Policies to attract R&D-related FDI in small emerging countries: Aligning incentives with local linkages and absorptive capacities in Chile

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Abstract
Over the last decade we have witnessed an unprecedented growth in the number of cross-border R&D investments towards large emerging countries such as China and India. However, small middle-income countries have played a marginal role as recipients of R&D-related FDI despite increasing policy efforts. In particular, several Latin American countries have recently launched new policy programs with the aim of attracting this kind of investments, but it remains uncertain whether public incentives can be useful to compensate for other locational disadvantages. The case of Chile provides an interesting empirical setting to explore these issues because during the last decade its government has been increasingly promoting R&D-related FDI through new policy instruments. This article suggests that for national innovation systems to benefit from the attraction of internationally-mobile R&D it is critical for public policies to ensure that appropriate linkages are established with local actors that hold absorptive capacities. Equally important for a small emerging economy like Chile is to prioritize R&D-related FDI in strategic technology niches where the country can realistically attain critical mass.
Keywords: absorptive capacity, linkages, global innovation networks, FDI, R&D, Chile, Latin America

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1. Introduction

Since the early 2000s an increasing number of multinational corporations (MNC) have located their research and development (R&D) centers in emerging countries (Gammeltoft, 2006). China and India have now become the top destinations of R&D-related foreign direct investments (FDI) worldwide (Castelli and Castellani, 2013). This has raised the attention of researchers and policy-makers on the impact of R&D-related FDI in emerging economies and the possibilities of emulating the Chinese and Indian "miracles" in other middle income countries. Behind this aim lies the believe that R&D-related FDI might have very positive effects on host countries in terms of technology transfer and the development of technological capabilities in local firms that interact with foreign MNCs (Santangelo, 2005). Under certain conditions, these investments can enable upgrading and catching up in particular industries or technology fields, as the examples of China in telecommunications (Fu et al., 2011) or India in software (Parthasarathy and Aoyama, 2006) illustrate.

During the last decade, researchers in international business, innovation studies and economic geography have provided rich evidence on the motivations, modes of entry and impacts of R&D-related investments by developed country MNCs in emerging economies, typically with an emphasis on the MNC rather than the host country. However, this literature has been limited on two accounts. First, on investigating systematically the role of public policies in the host countries for both attracting and embedding international R&D investments. And, second, on discussing the particular case of small emerging economies that cannot compete in terms of market size or broad technological base with much larger emerging economies such as China, India or Brazil.

Against this background, the general objective of this paper is to explore the policy options available for small emerging countries to attract R&D-related FDI, building on a case study of Chile. The liberal policies that Latin America pursued in the 1980s and 1990s under the Washington Consensus were not successful at using FDI as a lever for learning and capabilities accumulation (Cimoli et al., 2009). With time, it became clear that the aim of public intervention should not be limited to maximizing FDI inflows, but also to attracting the kind of FDI that better contributes to diversifying the economy, gaining access to foreign knowledge, and providing highly-skilled jobs. Consequently, since the mid-1990s, a shift from quantity to quality emerged in the FDI policies of several Latin American countries, including Chile, and attracting R&D-related FDI became a more explicit policy priority (Lederman et al., 2014; Monge-González and Tacsir, 2014; Nelson, 2005).

Beyond improving the conditions of the national innovation system, public policies can adopt a more proactive approach to attracting R&D-related FDI by offering incentives and support services to MNCs. But what kind of policy instruments might be more appropriate for small emerging countries? Under which conditions are public incentives aimed specifically at attracting R&D-related FDI efficient? This paper contributes to addressing these questions by analyzing the particular case of Chile.

Chile represents an interesting empirical setting for the purposes of our research since during the last decade its government has launched a new package of incentives to attract R&D-related FDI, in addition to broader measures to enhance the national innovation system. In particular, the Chilean government has launched some pioneering policy instruments in international context, such as a program to attract foreign universities and public research institutes or a program to attract foreign start-ups. Thus, the country's recent experience is highly relevant to foster policy learning in other emerging countries from Latin America and beyond.

Our research relied on interviews with key informants and on a variety of secondary sources. Section 2 first contextualizes the paper within the existing literature and then provides an overview of the Chilean innovation system and the role of FDI. Section 3 describes the methodology and Section 4 presents the results of a case study that explores the policy mix used by the government of Chile to attract R&D-related FDI. Section 5 rounds up the paper with some concluding remarks.

2. Analytical framework

2.1. Global innovation networks, linkages and absorptive capacities

Through R&D internationalization, MNCs aim at tapping into resources from multiple local contexts in order to leverage them into competitive advantages (Andersson et al., 2016; Cantwell, 2016; Dachs, 2014; Meyer et al., 2011). The internationalization of corporate R&D is driven by the increasing potential for disintegrating the R&D function into different technologically separable R&D services (Martínez-Noya et al., 2012) or, in other words, to the *fine-slicing* (Mudambi, 2008) or *organizational decomposition* (Schmitz and Strambach, 2009) of innovation activities. Among the factors influencing the location choice of MNCs' R&D centers there are traditional drivers such as market size, income level and costs, as well as knowledge related considerations like the availability of qualified scientists, the presence of innovative firms, or the possibility to tap into globally dispersed knowledge reservoirs (Kafouros et al., 2012; Lewin et al., 2009; OECD, 2011; Thursby and Thursby, 2006).

The internationalization of R&D has opened up new opportunities for emerging countries to participate in *global innovation networks* and build knowledge-intensive clusters through the attraction of FDI (Chaminade and Vang, 2008; Ernst, 2002; Manning et al., 2010; Necoechea-Mondragón et al., 2016). A recent analysis of *international knowledge connectivity* (Cano-Kollmann et al., 2016a) relies on a "flowers and bees" metaphor to illustrate how border-crossing firms (bees) and spatial locations (flowers) co-evolve in an organic symbiosis. Bees need flowers to survive (to remain competitive) while flowers need bees to be pollinated (to become more innovative). From the perspective of host countries, R&D-related FDI can facilitate the absorption of foreign knowledge and strengthen national technological capabilities; increase demand sources for both domestic R&D suppliers and local talent; and ultimately improve the position of a country in global innovation networks (Carlsson, 2006; Santangelo, 2005). Moreover, FDI in R&D can contribute to addressing existing inefficiencies of a host country's national innovation system, for example by fostering science-industry links or by accelerating the development of critical mass in designated priority areas.

Integrating into global innovation networks is especially important for emerging countries as a means of closing technology gaps and accelerating catching-up (Ernst, 2002; Fu et al., 2011; Narula and Dunning, 2010). But attracting R&D-related FDI requires a simultaneous effort to improve local supplier networks, universities, scientific infrastructures, institutions and human capital, in a process of coupling international and local innovation networks. Along these lines, it has been stressed that the benefits of R&D-related FDI on host countries increase when MNCs collaborate in innovation with local firms, universities and research institutes, leading to knowledge-intensive *linkages* (Guimón and Salazar-Elena, 2015; Markusen and Venables, 1999; Meyer et al., 2011; Nell and Andersson, 2012).

It is well known in the economic literature that the local development effects arising from any kind of new flows of investment depend of the possible linkages with local agents through input-provision (backward linkage effects) or output-utilization (forward linkage effects) (Hirschman, 1977). The specific path of creation of such linkages depends on firms' decisions concerning the sourcing of components and materials for their operations. In the case of backward linkages, this path might be seen as a sequence of decisions involving, first, whether to procure components in-house or outside the firm (i.e. internalize or contract) (Belderbos et al., 2001). If the firm decides to contract, it must then decide whether to procure the components locally or abroad. This set of decisions can be interpreted as a transaction cost economizing process (Coase, 1937; Williamson, 1981). The case of forward linkage effects is different since it requires the presence of local investors capable of generating new production lines using the new inputs available. In many cases, the forces set in motion by new flows of investment are strong enough to create local linkages through private profit-seeking efforts. However, in the absence of such private incentives, policies attempting to develop multiplying effects on local production from new flows of investment may play an important role in reducing transaction costs and improving the local institutions and organizations that facilitate such linkages (McGilvray, 1977; Acemoglu and Guerrieri, 2008).

The international business literature has often combined the notions of linkages and *spillovers* to analyze the developmental impact of FDI inflows. Spillovers take place when FDI increases the productivity of domestic firms in the host country both through linkages and other indirect means (Kokko et al., 1996; Rodriguez-Clare, 1996; UNCTAD, 2001). It has been found that spillover effects may take many different forms: formal and informal, technological and organizational, tacit and codified, intentional and non-intentional, demonstration and competition effects, human capital effects, etc. (Blomström, 1989; Görg and Strobl, 2001). It has also been argued that vertical spillovers -from foreign to domestic firms in upstream or downstream industries- tend to be stronger than horizontal spillovers -from foreign to domestic firms operating in the same industry- (Javorcik, 2004; Marcin, 2008). Along these lines, some authors have argued that public policies should prioritize FDI projects that better "fit" with the location's resource endowments and future potential, as this will tend to generate greater local value added (McCann and Mudambi, 2004). The existing literature has consistently stressed that the potential for local spillovers depends crucially on the heterogeneity of FDI projects (Blomström and Kokko, 1998; Chung, 2001; Marin and Bell, 2010). In this context, the scope of linkages and the associated knowledge spillovers can be expected to be larger in the case of foreign investments that engage in R&D projects in collaboration with local actors (Du and Williams, 2016; Owen-Smith and Powell, 2004).

But building knowledge-intensive linkages between foreign investors and local actors is a challenging endeavor for emerging countries that lack high-quality human capital, research infrastructures, and clusters of innovative firms (Behera, 2014; Cassiolato et al., 2014; Nadvi and Halder, 2005; Narula and Guimón, 2012; Paus and Gallagher, 2008). Indeed, in order to attract R&D-related FDI and benefit from its potential benefits, host countries need to develop a threshold level of *absorptive capacity* (Criscoulo and Narula, 2008; Filippetti et al., 2016; Hatani, 2009). Absorptive capacity has been defined as the ability to acquire, assimilate, and exploit knowledge developed outside the firm/country (Cohen and Levinthal, 1990) and is usually proxied in empirical studies by indicators of R&D expenditure, human capital and propensity to collaborate in innovation (Lane et al., 2006).

Kokko et al. (2001) established a connection between public policies and the magnitude of spillover effects from inward FDI. Public policies can attempt to facilitate linkages directly and are also critical for providing support to local universities and firms in the costly process of developing absorptive capacities. We tap into this strand of the literature by considering how governments can provide incentives to promote the kind of linkages between R&D-related FDI and local actors conductive to capabilities accumulation and technological upgrading in host economies.

In general terms, developing countries tend to face more difficulties in attracting R&D-related FDI than developed countries and see a higher need of government intervention. There are many different policy instruments that can be used to attract R&D-related FDI, and several authors have emphasized that strong policy coordination is required between FDI policies and science, technology and innovation policies (Cassiolato et al., 2014; Guimón, 2009; Mudambi and Mudambi, 2005; Mytelka and Barclay, 2006). Besides attracting new flows of R&D-related FDI, policy interventions should also aim at *embedding* the existing R&D activity of MNC subsidiaries in the national innovation system (Heidenreich, 2012). In the absence of embeddedness, the R&D centers of foreign capital may end up acting as enclaves, with insufficient linkages, limited knowledge spillovers, and a research agenda of little relevance to the local economy that diverts scarce resources from more useful purposes (Agosin and Machado, 2005; Athreye and Kapur, 2015).

A critical question that remains to be investigated in the literature is how to attract and embed R&D-related FDI in small emerging economies with limited absorptive capacity and high specialization in certain economic activities. This paper contributes to understanding the extent to which initial limitations in absorptive capacity can be overcome by active policies through an analysis of the recent experience of Chile. To set the stage for the case study, the following section provides an overview of Chile's national innovation system and of the role of inward FDI.

2.2. Chile's national innovation system and the role of FDI

In spite of diverse policy efforts, not all developing countries have been successful in attracting and embedding R&D-related FDI. Among the regions that have shown a limited capacity to attract this kind of investments is Latin America. Between 2003 and 2013, the region hosted just 3.7% of global FDI projects with a focus on R&D, while the Asia-Pacific region attracted 51.6% of the world total[1]. The case of Chile is illustrative of the challenges faced by Latin American countries in attracting R&D-related FDI, while it also provides fresh insights into possible policy approaches to address such challenges.

Similar to other Latin American economies (Alcorta and Peres, 1998), Chile has been diagnosed as having an "emergent" or "immature" national innovation system given the lack of critical mass in R&D, the low propensity of firms to innovate, and the underdeveloped linkages between different actors (Klerkx et al., 2015; OECD, 2007). Chile's gross national expenditure in R&D stood at just 0.39% of GDP in 2013; a very low figure not only with respect to the OECD average (2.4%) but also compared to other Latin American countries such as Brazil (1.21%) or Argentina (0.65%)[2]. The same applies to patenting activity: in 2013, the number of patent applications by residents was only 19 per million population; slightly higher than in Argentina (16), but lower than in Brazil (25) and much lower than in other emerging countries such as China (519), Russia (203) or Malaysia (40).[3] More elaborate comparative indicators of Chile's national innovation system suggest that the country scores high relative to other middle-income countries in terms of institutions and infrastructure, but strikingly low with regard to human capital and research (Table 1).

[1] Source: Calculated with data from fDi Markets, Financial Times Group, http://www.fdimarkets.com
[2] Source: UNESCO, UIS.Stat, http://data.uis.unesco.org/
[3] Source: WIPO Statistics Database, www.wipo.int/ipstats/en#data

INSERT TABLE 1 HERE

However, Chile's national system of innovation can also be characterized as "fragmented" or "dual", given the coexistence of low general levels of technological capabilities with a few pockets of excellence (Chaminade et al., 2009; Parrilli, 2004). Chile's universities and research groups have expanded substantially during the last decades and progress has been achieved in building critical mass in some scientific areas (OECD and World Bank, 2009). On the industry side, several innovative clusters have emerged, particularly related to traditional resource-based industries like mining, agriculture and aquiculture, but also to newer fields such as biotechnology or ICT and niches like solar energy and astronomy-related services. Using micro-level data from Chile's national innovation survey, we can identify specific industries that hold stronger absorptive capacity by examining to what extent firms in each industry (i) conduct internal R&D activities, (ii) contract external R&D, and (iii) collaborate in innovation with external partners (Table 2). Judged against these criteria, the industries with the highest absorptive capacity appear to be 'electricity, gas and water supply', and 'manufacture of chemicals and chemical products'. These are followed by 'post and telecommunications' (where most of the ICT industry is included), 'manufacture of food products and beverages', and 'computer and related activities'. Other industries appear to rely more heavily on external sources, such as 'mining and quarrying', 'fishing', and 'agriculture, hunting and forestry'. To complement this analysis, Figure 1 identifies the most common technology fields (rather than industries) of patents granted to Chilean residents.

INSERT TABLE 2 HERE

INSERT FIGURE 1 HERE

Traditionally, efforts to upgrade Chilean industries have relied on importing foreign technology, mainly through technology licensing, imports of equipment, and international scientific collaborations (Bell and Juma, 2007; Katz, 2001; Negoita and Block, 2012). In recent times, however, it has been recognized that Chile needs to invest more heavily in building its own technological capacities, not only to diversify the economy but also to remain competitive as a natural-resource based economy (Bitran and Gonzalez, 2010; OECD 2007). Innovation has progressively become a cornerstone of the government's strategies to enhance national competitiveness and growth (Klerkx et al., 2015). In particular, the "National Innovation Strategy for Competitiveness 2010-2014" (Ministry of Economy, Development and Tourism, 2010) comprised the following action lines: i) creating a culture of innovation and entrepreneurship; ii) increasing critical mass in scientific and entrepreneurial capacity; iii) removing bottlenecks to business creation and competitiveness; iv) encouraging global connections; v) improving technology absorption and transfer; and vi) generating, attracting and retaining top talent to become the innovation hub of South America. This strategic plan was followed by the "Productivity, Innovation and Growth Agenda" (Ministry of Economy, Development and Tourism, 2014), with a strong focus on fostering economic diversification building on R&D and innovation.

With regards to FDI, Chile was one of the first countries in Latin America to actively promote FDI as part of its development strategy since the mid-1970s which, combined with its rich natural resource endowments, made it one of the major recipients of FDI in the region (Alatorre and Razo, 2010). In relative terms Chile stands out as the country with the largest stock of inward FDI as a share of GDP in Latin America while in absolute terms it ranks third only behind the two largest economies in the region, Brazil and Mexico[4]. In line with the growing importance attached to innovation in the national policy agenda, since the 2000s the scope of FDI policies in Chile shifted substantially, with a new focus on targeting knowledge-based sectors and fostering industrial upgrading through international technology transfer (Alatorre and Razo, 2010; Poniachik, 2002). This has led to a growing convergence between FDI promotion policies and innovation policies.

To provide an overview of R&D-related FDI in Chile within the Latin American context, we rely on the fDi Markets database, which collects information on greenfield FDI project announcements (excluding mergers and acquisitions). Despite its limitations[5], this database is one of the few sources available to measure R&D-related FDI, because it provides information not only on the sector but also on the business activity associated with each investment announcement. In particular, the database classifies FDI projects into 18 business activities, including sales and marketing (the largest category); manufacturing; business services; retail; distribution and transportation; customer contact centers; logistics; headquarters; research and development (R&D); design, development and testing (DDT), and others. DDT is similar to R&D although it is more oriented towards the last stages of the innovation process. Both categories, R&D and DDT, can be jointly used as a proxy to measure R&D-related FDI (Castelli and Castellani, 2013).

Table 3 presents the total number of R&D and DDT projects recorded in Latin America between 2003 and 2013. More than 40% of these investments is concentrated in Brazil, while the rest of Latin America attracted a very small number of R&D-related FDI projects. The capacity of Brazil to attract FDI in R&D relates to its large market size and to a substantial increase of national investments in innovation. In addition, the Brazilian government has introduced incentives to stimulate the R&D activity of foreign firms in the country, such as the Inovar Auto Program launched in 2012 whereby auto manufacturers are offered tax incentives on the condition that they engage in R&D locally in cooperation with local suppliers (Ibusuki et al., 2015). In contrast, Chile, with a population of 17.6 million, represents a small market compared to other countries in the region such as Brazil (200.4 million), Mexico (122.3) or Colombia (48.3), although its income per capita is among the highest in Latin America[6]. Moreover, as discussed above, the country's performance in science and technology indicators is relatively poor. Reflecting these shortcomings, between 2003 and 2013 Chile received just 12 foreign investment projects in R&D and 22 in DDT (Table 3). Chile ranks third in the region in the R&D category after Brazil and Mexico, hosting 11.8% of the region's total, while it ranks fifth in DDT, after Argentina and Colombia too.

INSERT TABLE 3 HERE

[4] Source: UNCTAD, UNCTADstat, http://unctadstat.unctad.org

[5] fDi Markets underestimates FDI in R&D, because projects that are classified in a different business activity such as manufacturing may also bring along some associated R&D expenditure even if it is not the main focus of the project. In addition, the database only allows to measure the inflows of greenfield investment projects since 2003, without taking into consideration the R&D activity of the preexisting stock of foreign companies located in the country.

[6] Source: World Bank, World Development Indicators, http://data.worldbank.org/products/wdi

The existing literature confirms that R&D-related investments are driven by a variety of location factors including income, market size, cost advantages, and the availability of a qualified human capital, scientific infrastructure and specific knowledge pools, as discussed in Section 2.1. The first type of motives (market-seeking) tend to favor large emerging countries with dynamic markets such as India and China or, in the Latin American context, Brazil. With regard to the second kind of motives (knowledge-seeking), the literature suggests that as a general rule such investments will gravitate towards developed countries with superior technological capabilities (Martínez-Noya et al., 2012; Narula and Zanfei, 2004). Apparently, this puts Chile in a difficult position to attract R&D-related FDI, as it cannot compete on the basis of market size or low costs with other countries in Latin America, nor can it match the technological capabilities of more advanced countries. Returning to the "flowers and bees" metaphor (Cano-Kollmann et al., 2016a), it can be questioned whether Chile's flowers are sufficiently attractive to bees, given the country's immature innovation system and the associated lack of absorptive capacity. But, as discussed above, Chile holds some pockets of excellence in certain industries and technology fields. Because of its unique geography, Chile also constitutes a *natural lab* in certain niche areas such as astronomy, renewable energy, biotechnology, or natural disasters. It has also been argued that, compared to other countries in the region, Chile offers a more stable political environment and more developed institutions (Agosin and Price, 2009), which are important to foreign investors in R&D that aim at minimizing transaction costs and potential conflicts associated with *appropriability hazards* (Martínez-Noya et al., 2012). In addition, in recent years the government has launched new incentive programs targeted to foreign investors in R&D in order to compensate for other locational disadvantages. The rest of the article focusses on analyzing these policy developments.

3. Research question and method

As discussed in Section 1, the experience of Chile during the period 2000-2015 offers a relevant case study to explore the policy options for governments aiming to attract foreign investments in R&D. The objective was to address the following research question: what is the most appropriate policy approach to attract R&D-related FDI in small emerging countries and what are the associated challenges? Given the nature of our research inquiry, we used a qualitative approach relying on a review of official documents and a set of 16 semi-structured personal interviews with key informants. The interviews were conducted between 2014 and 2015 and lasted 1h on average. The interviewees included some of the main stakeholders involved in the attraction of R&D-related FDI into Chile, including high-level policy-makers and foreign investors in R&D, as well as other experts (Table 4). The selection of the interviewees was driven by a logic of *elite interviewing*; a type of non-probability sampling which aims at gathering information from the most influential actors at the senior level which are involved with the key processes being investigated (Tansey, 2007). As part of the research design, we guaranteed interviewees that their responses would be kept anonymous in order to persuade them to freely disclose their personal opinions.

INSERT TABLE 4 HERE

In line with the analytical framework introduced in Section 2, the working hypothesis was that success of small emerging countries like Chile in attracting and embedding R&D-related FDI is closely associated with the alignment of public incentives with *local linkages* and *absorptive capacities*. The information collected through the interviews was matched against these analytical categories and systematized. The interviews were useful for identifying the most relevant policy instruments; analyzing their alignment with the development of local linkages and absorptive capacities; and exploring the challenges associated with these kind of policies. To improve the validity of the research findings, a first draft of the paper was reviewed in detail by two senior managers of CORFO – the national development and innovation agency – who provided additional information and qualitative feedback.

The limitations and potential biases of this methodological approach are evident given the risk of subjectivity and low generalization capacity that characterize case study research (Yin, 2003). Considering the large variety of technological and institutional profiles across countries, it would be inappropriate for this paper to attempt to prescribe a 'one-size-fits-all' strategy to attract R&D-related FDI in emerging countries. Yet we believe that the case of Chile provides useful insights on a more general level that may be of interest for policy-makers from other countries.

4. Chile's policy mix to attract R&D-related FDI

Through a review of official documents and interviews with key stakeholders, we were able to identify the most relevant policy instruments used by the Chilean government to attract R&D-related FDI (Table 5). We focus here on the policy programs that provide fiscal or financial incentives targeted to foreign investors in R&D, without considering explicitly the broader policy framework to improve the quality of the national innovation system, which as discussed in Section 2.1 is a necessary condition to attract such investments.

INSERT TABLE 5 HERE

The rest of this section proceeds to analyze each of these policy instruments independently, focusing on how they were articulated to enhance their alignment with local linkages and absorptive capacities. These policy instruments are subsequently discussed jointly as an integrated *policy mix* (Borrás and Edquist, 2013; Howlett and Rayner, 2007), exploring complementarities, interactions and common challenges. This policy mix was initiated in the year 2000 and was substantially expanded since 2008, demonstrating the growing awareness of the Chilean government on the importance of attracting R&D-related FDI. Most of these policy programs were implemented by Chile's national development and innovation agency (CORFO) while the role of the FDI promotion agency (CIE) was less relevant, focusing on image-building and international missions and trade shows.

4.1. InvestChile

The first significant milestone in the government's new strategy occurred in 2000 with the establishment of InvestChile as a branch of CORFO aimed at attracting high-technology FDI into the country, comprising a new package of incentives (Agosin and Price, 2009). The InvestChile program offered subsidies to cover pre-investment studies, acquisition of fixed assets, staff training, and R&D activities, in addition to broader marketing and pre-investment services. In particular, foreign firms with high technology investment projects in Chile were offered a grant of up to 40% of the investment in fixed assets with a maximum of US$ 2 million per firm. Existing evaluations of the InvestChile program point to promising results in terms of the number of MNCs that received these grants and invested in Chile (CORFO, 2013). However, such evaluations fail to measure or even discuss the real impact of the program by comparing it with a hypothetical counterfactual situation where no incentives were offered. In other words, it remains unclear whether these investments would have arrived in the absence of incentives or not. According to some of our interviewees, although the incentives were relatively low, they served to attract the attention of prospective investors who otherwise would have overlooked the country's advantages.

Up to 2012 InvestChile was managed by CORFO, and the national FDI agency (CIE) only played a more marginal role focusing on providing information to prospective foreign investors and organizing seminars with MNCs in the targeted sectors. However, in 2013 the government decided to transfer the program away from CORFO and shifting over to CIE's hands. As a result, according to the information collected in our interviews, the program lost momentum and remained quite inactive up to 2015. In 2015, the InvestChile program was transformed into the so-called Support Program for Technology Investments. This new program is co-managed by CIE and CORFO, illustrating the need for a close coordination between innovation promotion agencies and foreign investment promotion agencies in order to efficiently target R&D-related FDI. CIE focusses on international promotion and initial dialogue and negotiation with foreign investors, while CORFO is responsible for following-up and for the management, implementation and monitoring of the grants. This new program started in 2015 so it is still at a very early stage. In essence, it provides similar lines of support as InvestChile although offering larger incentives and a more streamlined application process.

4.1.1. Alignment with local linkages and absorptive capacities

To improve the alignment of InvestChile with the development of local linkages and absorptive capacities, the program's grants are not offered automatically to projects that comply with a predetermined set of eligibility requirements, but rather through a competitive evaluation whereby projects are judged on different criteria (including strategic relevance, impact and local content, and contribution to the creation of technological capabilities). Moreover, eligible expenses include investment in fixed assets, human capital training and supplier development programs, thus contributing to building linkages and absorptive capacities. According to one of the policy-makers that we interviewed:

> *"Throughout its history, the InvestChile program has tried to be flexible to address the changing needs of multinationals, while at the same time conducting a close scrutiny of preselected projects to maximize local impacts."*

The program had an initial focus on ICT but with time it broadened substantially to include other industries such as biotechnology, agribusiness, renewable energy, mining technologies and specialized services, and aquiculture technologies. In addition to this industrial focus, the program progressively adopted a more functional approach, targeting high value added business functions such as R&D and shared service centers (Alatorre and Razo, 2010; Nelson, 2005). Therefore, although strategic selection of projects remained, the program shifted from a vertical approach focused on ICT to a more horizontal approach focused on high technology activities across a wide range of industries.

4.2. R&D tax incentive

In 2008 a tax incentive was enacted to encourage private investment in R&D, consisting in a tax credit of 35% for expenditures on R&D contracts with pre-certified third party R&D centers and universities up to a maximum of US$ 400,000. In 2012 CORFO decided to simplify the eligibility criteria and application procedures. The requirement to collaborate with external research centers was removed. Moreover, the maximum amount of tax credit available to each company was tripled and the incentive was broadened to include a wider variety of eligible expenditures.

The tax incentive for R&D is available on an equal basis for foreign and domestic companies, but an explicit objective is to attract foreign companies interested in executing R&D projects. According to OECD (2014) there is evidence suggesting that this kind of tax incentives can have an impact in diverting FDI from one country to another within a geographic region. OECD countries like Canada or France have recently enhanced their R&D tax incentives with the aim of attracting more R&D-related FDI at the expense of their neighbors. By offering one of the most generous tax regimes for R&D in Latin America (OECD, 2014), Chile aims to become the preferred location in the region for the R&D activity of MNCs.

4.2.1. Alignment with local linkages and absorptive capacities

Initially, the program attempted to catalyze linkages of MNCs with local universities and R&D centers by providing the tax credit only to those expenses resulting from R&D contracting, while internal R&D expenditures were not eligible. In addition, a pre-certification process for universities and R&D centers wishing to participate was established, which helped to increase transparency and control but also added up bureaucracy and complexity. As a result, up to 2012 this incentive was used only sparingly due to its many restrictions. This dilemma is illustrated by the following quote from a policy-maker that we interviewed:

> *"We soon realized that the fact that only R&D activities contracted to local actors were eligible represented a major drawback for foreign multinationals. Still, we thought that such a generous tax incentive should be connected with a clear impact on the national innovation system. In addition, it is easier to monitor expenditures if they are contracted out, rather than reported internally. We had an internal debate on how to deal with this trade-off, and finally decided to modify the program"*

As a result, the requirement to subcontract R&D activities with local agents was removed in 2012. This shows how policy attempts to enforce local linkages may be difficult to implement in practice, as they may come into conflict with MNCs' demands for flexibility and discretion. While such linkages are an important condition to ensure spillover effects on the national innovation system, it is not easy to impose them because foreign investors may end up losing interest on the incentive. In fact, according to the information provided to us by CORFO, since the change in the tax incentive was enacted the number of foreign investors that applied for it has increased substantially (from 40 in 2011 to 102 in 2014), but their collaboration in R&D with local agents has declined. While the policy instrument is targeted to R&D activities, the R&D tax incentive might be criticized for not having a particular sectoral focus, leaning towards large firms in well-established industries.

4.3. International Centers of Excellence

The International Centers of Excellence program was launched by CORFO in 2008 to co-finance the establishment in the country of R&D centers from world-class universities and public research institutes (Guimón et al., 2016). The first call for proposals was launched in 2009 and resulted in the selection of four centers. In 2011, a second call for proposals was launched leading to the creation of ten new centers, and the program was extended to target also the R&D centers of MNCs. Thus a total of thirteen R&D centers have been established so far in Chile through this program, comprising eight leading universities or public research institutes and five MNCs coming from seven different countries (Table 6). The program is currently the most costly among CORFO's programs to promote innovation in Chile, with an annual budget of around US$ 30 million. In the first call, each of the four selected centers was offered a non-refundable matching grant of up to US$ 19.5 million for a 10-year period, with a required co-financing of at least the equivalent to 59.5% of the grant received. Rather than distributing available public funding among a large number of projects, the program was designed to select a limited number of centers of excellence and offer them substantial funding, so they could reach critical mass relatively fast. Centers of excellence schemes to concentrate public R&D funding on a competitive basis have been adopted in a large number of countries (Hellström, 2011), but the distinctive feature of the ICE program is its focus on attracting foreign institutions. Thus, the program combines elements of centers of excellence with elements of global R&D attraction.

INSERT TABLE 6 HERE

The program's ultimate objective is to contribute to strengthening national technological capabilities and industrial competitiveness through the establishment in Chile of R&D centers from leading international research institutions that will carry out R&D, technology transfer and commercialization activities. In addition to developing new solutions for Chilean industry, the centers are expected to foster a systemic change in the national innovation system. Another indirect impact relates to their capacity to engage existing MNC subsidiaries in enhanced R&D activities and to attract new FDI inflows, acting as an attraction factor. For example, Mentor Graphics, a leading firm in microcircuit design from the United States, and Komatsu, a mining corporation from Japan, which arrived years ago to the country and were supported by the InvestChile program, have recently expanded their R&D activity in the country through new cooperation agreements with the Centers of Excellence (INRIA and Fraunhofer Gesellschaft, respectively). Moreover, in the words of the director of one of the Centers of Excellence that we interviewed:

> "*During the last year we have been contacted by several companies from our country of origin that were exploring the possibility of investing in Chile and engaging in new R&D activities in the country. Some companies were interested in partnering with us in this process and saw us as an interesting intermediary or broker within Chile's national innovation system. At the same time, the Chilean government has also asked us to participate in some commercial visits of multinational companies from our country.*"

4.3.1. Alignment with local linkages and absorptive capacities

The selection of centers under this program was highly competitive and guided by their potential contribution to developing new technological solutions to increase the competitiveness of Chilean industries through joint research projects, contract research and technology commercialization. As shown in Table 6, all selected centers are clearly aligned with the specific needs of the country's strategic industries. Some of the centers focus on specific industries (such as mining, nutrition or renewable energy) while others embrace technologies with applications across several industries (such as IT, biotechnology or nanotechnology). While most of the centers have a specialization in knowledge areas in which there is a certain level of absorptive capacity by local firms (i.e., those identified in Section 2.2), those centers specialized in renewable energy or nanotechnologies can arguably have less possibilities of successfully establishing local links. Indeed, establishing fruitful linkages with local industries is an ongoing challenge, as illustrated by the following quote from our interview with a manager of one of these centers:

> *"Building a relationship of trust with Chilean firms is being harder than what we thought initially. Chilean firms normally search for ready-to-use technology and are reluctant to finance the development of new technologies assuming a risk. They are not used either to participate in research consortia with other firms. There are cultural barriers such as lack of trust and low propensity to collaborate when it comes to engaging with firms."*

In addition to linkages with firms, the centers were required to hire Chilean scientists and to establish collaboration agreements with Chilean universities. However, the governance of such linkages and partnerships was plagued with challenges, not only related to finding local research teams with the required capabilities, but also in terms of diverging expectations and contractual conflicts, particularly with regard to the ownership of intellectual property rights and the distribution of licensing royalties resulting from joint research projects.

The program also attempts to contribute to the broader objective of improving Chile's national innovation system, in particular by enhancing science-industry collaboration and technology commercialization. Moreover, these research centers are expected to contribute to the training of young scientists by hosting and co-supervising PhD students and postdocs and by participating in postgraduate programs ran by Chilean universities.

4.4. Start-up Chile

The Start-up Chile program was launched in 2010 to attract innovative start-ups from abroad by offering foreign entrepreneurs a residence visa and a non-reimbursable grant to develop their projects. In addition to the grant, selected start-ups receive mentoring, office space, and access to social and capital networks in the country. The program's objective is to turn Chile into the innovation and entrepreneurship hub of Latin America by attracting the world's best and brightest entrepreneurs to develop their start-ups in Chile. To enhance the program, CORFO has partnered with some global technology companies like Google, Amazon, Microsoft and PayPal, among others.

This program complements other programs to attract R&D-related FDI, by focusing not only on attracting R&D investments by large MNCs and world-class public research institutes, but also by entrepreneurs and small technology-intensive firms. As illustrated by the following quote from one of our interviewees:

> "*Although the program is not explicitly aimed at attracting FDI in a strict sense, it is expected to contribute to meeting this target, since some of the start-ups funded might ultimately set up a company in Chile and engage in R&D and innovation. Moreover, the arrival of foreign entrepreneurs creates a dynamic ecosystem of global actors that improves the attractiveness of the country as a destination of technology-intensive FDI.*"

In the pilot phase released in 2010, a total of 22 startups from 14 countries were brought to Chile, providing each of them with US$ 40,000 of equity-free seed capital, and a temporary one-year visa to develop their businesses in Chile for a period of at least six months (CORFO, 2011). Following this pilot experience, in 2011 the first official call for proposals attracted 330 applications, from which 87 start-ups from 30 different countries were selected. Through subsequent annual calls, more than 1,000 start-ups from more than 70 countries participated in the program up to 2015 (Higgins, 2015).

4.4.1. Alignment with local linkages and absorptive capacities

The program stipulates that selected entrepreneurs need to commit to live in Chile during at least 6 months and are also expected to organize and actively participate in networking events, mentoring and other activities that foster entrepreneurship locally. This contributes to ensure that at least some minimum local linkages are established which might contribute to building absorptive capacities. A survey conducted in 2012 by CORFO to 91 start-ups that had participated in the program indicates that 64% of them had hired new employees in Chile; 76% had established collaboration linkages with Chilean firms; and 22% had applied for new patents in Chile since obtaining the grant. However, there are also more critical perceptions, as illustrated by the following quote from one of our interviews:

> *"Bringing to the country a bunch of kids with early stage start-ups has not provided strong local impacts (...) very few of them have developed in the country to generate significant income and employment. Many of them left after one year or so and many of the remaining ones are virtually inactive."*

Indeed, a major challenge is that only around 20% of participating foreign start-ups remained in Chile after complying with the grant's minimum requirements (Higgins, 2015). To address this, in 2015 CORFO expanded the program by offering the so-called Start-up Chile Scale grant, on top of the initial grant. This new grant aims at scaling-up the most successful start-ups that emerge through the program and at ensuring that they remain in Chile after the initial support. In particular, an additional equity-free grant of around US$ 100,000 is offered to the best 1% of the start-ups that initiate the Start-up Chile program each year. To qualify for this grant, the start-up must incorporate in Chile and commit to maintain the operations in the country. It also needs to commit to co-finance at least 30% of the project's total budget.

Hitherto, this program has not focused on specific areas of interest or tried to provide incentives to start-ups in those technological areas in which Chile has technological strength. As a result, some of the start-ups are loosely embedded in the local industry and, as one could expect, have difficulties scaling up.

4.5. Discussion

During the past decade the government of Chile has put in place a comprehensive set of policy instruments aimed at attracting R&D-related FDI, contributing to overcome the locational disadvantages related to the country's peripheral nature and to the weaknesses of its national innovation system. This policy mix comprises both fiscal and financial incentives, and adopts a broad scope to include not only large MNCs but also start-ups, as well as foreign universities and public research institutes. The different policy programs are complementary as they target different actors and combine grants and tax incentives, while sharing the common objective of attracting the kind of foreign investments that most contribute to the development of local capabilities in strategic sectors. In turn, this kind of policies might lead to a more internationalized and diverse national system of innovation that becomes more attractive to foreign investors in R&D.

The case of Chile suggests that policies to attract R&D-related FDI in small emerging countries could be more effective (at least initially) when targeted towards specific industries or technological fields where there is already some absorptive capacity, thereby enabling the transfer of knowledge to domestic firms and research centers. Active policies to prioritize strategic industries and technologies with potential to connect with global innovation networks are consistent with broader industrial policy frameworks that advocate for *selective* policy interventions aimed at pushing innovation-led *smart* growth and setting the *direction* of change, rather than just addressing market failures (Lall, 1992; Mazzucato, 2016). It has also been emphasized that innovation policies in emerging countries need to become more closely aligned with identified problems in the national innovation system (Chaminade and Padilla, forthcoming). As discussed in Section 2.2, human capital and research are the biggest weaknesses of Chile's national innovation system. Chilean policies to attract R&D-related FDI are well aligned with this problem, since they aim at complementing and enhancing investments in R&D by local actors, while contributing to the training of human capital and the attraction of talent. In any case, it can also be argued that building absorptive capabilities should go before requiring investors to link to the local environment. The request of some programs to link their investments to local actors might be considered a hindrance if the capabilities are not there, as illustrated with the case of the R&D tax incentive.

Chile cannot compete with the size and diversity of the innovation system of countries like Brazil or Mexico, thus a niche strategy seems to be better fitted, specializing in technological fields where Chile has some competitive advantage and potential to develop critical mass. Along these lines, in recent years CORFO has been adopting a so-called *smart specialization strategy*, inspired by the European experience (European Commission, 2012). Within this strategic framework, CORFO has tried to identify both industries and key enabling technologies, whose prospective competitive roadmaps can be addressed by focusing science, technology and innovation capacities and instruments (CORFO, 2016). The prioritized industries under this approach have been: mining; sustainable tourism; healthy foods; fisheries and aquaculture; creative industries; e-health and eco-efficient building. In addition, four key enabling technologies have been also considered within the strategy: logistics; solar energy; advanced manufacturing; and industrial digitalization. Taking into account that Chilean economy exhibits, on the one hand, a persistent anchorage around its natural resources endowment and, on the other hand, a rather poor level of diversification and productive sophistication, even compared against other Latin American economies, this approach allows the government to target new industries and technologies towards which the country can diversify, while promoting capacity building and upgrading processes into the current national productive matrix in order to access new options of functional specialization within global value chains.

Chile's policies to attract R&D-related FDI have become a critical component of this policy agenda, by targeting those strategic industries and technologies (in particular through InvestChile and the International Centers of Excellence programs) and by addressing both industrial diversification and upgrading of current industries. However, in some cases the diversification strategy may be at odds with the strategy of focusing on attracting foreign investment into those industries and technologies where local actors hold absorptive capacity, which were identified in Section 2.2. In particular, some of the strategic priorities of CORFO's smart specialization strategy -such as creative industries and solar energy- are not clearly matched with the capacities of local firms. Where the match between strategic priorities and local absorptive capacity is weak, linkages and spillovers are less likely to occur. In these areas, when providing incentives to foreign investors, policy-makers should therefore dedicate even greater efforts to complementary measures to build the absorptive capacity of local actors.

In any case, selecting industries or technologies and "picking up winners" is a risky policy process. Therefore, as discussed in Rodrik (2005), it is important to develop policy regimes that are "self-correcting", i.e. that incorporate mechanisms for recognizing mistakes and withdrawing support from them. This involves designing incentives with "automatic sunset clauses" to ensure that public funding is temporary, based on periodic reviews, and transparent to all parties involved (Rodrik, 2005). It is also worth stressing that, beyond broad industries or technology fields, an ongoing monitoring of niche areas with potential to develop absorptive capacity is also critically important given the increasing fine-slicing of global R&D activities (Mudambi, 2008) and the claim that insertion in global value chains permits a narrower range of national specialization (Cantwell and Vertova, 2004).

This paper has emphasized that in order for national innovation systems to benefit from R&D-related FDI it is important to ensure that appropriate linkages are established with local actors and strategic technological priorities at national level. Incentives provided by the Chilean government to attract foreign investors in R&D have been designed in a way that encourages (or even enforces) the establishment of linkages between foreign investors in R&D and local firms and universities. However, forging knowledge-intensive linkages remains a challenging task given the immature nature of Chile's national innovation system.

In addition, the case of Chile is also useful to illustrate the kind of global-local trade-offs associated with providing public funding to foreign investors in R&D. Critics have argued that the generous funding provided to foreign institutions could be used instead to strengthen national universities and private enterprises, which are much needed of additional funding to build absorptive capacities. In the words of one of the policy-makers interviewed:

> "*We need to constantly address the concern that supporting FDI in R&D may not be desirable since it might lead to some sort of 'techno-colonialism', whereby foreign investors in R&D focus their efforts of commercializing in Chile technologies they had developed in their home countries.*"

This kind of global-local frictions makes monitoring and evaluation efforts especially important, comparing the impact of these policy instruments against the counterfactual alternative of dedicating those funds to firms and research centers of national ownership. Such additionality would derive from the capacity of foreign investors to develop new solutions for Chilean industry and to instigate a systemic change in the national innovation system by enhancing university-industry collaboration, technology commercialization, and linkages with global innovation networks, thus addressing existing inefficiencies in Chile's national innovation system. Another critical issue concerns sustainability, since these are expensive programs that divert taxpayer money toward foreign institutions, and it is questionable whether the interest of foreign investors would continue if the strong incentives provided by the government are eventually cut down.

5. Conclusions and limitations

While the existing literature has focused on identifying and measuring the spillovers associated with global-local linkages, this article has explored how linkages can be modulated by public policies. The case of Chile suggests that national policies to attract R&D-related FDI in small emerging countries should first carefully assess the technological specialization of the country and identify technology fields or industries where there is already a threshold level of absorptive capacity that can facilitate the transfer of knowledge and the development of critical mass. Incentives can then be selectively targeted to specific projects that demonstrate strong potential for building knowledge-intensive linkages with local actors. An ongoing monitoring and nurturing of these linkages is critically important for international knowledge connectivity to induce domestic learning and competence building. This policy approach requires a close coordination between FDI policies and science, technology and innovation policies, which are two policy areas that operate rather separately in many emerging countries.

The case of Chile is useful to illustrate the role of proactive policies in small emerging countries to attract R&D-related FDI while leveraging local technological capabilities. Early results suggest that the government has been successful in attracting the kind of FDI that may contribute to increasing the competitiveness of Chile's traditional industries while diversifying the economy towards knowledge-based sectors. However, our research suffers from a lack of conclusive evidence regarding the ultimate economic outcomes of different policy options. Inevitably, the economic impacts of the policies discussed in this paper still remain largely uncertain, partly because of the inherent difficulty of drawing clear connections between this kind of public incentives and measurable economic outcomes (Cantwell and Mudambi, 2000), and partly because many of these programs have been launched very recently. Future research should delve further into assessing the outcomes of these policies, considering as well the extent to which public support induces additional investments in R&D rather than supporting R&D projects that would have been undertaken in Chile anyway (Cano-Kollmann et al., 2016b)

Although we have focused on specific policies providing incentives to foreign investors in R&D and innovation, it is important to stress that this kind of policy instruments need to be integrated into a broader national innovation strategy that ensures an endogenous development of local technological capabilities in tandem. In the case of Chile, in view of its very low levels of investment in R&D and of the immature nature of its national innovation system, it seems evident that first and foremost the country should substantially increase its endogenous efforts to develop absorptive capacity. But it is beyond the scope of this article to provide a comprehensive review of Chile's national innovation system and of the required policies to improve it. Suffice it to emphasize again that attracting R&D-related FDI should not be taken as a simple solution to replace local

R&D efforts, but rather as a means to complement those efforts thereby leveraging local resources and connecting them with global innovation networks.

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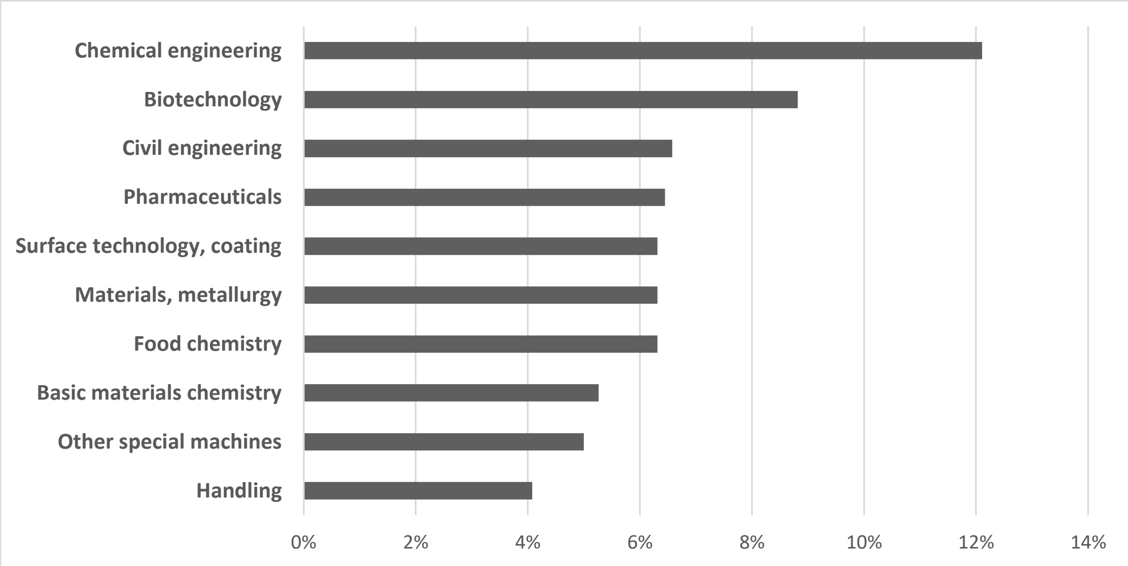
Figure 1. Top ten technology fields of patents granted to residents in Chile, as % of total patents 2005-2014



Notes: Based on a total of 760 patents granted to residents in Chile between 2005 and 2014, both in the national patent office and in other international patent offices (equivalent count).

Source: Own elaboration based on WIPO statistics database, www.wipo.int/ipstats/en#data

Table 1. Chile's position in the Global Innovation Index compared with selected emerging countries, by component

Component	*Chile*	*Argentina*	*Brazil*	*Mexico*	*China*	*Malaysia*	*South Africa*
Institutions	36***	106	78	65	79	43	46
Human capital and research	62	47	60	53	29	34	55
Infrastructure	38**	65	59	67	36	43	85
Market sophistication	47*	106	57	51	21	24	17
Business sophistication	41*	69	39	77	7	29	56
Knowledge and technology outputs	59*	97	67	70	6	35	63
Creative outputs	55*	83	90	62	30	43	77

Notes: The figures represent the global rank of a country in each component of the Global Innovation Index. The symbol *** indicates that Chile's position is better than all the other countries considered. The symbol ** indicates that Chile's position is better than all but one of the countries in the sample. The symbol * indicates that Chile's position is better than at least three of the other countries.

Source: Own elaboration based on Global Innovation Index 2016, https://www.globalinnovationindex.org

Table 2. Chilean industries with the higher level of absorptive capacity

Sector of activity	*N*	*Internal R&D*	*External R&D*	*Collaboration for innovation*
Electricity, gas and water supply	121	**	**	**
Manufacture of chemicals and chemical products	95	**	**	**
Post and telecommunications	100	**	*	**
Manufacture of food products and beverages	267	**	*	**
Computer and related activities	159	**	*	*
Mining and quarrying	60	*	**	**
Health and social work	184	*	*	*
Manufacture of paper and paper products	63	*		*
Manufacture of machinery and equipment	179	*		
Manufacture of basic metals and metal products	171	*		
Fishing	109		**	*
Agriculture, hunting and forestry	226		*	*
Sewage and refuse disposal, sanitation and similar activities	199		**	

Note: All sectors (30) were sorted according the propensity of firms to engage in the activities listed in the columns of the Table. The propensities are binary variables taking the value 1 if the firm engages in such activities and 0 otherwise. Only those sectors (13) that appear in the Top-10 of all sectors for at least one of the indicators are listed in the Table. The symbols ** and * stand for Top-5 and Top-10, respectively. The sample size for each sector (N) is indicated in the second column. Only those sectors with a sample size larger than 50 firms are considered. The total sample size for all sectors (30) was 4614 firms. Sectors are classified based on the International Standard Industrial Classification (ISIC Rev.3).

Source: Own elaboration based on Chilean National Innovation Survey, 8th Edition, 2013, http://www.economia.gob.cl/estudios-y-encuestas/encuestas/encuestas-de-innovacion-e-id/octava-encuesta-de-innovacion-en-empresas-2011-2012

Table 3. R&D-related FDI in Latin America, number of projects by country 2003-2013

	R&D		*DDT*		*R&D + DDT*	
Country	*Number*	*% of total*	*Number*	*% of total*	*Number*	*% of total*
Argentina	1	1%	36	10%	37	8.3%
Brazil	49	48%	131	38.1%	180	40.4%
Chile	12	11.8%	22	6.4%	34	7.6%
Colombia	5	4.9%	24	7%	29	6.5%
Costa Rica	3	2.9%	10	2.9%	13	2.9%
Dominican Rep.	0	0%	4	1.2%	4	0.9%
Ecuador	1	1%	2	0.6%	3	0.7%
Mexico	17	16.7%	99	28.8%	116	26%
Panama	5	4.9%	3	0.9%	8	1.8%
Peru	3	2.9%	3	0.9%	6	1.3%
Puerto Rico	5	4.9%	3	0.9%	8	1.8%
Uruguay	1	1%	4	1.2%	5	1.1%
Others	0	0	3	0.9%	3	0.7
Total	102	100%	344	100%	446	100%

Notes: R&D refers to "research and development" and DDT refers to "design, development and testing".

Source: Own elaboration based on fDi Markets, Financial Times Group, http://www.fdimarkets.com

Table 4. Distribution of the interviews by type of respondent

Senior managers of national development and innovation agency ("Corporación de Fomento", CORFO)	5
Directors of foreign-owned R&D centers established in Chile	4
Senior managers of national investment promotion agency ("Comité de Inversión Extranjera", CIE)	2
Director of the Innovation Division at the Ministry of Economy, Development and Tourism	1
Director of Investment Attraction at the Economic Commission for Latin America and the Caribbean (ECLAC), United Nations	1
Other experts (researchers and university professors from Chile)	3
Total	16

Table 5. Main policy programs to attract R&D-related FDI in Chile

Program name	*Year launched*	*Brief description*
InvestChile	2000	Small grants for FDI in high-technology sectors and international promotion campaign. Interrupted in 2012. Re-launched and expanded in 2015 under a different name.
R&D tax incentive	2008	Tax credit of 35% for R&D expenditures. Modified in 2012 to expand eligibility criteria.
International Centers of Excellence	2009	Large grants to co-finance the establishment in Chile of selected R&D centers from leading universities, public research organizations, and multinational companies.
Start-up Chile	2010	Small grant and residence visa for foreign entrepreneurs to develop their start-ups in Chile. Expanded in 2015 with a scale-up grant to encourage the continuation of selected projects.

Source: Own elaboration.

Table 6. International Centers of Excellence established in Chile

Name of owner	*Call*	*Track*	*Country of origin*	*Main research lines*
CSIRO	1	Institutional	Australia	Mineral processing, geo-resources and mine planning; intelligent mining systems; metallurgical systems; water, energy and environmental impact.
Fraunhofer IME	1	Institutional	Germany	Biotechnology applied to raw materials, agriculture, aquaculture and the sustainable use of natural resources.
Inria	1	Institutional	France	Digital technologies, computer science, and mathematics, with applications across different sectors including aquaculture, mining, astronomy, solar energy, recycling, e-government, etc.
Wageningen UR	1	Institutional	Netherlands	Food processing, food safety, agriculture, sustainability.
DCNS	2	Institutional	France	Marine renewable energy, including tidal power and wave power.
Fraunhofer Gesellschaft	2	Institutional	Germany	Solar energy technologies.
LEITAT	2	Institutional	Spain	Nanotechnology, advanced materials, renewable energy, sustainability.
UC Davis	2	Institutional	U.S.A.	Agriculture, genetic improvement, adaptation to climate change, post-harvest waste treatment, viticulture and enology.
University of Queensland	2	Institutional	Australia	Sustainable mining, mineral processing, mining and geology, water management.
Emerson	2	Business	U.S.A.	Mining technologies to improve productivity and efficiency; solutions to improve the maintenance of remote mining operations.
Laborelec	2	Business	Belgium	Renewable energy and eco-efficiency, with initial focus on the integration of solar-based energy systems and on low-footprint power generation.
Pfizer	2	Business	U.S.A.	Precision medicine, companion diagnosis, DNA sequencing, with initial applications for lung cancer.
Telefonica	2	Business	Spain	Information technologies, smart cities, internet of things, big data.

Notes: Call 1 was issued in 2009 and the selected centers started operating in 2011/2012. Call 2 was issued in 2012 and the start of operations was 2014/2015. The "institutional" track targets international non-for-profit universities and research institutes. The "business" track targets multinational companies.

Source: Adapted from Guimón et al., 2016.