- entry into the policy-making process of the private sector and subnational governments may have already modified the traditional –and poor– equilibrium that produced decades of underinvestment in innovation in the region, and that would be enough to label it the most important development in STI policy in recent years. It brings along with it, however, a whole set of considerable challenges: (i) how to insure that decentralized decision-making will not undermine key national programs and initiatives that necessarily require large scale; (ii) how to develop institutional capabilities in the subnational levels of government, akin to their new weight and participation in policy-making; and (iii) how to find ways to channel private sector increased activism in ways that will be constructive to policy-making, mitigating the risk of capture, and minimizing demand for distortionary policies.

IV. LESSONS LEARNED FROM THE IDB'S EXPERIENCE IN THE SECTOR

4.1 The IDB has been supporting innovation, science and technology in the LAC region since 1962. The longevity of both financial and technical support demonstrates the commitment on the part of the bank and a growing number of countries in the region to strengthening the sector. This commitment stems from mutual recognition of the critical role that the sector plays in the ability to increase productivity and compete in global markets.

4.2 Approaches to support to innovation, science and technology have changed over the years. The evolution is a reflection of the learning process experienced by

---

49 Witness the work of the Private Competitiveness Council and the Connect Bogota initiative in the case of Colombia, the work of the *Red Enlaces* that links business people focused on innovation, or the forceful participation of private sector representatives in the preparation of the competitiveness agenda in Peru or in the work of the Competitiveness and Innovation Council in Chile, or the role of the Economic Development Board and the Innovation and Competitiveness Council in the case of Trinidad and Tobago, among many that could be cited.

50 A very partial list includes; Recife, Belo Horizonte, Buenos Aires, Guadalajara, Monterrey, Medellin, Montevideo and Santiago.

both the IDB and the region. Lending programs have transitioned from supply driven support to demand driven support, then to a systemic approach to the sector. Programs, however are always tailored to the particular needs of a country, and supply oriented approaches are still regarded as critically important since the overall performance of the region is still lagging, and in particular, albeit not only, when the sector's development is still in its infancy.

A. Office of Evaluation and Oversight (OVE) contributions

4.3 The 1994 IDB's board of directors solicited an ex-post evaluation of the bank's science and technology projects from the Office of Evaluation and Oversight (OVE). The report was finalized in 1998 and drew the main conclusion that the programs reviewed played a significant role in strengthening national capacity in science and technology in the borrowing countries. The report pointed out that especially in early periods (from 1962 to 1981) only 3 countries requested loans in science and technology: Argentina, Brazil and Mexico, and those were the countries that already had more S&T infrastructure and capacity. The situation has changed significantly: even if some of the largest economies in the region still demand STI operations, the demand has spread to almost all borrowing countries, although the different baselines and local conditions lead to tailoring Bank programs to different levels of economic development and institutional strength of STI policies. The report also highlighted what was at the time the IDB's recent transition toward the contemporary systems approach of focusing support on the network of institutions, both public and private in National Innovation Systems, a general orientation that remains presently.

4.4 Since the report produced in 1998, there have been at least six OVE impact evaluations of specific innovation programs (see Annex, Table 1). The results of the OVE impact evaluations as well as other impact evaluations carried out by the IDB and other leading researchers[51] have been in line with international literature which suggests that program incentives for business innovation have been shown to have positive results in increasing the firm's ability to invest in innovation, little evidence of crowding out private sector investment and, in the most recent studies, evidence about an impact on firm productivity levels and positive spillovers on firms that did not participate directly in the programs. There is currently an effort on the part of researchers both inside the Bank (Competitiveness and Innovation Division (CTI) and the Office of Strategic Planning and Development Effectiveness (SPD)) and outside to make use of newly available and much improved data to extend the time horizon of the analysis. So far, these results have demonstrated that the innovation programs have had a positive and significant impact on labor productivity levels. Furthermore, there is preliminary evidence that programs that encourage

[51] For a detailed summary of the results, please refer to chapter 5 of the IFD's flagship publication "The Fiscal Institutions of Tomorrow" (Crespi, 2012). Their contribution to policy design and their direct relevance to this Sector Framework Document are highlighted in chapter II, above.

business-university linkages are the ones that typically have the greatest impact (Crespi, 2012).

4.5 Impact evaluations of business innovation support programs are fraught with challenges in terms of identifying: (i) counterfactual groups; (ii) indirect and direct beneficiaries; and (iii) externalities. This clearly implies that in the era of the systems approach to support innovation, science and technology, there is an ongoing effort in sharpening the methodological approaches so as to better capture the costs and benefits of the typical programs in the sector. In parallel, since the range of public interventions has been expanding, new approaches and methodologies need to be devised to assess the impact of policies such as; value chain upgrading and cluster policies, entrepreneurship development, institutional strengthening, innovation climate, and others. Doing so is clearly a major pursuit in the Bank's knowledge agenda in the sector.

B. Development Effectiveness Matrix (DEM) results

4.6 Since the inception of the Development Effectiveness Matrix (DEM) in 2009, the IDB as a whole, as well as the contributions of the projects from the sector, have been improving. Table 3, below, indicates that the sector has performed above average (benchmarking against the rest of the IDB) in most areas and by 2013 has reached the milestone of 100% of the projects having been assessed as highly evaluable, the result of a highly intensive investment in impact evaluation methodology and practice both within CTI and in close collaboration with SPD.

Table 3: Summary of the Development Effectiveness Matrix (DEM) for the Sector

	2009		2010		2012		2013	
	IDB Average	CTI Average	IDB Average	CTI Average	IDB Average	CTI Average	IDB Average	CTI Average
Evidence-based Assessment & Solution	6.7	7.2	7.6	7.7	8.3	8.6	8.8	8.2
Cost-Benefit or Cost-Effectiveness	4	3.3	6	2.3	9.4	9.5	9.6	9.5
Evaluation & Monitoring Plan	5	6.5	5.9	7.2	7.5	8.2	7.8	8.4
Risks & Mitigation Monitoring Matrix	7.3	5.8	7.7	8.3	9.8	10	99.1%*	100%*
Average Overall Evaluation Score	5.8	6.1	6.8	6.8	8.7	9.1	8.7	8.7

*The CTI average for 2009 and 2010 includes operations created under SCL and CMF and whose team leader is a Specialist of CTI.

4.7 The largest leap has taken place in the cost-benefit or cost-effectiveness category, which has visibly increased to reach a level that, although it can still be improved, demonstrates strength in the area. In 2011, in response to some of the challenges posed by evaluating the effectiveness of interventions in the sector, the IDB has produced a set of evaluation guidelines (Evaluating the Impact of Science, Technology and Innovation Programs: a Methodological Toolkit).[52] The guidelines provide technical advice on how to assess the effectiveness of innovation, science and technology programs. The toolkit addresses specific challenges of evaluating STI programs, such as, assessing the intervention logic, providing methodological choices, and problem solving tips –that are based on previously encountered challenges with data and/or analysis. The publication devotes substantial sections to discussions about data (data sources, quality issues, and data collection strategies and the application of quantitative methods such as experimental and quasi-experimental design). The development of products such of these are fundamental to the growth of the IDB's capabilities in the sector and for position the IDB as a provider of technical assistance to countries in this area.

4.8 NSG operations, in turn, have also played an important role in the promotion of STI in the region through a range of activities, which include support for innovation finance through equity investments, ICT infrastructure, social innovation, and productive integration projects. Since 2001, NSG has approved 396 operations worth US$1.2 billion for these STI-related activities (see details in the Annex, Table 5). The Multilateral Investment Fund (MIF) has played a catalytic role in developing the financial eco-system needed to support firm innovation; OVE found that 85% of all MIF projects introduced innovation into its interventions, and 22% of its operations introduced innovations that were replicated in other areas of the economy.[53] The Structured and Corporate Finance Department (SCF) devoted several operations to the expansion and upgrading of telecommunication networks in the region through 2007, but nowadays has exited from this market segment. These older operations do not have DEMs or evaluations by OVE. In addition, the IDB created Opportunities for the Majority (OMJ) sector to finance innovative private sector projects that provide solutions for those individuals living at the base of the pyramid; in a review of 32 OMJ projects, OVE found that 75% of OMJ projects studied were innovative.[54]

---

[52] The guidelines can be accessed in English at: http://brik.iadb.org/handle/iadb/62598.

[53] Office of Evaluation and Oversight. Background Paper: Project Level Review 2005-2011. Second Independent Evaluation of the MIF (2013).

[54] OVE (2012) classifies operations as "radical or disruptive" innovations that cause discontinuities in science and technology and/or market structure, and "incremental" innovation as new features, benefits or improvements in existing technology in existing markets (OVE, Corporate Evaluation: Opportunities for the Majority, June 2012).

C. Lessons learned from the IDB's operational experiences[55]

4.9 The IDB's projects in the innovation, science and technology sector have generated lessons. Those that follow are collected from the experience of the Bank's operations in STI projects completed since 2009. An analysis of a sample of 11 operations in 9 countries was conducted by a team led by the Bank's Knowledge and Learning Sector in coordination with CTI. The analysis is based on a desk review of operational documents including the Project Completion Reports (PCRs), and in-depth interviews with team leaders involved in both the design and implementation of the lending programs, as well as a selection of leaders of national executing agencies.[56]

1. Overall impact and effectiveness of the Bank's work on innovation, science and technology

4.10 **A missed opportunity.** One lesson stands apart as the most important of them all. There is a stark contrast between the high impact and effectiveness of the Bank's work in STI and the overall limited effect that such work has produced, when the economies are gauged by their competitive performance, their productivity growth or the knowledge intensity and sophistication of their productive structure. In view of this, there is little doubt that, facing a policy-making process in the STI sector that failed to spontaneously produce efficient outcomes for decades across the region, the Bank missed the opportunity to champion investments in the sector to a level that would have taken the region closer to the technological performance of their peers in Asia and the less developed regions of Europe, or prevented the wide productivity gap that has persisted between LAC and the advanced economies (IDB, 2010b).

4.11 **Avoid missing the next knowledge revolution.** Upcoming technological revolutions are anticipated worldwide, yet it is well established that their beneficial effects will not be automatically absorbed by the developing economies, in the absence of deliberate plans and effective policies. This calls for a correction in the course of the Bank STI efforts on two fronts: at the programming level, it must deal with the consequences of the acute disparity between the rates of return to investment in innovation and the current level of investment in the sector, turning innovation-related investments and a growing integration of knowledge in the economies of the region into upmost priorities. At the technical and operation level, it must put together an enhanced knowledge agenda that takes the instruments, programs and policies incorporated in lending

[55] This section is intended to be considered as closely related to the rest of this document, particularly as it delineates what the Bank will do in the sector, and the dimensions of success and underlying principles guiding the lines of activity recommended.

[56] In this regard, this section also reflects to a large extent the very experience of countries in STI policy making, which is no doubt larger than the Bank's projects, but at the same time closely intertwined with Bank operations in many instances.

and technical cooperation programs into not only micro-level effective instruments, but also in vehicles able to affect overall economic performance.

4.12 **Technical cooperation funds have been critical in leveraging resources for STI in the region.** The availability of technical cooperation fund focused in supporting STI operations have played a critical role on several fronts –including, for instance, the development of the information availability and the accumulation of knowledge products in the sector– but above all as support for the pre-investment and design activities of larger operations, producing a leveraging effect that is tangible and hard to replicate in the absence of non-reimbursable funding.[57]

2. Institutional support

4.13 **Coordination, coordination, coordination.** The STI sector requires intensive intra-governmental coordination as well as considerable dialogue and harmonization of public and private strategies and perspectives. It is key to include support of the adoption of international best practices in this area if major risks of dynamic inconsistency are to be avoided. Within the Bank, this reality calls for a stronger interaction between NSG and SGO operations aimed at maximizing the impact of the Bank investments.

4.14 **Work with the institutions you have.** It has been key, in the Bank, experience in the sector to build capabilities in critical institutional areas such as policy design, execution, management know-how and information systems, even in cases in which the institutional framework for the sector is weak or poorly defined. An interesting case of this has been the decision to implement projects through execution units created ad hoc for Bank programs. Far from preventing national institutional development, in practice, such capability builds up and proves to be eventually decisive when a window of opportunity for institutional change presents itself. Waiting for the ideal institutional setting and mature capabilities to be present before starting work in the STI sector is not a good strategy.[58]

3. Instrument design

4.15 **Building capacity for policy instrument design and management from the ground up.** Experience shows that piecemeal building up policy instruments and the capability to manage them is a feasible and desirable strategy, one that has a good chance of leading towards more sophisticated policies and executing

[57] Particularly worth mentioning in this context is the role played the Korean Fund for Technology and the Knowledge Economy Fund (a Multi-donor Thematic fund that has benefitted from contributions from Finland and Spain). In a recent report to donors, the Knowledge Economy Fund registered a strong leverage effect, mentioning d that the ratio of non-reimbursable technical cooperation funds to larger lending programs that the fund was instrumental in promoting and designing was in the order of 1 to 100 (see *Fondo para la Economía del Conocimiento: Informe de Progreso*, ORP, 2011).

[58] This has to be understood in consonance with the pursuit of the development of adequate institutional frameworks for STI over the long term, a major issue that will not be neglected by IDB operations.

agencies, develops capable human resources for policy design and management, and, as it proceeds, generates valuable information that allows for course corrections and helps in risk mitigation.

4.16 **Incentive compatibility must preside over the evolution in the detailed design of policy instruments.** Experience clearly points to the refinement in instrument design that has taken place over the years in IDB operations, refinement that has made features such as the requirement of co-financing on the part of firms benefiting from innovation incentives, competitive mechanisms for the selection of projects to be publicly financed or relative advantages of non-reimbursable funding for innovation over traditional credit lines in several circumstances, standard features of operation design. They are clearly understood today as features mitigating agency problems and moral hazard. The search for further design refinements is ongoing.

4.17 **A learning process in the private sector.** The instruments individually supporting businesses are effective in generating innovation capabilities and processes and technological modernization; they also tend to be in high demand. However, these tools have limitations in their ability to reach many potentially innovative companies and may favor those with prior experience or those that are already located in networks. In many cases, it appears necessary to give the firms support in terms of project preparation and technological awareness, in order to help them develop basic skills to participate as full partners in the opportunities afforded by public programs. In other cases, a sound combination of credit and non-reimbursable financing may support both sustainability and a better incentive system for firms (by focusing reimbursable instruments in those areas of business upgrading that carry less externalities and reserving grants for projects with significant spillovers).

4.18 **Multi-sectoral collaboration in sectoral instruments can be further developed.** Sector funds (innovation funds focused on a particular industry) offer an opportunity for multi-sectoral coordination and joint learning with other areas of the Bank (natural resources, agriculture, energy, health, infrastructure and communications) that can offer the counterparts in the countries consistency and synergies. This type of coordination has occasionally occurred in the past –as in the case of biofuels in Colombia– but, it should intensify in the design of future operations.

4.19 **Regional integration may present unprecedented opportunities for widening market size and generally overcoming scale and scope constraints in the functioning of innovation policy instruments.** A growing demand for integrating innovation and trade policy has been forthcoming recently, coming from national authorities. The potential of trade agreements to facilitate and multiply the impact of conventional innovation policy instruments should become a part of the design of such instruments.[59]

4.20 **Scientific activity can be effectively supported.** Instruments to subsidize research projects on a competitive, peer reviewed based basis, have shown positive effects on production of original knowledge and the amount and quality of scientific publications. They also play a role in the formation of highly skilled human resources and help strengthen research capacity in universities and research institutes within the country.

4.21 **Excellence and inclusion in competitive research funding**. A recurring issue in the design of competitive grant funding for both scientific research and firm innovation is that, since by necessity they are based on merit, the outcome usually allocates resources to actors better placed to access these opportunities. Thus, in the LAC region, there has been a tradeoff between merit-based policies and diversity and inclusion. Thus, often, prioritizing excellence can imply less diversity or inclusion. In this context, a past operational response has been the use of modalities such as targeted requests for proposals (young researchers, regional research institutions, women entrepreneurs[60]), with the objective of identifying and supporting high performance players among socially excluded groups without sacrificing the search for scientific excellence or productivity upgrading in firms.

4. Instrument implementation

4.22 **Instruments with business participation.** Joint research projects between research institutions (such as universities) and firms present particular challenges, such as the time needed to build trust, build a system for resource and project management, and the search for common ground between the pursuit of research excellence and the production of knowledge that can be applied for productive purposes (which does not always coincide). To address this issue, emerging responses based on experience point toward complementary factors such as:

[59] Based on their assigned responsibilities, CTI and The Integration and Trade Sector (INT) have provided LAC countries with both analytical and operational support in their policy initiatives regarding innovation and exports and foreign investment, respectively. In particular, whereas –as stated above– CTI has thoroughly investigated the impact of innovation promotion programs in LAC, INT has carried out extensive research on the effects of trade and investment promotion programs implemented throughout the region (e.g., Volpe Martincus, 2010 and background papers). Collaboration on this matter is ongoing. INT has also provided LAC countries with extensive support in the negotiations and implementation of trade agreements with regional and extra-regional partners, still another area in which CTI and INT are exploring further collaboration, building on the current trend to link innovation as an area of interest in trade partnerships.

[60] The Gender and Diversity Sector Framework Document, still in the making, identifies women entrepreneurship as a LAC development challenge, providing details of the issue raised in this SFD. It highlights, in particular, the fact that, even though "…The LAC region has higher rates of female entrepreneurship and a smaller gap in participation between men and women than other regions… the vast majority of women-led business in the region, however, are unable to grow beyond microenterprises of move out of the informal economy…The percentage of formal SMEs where women own at least 51% of ownership stakes is only 22%, and the percent of firms with a female top manager (CEO or COO) is only 21%... Micro and small female-owned firms are less productive than male-owned firms".

(i) developing innovation management skills in businesses; (ii) work within universities to improve links between society and business, and long-term collaboration; and (iii) setting up specialized technology transfer offices that can act as a highly specialized bridge between business and the academy. As for young systems with new business innovation programs, an effective starting point has been an awareness building process, extensive dialogue with the private sector and partnership involving potential firms to incorporate innovation as essential part of its activities.

4.23 **Continuity and complementarity of supply instruments.** Experience shows that the regularity of requests for proposals and simultaneous supply of complementary instruments to support scientific research as well as firm innovation lends STI policy predictability and credibility. In an often overlooked special case, operational experience shows the importance of balancing strategies to support scientific development, so that the increase in the number of highly specialized human capital is accompanied by a proportional increase in the infrastructure. Optimal design provides comprehensive packages of components such as planning for repatriation of researchers while taking into account the availability of laboratories, equipment, space and a supporting environment to ensure sustainability of the programming efforts.

4.24 **Information systems, critical but hard to manage.** Despite the progress made in strengthening and integrating information systems, there is still a long way to go. In particular, there are opportunities for improvement in; executing agency and public office information systems that improve productivity and efficiency, online assessment and monitoring projects, and the creation of automatically updated databases (and data sharing) that allow for impact assessments methodologies based on best international practices. Investment in information and management systems upgrading (for innovation agencies) are highly complex and require exceptional planning and management capabilities among all the other activities contemplated in almost any particular project in the sector.

4.25 **Effectiveness of learning visits**. Counterparts and specialists agree that for young systems, study visits to peer agencies and the exchange of instruments (operating manuals, formats for proposals, evaluation forms and plans), has facilitated and expedited the implementation of new programs, and it has done so in a highly cost-effective way.

5. Policy and project monitoring and evaluation.

4.26 **Building local capacity**. The creation and consolidation of a critical mass of local expertise with the skills to conduct monitoring and evaluation of STI policies and programs is still a work in progress. The Bank's investments have produced a leap forward in the region, but results are still far from adequate in order to have high-quality and timely evaluations that are essential for evidence based decision making, attention to this area must be maintained and reinforced in future operations.

6. Diffusion/communication of results.

4.27 **The need to make the case for innovation.** Given that many of the products of investments in STI are intangible and complex, and are often poorly understood by decision-makers and the public at large, special resources must be reserved in each investment program to disseminate the benefits that particular target groups (SMEs, research institutions) and society at large receive as a result of this kind of investment. This is especially valid in the case of new programs, in which communication and dissemination activities have contributed to the participation of new beneficiaries and to maintaining demand. Bank`s staff expertise and connections to a worldwide network of knowledge sources, plays a key role in ongoing policy dialogue with authorities and stakeholders at large. Work with specialized communication consultants and the development of links with journalists who are familiar with the specialized topics of STI have proven to be useful.

4.28 **Making STI investments relevant for society goes beyond "communication" strictly defined.** The implementation of social innovation programs, using open innovation participatory platforms aimed at finding solutions to issues of social inclusion and poverty reduction, has proved to be a powerful instrument to get larger constituencies interested and involved in STI activities and policies. In this case, policy itself becomes the most effective message.

D. IDB strengths and comparative advantages in the innovation, science and technology sector

4.29 With a portfolio of 31 lending programs and US$1.3 billion, and active in the majority of the borrowing countries with two thirds of current active loans operating in C and D countries, the IDB has built the largest operational footprint of any IFI operating in LAC, in the area of STI (see Annex: Table 2, Table 3, and Table 4). Today, the IDB can count on strong name recognition, excellent rapport with national counterparts and a reputation as a source of state of the art technical advice. The STI sector at the IDB has been actively strengthening collaboration with other international institutions active in the field, such as the World Bank, OECD and ECLAC to facilitate cooperation rather than competition and best serve the needs of the countries in the region. As a consequence, the demand for IDB support for STI projects is growing, and the complexity and sophistication of the interventions contemplated in new operations is ascending.

4.30 The high regard for the IDB in STI is a result of the proven effectiveness of the policy instruments typically included in Bank operations (such as innovation funds), and the fact that several success stories in the area of capacity building in the region are closely associated with the Bank's support and funding.[61] Since most of the operations in STI are primarily concerned with private sector development, many firms across the region, SMEs in particular, know of the Bank as a supportive source of funding or technical assistance, through the vehicle that public innovation and competitive programs provide. NSG and MIF in particular have led the way in key areas such as venture capital development, further contributing to the recognition the Bank finds among business. Also contributing to the favorable valuation of the Bank's work in the sector is its willingness to become a partner in the medium to long term, becoming a source of dynamic consistency as authorities or budgets change from one year to the next in an area of public policy that is particularly sensitive to short term volatility.[62]

4.31 This stock of experiential know-how, in turn, has been recognized by governments thanks to the Bank's investments in impact evaluation and knowledge products, which have played a critical role in presenting evidence of what works and what does not. Furthermore, the IDB has acted as a catalyst, leading the way to new avenues of policy intervention that have found resonance in the problems and concerns of the counterparts, such as the pioneering work of the Bank in social innovation and mobile services, original applied research on service innovation, natural resource-based innovation, technological diffusion, entrepreneurship, and still others.

4.32 The Bank has, in fact, placed itself in the leadership of the policy research agenda at the international level, as evidenced in the number and quality of knowledge products published.[63] A close partnership between CTI and the Department of Research and Chief Economist (RES) has resulted in substantial collaboration in flagship knowledge products of the Bank, such as the IPES on productivity (2010), and the DIA publications on information technology (2010) and, most recently productive development policy (2014). Similarly long-standing collaboration between CTI and SPD has led to a copious series of products centered in impact evaluation and methodological manuals. Often, Bank projects incorporate financing of data gathering (innovation and enterprise surveys) activities in cooperation with innovation and competitiveness agencies or national statistical agencies, which results in both new useful knowledge and institutional strengthening in the counterparts. Several projects invest directly, by request from the governments, in program evaluation beyond the minimum requirements of

---

[61] This is a particularly important strength of the Bank in the current environment of growing resources being channeled to STI in a number of countries in LAC. Normally the budget assignments run ahead of the indispensable institutional capability to use them well, doubling the already critical importance of institutional strengthening.

[62] The role of the Bank –as a factor contributing substantially to institutional development and policy making in STI over the time, in a particular case Colombia– has been the subject of recognition and analysis in a recent volume ¨*Colciencias cuarenta años: Entre la legitimidad, la normatividad y la práctica*¨ (2013). See chapter 10.

[63] A search in the IDB's repository of institutional knowledge (BRIK) yields 102 publications by CTI (a Bank Division directly focused on STI policy).

regular mid-term or final evaluation of Bank projects. Through ESW and technical cooperation financing, the Bank has also been instrumental in putting together comprehensive innovation and private sector assessments that have played an important role in shaping policy and institutional reforms in several countries.

4.33 The Bank, in close partnership with the Development Agencies of Canada and the United Kingdom, has managed the Compete Caribbean program, which has become an effective lever to introduce and strengthen innovation across the Caribbean Region. Pioneering knowledge work on competitiveness, productivity, the current state and challenges of the private sector and innovation in Caribbean nations has been advanced within the framework of this program.[64] The Bank`s leadership in productive development policies in the region is recognized both in terms of supporting institutional development in the competitiveness and innovation sector (as, for example, through a series of operations supporting policy analysis and coordination in innovation and competitiveness councils), and in terms of actually interfacing with private companies through a system of competitive grants for innovative firms.[65]

4.34 The Bank has built a strong track record in the support for internationalization of services, an area in which ICT constitutes the key enabling technology. A combination of lending, research and technical assistance in this area has resulted in a mutually reinforcing complement to the growing involvement of the Bank in innovation in the service sector and stands out as a solid basis for deepening the impact of the combined work of INT and CTI.[66]

4.35 The Bank has also built up an innovation engine of its own in the iLab (see Annex, Box 3). This platform has been a successful vehicle for piloting new ideas in an open innovation framework. It has produced tangible results in the areas of social innovation and mobile services; both are highly valued by the Bank clients. Experience and design produced by the iLab has already been scaled and incorporated in components of lending operations as well as technical cooperation programs. It has also been conducted in a way that it has produced substantive

---

[64] This stock of knowledge products include private sector assessment studies for each Caribbean economy, the first national innovation survey for each Caribbean nation, a study of regional value chains, a review of the gap in innovation and technology affecting the region in the tourism sector, an analysis of the Caribbean entrepreneurial diaspora, a mapping of industrial clusters across the Caribbean (Rabelotti, 2014) and the first ever comprehensive innovation policy review of a Caribbean country`s innovation system, in the case of Trinidad and Tobago.

[65] In launching this type of funding for innovation projects in firms, Compete Caribbean can be seen as replicating at the regional level the successful support for business innovation through competitive innovation funds that the Bank usually channels at the national level in larger economies.

[66] Specifically, the Bank, in supporting the development of the global services sector, works jointly with trade promotion organizations and industrial associations in towards the establishment and strengthening of institutional structures for its growth. It also has acquired substantial convening capacities by successfully organizing, yearly, the Latin American and Caribbean Forum on Outsourcing and Offshoring (Outsource2LAC), under the responsibility of the Trade and Investment Unit (INT/TIU).

hard evidence about the impact of the programs, thus contributing to the knowledge agenda of the Bank in the STI sector.[67]

4.36 Still another source of the Bank strength in the STI sector is the long-standing and continuously running Regional Policy Dialogue in competitiveness, science, technology, and innovation policy. Thirteen meetings since its launching in 2006 have allowed the Bank to stay tuned to the concerns and priorities of national authorities, to put them in contact with cutting edge research and new ideas, and to bring international experts to the region. Regional initiatives have been a byproduct of the dialogue, several of them financed through technical cooperation funding or the Regional Public Goods window. Among other tools at the service of the Bank in the sector, the Regional Policy Dialogue stands out as having the potential to become a key channel for the IDB to exercise its leadership and mainstreaming best practices in STI policy.

E. Preferred IDB approaches and areas of activity and actions to be avoided in supporting STI

4.37 At the service of this purpose, the Bank will be concerned with promoting and supporting public policies that directly encourage firm innovation –particularly in SMEs–, establish an enabling environment for technology based entrepreneurship and ensure that complementary inputs and public goods indispensable for the innovation system to work (such as highly skilled human capital, scientific infrastructure and research) are in place. Ultimately, adequate national innovation systems should play a critical role in enhancing firm productivity and hence provide a solid base for growing competitiveness across LAC economies. In addition, the Bank will support private sector investment, through direct and indirect investment and technical assistance to firms or projects with innovative approaches that enhance productivity, increase market competition, improve environmental and social outcomes, and are financially sustainable. These efforts seek to lever the knowledge, capital, and technology of the private sector to bridge the productivity gap in LAC.

4.38 The aforementioned list of strengths places the Bank in a privileged position to deepen the support for the sector, from the vantage point of maximizing the impacts of the reforms and programs financed. The interest across LAC, both in the private and the public sector, for innovation policy is growing. This is primarily the result of the ostensible impact of technological change in the economy worldwide. But it means that, having earned a name of reference in the field, the Bank is likely to expect growing demand for its financial and technical assistance services in STI. This does not translate into the Bank getting involved in every possible aspect of STI policy, but the systemic approach the Bank

[67] The iLab has also had spillover effects through the application of open innovation platforms to promote innovation processes within the IDB itself. The early success of this line of work points to the potential of further pursuing this path. A full exploration of this idea lies beyond the scope of this document.

espouses inevitably leads to being able to act effectively whether a particular request for supports deals with the business, the public sector or the academic pillars of the innovation system. The way the Bank will stay focused and avoid getting overextended is by a careful targeting of its programs to those activities that are likely to have the most direct effect on productivity and competitiveness and those that generate the most extensive externalities: thus, if highly skilled scientific and engineering personnel is a key component of what a given economy needs to enhance its knowledge intensity, the Bank should prefer the support to specific scholarship or talent acquisition programs, as opposed to wholesale university reforms that are likely to represent a far more indirect path to the impacts sought; if support for firm innovation is to be supported, it would be better to concentrate IDB support in areas that maximize externalities (such as firm innovation projects that raise productivity by enhancing innovation routines, hiring highly skilled personnel and produce intellectual property) than on areas in which the regular financial market can normally take care of firm needs (such as credit for the acquisition of machinery). Finally, a stronger coordination between NSG and SGO should lead to tapping the potential of financial markets for the support for innovation, on a scale and dimension still unexplored in Bank operations.

V. GOALS, PRINCIPLES AND DIMENSIONS OF SUCCESS

5.1 This SFD aims, at aligning the Bank's actions in STI in for the purpose of making the most effective contribution possible, to enhance competitiveness through business innovation over the next three years. In doing so, focusing on the knowledge intensity of the region's economy is a necessary condition for success, in the context of the ongoing technological revolutions.

5.2 Five dimensions of success have been defined as the distinctive sign that such goal is being reached and LAC economies are in the process of becoming more knowledge intensive. They have to do with a growing investment in STI across LAC economies, ensuring appropriate financing of business innovation, building up adequate scientific and technological capabilities, increasing the availability of highly qualified human capital for innovation, and improving the business and innovation climate.

5.3 The five dimensions are the combined result of what we know about what works in innovation and science policy, the particular challenges facing the region in this sector and what the Bank has learned throughout its long trajectory of hands-on involvement, as outlined in the three previous chapters. They are built on the persuasion, strongly backed by recent economic development history, that well focused and significant efforts can make a difference and turn economies around in the time span of one generation, taking productivity, social welfare and competitiveness to a whole new level on the basis of the intense incorporation of knowledge in the economy. The processes of technological leap-frogging and catching up are hard enough that not many developing countries have been able to get it right, yet there are sufficient success stories (Finland, Israel, South Korea constitute outstanding cases) to prove that such processes are indeed possible and to provide signals regarding possible paths to move forward (see Annex, Box 4).

5.4 Considerable heterogeneity in the development of national innovation systems and in the economic structure of borrowing countries dictates the need to advance operation's design and implementation strategies on a case by case basis. Three main criteria will preside the choices to be made in each case in this regard: (i) the pre-existing institutional capacity for implementation of particular programs or reforms; (ii) the distance of the main economic sectors concerned by the operation to the technological frontier and their potential as basis for economic diversification;[68] and (iii) the degree of development of the available knowledge infrastructure (local availability of inputs for innovation). A discussion of how these principles are to be combined and an illustration of how this would dictate different types of intervention in the case of LAC countries at diverse levels of economic development can be found in Table 2 above.

5.5 There will be, to the extent possible, general principles underlying Bank operational and knowledge work in the STI sector. They are:

a. Building institutional capacity in the national innovation systems following the internationally sanctioned best practices in the field remains a major area of focus in the design of all Bank operations.

b. Activities, programs and policy instruments supported in the context of Bank operations tend to respond to a clearly identified market failure or coordination failure.

c. In line with common practice of risk evaluation processes, Bank interventions and design, minimize and mitigate the risk of capture by stakeholders and dynamic inconsistency in their execution.

d. Given the heterogeneity of baselines in material, intellectual and institutional resources across economies of LAC, the Bank will strive to develop STI lending and technical assistance programs that are tailored to the specific needs of each country at any given time.

e. As stated in the Development Effectiveness Framework (GN-2489), Bank operations will incorporate a strong component of evaluability, and a sustained effort to improve data availability and carry out impact evaluation will stay as a central component of the knowledge agenda of the Bank in the sector.

f. Bank operations in STI will include activities and resources devoted to better communicate their results and impacts.

---

[68] See DIA (IDB, 2014) for guidelines regarding how to assess operationally this criterion.

5.6 More specifically, measuring the success of the Bank in reaching the objective of its involvement in the STI sector concentrates emphasis along the following dimensions.

A. Dimension 1. Investment in STI, both public and private, grows so as to reduce the innovation shortage typical of LAC economies, perceptibly reducing the gap between the region and advanced economies.

5.7 In response to the tendency of the STI policy-making process to result in suboptimal levels of investment in the sector, the Bank´s lines of action should take a proactive stance and exercise leadership as a promoter of a correction in this trend, in light of the high returns to investment in innovation has, the experience of recent success stories in development and competitiveness in emerging economies (see Annex, Box 4) and overall trends that dictate an accelerated knowledge intensity across all sectors of the economy. Three lines of action are proposed for this dimension:

a. Supporting capacity building in STI policy, so as to enhance institutional, technical and managerial performance in the sector's policy-making process. Stronger and more capable institutions in the sector are a necessary building block of improved public investment in STI and the possibility that public policy becomes an effective tool for the integration of knowledge into economic activity.

b. Contributing to a better financed public policy in innovation, science and technology to help improve the baseline of low public investment in STI**.** The Bank will support an upward trend across the region in this sector, so as to start reducing the current insufficient correction of market failures negatively affecting innovation activity in the region.

c. Mainstreaming the application of innovation-related approaches (open innovation, design thinking, Web 2.0 Internet platforms) to the development of novel solutions to social issues (access to social services, social inclusion).

5.8 During the period covered by this SFD, it is proposed that the Bank should prioritize the following activities:

a. Proactively engage borrowing countries in assigning priority to STI investment and STI policy institutional reforms in the context of regional policy dialogue, sector work, country strategies and programming mission.

b. Focus on making the case for innovation in country and regional dialogues in the context of a strategic communications process.

c. Pay special attention in country dialogue and project design to the untapped potential of innovation in the services and natural resource sectors.

d. Expand technical assistance and lending operations to subnational levels of government (states, provinces, cities and municipalities) wherever there is a demand from countries for it, taking advantage of recent trends in STI policy-making towards a more intense involvement of regions and cities in innovation policy.

e. In the particular case of the Caribbean, build on the success of the Compete Caribbean program to deepen support for capacity building and investment in innovation in that region.

f. Further develop open innovation platforms that can provide a foundation for social innovation and the engagement in innovation activities of the population at large, thus contributing to a growing awareness of the impact of innovation across institutions, the public sector and among variety of social groups. This with the aim of maximizing the impact of the Bank`s work in innovation on the effectiveness of the inclusion agenda pursued by the Banks at large

g. Deepen research in the areas that will directly impact the ability of the Bank to measure and understand the impact of STI investment in competitiveness and productivity growth, as well as on new policies and instruments that will scale up the economic impact of interventions in the STI sector (examples include natural resource-based innovation, innovation in services, innovation climate and intellectual property, technological diffusion and technological transfer, among others). New knowledge in this area is expected to increase the impact of IDB programs as well as to improve the ability of the Bank to make the case for investment in innovation, science and technology.

B. Dimension 2. A larger share of firms in the region, particularly SMEs and start-ups, gain better access to adequate financing for their investments in technology and innovation, and consequently increase the knowledge content of the goods and services that they produce and export.

5.9 This dimension of success highlights the importance of ensuring continuity and expanding IDB lending operations that provide both non-reimbursable and reimbursable support aimed at encouraging existing firms to innovate, as well as to support fast growing innovative startups to operate in a context in which seed, angel and venture capital financing becomes available. The low level of private investment in innovation that characterizes LAC constitutes a key issue to be addressed if the region’s productivity gap with respect to other regions of the world. One line of action is proposed for this dimension:

a. Maintaining and deepening the primary focus of Bank operations in STI on promoting and accelerating the productive uses of knowledge in firms. Productivity growth should be one of the underlying objectives of most IDB STI operations, and tearing down the barriers that prevent knowledge from being created, acquired, disseminated and used in productive activities must be considered as an overall priority.

5.10 During the period covered by this SFD, it is proposed that the Bank should prioritize the following activities:

a. Seek a closer integration between NSG and SGO in the area of financing innovation, so as to take advantage of the comparative advantages of each. NSG can offer support to innovative firms, value chains, projects and sectors through loans and guarantees, and through the equity and quasi-equity instruments of the IIC and MIF that support riskier private endeavors that generate positive economic and social impacts. SGO can improve the business climate for innovation (see below dimension 5), particularly with support to capital markets, IPR, and other elements needed for an effective venture capital market and risk capital, while also supporting innovative instruments and programs that engage the private sector agents. International best practice clearly points to the need to combine well designed public programs in innovation with business sense and criteria when it comes to scaling up project financing and developing sophisticated financial instruments targeted at entrepreneurs. The Bank has accumulated considerable experience on both counts, but it should pursue deliberately synergies and complementarities between its public and private areas in the future.[69]

b. A particular area of focus in this dimension will be the need to expand and enhance Bank support for technology-based start-ups with high growth potential and strong effects on productivity growth and employment creation; a joint SGO-NSG effort. All comments in the preceding point about the need to achieve a closer integration between SGO and NSG apply also here.

c. Provide financial support for business innovation through a combination of instruments. Whenever Bank`s resources are used for funding non-reimbursable grants programs, supported projects will have to be judged to have potential to generate clear externalities (as an example, priority will be given to projects that involve multi-stakeholders collaboration and where intangible investments dominate), on the other hand individual firms innovation projects where the investment is mostly formed by tangible assets should be supported mostly through long term credit lines and guarantees. A combination of the alternatives mentioned above will be used as the particular circumstances and objectives of a given project dictate. Finally, whenever feasible business innovation programs will be combined with

---

[69] For example, innovation grants and non-reimbursable seed capital programs funded through SGO should play a role in generating the deal flow that could be later on scaled up through venture capital interventions through NSG. Beyond this specific instance, the STI sector provides valuable opportunities for public-private collaboration as already pointed out, a matter that requires strong collaboration between the IDB Group teams working on SGO and NSG projects.

ex-post incentives for technology transfer and diffusion (e.g. making at least part of non-reimbursable financing to the pioneers conditioned to the technology take-up by the users or followers). In doing all this, the Bank will remain alert at the potential afforded by the scale economies made possible by multi-country coordination and by the opening of entrepreneurial and investment opportunities made possible by free trade agreements.

d. Expand the role of innovation financing opportunities (grants, credit and technical assistance) for socially excluded groups through specifically targeted programs, as for instance in the case of programs seeking to enhance support for women entrepreneurs and business owners, as well as for young entrepreneurs.

e. Pursue an intellectual and pilot testing agenda directed at finding ways to expand the impact of its programs across the business sector in the region.[70] Accumulated experience shows that programs, although successful in their own terms, have had limited impact on productivity growth and competitiveness when the economy is considered as a whole. New types of programs, larger programs, more significant inroads in innovation in the service sector and ICT adoption by firms, programs that go beyond individual firms to address the dynamic of value chain upgrading and cluster development are just a few examples of ideas that are being already tried at a small scale but are worth exploring systematically. In due course, this research and piloting activities should be scaled up in larger lending and better-informed technical cooperation programs. For this, the impact evaluation research agenda will be revamped and moved to a more sophisticated level by making use, whenever is possible, of randomized control trials and learning from the heterogeneous impacts that the "innovation policy treatment" has across different sub-populations, treatment doses, interaction with other productive development politics and with the business and innovation environment (including market competition).

C. Dimension 3. LAC economies make observable gains in obtaining the highly skilled human capital necessary to support and further develop their innovation systems.

5.11 This dimension of success speaks to the growing awareness across LAC that highly skilled human capital is a key component of STI development across the world. Not only scientific researchers with advanced training but also entrepreneurial talent, well-educated engineers and technicians and the full array of professionals required for the functioning of an innovation system, such as technology and innovation managers, lawyers with expertise in intellectual property rights, knowledge brokers, designers and the like constitute a core

[70] The framework for the development of productive development policies recently put forward by the Bank in the 2014 DIA provides a timely context for the knowledge agenda proposed here.

element for the purpose of productivity catching up across the world. Two lines of action are proposed for this dimension of success:

a. Sustaining and deepening Bank support for scholarship programs that target Science, Technology, Engineering, and Mathematics (STEM) fields.

b. Supporting a new generation of talent acquisition programs that seek to accelerate the availability of highly skilled human capital in LAC. This should be achieved through diaspora management, selective immigration and incentives for the return of nationals working abroad in STEM fields or in the area dynamic entrepreneurship and other key areas needed for the development of innovation ecosystems.

5.12 During the period covered by this SFD, it is proposed that the Bank should prioritize the following activities:

a. The inclusion of financial and technical assistance support in talent acquisition strategies in the context of technical cooperation and lending operations, including, although not limiting itself to, funding for scholarship programs in STEM and engineering, strengthening of domestic graduate programs and diaspora management policies. Special attention should be paid to the support for the inclusion of women, indigenous peoples and African descendants in these programs.

b. Support public and private initiatives, regulations and programs that lead to improvements in the availability of highly skilled human capital through the creation of better incentives for individual, businesses and research institutions to attract talent or by creating a growing demand for it. Develop knowledge products in the field of human capital for innovation, including research on the impact of migration and diasporas on productivity and competitiveness, international best practices in the area of talent acquisition strategies, impact assessment of such strategies and economic impact and mitigation strategies for brain drain.

D. Dimension 4. Public and private investment in technological and scientific infrastructure grows, to a level closer to the one needed to provide the adequate level of inputs for each economy in the region, thus becoming better able to identify, understand, adapt and productively utilize the best available production processes.

5.13 Accelerated technology adoption in firms requires a minimum of complementary investments in scientific and technological capabilities. The level and specific design that these complementary investments should take vary according the level of sophistication and diversification of the economy, but as such they are an unavoidable component of successful STI policy. This dimension of success translates into one line of action:

a. Providing support, in the context of the Bank's lending and technical assistance operations, to scientific research, laboratory equipment, quality systems and metrology services.

5.14 During the period covered by this SFD, it is proposed that the Bank should prioritize the following activities:

a. The provision of technical assistance on best practices and optimization of investments in scientific infrastructure and equipment, and in building the capacity to run and manage effective, peer reviewed, research funding policy instruments, with a priority on mission oriented research.

b. Support for investments and instruments through lending programs, including quality systems, metrology, laboratories both for research and for the delivery of technological services to industry, as well as the training of human resources required to operate and maintain them. A strong emphasis will be placed on making lending for equipment and scientific infrastructure projects conditional on ensuring that the investments count on a thorough analysis of their effectiveness, as well as an adequate plan for shared access, management and maintenance, so as to avoid waste and duplication.

c. Explore innovative paths to develop private financing of scientific research and infrastructure, in close coordination with NSG. Private funding for scientific research and for research facilities through non-for profit or cost-recovery schemes led by large research universities is a worldwide trend that is already visible in LAC and should be encouraged and facilitated by Bank actions.

E. Dimension 5. The business and innovation climate for private sector development and more intense firm innovation should improve across the region, as measured by both consistent business climate and innovation indexes.

5.15 This dimension of success seeks to respond to the ample room for improvement in the business climate and competitiveness-related regulation in most countries in LAC, and complement it with a new focus on innovation climate, one that will help firms not only to do business, but to do it in a significantly new a more productive way through innovation and technology. Two lines of action are proposed for this dimension:

a. Incorporating innovation climate elements in the reforms contained in competitiveness PBLs, aiming at producing systemic impacts through reforms in regulations affecting innovation in areas such as commercialization of intangible assets through intellectual property[71] and venture financing.

b. Prioritizing investments in the development of effective innovation ecosystems in lending and technical assistance operations.

5.16 During the period covered by this SFD, it is proposed that the Bank should prioritize the following activities:

a. Deepen support for the development of intellectual property rights regimes and institutions –patenting, licensing–, venture capital finance,[72] value creation trough IP management, competition policy, innovation-oriented trade reforms, development of the creative industries, strengthening of university-industry links, and mechanisms for facilitating the transfer of tacit knowledge key for the innovation environments to become functional (facilitating the availability of knowledge brokers, intangible assets valuation expertise, business acceleration).[73]

b. Develop a research agenda on business and innovation climate, further refining existing indexes and indicators and better establishing the links between reforms that produce visible movements in those measurements and productivity growth and competitiveness.

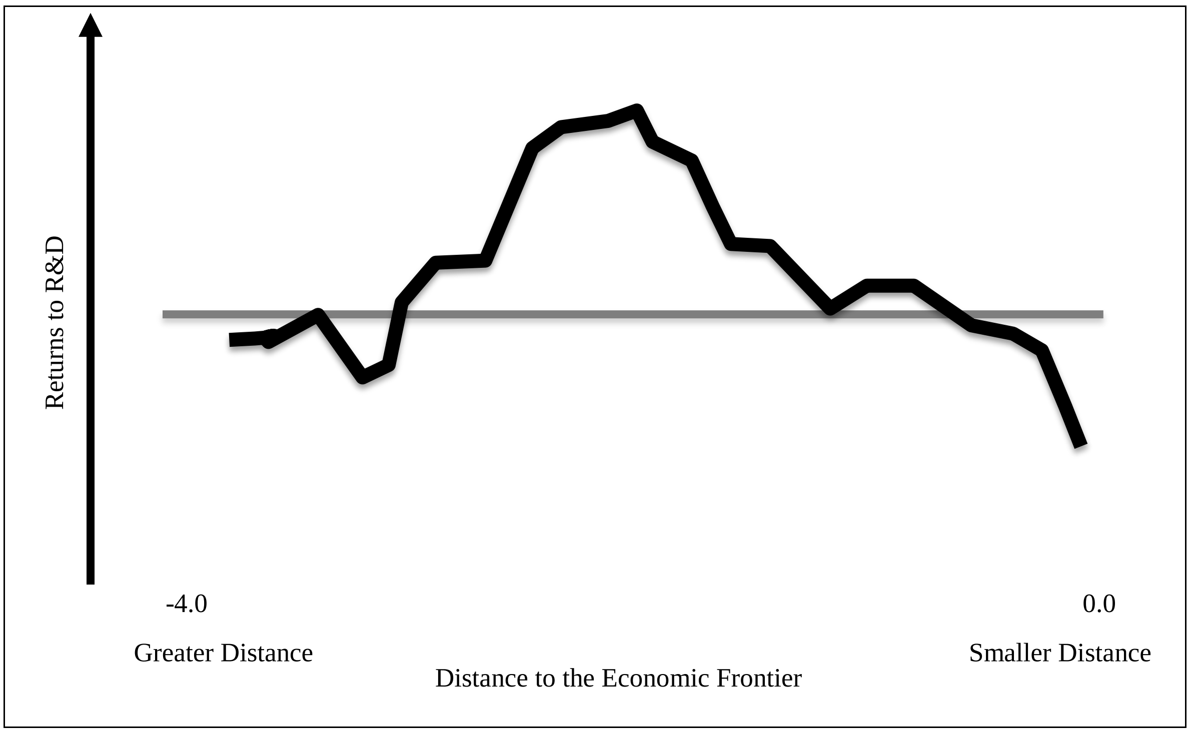
[71] LAC countries register a wide normative and institutional variation when it comes to intellectual property rights. The Bank will always adapt any action in this sphere to local conditions and regulations. The distinctive IDB approach will be presided in all cases, however, by the objective of enhancing the economies' capacity to develop markets in which ideas and knowledge can acquire economic value through capacity building, talent development and the dissemination of skills relevant to this field in the region's innovation systems.

[72] Actions undertaken in connection to the development of the VC market will be consistent with the principles and dimensions of success spelled out in the Support for SME and Financial Access and Supervision SFD.

[73] Beyond and in coordination with CTI's work on innovation climate, and as established in the Sector Strategy for the Support of Regional and Global Integration (2011), the Bank, through INT, has carried out support to policy reform, regulatory modernization, institutional strengthening and capacity building needed in order to facilitate cross-border circulation of goods, services, capital, people and technology, so as to promote a better integration of national systems and the private agents in the world economy.

FIGURES, GRAPHS AND TABLES

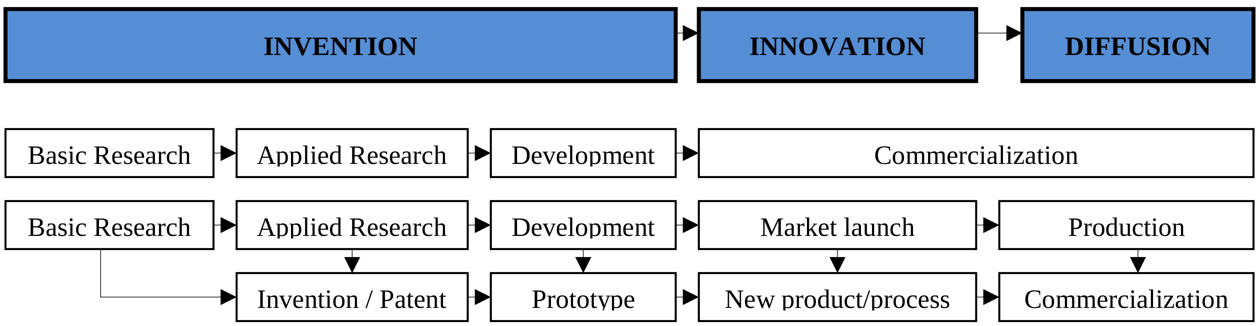
Figure 1: Rates of return to R&D and stages of economic development. Previous findings by Lederman and Maloney (2003) found that rates of return were higher in countries with lower levels economic development (as measured by GDP in PPP per capita). Those findings suggested that countries could take advantage of being behind the technological frontier by adapting or using technologies developed at the frontier presumably at a lower cost of innovation investments. Recent analysis by Goñi and Maloney (2014) find evidence of an inverted U relationship between returns to R&D and stages of development (as measured by distance to the economic frontier). This implies that there is a point at which countries fall out of range and higher returns to R&D for economies that are a great distance from the frontier –as, for instance, the less developed economies in the LAC region- begin to dissipate. The authors conclude that this is most likely due to lack of complementary capacities (i.e., human capital, scientific infrastructure, and overall characteristics of the NIS) needed within a society in order for efficient technological absorption.



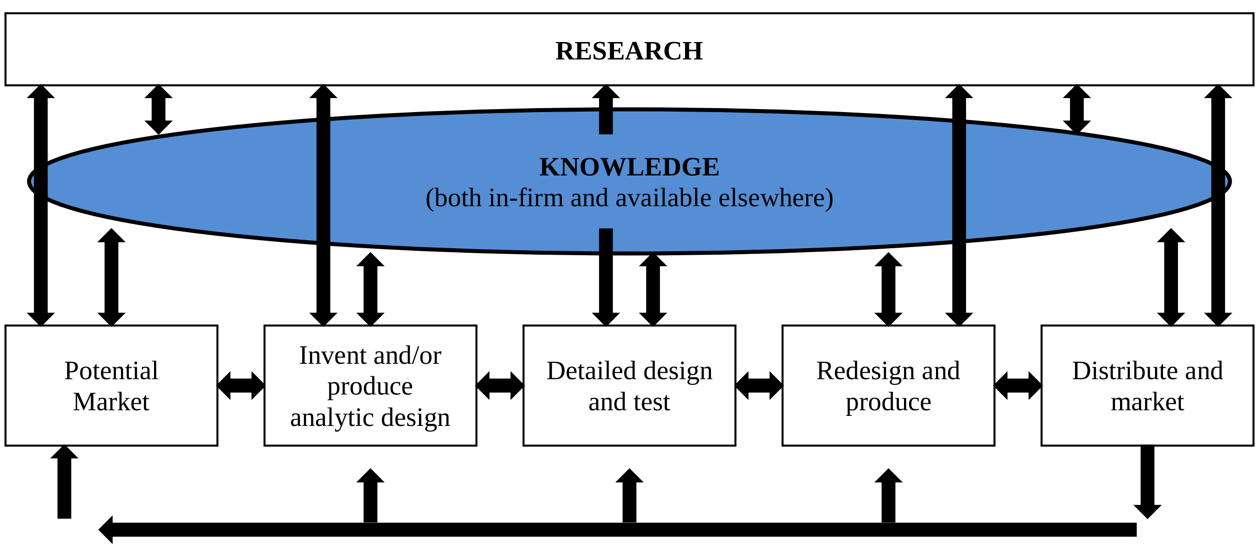
Source: Notional representation of findings from Goñi and Maloney, 2014.

Figure 2: Linear vs. non-linear (systemic) views of innovation. Increasingly, innovation is regarded as an endeavor that requires multi-actor involvement (private, public and academic) as well as conducive channels through which information and resources can move freely (university-industry linkages, financial institutions and markets, just to name a few). The following figure illustrates the different viewpoints of innovation as a linear process (a) and as a systemic process (b), as described in more detail in paragraph 2.11 in the main body of the document.

a. Innovation as a linear process

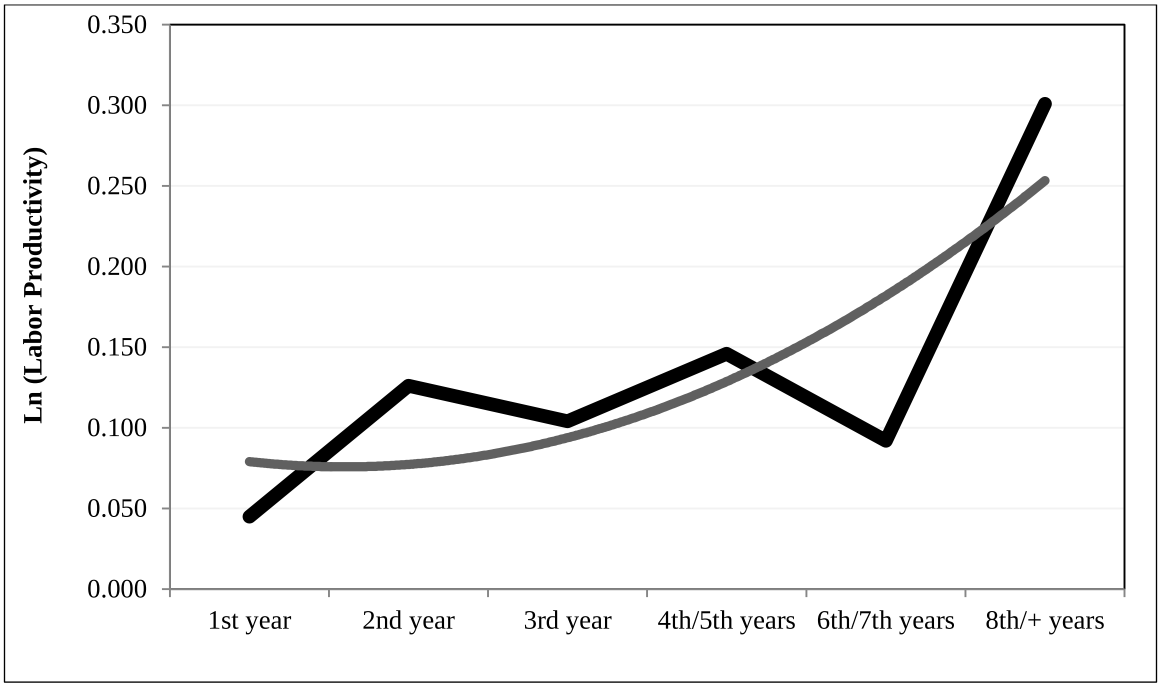


b. Contemporary view of innovation as a complex, multidirectional and systemic process



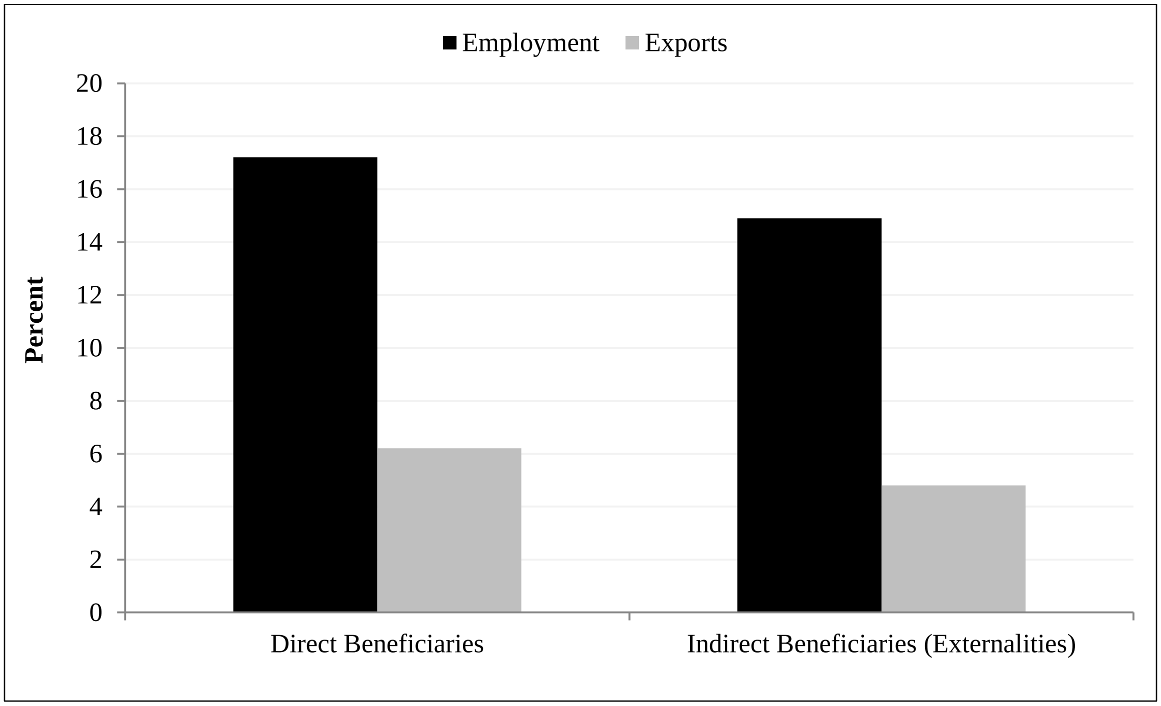
Source: Saenz, 2005

Graph 1. **Impact of COLCIENCIAS matching grants on firm productivity in SMEs (% differences compared to the control group).** Frequently discussed issues with innovation support and subsequent efforts and payoffs are the time lags between the former and the later. Support for innovation is expected to increase the innovative efforts of firms receiving funding and, down the line, productivity levels. As described in paragraph 2.23 and 2.24 and shown in the graph below, evaluation of the matching grant program for firms in Colombia illustrates that increases in productivity can come long after the initial investments to support innovation are made. The line in black represents the degree to which (in %) the SMEs with matching grants from COLCIENCIAS outperformed the control group. The grey line illustrates a smoothing effect for the data presented in the black line over the years in the time period considered in the study.



Source: Crespi, Maffioli, and Melendez, 2011

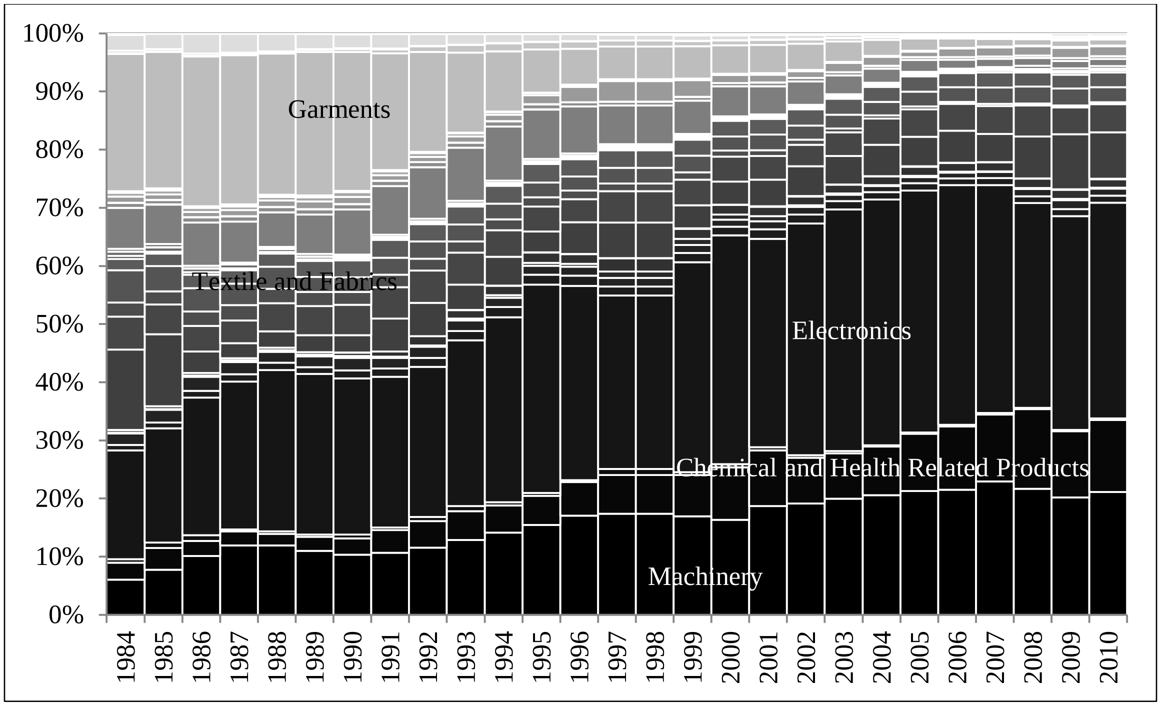
Graph 2. Employment and export growth in direct and indirect beneficiaries: evaluation of FONTAR in Argentina. A common argument in favor of public support for firms to innovate is that there are positive spillover effects that go beyond the walls of the individual firms that have received public support. Although sound empirical evidence is scarce, very recent analysis of an extensive employer-employee matched panel dataset for the entire population of firms and workers from 2002-2010 in Argentina, explores the effects of innovation funds on direct beneficiaries and positive spillovers to indirect beneficiaries. The rich dataset permitted tracking knowledge diffusion through observing the mobility of highly qualified workers from a beneficiary firm (a recipient of FONTAR funding) to other firms (non-recipients), as well as evaluation of performance measures for both in terms of employment growth and exporting probability (shown below in the graph) after some time. The findings published in Castillo et al., 2014 confirmed a lag between when the funds were received and the eventual pay-offs, because the performance measures were found to be increasingly positive over time; and positive spillover effects for Argentinian firms that were not direct beneficiaries of the FONTAR program.



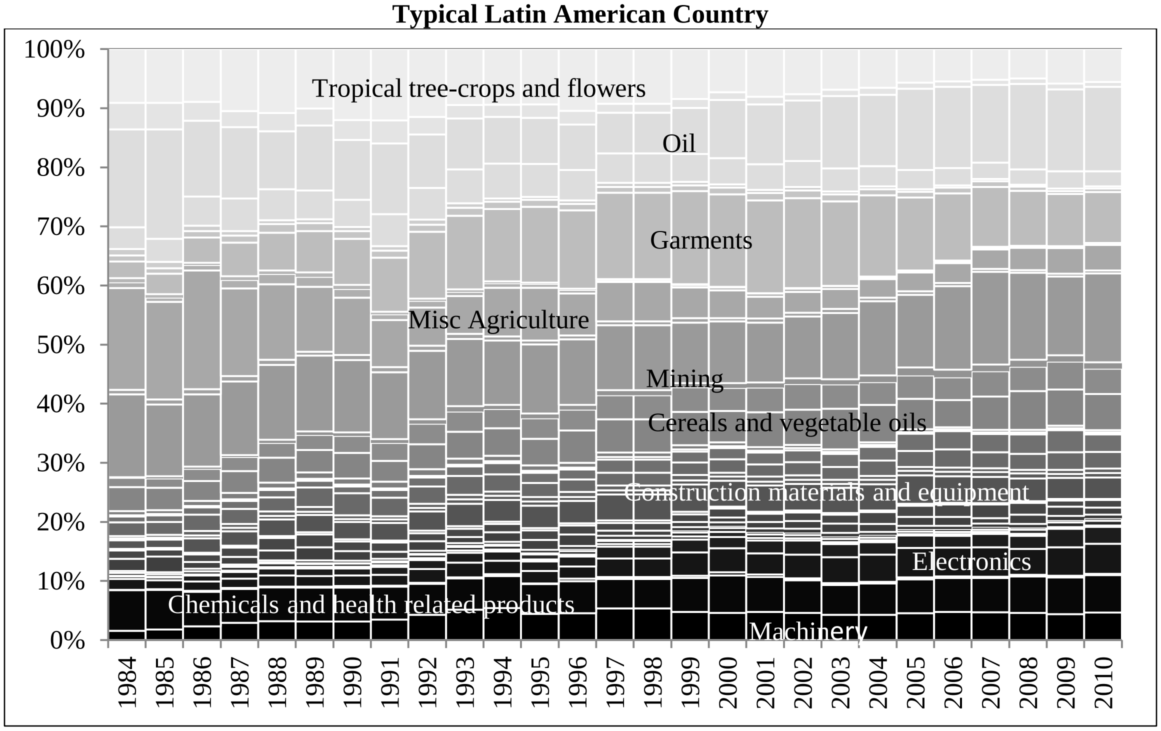
Source: Castillo et al.,2014.
Notes: The analysis was also carried out over an 8 year period, from 2002-2010, showing how the relationships may have changed a few years after firms received funding. For more details regarding the analysis please see the recent publication by Castillo et al., 2014.

Graph 3. A Low knowledge-intensive economic structure: transformation of the productive structure of Korea vs. LAC. A glance at the change in the technological complexity of exports over the last 30 years in South Korea compared to the typical country in Latin America immediately reveals the relative stagnation in region.

South Korea

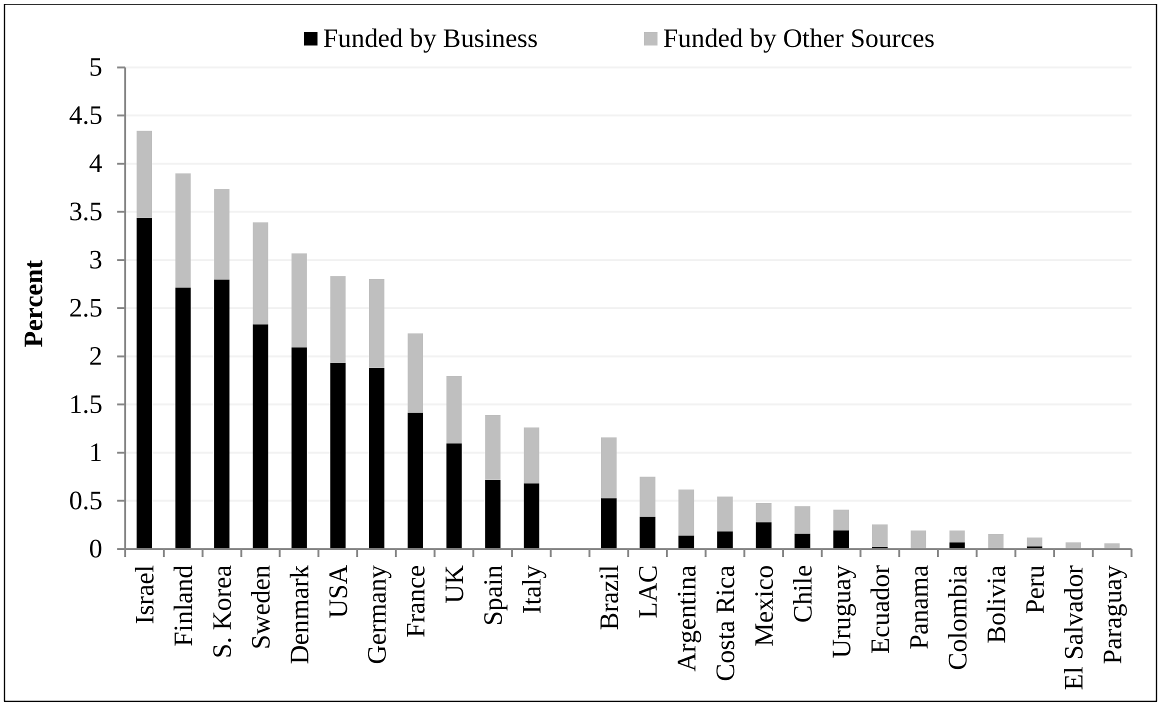


Typical Latin American Country



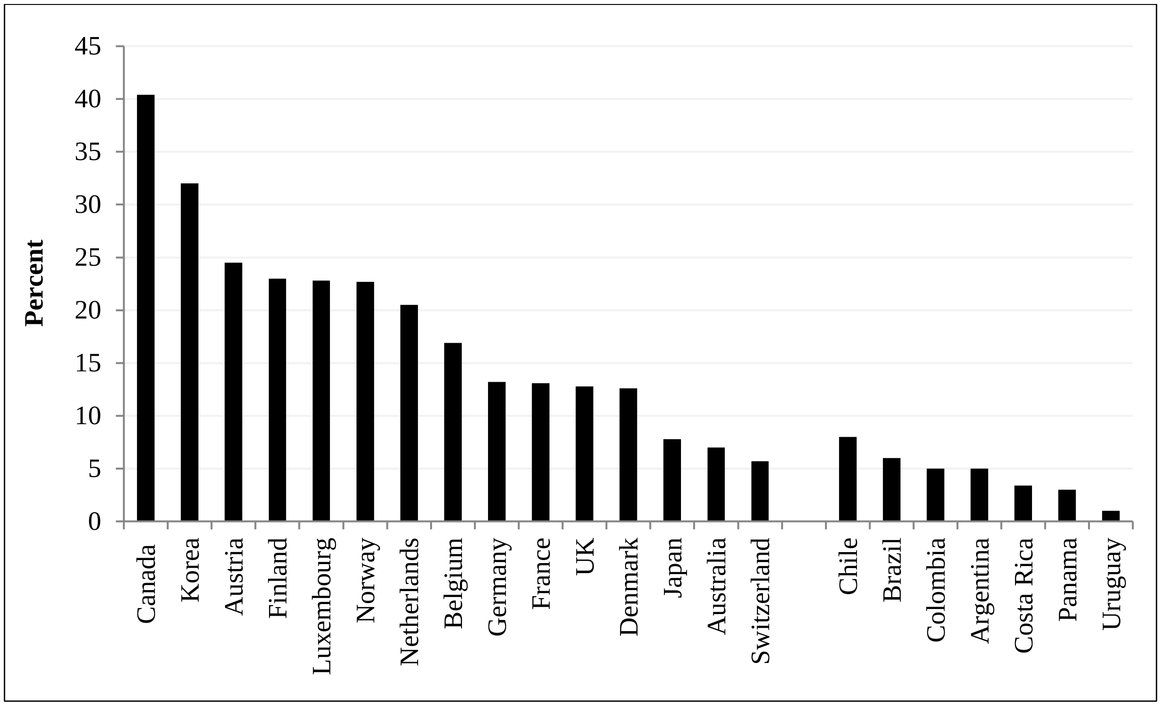
Sources: IDB, 2014: calculations based on Hausmann et al. (2011)

Graph 4. Investment in R&D as a share of GDP and the proportion that is funded by the business sector. Relative to their own economies, the overall investment in R&D (as a proxy for innovation investment) is low in LAC when compared to advanced economies from the OECD. Brazil is clearly an outlier in the region and accounts for the majority of R&D investment in the regional average. In the LAC economies that tend to have the lowest R&D investment, the private sector is barely a financial presence in the R&D effort.



Sources: OECD and RICYT.
Notes: Data are from 2010 or the latest available year: 2009 for Bolivia, Costa Rica and Peru, and 2008 for Ecuador and Paraguay. Data for Peru are based on authors' calculations using innovation survey data and data from OECD, 2011.

Graph 5. Public support for innovation in firms. As discussed in paragraph 3.9 and shown in the graph below, firms in LAC may have fewer opportunities than firms in the OECD to receive public support for their innovation activities. This suggests that although the public sector often accounts for the greatest proportion of R&D financing, currently those resources are not reaching firms trying to innovate in LAC.



Source: IDB (2010a) based on the following Firm Innovation Surveys: Innovation Surveys (Argentina: 1998-2001, Brazil: 2005, Chile: 2004- 2005, Colombia: 2003-2004, Costa Rica: 2008, Panama: 2008, Uruguay: 2005-2006). Data for OECD countries are from OECD (2009).
Notes: Data refer to the manufacturing industry. Indicators are weighted for OECD countries; data for LAC countries (excepting Brazil) are provided by researchers and are un-weighted.

Table 1. OVE impact evaluations of STI Programs

Country / Project	Type of Intervention	Authors/Year of Pub.
Argentina / FONTAR-TMP1	Subsidized Loan	Chudnovsky et al., 2006
Brazil / ADTN	Subsidized Loan	De Negri et al., 2006a
Brazil / FNDCT	Parallel Subsidies	De Negri et al., 2006b
Chile / FONTEC	Parallel Subsidies	Benavente et al., 2007
Panama / FOMOTEC	Parallel Subsidies	López, et al., 2010
Argentina / FONTAR-TMP1 and FONTAR-ANR; Brazil / ADTN and FNDCT; Chile / FONTEC; and Panama / FOMOTEC	Evaluated for - R&D input additionality, behavioral additionality, increases in innovative output, and improvements in performance	Hall and Maffioli, 2007

Source: Crespi (2012). Note that many other STI impact evaluations have been carried out in the region, additional findings and details can be found in the IDB's 2012 publication, Institutions for Tomorrow. This table highlights the work carried out by the Office of Evaluation and Oversight in conjunction with the listed authors to contribute to knowledge and program design in the area of STI.

Table 2. Active (current) Loan Operations in CTI

#	Country	Operation Name	Amount Approved (US$)	Approval Year
1	Argentina	Norte Grande Competitiveness Program	16,000,000	2008
2	Argentina	Development of Satellite System and Applications Program	50,000,000	2006
3	Argentina	SMEs Credit Access and Competitiveness Program	50,000,000	2007
4	Argentina	CCLIP: Program of Technological Innovation	100,000,000	2009
5	Argentina	Technological Innovation Program II	200,000,000	2010
6	Argentina	Technological Innovation Program III	200,000,000	2012
7	Argentina	MSME Competitiveness Support Program	50,000,000	2013
8	Argentina	Competitiveness of Regional Economies	200,000,000	2014
9	Argentina	Science and Technology Scholarships - Program BEC.AR	24,000,000	2013
10	Argentina	Program for the Technological Development of Mendoza	50,000,000	2014
11	Barbados	Barbados Competitiveness Program	10,000,000	2009
12	Brazil	Competitiveness of Business in Local Production Systems in São Paulo	10,000,000	2007
13	Brazil	Innovation and Dissemination Local Cluster Competitiveness State of Pernambuco	10,000,000	2009
14	Brazil	Cluster Competitiveness Support Program for Minas Gerais	10,000,000	2009
15	Brazil	Strengthening of the Entrepreneurial Activity Program Estado de Bahía	10,000,000	2006
16	Colombia	Strengthen the National Science, Technology, and Innovation System, Phase I	25,000,000	2010
17	Costa Rica	Innovation and Human Capital for Competitiveness Program	35,000,000	2012
18	Dominican Republic	Program to Support Competitiveness Policy II	10,000,000	2010
19	Dominican Republic	Business Development & Competitiveness in the Province of San Juan	35,000,000	2013
20	El Salvador	Innovation for Competitiveness Program	30,000,000	2012
21	El Salvador	Productive Corridors Program	40,000,000	2014
22	Guatemala	Program to Support Strategic Investments and Productive Transformation	29,000,000	2006
23	Guyana	Support for Competitiveness	8,650,000	2006
24	Peru	Innovation Project for Competitiveness	35,000,000	2012
25	Peru	Program for Improving Productivity and Competitiveness	5,000,000	2010
26	Panama	Multiphase Technological Transformation Program-Phase I	19,700,000	2008
27	Paraguay	Enterprise Development for SME	7,903,405	2001
28	Paraguay	Science and Technology Program	6,387,543	2005
29	Uruguay	Clusters Competitiveness and Value Chains	9,000,000	2006
30	Uruguay	Technology Development Program II	34,000,000	2008
31	Uruguay	Program to Support Future Entrepreneurs	8,000,000	2012
31	**TOTAL**		**1,327,640,948**	

Source: IDB, OPS System.
Notes: Other IFIs have smaller active portfolios in LAC, for example the IFC has US$155 million open commitments for innovation and entrepreneurship, and the World Bank has US$954 million active lending for innovation components.

Table 3. Active (current) TC Operations in CTI

Count	Country	Approval Year(s)	Total Amount Approved (US$)
2	Argentina	2010, 2012	760,000
5	Brazil	2009, 2010, 2013	2,450,208
2	Colombia	2010, 2012	636,000
2	Costa Rica	2011, 2012	288,000
1	El Salvador	2012	160,000
1	Mexico	2011	100,000
2	Peru	2014	617,872
2	Panama	2012	455,000
1	Paraguay	2013	165,000
16	Regional	2008-2014	8,990,304
1	Trinidad and Tobago	2013	260,000
1	Uruguay	2013	170,000
36	**TOTAL**		**15,052,384**

Source: IDB OPS System.

Table 4. Inactive Loan and TC Operations in CTI

Country	Count of Loans	Count of TCs
Argentina	6	7
Barbados	0	1
Belize	0	1
Bolivia	3	1
Brazil	8	2
Chile	7	6
Colombia	4	8
Costa Rica	2	11
Dominican Republic	1	7
Ecuador	3	7
El Salvador	0	4
Guatemala	2	1
Guyana	1	1
Haiti	0	1
Honduras	1	7
Jamaica	2	2
Mexico	6	9
Nicaragua	1	7
Peru	2	8
Panama	3	6
Paraguay	2	1
Suriname	0	3
Uruguay	2	5
Venezuela	2	7
Regional	0	38
TOTAL	**58**	**151**

Source: IDB OPS System.
Notes: Loans and TCs classified under CTI with CO or CF status were extracted from the OPS system, had an Operation Name and Approval Amount more than zero and Approval Year before 2014 and after 1967 were considered. Over that time period he total approved amount of CO or CF loans was US$2.1 billion and for TCs it was US$23 million. The size of this closed portfolio is also larger than other IFIs operating in LAC; the IFCs closed commitments in innovation and entrepreneurship amount to US$1.5 billion, and the World Bank's closed components of lending in innovation total US$612 million.

Table 5. NSG Operations in STI. Since 2001, NSG has approved 396 operations worth US$1.2 billion for these STI-related activities. MIF has invested US$361 million of equity and approving US$24 million worth of technical cooperation to support the region's venture capital industry. SCF has devoted US$340 million to the expansion and upgrading of telecommunication networks in the region through 2007, but has since exited from this market segment. OMJ has approved 56 operations worth US$386 million. NSG has also financed 97 projects worth US$60 million that promote productive integration, which helps insert local firms in value chains where technology transfers are likely to occur. It should be noted that since technology and innovation are transversal themes, many NSG projects have STI components while the main project may not be labeled as in this sector. MIF, for example, acts as a catalyst for innovation in the region, particularly when it comes to SMEs as they represent 72% of the MIF's beneficiaries (OVE, 2013).

NSG Operations in STI

	Loans, equity, guarantees (US$ millions)	TC's (US$ millions)	Total (US$ millions)	Operation Count
Innovation Finance	361	24	382	183
ICT Infrastructure	340	29	369	60
Social Innovation	378	8	386	56
Productive Integration	5	55	60	97
Total	**1,084**	**112**	**1,196**	**396**

Note: The table includes operations from SCF, OMJ, and MIF. IIC is not included.

Box 1. Innovation in services in Latin America and the Caribbean.

In order to accelerate growth and catching-up with industrialized economies, increase productivity in services is a key challenge of the region (IDB, 2010b). Besides the negative effect of the sector by itself, the poor performance of these activities impacts economies in many ways. Low productivity in traditional services, as transportation or wholesale, affects the whole economy, since these services are links connecting the different stages of production. Furthermore, the lack or underperformance of Knowledge Intensive Business Services (KIBS) firms harms the innovation capabilities of the rest of the economy, since KIBS are often co-producers of innovations with firms from other sectors (Hertog, 2010).

There were very little evidence on this subject for LAC (Tacsir, 2011), but during 2012 CTI conducted a research project aimed to improve understanding of innovation and productivity in LAC services firms. This project covered traditional services and KIBS from 9 LAC countries, using different methodological approaches. A set of case studies analyzed the development of rural tourism and the software sector in Argentina; logistics, mining services, retail and off-shoring services in Chile; eco-tourism in Costa Rica; cultural services in Jamaica; and biotech services in a multi-country study. Impact evaluations were performed in order to estimate effect of public financial support programs in services firms, in Argentina, Chile, Colombia and Uruguay. Finally, quantitative studies, making use of national innovation surveys data, applied the model developed by Crepon et al. (1998), to analyze services in Brazil, Chile, Colombia, Mexico, Peru and Uruguay.

Main findings of this project can be summarized as follows[74]: a) Service sector is highly heterogeneous regarding innovation activities and performance. Only few LAC service firms are close to the technological frontier. However, higher productivity firms aren't growing. There are inefficiencies in the allocation of resources in this sector that are harming aggregate productivity levels (Arias-Ortiz et al., 2014); b) services firms are as innovative as manufacturing firms, but innovation strategies are different. Service firms rely less in R&D and more in other innovation activities (such as training, software, licenses, and know-how acquisition), compared to manufacturing firms; c) the size of the firm is less relevant to invest in innovation in services firms. This suggests that there are less fixed costs for involving in innovation related activities, but access to finance remains a key obstacle. Furthermore, innovation in services is more open. It is based on external inputs and demands higher levels of cooperation; d) technological innovation has a strong and positive impact on productivity in services firms, but also non-technological innovations could be very and perhaps even more relevant for improving performance; and e) services firms are less likely to receive public financial support for innovation, especially in the case of the traditional services. This is mainly due to the design of innovation programs is biased towards R&D and other technological investments that are less relevant for services firms.

These results should be taken into account when designing innovation programs, because the nature of services intensifies some of the markets failures that hinder innovation investments. Even when fixed costs are less relevant than in manufacturing, to ease access to finance for innovation is crucial. Innovation support programs, as currently designed, are biased towards manufacturing-type of innovation. To increase participation of service firms, programs should be flexible enough to include support for "softer" inputs for innovation. All in all, there is little doubt that countries can effectively increase productivity in services through encouraging innovation.

Finally, there is a need to improve measurement of innovation activities in services. Innovation surveys should extend coverage to all services activities, but also incorporate questions that allow capturing innovation investments that are related to non-technological innovations.

[74] More details can be found in Crespi et al. (2014).

Box 2. Natural Resources: A new path for knowledge-based development?

Globally, and in keeping with the new possibilities afforded by the deployment of ICT technologies, the traditionally vertically integrated global value chains in NRs sectors are being reconfigured as new production routines are established based on outsourcing and subcontracting. The demand pull together with changes in the production function have induced the rise of new sectors of knowledge intensive suppliers that serve special demands from large natural resources companies. In natural resource endowed developed countries such as Finland, Norway, Canada or Australia; these suppliers, some of them producing goods such as zero tillage machine in agriculture or services such as drone generated information for plague controls, are evolving to satisfy a growing demand for new technology and innovation in NR sectors (OECD, 2008). Indeed, these companies are “providers of solutions” for technological and organizational problems faced by NR intensive firms. For instance, the development of a new type of paper brings together a diverse range of new expertise in fiber, biotechnology, chemistry, engineering, business management, logistics and software development. For many NRs firms, these skills are beyond their internal capabilities and are provided by outside specialized providers linked to them. What the evidence from developed countries suggests is that the reliance on NRs can foster economic growth when underpinned by efforts to increase technological innovation and accumulation of capabilities to innovate around these resources. Knowledge intensive specialized supplier firms developed around these industries are central not only for innovation and technology diffusion across the natural resource base but also for diversification towards related higher value products and activities (Figueiredo, 2013). This new understanding matters for policy makers in LAC because the changes in world conditions provide resource rich countries with a new “window of opportunity” to use NR abundance both to fuel new knowledge intensive related sectors and to use them as source for productivity growth. There is some circumstantial evidence that the above mentioned trends are also showing-up in LAC. For example in the Chilean mining industry a new cluster of suppliers SMEs has revealed itself as highly dynamic. Indeed according to *Fundacion Chile* there are around 800 knowledge intensive suppliers in the sector and exports of mining engineering services have grown from US$10M in 2000 to US$400M in 2012 (OECD, 2013). Similar, although less spectacular trends, are observed in animal health services for aquiculture also in Chile, in the bio-informatics for ethanol in Brazil and non-traditional exports (mango) in Peru, traceability services for meat exporting in Paraguay and Uruguay, agronomy services for transgenic crops in Argentina, among many others. However, despite these encouraging developments preliminary analysis with focus in the mining and agricultural industry suggests that several market failures (in particular coordination, regulatory and externalities) hinder the development of linkages between natural resource based sectors and innovation intensive firms and so that the actual market outcome might be less than the optimum efficient one. This opens a new space for innovation policy intervention and in deed this is what natural resource rich countries did. In this context, it is worth takin a closer look at the experience of Norway.

Until the early 1970s, Norway had trailed its neighbors economically. By the turn of the millennium Norway enjoyed the largest GDP per capita in Scandinavia. In doing this, Norway has been able to draw the full benefits from its oil discovery in1969 without suffering significantly from the drawbacks, the so called Dutch disease, in contrast with most other resource rich countries (Stevens, 2003). Norway took early initiatives in order to immunize itself against the Dutch disease. In fact Norwegian policymakers contemplated the dangers of the disease long before it was theorized and named. They subsequently learned effectively how to fine tune the relevant set of policies. Investment in education and active promotion of innovation, including efforts to better embed the offshore oil and gas sector in the national innovation system, feature prominently among them.

A centralized wage formation system and a strong social consensus ensured that wage increases did not outpace the growth of productivity increases in the manufacturing sector. Fiscal discipline and the establishment of a Petroleum Fund abroad to be used domestically only as a counter-cyclical tool, shielded the economy from excessive demand and prevented unwarranted real appreciation of the domestic currency. Spillovers from the energy sector were maximized through the domestic accumulation of expertise in off shore oil extraction, including support to relevant R&D, instead of relying almost exclusively on foreign specialists. Broader education and innovation policy emphasized maintaining and expanding know-how in industrial and service activities with a view to build new knowledge-based comparative advantages. Several mining intensive countries such as Chile, Peru and Colombia have recently initiated actions along a similar path in the case of LAC.

Source: Guinet (2014)

Box 3. Social innovation in the IDB: The case of the Innovation Lab

In recent years, innovation and technology has experienced an unprecedented growth, touching people's lives more than ever before; however these advances have not been reflected in the same amount in the betterment in the lives of socially excluded groups. This is where social innovation and the work of the Innovation Lab (I-Lab) comes in, to find cost-effective, long-lasting solutions answers to social problems.

The I-Lab is an initiative of the Competitiveness and Innovation Division aimed at the development of social innovations inside the IDB. The I-Lab is a platform to share challenges and exchange ideas and solutions on various development issues in Latin America and the Caribbean. Through the Innovation Lab networks, problems of the region are converted into high impact innovations. Through new technologies, has contributed to the identification of the most important problems of people with disabilities as well as the most innovative solutions.

The I-Lab approach is based on three principles: (i) we cannot assume what the problems faced by the socially excluded groups are; (ii) the problems usually are complex and multifaceted so the development of the solution requires an interdisciplinary collaboration; and (iii) the use of technology offers a fresh approach to identify and resolve old problems.

Based on these principles in 2008 the first call of the I-Lab was launched. The objective of this call was the inclusion of people with disabilities. The call started with a Problem Contest. The contest was open for six weeks and the three most voted problems came in with a total of over 150,000 votes from all over the region. The website http://www.bidinnovacion.org/ received 1.6 million hits in three months, with 49 problems having been presented from 58 different countries. The leading problem received 61,160 votes.

The initiative continued with the Solutions Contest for the five problems that were voted the highest, where over 200 project proposals were submitted. The selection of the best projects was done by a high level panel of expert in different disciplines that analyzed the proposals. Finally funds were provided to innovators, businesses, and universities, several of them linked to top technology and research centers around the world, that would be able to develop solutions to the most voted challenges, as identified by the very own beneficiaries.

The opportunities to solve social problems through innovation are vast, for examples of the I-Lab projects refer to the publication IDB (2013) and the website http://www.bidinnovacion.org/.

Box 4. Getting prosperous through ideas: How to turn around economies by investing in innovation

Recent economic development history contains outstanding examples of success, understood as the case of countries that have achieved, in the timespan of one generation and starting from a low level of income, a profound structural change in their economies, turning them into high productivity engines that have become technological leaders worldwide and gained considerable resilience when faced with external shocks. This Box presents a synthetic account of three cases, Finland, Israel and South Korea. Reading them shows that the path to knowledge-based development is not one, lineal and easy to follow: each country found its own way as dictated by circumstances, opportunities and pre-existing endowments and constraints. Yet several common threads can be easily identified: long term commitment, flexible, smart and state of the art public policy, large investments in knowledge diffusion, transfer and creation, institution building and coordination and, last but not least, private sector-centered policies, can be found, in different flavors, in all cases.

Finland, a top performer in innovation, education, ICT industry and more

At the time of World War II, Finland was a raw material exporting country (50% of exports) and an agricultural society. In just one generation Finland achieved a massive structural change. By 2005, 50% of exports consisted of electronics and machinery. Besides the presence of a variety of favorable initial conditions, such as a strong cultural homogeneity, a tradition of high priority for education, good quality of infrastructure and a capacity to absorb external technology, a key factor explaining this productive transformation was the creation of a solid system that supports innovation and the way this system, and the related public policies, has been able to react in response to external economic crisis. It is instructive to review the evolution of Finland's innovation policy through its three principal stages.

Building up of the system: During the first two decades after World War II, in a context of a relatively closed and highly regulated economy, the focus was on a strong support for investment in advanced human capital, through the establishment of regional universities, polytechnics and expanding vocational education. In 1967 the Finnish Innovation Fund (SITRA) was created with the main purpose of promoting research and product development in firms, providing loans and grants, and focusing innovation policy in the support to traditional sectors (e.g. forestry and associated machinery).

Crisis disruption and Reaction I. The oil crisis of mid 70s put the Finnish economy under strong pressure and consequently brought high inflation and unemployment rates. The reaction of the country consisted in a mix of policies aimed to diversify the economy. One set consisted of a measure of deregulation and an increase competition in the economy, through gradually opening to foreign trade, lifting of price controls, deregulation of telecoms and financial liberalization. Secondly, and perhaps the most relevant, was the appointment of the "Technological Committee" in 1980. This committee (composed by unions, researchers, private and public sector representatives) agreed to strengthen innovation policies, setting a target for R&D spending of 1% of GDP, and focusing policy on the diffusion of three general purpose technologies technologies: microelectronics, biotechnology and new materials. Following this impulse, and based on SITRA's learning, the Finnish Funding Agency for Technology and Innovation (TEKES) was created. TEKES started operating with a programmatic focus on the target technologies and prioritized competitive grants that required collaboration between universities and industry. The coordination of the state agencies active in innovation policy was delegated to the newly created Finnish Science and Technology Council in 1987.

Crisis disruption and Reaction II. The URSS collapse in 1990, a significant market for Finland exports, generated a severe economic crisis. The negative impact was observed in a strong decline of GDP, and unemployment rates approaching 20%. Nevertheless, Finland quickly recovered from the crisis, based mostly on a rapid growth of exports. This exceptional recovery was primarily the consequence of the set of public policies started in the 80s, and the continuation of the process of deregulation, opening the economy, and prioritizing of innovation policies. The ICT sector, strongly supported the decade before, revealed itself highly competitive (mobile phones) and universities (with flexible programs) provided the skilled human capital that the sector required. The pool of skilled workers was enriched through tax incentives to firms to incorporate international experts, and scholarships to attract foreign students. Furthermore, the country radically increased the R&D budget (doubling TEKES budget between 1990 and 1995).

Today, Finland's innovation policy is increasingly focused on innovation policies supporting clusters and collaboration among firms and firms and research institutions. About 50% of TEKES R&D funding is distributed through technology programs carried out jointly by firms, research institutes and universities (OECD, 2005). This cooperation is a precondition for obtaining funding for a national technology program. Networking with smaller firms is a key criterion for TEKES R&D funding directed to large firms. As a consequence, SMEs receive over 50% of all R&D public funding for business enterprise sector (OECD, 2005). Thus, TEKES ends up supporting intense knowledge spillovers.

Source: OECD (2005).

Israel, the start-up nation

Being one of the most successful stories about transformation of an economy from low to high technology sectors, Israel is an example of how to develop a system supporting technological progress. By the mid-60s, Israel presented a significant technological and higher education infrastructure, as a result of a process that began in 1925 under British rule. The subsequent innovation policy process can be organized in three steps:

Background conditions phase (1969-1984): During this phase, on the one hand, the government boosted the supply of advanced human capital by the establishing three new universities and several applied research institutes. On the other hand, a new institutional setting for innovation policy was put in place in 1969 with the creation of the Office of the Chief Scientist at the Ministry of Industry and Trade. The office worked providing horizontal subsidies to R&D in the business sector, mostly to individual firms oriented to export markets. Furthermore, it provided incentives to R&D performed by multinationals (MNEs) in Israel, and targeted support to the defense industry.

Pre-emergence phase (1985-1992): This stage was mostly focused on improving framework conditions through increasing competition and stabilizing the macroeconomic environment. Public financing for innovation was expanded, this time by passing a law that increased subsidies to business R&D. At the same time, the defense industry faced a decrease of funding, which injected to the economy a pool of engineers and high technology skilled workers that, often, turned out to become entrepreneurs. Towards the end of this phase, the ICT industry was revealing itself as competitive. These efforts were complemented with horizontal programs (Magnet Program) aimed at supporting collaborative innovation and technological incubators.

Emergence phase (1993-2000): The results of the previous innovation efforts generated enough deal flow and a proper technical human capital base, but the system was still lacking adequate funding. About 60% of technically successful innovation projects failed because a lack of funding for further development and poor management skills. With the goal to address these issues, Israel implemented the YOZMA (Hebrew word for "initiative") Program: a Fund of Funds based on the limited partnership model that setup 10 privately owned funds with up to 40% of public funding and managed by VC companies with reputable expertise. The funds had upside incentives: a 5 year option to buy government shares at cost. This successful program led to full privatization of the initiative in 1998 and was key to the consolidation of innovation as a central element of Israel economic performance.

Source: Avnimelech and Teubal (2008).

Innovation Policy Building through Catch-up: The Case of South Korea

South Korea has been one of the most successful latecomer economies in achieving rapid economic growth and is approaching the ranks of advanced economies in terms of GDP per capita. One elements of Korea's success has been its emphasis on capability and technological development, which has led to the consolidation of private exporting and R&D capacity. During the catch-up process, Korea went through four different phases. In each phase, the government implemented innovation policies using a broad range of instruments.

Initial efforts (the 1960s to the mid-1970)

In 1960s, when Korea began its modernization process, the country faced two key barriers: low technological capabilities of domestic firms and poor human capital (in particular, in applied sciences and engineering). In this context, the government focused on encouraging technology imports with licensing, developing a new graduate school of engineering and applied sciences (the Korean Institute of Science and Technology, KIST), and setting up key institutions for science and technology infrastructure. These actions facilitated the absorption of imported technologies and contributed to attract technology-based FDI. In this stage, domestic firms were involved only in assembling and packaging processes, with very limited investment in innovation. For the Korean firms, this was a learning-by-doing period without an explicit attempt to develop new capabilities or technologies. During this period R&D investment was never higher than 0.5% of the GDP.

More active catch-up phase (mid-1970s to the mid-1980s)

In this second phase, Korean firms became more active in the adoption of foreign technologies through imitative innovation and reverse engineering. They invested more intensively in the adaptation of foreign technology and in the development of local technological capabilities, mainly through technological licensing and knowledge transfer. The government focused on technological development by funding private R&D through tax incentives, and by conducting R&D activities directly and sharing the results with private firms. In the 1980s, a public-private joint R&D program was set up to support higher-risk projects. Consequently, the R&D/GNP ratio increased from 0.42% in 1975 to 1.41% in 1985. During this stage, government investment in R&D was still greater than private sector investment.

Rapid catch-up (the mid-1980s to the mid-1990s)

This third phase was a period of rapid catch-up led by the major Korean businesses. Firms increased production of knowledge-intensive products and started to develop new products. Realizing the limits of a strategy based on licensing and embodied technology transfer, Korean firms started to establish their own in-house R&D centers. To encourage this trend, the government eased the accreditation process needed for setting private R&D institutes, and a large number of institutes were set up. The R&D/GNP ratio increased from 1.41% in 1985 to 2.32% in 1994. Such active engagement of private R&D activities enabled Korea to absorb the newly emerging technologies. From this period onward, private R&D investment has been a key part of the Korean innovation and technology development process, accounting for more than 70% of total R&D investment.

Maturing of the catch-up phase (the mid-1990s to the present)

As South Korea approaches the technological frontier, the country is entering a new and critical phase in its development. With growth of labor and capital inputs slowing and increasing competition from new industrializing countries, South Korea faces new challenges. The catch-up model is now under stress, and South Korea is shifting from a “catch-up” to a “creative” innovation system. The creative model requires increased spending on R&D – by both public and private sectors – and improved knowledge flows and technology transfer across the system. This needs stronger support to innovative SMEs and Start-Ups; increasing the role of longer-term, fundamental research; developing research capacity in the universities; and dealing with lagging productivity in services. This transition towards a creative economy can already be seen in some innovation indicators. Patents owned by Koreans increased from 7 in 1982 to 3,558 in 1999 according to a U.S. register. In 2006, the R&D/GNP ratio passed the 3% threshold.

Source: Lee (2013) and OECD (2009b)

References

Ács, Z. J and D. Audretsch. 1989. "Small-Firm Entry in U.S. Manufacturing," Economica, London School of Economics and Political Science, vol. 56 (222), pages 255-65.

Ács, Z., P. Stenholm & R. Wuebker. 2012. "Exploring Country-level Institutional Arrangements on the Rate and Type of Entrepreneurial Activity" Mimeo.

Aghion, P., P. David, and D. Foray. 2009. "Science, Technology and Innovation for Economic Growth: Linking Policy Research and Practice in STIG Systems." *Research Policy* 681-693.

Aghion, P. and P. Howitt. 1992. "A Model of Growth through Creative Destruction." *Econometrica* 60(2): 323-351.

Alves de Mendonça, M. A., F. Freitas, and J. M. de Souza. 2008. "Information Technology and Productivity: Evidence for Brazilian Industry from Firm-level Data." *Information Technology for Development* 14(2): 136–153.

Aninat, C., J. M. Benavente, I. Briones, N. Eyzaguirre, P. Navia, and J. Olivari. 2010. The Political Economy of Productivity: The Case of Chile. IDB Working Paper No. 105. Inter-American Development Bank, Washington, DC.

Arrow, K. 1962. "Economic Welfare and the Allocation of Resources for Invention." in R. Nelson, editor. *The Rate and Direction of Inventive Activity.* Princeton, NJ, United States: Princeton University Press.

Arza, V. 2010. "*Vinculaciones entre organismos públicos de investigación y empresas en Lationamérica*". Argentina. Mimeo.

Arias-Ortiz, E., G. Crespi, A. Rasteletti and F. Vargas. 2014. "Productivity in Services in Latin America and the Caribbean". IDB Discussion Paper No. IDB-DP-346, Washington, DC: Inter-American Development Bank.

Audretsch, David B and M. Keilbach. 2003. "Entrepreneurship Capital and Economic Performance," CEPR Discussion Papers 3678, C.E.P.R. Discussion Papers.

Avalos, I. 2002. *El Programa de Agendas de Investigación como intento de asociar a los tres sectores: Experiencias en Venezuela.* Washington, DC: Inter-American Development Bank. Unpublished.

Avnimelech, G. and Teubal, M. 2008. "The Emergence of Israel´s Venture Capital Industry: How Policy can Influence Cluster Dynamics" in P. Braunerhjelm and Maryanne Feldman, *Cluster Genesis: Tecnology-Based Industrial Development*, Oxford University Press, Oxford.

Benavente, J.M., De Gregorio, J. and M. Nuñez. 2005. “Rates of Return for Industrial R&D in Chile”, Working Paper, Economic Department, Universidad de Chile.

Benavente J. M., G. Crespi and A. Maffioli. 2007. “Public Support to Firm Innovation: The Chilean FONTEC Experience.” Office of Evaluation and Oversight (OVE) Working Paper No. 0407. Washington, D.C.: IDB

Benavente, J. and C. Bravo. 2009. “Innovation, R&D Investment and Productivity in Latin American and Caribbean Firms: The Chilean Case.” Washington, DC, United States: Latin American and Caribbean Research Network, Inter-American Development Bank.

Bresnahan T. F. and M. Trajtenberg. 1995. “General Purpose Technologies: Engines of Growth?”. NBER Working Papers 4148. National Bureau of Economic Research.

Castillo, V., A. Maffioli, S. Rojo, and R. Stucchi. 2014. Knowledge Spillovers of Innovation Policy through Labor Mobility: An Impact Evaluation of the FONTAR Program in Argentina. IDB Working Paper No. 488. Inter-American Development Bank, Washington, DC.

Chen, D. and C. Dahlman. 2005. *The Knowledge Economy, the KAM Methodology and World Bank Operations.* Manuscript. The World Bank Institute. Washington, DC: The World Bank.

Chudnovsky D., A. López, M. Rossi and D. Ubfal. 2006. “Evaluating a Program of Public Funding of Private Innovation Activities. An Econometric Study of FONTAR in Argentina.” OVE Working Paper No. 1606. Washington, D.C.: IDB.

Cimoli, M., et al. 2006. “Growth, Structural Change and Technological Capabilities Latin American in a Comparative Perspective.” *Laboratory of Economics and Management,* Working Paper Series.

Cimoli, M. (comp.) 2010. *Vínculos entre universidades y empresas para el desarrollo tecnológico.* CEPAL.Secretaría General Iberoamericana. Santiago de Chile.

Cohen, W. and D. Levinthal. 1989. “Innovation and Learning: The Two Faces of R&D.” *The Economic Journal* 99(397): 569-596.

Cornell University, INSEAD, and WIPO. 2014. The Global Innovation Index 2014: The Human Factor In innovation, Fontainebleau, Ithaca, and Geneva.

Crépon, B., E. Duguet, and J. Mairesse. 1998. “Research, Innovation, and Productivity: An Econometric Analysis at the Firm Level.” NBER Working Paper 1-43. Cambridge, MA: National Bureau of Economic Research.

Crespi, G. 2012. “Fiscal Incentives for Business Innovation”. In A. Corbacho, coord., *The Fiscal Institutions of Tomorrow*. Institutions for People series. Washington, DC: Inter-American Development Bank.

Crespi, G., Maffioli, A. and M. Meléndez. 2011. “Public Support to Innovation: The Colombian COLCIENCIAS' Experience”. IDB Publications 38498. Inter-American Development Bank.

Crespi, G., A. Maffioli, P. Mohnen, & G. Vazquez. 2011. Evaluating the Impact of Science, Technology and Innovation Programs: A Methodological Toolkit. Impact-Evaluation Guidelines Technical Note: IDB-TN-333. Inter-American Development Bank. Washington, DC.

Crespi, G. and P. Zuñiga. 2010. “Innovation and Productivity: Evidence from Six Latin American Countries”. IDB Working Paper Series No. IDB-WP-218. Washington, DC: Inter-American Development Bank.

Crespi, G., E. Tacsir and F. Vargas. 2014. “Innovation and Productivity in Services: Empirical Evidence from Latin America”. IDB Technical Note No. IDB-TN-690, Washington, DC: Inter-American Development Bank.

Daude, C. and E. Fernandez Arias (2010). “Aggregate Productivity: The Key for Latin American Development”. Chapter 2 in C. Pagés (Ed.) *The Age of Productivity*. Washington DC. IDB.

De Negri J. A., M. Borges Lemos and F. De Negri 2006a. “Impact of R&D Incentive Program on the Performance and Technological Efforts of Brazilian Industrial Firms.” OVE Working Paper No. 1406. Washington, D.C.: IDB.

De Negri J. A., M. Borges Lemos and F. De Negri. 2006b. “The Impact of University Enterprise Incentive Program on the Performance and Technological Efforts of Brazilian Industrial Firms.” OVE Working Paper No. 1306. Washington, D.C.: IDB.

Disney, R., Haskel, J. and Y. Heden. 2003."Restructuring and productivity growth in uk manufacturing,"Economic Journal, Royal Economic Society, vol. 113(489), pages 666-694, 07.

Docquier, F. and M. Schiff. 2008. “Measuring Skilled Emigration Rates: The case of small states”. IZA Discussion Paper 3386. Bonn.

Fabegerberg J and B. Verspagen. 2002. “Technology Gaps, Innovation Diffusion and Transformation: An Evolutionary Approach”. Research Policy. 31: 1291-1304.

Figueiredo, P. N. 2013. "Beyond technological catch-up: An empirical investigation of further innovative capability accumulation outcomes in latecomer firms with evidence from Brazil (No. 048)". United Nations University, Maastricht Economic and social Research and training centre on Innovation and Technology.

Foray, D. 2007. "Enriching the Indicator Base for the Economics of Knowledge." *Science, Technology and Innovation Indicators in a Changing World, Responding to Policy Needs.* Paris, France: OECD.

Freeman, C. 1987. *Technology Policy and Economic Performance: Lessons from Japan*. London, England: Pinter.

Greenwald, B. and J. Stiglitz. 1989. "Financial Market Imperfections and Productivity Growth," Working Paper Series 206, Research Institute of Industrial Economics.

Griffith, R., S. Redding, and J. Van Reenen. 2004. "Mapping the Two Faces of R&D: Productivity Growth in a Panel of OECD Industries." *Review of Economics and Statistics* 883-895.

Griliches, Z. 1979. "Issues in Assessing the Contribution of Reserach and Development to Productivity Growth". Bell Journal of Economics. 92-116.

Goñi, E. and W. F. Maloney. 2014. "Why don`t Poor countries do R&D?". Policy Research Working Paper 6811. Washington DC. The World Bank.

Guinet, J. 2014. "Assessment of the National Innovation Ecosystem of Trinidad and Tobago." Final Report. Washington, DC: IDB

Hall, B. H. and J. Lerner. 2010. "The Financing of R&D and Innovation,"MERIT Working Papers 012, United Nations University - Maastricht Economic and Social Research Institute on Innovation and Technology (MERIT).

Hall, B. and A. Maffioli. 2007. "IDB's Science and Technology Programs: An Evaluation of the Technology Development Funds (TDF) and Competitive Research Grants (CRG)." OVE Evaluation Report. Inter-American Development Bank Washington, D.C.: IDB.

Hall, B. and A. Maffioli. 2008. "Evaluating the Impact of Technology Development Funds in Emerging Economies: Evidence from Latin America". NBER Working Papers 13835. National Bureau of Economic Research.

Hall, B., J. Mairesse, and P. Mohnen. 2009. "Measuring the Returns to R&D." *NEBR Working Paper No. W15622*. Cambridge, MA, United States: National Bureau of Economic Research.

Hall, R. and C. Jones. 1999. "Why do some countries produce so much more output per worker than others?". The Quarterly Journal of Economics. 83-116.

Haltiwanger, J., R.S. Jarmin, and J. Miranda, 2010. "Who Creates Jobs? Small vs. Large vs. Young," NBER Working Paper 16300.

Hallward-Driemeier, M. and L. Pritchett. 2011. "How business is done and the 'doing business' indicators : the investment climate when firms have climate control," Policy Research Working Paper Series 5563, The World Bank.

Hausmann, R., D. Rodrik, and C. F. Sabel. 2008. Reconfiguring Industrial Policy: A Framework with an Application to South Africa. CID Working Paper No. 168. Center for International Development, Harvard University, Cambridge, MA.

Hausmann, R., C. A. Hidalgo, J. Jiménez, R. Lawrence, E. Levy Yeyati, C. Sabel, and D. Schydlowsky. 2011. *Construyendo un mejor futuro para la República Dominicana: herramientas para el desarrollo*. Technical report. Center for International Development, Harvard University, Cambridge, MA.

Hertog, P. den. 2010. "Managing Service Innovation: Firm-level Dynamic Capabilities and Policy Options." Utrecht, The Netherlands: Dialogic Innovatie and Interactie.

Holtz-Eakin, D. and C. Kao. 2003. "Entrepreneurship and Growth: The Proof is in the Productivity," *Center for Policy Research.* Paper 111.

IPEA (Instituto de Pesquisa Economica Aplicada). 2012. Almeida, M. and B.R. Schneider. Globalization, Democratization, and the Challenges of Industrial Policy in Brazil.

Inter-American Development Bank. 2010a. *Science, Technology, and Innovation in Latin America and the Caribbean: A Statistical Compendium of Indicators*. Washington, DC: Inter-American Development Bank.

Inter-American Development Bank. 2010b. Pagés, C., ed. "The Age of Productivity: Transforming Economies From the Bottom Up." *Development in the Americas*. Washington, DC: Inter-American Development Bank-Palgrave-McMillan.

Inter-American Development Bank. Chong, A., editor. 2011. *Development in the Americas: Development Connections: Unveiling the Impact of New Information Technologies*. Washington, DC: Inter-American Development Bank-Palgrave-Macmillan.

Inter-American Development Bank. 2013. "Social Innovation: The Experience of the IDB's Innovation Lab". Washington, DC: BID.

Inter-American Development Bank. Crespi, G., Fernández-Arias, E. and E. Stein, editors. 2014. *Development in the Americas: Rethinking Productive Development: Sound Policies and Institutions for Economic Transformation.* Washington, DC: Inter-American Development Bank-Palgrave-Macmillan. (Forthcoming)

ITAM (Instituto Tecnológico Autónomo de México). 2012. *Evaluacion de Impacto del Programa para el Desarrollo de la Industria del Software* (PROSOFT). Available at:http://www.prosoft.economia.gob.mx/Imagenes/ImagenesMaster/Estudios%20 Prosoft/GREF_16.pdf.

Johnson, C. 1982. *MITI and the Japanese Miracle.* Stanford, CA, United States: Stanford University Press.

Kane, T. J. 2010. "The Importance of Startups in Job Creation and Job Destruction". Available at SSRN: http://ssrn.com/abstract=1646934.

Katz, J.M. (2001). *Structural Reforms, Productivity and Technological Change in Latin America*. CEPAL-ECLAC. Santiago de Chile.

Kim, L. 1997. *Imitation to Innovations: the Dynamics of Korea's Technological Learning.* Boston, MA, United States: Harvard Business School Press.

Kim, L. 1998. "Crisis Construction and Organizational Learning: Dynamics of Capability Building in Catching-up at Hyundai Motors." *Organization Science*, 506-521.

Kim, L. and R. Nelson. 2000. *"Technology, Learning, and Innovation: Experience of Newly Industrializing Economies.* Cambridge, England: Cambridge University Press.

Kline, S. J., and N. Rosenberg. 1986."An overview of innovation." The positive sum strategy: Harnessing technology for economic growth 275 (1986): 305.

Lach, S., A. Bartel, and N. Sicherman. 2005. "Outsourcing and Technological Change." *NBER Working Paper 11158*. Cambridge, MA, United States: National Bureau of Economic Research.

Lederman, D. and W. Maloney. 2003. "R&D and Development." *World Bank Policy Research Working Paper No. 3024*. Available at: SSRN: http://ssrn.com/abstract=402480.

Lee, K. 2013. "How Can Korea Be a Role Model for Catch-Up Development? A Capability-Based View." En: A. K. Fosu (ed.), *Achieving Development Success: Strategies and Lessons from the Developing World*. Oxford, Reino Unido: Oxford University Press.

Lengyel, M. 2009. *La co-producción de la innovación y su diseño institucional: Evidencia de la Industria Argentina.* Latin American and Caribbean Research Network. Washington, DC: Inter-American Development Bank. Unpublished.

Lerner, J. 2009. Boulevard of Broken Dreams. Princeton, New Jersey: Princeton University Press.

Lerner, J., A. Leamon, and S. García-Robles. 2013. "Best Practices in Creating a Venture Capital Ecosystem," Multilateral Investment Fund (MIF/FOMIN), Washington, D.C.

López, A. 2009. "Las evaluaciones de programas públicos de apoyo al fomento y desarrollo de la tecnología y la innovación en el sector productivo en América Latina: Una revisión crítica," Innovation Note. Washington, DC: Inter-American Development Bank.

López, A., A. M. Reynoso and M. Rossi. 2010. "Impact Evaluation of a Program of Public Funding of Private Innovation Activities: An Econometric Study of FONTAR in Argentina." OVE Working Paper. Washington, D.C.: IDB.

Lundvall, B. 1992. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning.* London, England: Pinter.

Maloney, W. and A. Rodríguez-Clare. 2007. "Innovation Shortfalls." *Review of Development Economics* 11(4): 665–84.

McKinsey Global Institute. 2014. Global Flows in a Digital Age. Accessible at: http://www.mckinsey.com/insights/globalization/global_flows_in_a_digital_age. McKinsey & Company 2014.

Metcalfe, S. 1995. The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives. in Stoneman, P., ed. *Handbook of the Economics of Innovation and Technological Change.* Oxford, England: Blackwell.

Navarro, J.C., J.J. Llisterri and P. Zuñiga. 2010. "The Importance of Ideas: Innovation and Productivity in Latin America". Chapter 10 in C. Pagés (Ed.) *The Age of Productivity.* Washington DC. IDB.

Navarro, J.C and A. Artopoulos (forthcoming, 2014). ¨*La política de la política pública en ciencia, tecnología e innovación en América Latina: modelo conceptual y casos estilizados*¨. Washington, DC. IDB..

Navarro, J.C. and F. Vargas (forthcoming, 2014). ¨*La colaboración Industria-Universidad en Latinoamérica: sus efectos sobre la innovación y la productividad*¨. Washington, DC. IDB.

Navarro, L. 2014. Entrepreneurship Policy and Firm Performance: Chile's CORFO Seed Capital Program. Policy Brief. Inter-American Development Bank: Washington DC.

Nelson, R. 1959. "The Simple Economics of Basic Scientific Research". Journal of Political Economy. 67: 297-306.

Nelson, R. and H. Pack. 1999. "The Asian Miracle and Modern Growth Theory." *The Economic Journal* 109(457): 416-436.

Observario Colombiano de Ciencia y Tecnología, Universidad Nacional de Colombia y Universidad del Rosario (2013). ¨*Colciencias cuarenta años: Entre la legitimidad, la normatividad y la práctica*¨. Bogotá.

OECD and Eurostat. 2005. Oslo Manual. *The Measurement of Scientific and Technological Activities. Guidelines for Collecting and Interpreting Innovation Data,* 3rd edition. Paris: OECD/Eurostat.

OECD. 2005. *Innovation Policy and Performance: A Cross-Country Comparison*. OECD, Paris.

OECD. 2007. *OECD Reviews of Innovation Policy.* Chile. Paris.

OECD. 2009a. OECD Reviews of Innovation Policy: Korea. OECD, Paris.

OECD. 2009b. *OECD Reviews of Innovation Policy.* Mexico. Paris.

OECD. 2011. *OECD Reviews of Innovation Policy.* Peru. Paris.

OECD. 2013. OECD Territorial Reviews OECD Territorial Reviews: Antofagasta, Chile 2013, OECD Publishing, http://dx.doi.org/10.1787/9789264203914-en

OECD. 2014. *OECD Reviews of Innovation Policy.* Colombia. Paris.

OECD MSTI (Organization for Economic Cooperation and Development. *Main Science and Technology Indicators)*. 2014. Database online. Paris, France: OECD.

Office of Evaluation and Oversight. 2013. Background Paper: Project Level Review 2005-2011. Second Independent Evaluation of the MIF.

Office of Evaluation and Oversight. 2012. Corporate Evaluation: Opportunities for the Majority, June 2012.

Parra Torrado, M. 2011. *Exenciones fiscales para la I+D+i: experiencias en América Latina y retos pendientes*. IDB Discussion Paper No. 247. Inter-American Development Bank, Washington, DC.

Perez, C. 2008. *A Vision for Latin America: A Resource-based Strategy for Technological Dynamism and Social Inclusion*. Presented to the ECLAC Program on Technology Policy and Development in Latin America.

Rabellotti, R. 2014 (forthcoming). “Clusters in the Caribbean: Understanding their Characteristics, Defining Policies for their Development”. Pavia. Compete Caribbean.

RICYT (*Red de Indicadores de Ciencia y Tecnología*). 2014. *Base de datos de indicadores, 2014*. Available at: http://www.ricyt.edu.ar

Rivas, Gonzalo. 2010. How and When to Intervene? Criteria to Guide Interventions to Support Productive Development. Washington DC. Technical Notes. IDB.

Rivas, Gonzalo and Sebastián Rovira (Ed.). 2014. *Nuevas Instituciones para la Innovación: Prácticas y Experiencias en América Latina*. Santiago de Chile. CEPAL.

Rivas, Gerardo. 2010. “*Evaluación Intermedia del Programa de Ciencia y Tecnología del Perú*”. Lima. Mimeo.

Romer, P. 1990. “Endogenous Technological Change.” *Journal of Political Economy 98(1990):* S71-S102.

Rostow, W. 1960. *The Stages of Economic Growth.* Cambridge, England: Cambridge University Press.

Rouvinen, P. 2002. “Characteristics of product and process innovators some evidence forms the Finnish innovation survey”. *Applied Economics Letters*. 575-580.

Rovira, S, I. Egler and W. Peres (comp.). 2012. ¨La *integración productiva latinoamericana mediante proyectos regionales en ciencia, tecnología e innovación*. Section 3 page 27, paragraph (3.17)

Sagasti, F. 2011. *Ciencia, tecnología, innovación: políticas para América Latina*. Lima: Fondo de Cultura Económica.

SCImago. (2007). SJR — SCImago Journal & Country Rank. Retrieved August 07, 2014, from http://www.scimagojr.com.

Soete, L; B. Verspagen and Ter Weel B. 2010. “Systems of Innovation”. In: B. H. Hall, and N. Rosenberg, editors. The Economics of Innovation. Amsterdam: North Holland.

Steinmueller, E. 2010. “Economics of Technology Policy”. In: B. H. Hall, and N. Rosenberg, editors. The Economics of Innovation. Amsterdam: North Holland.

Stevens, P. 2003. “Resource Impact: Curse or Blessing? A Literature Survey” Journal of Energy Literature, 9 (1), pp. 3-42.

Stiglitz, J. and Weiss, A. (1981). “Credit Rationing in Markets with Imperfect Information”. American Economic Review. 71(3): 393-410.

Tacsir, E. 2011. “Innovation in Services: The Hard Case for Latin America and the Caribbean.” IDB Discussion Paper No. IDB-DP-203. Washington, DC: Inter-American Development Bank

UNCTAD (2011) *Science, Technology and Innovation Policy Review*. El Salvador. Swizerland.

UNCTAD (2011) *Science, Technology and Innovation Policy Review*. Peru. Swizerland.

UNCTAD (2012) *Science, Technology and Innovation Policy Review*. Dominican Republic. Swizerland.

UNESCO (United Nations Educational, Scientific and Cultural Organization) Institute for Statistics. Available at: http://data.uis.unesco.org/

Ventura, J. P. 2010. "*Análisis de Capacidades Institucionales de Organismos de Ciencia y Tecnología en América Latina y el Caribe.” Reporte de Consultoria*, comissioned by the Inter-American Development Bank.

WIPO (World Intellectual Property Rights Organization). Available at: http://www.wipo.int/patentscope/en/