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Harmonized Latin American innovation Surveys Database (LAIS)

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Harmonized Latin American innovation Surveys Database (LAIS): Firm-level microdata for the study of innovation

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Harmonized Latin American Innovation Surveys Database (LAIS)

Firm-Level Microdata for the Study of Innovation

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Abstract*

This paper provides the methods through which the first version of the Harmonized Latin American Innovation Surveys database (LAIS) was built. LAIS, which is made freely available through the Inter-American Development Bank, contains nearly 690 variables and 119,900 observations at the firm level from 30 national innovation surveys conducted between 2007 and 2017 in 10 Latin American countries, increasing the number of countries of the region with publicly available microdata. This paper describes how, starting from significantly different survey methods and questionnaires between countries, criteria were applied to identify and select variables from different surveys measuring the same underlying concept. It also discusses and guides how differences in survey methodologies may affect comparisons even after the harmonization of variables. LAIS includes data on innovation activities expenditures, sources of information and collaborations for innovation, innovation obstacles, outputs and effects, protection of innovation results, and general firm characteristics. Since LAIS significantly decreases the cost of making data comparisons between countries, it will allow more scholars to research innovation in Latin American firms and to tackle long-standing unanswered questions about the importance of framework conditions in LAC for innovation decisions in firms. The dataset and supporting documentation are available at: http://dx.doi.org/10.18235/0004040

JEL codes: O10, O12, O31, O32 C81

Keywords: cross -country data, innovation, innovation processes, innovation surveys, microeconomics, Latin America

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Acronyms

CIS Community Innovation Survey

DUI Doing, using, and interacting

EU European Union

IAF Innovation-active firms

ICT Information and communication technologies

IF Innovative firms

IDB Inter-American Development Bank

IPR Intellectual property rights

IS Innovation surveys

ISIC International Standard Industrial Classification

LAC Latin America and the Caribbean

LAIS Latin American Innovation Surveys database

NIF Non-innovative firms

PROTEqIN Productivity, Technology, and Innovation Survey

RICYT Network for Science and Technology Indicators – Ibero-American and Inter-American

STI Science, technology, and innovation

WBES World Bank Enterprise Survey

1. Introduction

One of the main constraints for researching innovation in firms in Latin America and the Caribbean (LAC) has been the limited availability of micro-level data. Generating quantitative evidence that can feed policymaking in science, technology, and innovation (STI) is also affected by the difficulties in making comparisons between data from LAC and other regions of the world. Although first attempts to produce innovation statistics in the region date back to the 1990s, it has been only in the last decade when a significant number of countries have implemented business innovation surveys (IS) with a certain regularity. Most of the research conducted using these surveys has been restricted to single countries (Benavente, 2006; Frank et al., 2016; Moraes Silva, Furtado, and Vonortas, 2017; Ramírez, Gallego, and Tamayo, 2019; Santiago et al., 2017, among others). Since accessing, analyzing, and merging different datasets is costly, the few exceptions are studies that compare results of econometric analysis from different countries (Crespi and Zuñiga, 2012; Raffo, Lhuillery, and Miotti, 2008; Zuñiga and Crespi, 2013). This paper presents the Harmonized Latin American Innovation Surveys database (LAIS), the first dataset with rich innovation data at the firm level for a variety of LAC countries. LAIS increases the availability of microdata by including four countries for which IS databases were not publicly available before, and significantly decreases the cost of making a quantitative comparative analysis between countries because it addresses differences in variables, questionnaires, and survey methods. This version of LAIS contains 687 variables and 119,900 observations from 30 IS conducted over the period 2007–2017, covering 10 countries.

Despite having similar theoretical and conceptual frameworks, based on the Bogotá Manual (Jaramillo, Lugones, and Salazar, 2001) and the previous version of the Oslo Manual (OECD/Eurostat, 2005), early versions of IS in LAC showed significant differences between questionnaires. Later, the adoption of (sections of) the Community Innovation Survey (CIS) questionnaire, and, more recently, the diffusion of a basic IS questionnaire for LAC countries (Anlló et al., 2014) promoted the convergence towards more similar questionnaires. Nevertheless, some significant questionnaire differences remain. Also, each LAC country implements IS using a specific combination of methodologies and methods (i.e., filters in questionnaires, sample design, coverage). Hence, international comparability, at the macro and micro level, is a real challenge. Difficulties are even more evident when comparing to data from European Union (EU) countries, where the existence of a robust regional institution like Eurostat allows a higher degree of homogeneity in questionnaires and survey methods. The World Bank Enterprise Survey (WBES) and the Productivity, Technology, and Innovation Survey (PROTEqIN) attenuate part of this problem. These surveys provide firm-level data applying the same questionnaire in different LAC countries, allowing the production of new evidence on firm behavior in the region (Dohnert, Crespi, and Maffioli, 2017; Grazzi and Pietrobelli, 2016). However, since the scope of these surveys is more comprehensive than just innovation, and country sample sizes are relatively small, the usefulness to the study of innovation in firms is limited.

Despite the absence of an institution like Eurostat, two other organizations have played a significant role in promoting innovation measurement in LAC: The Network for Science and Technology Indicators – Ibero-American and Inter-American (RICYT) and the Inter-American Development Bank (IDB). The RICYT led the production of the Bogotá Manual, developing the

first guidelines for the application of IS in LAC countries, and has played a coordinator role between innovation data producers in the region. The IDB has played a significant role by producing and disseminating good practices, providing technical assistance and financing IS in the LAC region, and by promoting the use of data by researchers and policymakers (Anlló et al., 2014; González Olmos, 2012; Guillard and Salazar, 2017). The LAIS database is a product of these activities and a step towards the convergence of innovation statistics in the LAC region.

The LAIS database contains firm-level data over the period 2004–2016,[1] from Argentina (AR), Chile (CH), Colombia (CO), Ecuador (EC), El Salvador (ES), Dominican Republic (DR), Panama (PA), Paraguay (PR), Peru (PE), and Uruguay (UR). All these surveys cover the manufacturing sector and selected services in some countries. Most of these surveys make use of the official business registry available in each country, allowing for the estimation of representative statistics at the country-sector level. The dataset includes variables describing general characteristics of a firm and its performance, human resources, the use of intellectual property rights, innovation expenditures, source of financing, source of information and cooperation for innovation, and innovation objectives, obstacles, outputs, turnover, and perceived impacts.

We expect that LAIS, as an open source of microdata, will nurture the research agenda on innovation indicators and the study of innovation in the region, providing evidence for policymaking. Although the data in LAIS is mostly of a cross-sectional nature, we expect that more studies on innovation determinants, obstacles, modes or strategies, and, eventually, impacts, can be conducted (Mairesse and Mohnen, 2010). Exploiting the cross-country dimension of LAIS will allow researchers to answer pressing questions for the region related to how framework conditions affect innovation in firms, and which business environment aspects influence the effectiveness of innovation policy. We also expect that the benefits of comparative analysis facilitated by the LAIS dataset may encourage countries without IS to start measuring innovation in their economies and to nudge countries with currently limited access to their microdata to design protocols that allow them to facilitate access to their databases to the international research community.

In the next section of this paper, we present a brief review of empirical innovation studies that have made use of IS data in LAC and propose research topics that can be addressed using the LAIS database. In Section 3 we present the main characteristics and methodological differences between IS in LAIS. In Section 4 we present and discuss the methods we apply to harmonize IS data and its availability in LAIS. In Section 5 the final anonymization and cleaning procedures applied are presented, and Section 6 presents selected descriptive statistics that highlight the novelty of the LAIS dataset. Finally, concluding remarks are presented in Section 7.

2. Research on Innovation in Latin America

The increasing availability of IS in Latin America has allowed a growing body of literature on the economics of innovation in the region. LAIS provides new IS data to the public and a set of harmonized variables that will ease the production of more research on this topic. Besides making

[1] Surveys conducted between 2007 and 2017.

available innovation data that can allow more research on somewhat under-researched countries of the region, the main contribution of LAIS is to allow questions to be addressed related to the context where firms operate, exploiting the cross-country nature of the data.

Most of the studies using IS data[2] in the LAC region have made use of the data of general characteristics of the firm, together with detailed information about innovation expenditures, innovation outputs, and some indicators of firm performance, such as annual sales, exports, and innovation turnover, to produce country-specific analysis on the determinants of innovation, the production of innovations, and the impact of innovation on firm performance, along the lines of Crepon, Duguet, and Mairesse (1998) (CDM model) and Lööf and Heshmati (2006). For instance, studies in Argentina (Arza and López, 2010; Chudnovsky, López, and Pupato, 2006), Brazil (Kannebley, Porto, and Pazello, 2005), Chile (Álvarez, Bravo-Ortega, and Navarro, 2011; Álvarez, Bravo-Ortega, and Zahler, 2015; Benavente, 2006), Colombia (Arbeláez and Parra Torrado, 2011; Gallego, Gutiérrez, and Taborda, 2015), Mexico (de Fuentes et al., 2015), Peru (Tello, 2015; 2017), and Uruguay (Aboal and Garda, 2015; Cassoni and Ramada, 2010) generally confirmed the virtuous relation between innovation investments, innovation, and productivity. Crespi and Zuñiga (2012) compare the results from CDM-like estimations, using the same specification, in Argentina, Chile, Colombia, Costa Rica, Panama, and Uruguay, finding average differences in labor productivity between innovators and non-innovators ranging from 24 to 192 percent. Crespi and Vargas (2015) follow the same approach but focus on the service industry in Chile, Colombia, and Uruguay, where the average differences in labor productivity between innovators and non-innovators ranks between 50 and 139 percent. The extent to which economic environment and policies influence the return to innovation and R&D investments, or the relative importance of its determinants, are clear avenues for research using LAIS.

The relationship between innovation in firms and employment growth has also been studied by using only data from IS or merging it with other sources, as in Argentina (Elejalde, Giuliodori, and Stucchi, 2015), Chile (Álvarez et al., 2011), and Uruguay (Aboal et al., 2011), where results consistently show a positive relationship between employment growth and product innovation, and a somewhat neutral relationship with process innovation. Zuñiga and Crespi (2013) analyze the sensitivity of employment growth to the innovation strategy of the firm, finding a higher response in firms that rely on in-house R&D efforts only in Argentina and Uruguay, while in Chile the effect is significantly smaller and related to the acquisition of external technologies. LAIS data would help researchers to answer research questions that point to conditions at the country and industry level behind these differences.

Innovation policy in LAC has recently benefited from the study of the perceived innovation barriers of the firm. Following the approach developed by Pellegrino and Savona (2013), research on innovation obstacles has been conducted in Argentina (Arza and López, 2018), Chile (Zahler, Goya, and Caamaño, 2018), Mexico (Santiago et al., 2017), and Uruguay (Bukstein, Hernández,

[2] When data from IS is merged with other sources, like trade data and national industrial surveys, it has been possible to estimate the relationship between innovation and export diversification in Brazil (Cirera, Marin, and Markwald, 2015) and complementarities with investments in information and communication technologies (ICT) in Colombia (Gallego, Gutierrez, and Lee, 2015) and Uruguay (Aboal and Tacsir, 2018).

and Usher, 2019). Interestingly, although all these studies find evidence of the negative effects of obstacles on innovation, there are significant differences concerning the type of obstacle that is more relevant. For instance, in Mexico, regulatory obstacles are a significant barrier for innovation in services, while in the case of Chile the market structure is an obstacle. Certainly, models that exploit differences between countries can shed more light on the causes behind the relative importance of the different innovation obstacles. An even more direct connection with innovation policy was followed by Busom and Vélez-Ospina (2017) in Colombia and Fernández-Sastre and Martín-Mayoral (2015) in Ecuador by studying the impact of public support on innovation in firms.

More recently, a few studies have made use of more variables describing how firms innovate to study the identification and impact of innovation modes. Fernández-Sastre and Reyes-Vintimilla (2020) in Ecuador identify six innovation strategies among firms, each of them related to a specific pattern of technology adoption. Carrillo-Carrillo and Alcalde-Heras (2020), by using the STI and doing, using, and interacting (DUI) taxonomy of innovation modes, highlight the relevance of the latter for product innovation in Mexico, in contrast to results from European countries where the STI mode dominates. Exploiting the more abundant innovation data in LAIS allows us to expand the understanding of how LAC firms innovate, as in Vargas (2021).

Despite the growing interest in academia and policymaking in open innovation, there is only a handful of studies using IS data for this purpose in the LAC region. One of the reasons is that the typical IS only has data regarding certain aspects of inbound open innovation (Alexy and Dahlander, 2014). In this regard, a positive effect of firm collaboration with universities in product innovation was found for Chile and Colombia by Marotta et al. (2007). The importance of external knowledge is also estimated by the effect of the use of information from clients on product innovation in Colombia (Corredor, Forero, and Somaya, 2015). Certainly, the study of selection, complementarities, and effects of innovation partners is a topic where researchers can exploit the good description of cooperation partners and objectives available in LAIS.

LAIS also provides data on somewhat neglected research topics, such as the use of formal and informal methods of protections of innovation. Considering the heterogeneity of intellectual property rights (IPR) systems in LAC, the large size of the informal economy, and the low level of innovation investments, it seems natural to ask whether difficulties in protecting the benefits of innovation are significantly harming innovation investments in LAC firms, the suitability of formal IPR for these firms, and to what extent business strategies are proven suitable mechanisms to protect innovations in the region. Hall (2020) reports how patents are used mostly by foreign applicants, while domestic firms file trademarks more intensively than foreign firms in Chile. Nevertheless, neither of the two seems to be related to increased performance in firms using IPR. This is an area that deserves further research in the region.

3. Main Characteristics of LAIS

This version of LAIS contains 687 variables and 119,900 observations from 30 IS conducted over the period 2007–2017, covering 10 countries. The countries included in LAIS are Argentina (AR),

Chile (CH), Colombia (CO), Ecuador (EC), El Salvador (ES),[3] Dominican Republic (DR), Panama (PA), Paraguay (PR), Peru (PE), and Uruguay (UR). For the sake of simplicity, in this document we refer to each specific IS in LAIS with a combination of its country code and the year of implementation, and whenever a country code appears without a year it refers to all of their surveys. For instance, UR13 refers to the IS from Uruguay implemented in 2013, and AR refers to IS implemented in Argentina in 2013 and 2016. The essential characteristics of each IS wave included in LAIS are presented in Table 2.

As mentioned previously, IS in LAC countries are implemented following different methodologies that affect the comparability of the data. Decisions about the sampling frame, the mode through which responses are collected, the type of interaction between respondents and the statistical organization, and differences in the statistical unit affect the comparison of results between countries. Since the data harmonization process is not able to correct for any discrepancies at this level, we describe the characteristics and differences between surveys included in LAIS for researchers to make informed decisions about the interpretation of their results.

3.1. Institutional

3.1.1. Accessibility

Although it may seem evident that allowing open access to data is the best strategy to increase societal benefits of data production, many statistical agencies have incentives to lean in the opposite direction—that is, restricting access to data due to the need (often a legal requirement) to assure the confidentiality of the participants in surveys. In many cases, the application of simple data anonymization routines that eliminate direct and indirect identifiers are enough to protect the identity of respondents (Eurostat, 1996). In other cases, because of eventual specificities of the domestic economies, statistical agencies may perceive or identify high risk of identification of individual companies. Therefore, they choose to provide controlled access to datasets, whether by licensing the access to data, providing limited remote access, or allowing on-site access only.

Hence, because of the different approaches to data accessibility, not all LAC countries that have conducted an IS can be included in the LAIS dataset. Currently, access modalities range from public access through websites, such as in Chile, Ecuador, Peru, and more recently Colombia, to on-site access only, where data is made available to registered users in the computers and offices of the local statistical office, like in Brazil and Mexico. The access policies of LAC countries with at least one IS wave are summarized in Table 1.[4] The LAIS dataset, therefore, includes microdata only from countries where the microdata can be accessed through the web and those that received direct financial and technical support from the IDB in the implementation of the IS.

[3] Although the harmonization of variables from ES13 and ES16 has been completed, this version of LAIS database is only allowed to publish the data from ES13.

[4] In 2016, an innovation survey was implemented in Bolivia by a university and the IDB, but it is not included in this analysis because it is not an official survey implemented by the country (Foronda, Beverinotti, and Suaznábar, 2018).

3.1.2. Capacities

The implementation of IS by national statistical offices involves a learning process that may lead to increased quality of the data, depending on time and experience. For this reason, we expect that the quality of IS data from countries that have implemented, for instance, their fifth IS wave will be higher than from those who recently started measuring innovation. However, we do not have tools that allow for testing this intuition. Simultaneously, statistical agencies are not homogeneous in terms of quality of data production; therefore, more sources of differences could arise from uneven statistical capacities (Dargent et al., 2018).

3.1.3. Timing

The timing of the survey will also affect comparability in a way that we cannot predict nor control. Since each country follows its own statistical calendar, the variety of IS included here have different timing for data collection and the period of coverage. Furthermore, since innovation investments tend to be pro-cyclical (Fabrizio and Tsolmon, 2014; Giedeman, Isely, and Simons, 2006; Sedgley, Burger, and Tan, 2018), straight comparison between country statistics of IS with partial overlap of the reference period may be problematic when a year of unusually high/low economic growth is involved.

3.1.4. Sampling frames

As we mentioned earlier, although each of the surveys is based on the best sampling frame available in the country, the quality of these frames is not homogeneous. Changes at this level may bias the composition of the sample, and the sampling weights may not necessarily correct the bias. Therefore, attention needs to be paid when interpreting differences between statistics estimated at the sector and country level.

3.2. Target Population

3.2.1. Sectoral coverage

Although some evidence suggests that economic sectors are not strong determinants of the way firms engage in innovation (Srholec and Verspagen, 2012), differences in sectorial coverage need to be considered or addressed when estimating and interpreting country-level innovation statistics. All IS in LAIS cover the manufacturing sector. Surveys from CH, CO, DR, EC, PA, PR, and UR also include some selected service activities. Additionally, CH, DR, EC, and PA include firms in natural resources–based sectors (see more details in Table 3 and Table 4).

3.2.2. Firm size

Most IS from the sample consider all firms with 10 or more employees as the target population. This threshold is smaller in the Uruguayan surveys where the target population includes firms with five or more employees. In the surveys of CH and PA09, the target population consists of all firms

in the national territory with annual turnover of at least US$104,000[5] (approx.) and US$150,000[6], respectively.[7] In CO, the manufacturing sample targets firms with 10 employees or more and an annual turnover above a biannually defined threshold. The services sample in CO includes larger companies, defined by using a different combination of employees and annual turnover threshold for each activity (for details, see Table 7). Finally, in PA14, the target population is defined as all firms operating in the country.

3.2.3. Statistical unit

The statistical unit of all the innovation surveys included in the dataset is the firm. However, what is considered a *firm* in each country may vary. For instance, in some countries, any legal entity that has a tax identification number can be classified as a firm, while in others, a firm is defined as the minimum size organization that can make business decisions, regardless of the legal status or tax ID. We do not have clear information on this regard for all countries; therefore, any difference found at this level must be addressed by the data user.

3.2.4. Reference period

Most countries of the region have a period of observation of three years except for CH and CO Table 6). This difference gives rise to two comparability issues. First, it is well known that the length of the period covered by a survey affects the quality of the data (Schwarz, 1999). Recall bias may increase with the length of the observation period. Therefore, we should expect a lower quality of data in countries with more extended periods of measurement. Second, while firms that continuously engage in innovation activities are almost equally likely to be classified as such in a period of two or three years, occasional innovators have a higher chance to be identified in surveys with more extended reference periods. Hence, everything else being equal, the prevalence of innovation in IS covering two years may be lower than countries measuring innovation in a period of three years.

3.3. Methodology

Most of the IS in the LAIS dataset are cross-sectional in nature and represent a sample of the target population, based on combining stratified random sampling with a forcefully included group of firms. The IS in CO and UR are the exceptions. In the case of CO, each IS is a census of all companies in the target population, hence a significant share of firms is surveyed permanently. In UR, the panel nature of the data is by design, since the sample of UR10 has been maintained and is updated continuously with a selection of newly created firms. In these two cases, besides a variable that identifies each observation in LAIS, we have kept the identification number from the original source (firm_id). That means the panel structure of the data can be exploited in CO

[5] 2,400 Unidades de Fomento (UF) (Chilean Unit of Account). In the 2015 survey, it was 2,400.1 UF.
[6] 150,000 balboas.
[7] In the case of manufacturing in Chile, the threshold also considers that firms must have at least 10 employees.

(only in manufacturing) and UR. In CO it is also possible to link the data to the Annual Manufacturing Survey[8] to add new variables to the analysis.

3.3.1. Forcefully included firms

In most IS included in LAIS, large firms are forcefully included in the sample. In this way, countries aim to measure the activity of those firms that account for a significant share of the economy. In some countries, specific sectors and firms that received public support for innovation are also forcefully included, the latter in order to conduct program evaluations. The details on firms forcefully included in each IS are presented in Table 7.

3.3.2. Stratified random sampling

Among stratification variables, firm size and economic activity are the most common criteria as all IS in the sample account for it. However, the definition of firm-size strata varies across surveys, as shown in Table 9. The definition of the economic-activity strata used in each survey is provided in Table 10. Finally, in CH, DR, and EC, the geographical dimension represents the third stratum (for details, see Table 8).

3.3.3. Geographical coverage

Only CH, DR, and EC include geographic regions as another strata level. The rest of the IS in the sample do not impose geographical restrictions to a sample share that is randomly selected. Therefore, although firms in any region of the country (in the targeted population) have the potential to be selected in the sample, the random sampling may result in regions not having any observation in the sample. Two exceptions are worth noting. In the case of PE, only firms based in the regions that together account for more than 90 percent of the country's manufacturing activity are included in the sampling frame. In PA14, firms from the Darien region are excluded from the studied population.

3.3.4. Levels of statistical inference

Although the design of IS in each country allows for the coverage of several economic activities, this feature does not directly imply that statistics estimated are statistically representative in each of these economic sectors. Indeed, regardless of stratification, the majority of IS in LAIS are designed to be representative only at the Division level of the corresponding version of the International Standard Industrial Classification (ISIC).

Some IS also allow representative statistics to be estimated according to the size of the firm. Indeed, based on their classification of firm size, data from AR, CH, CO, EC15, and UR meet this statistical requirement. Furthermore, in the case of AR, CH, CO, and EC15, the results are also representative at the level of firm size by economic activity.

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[8] This survey is freely available, in Spanish, on the website of the National Administrative Department of Statistics (DANE) at http://microdatos.dane.gov.co/index.php/catalog/MICRODATOS/about_collection/6/2.

Only data from CH and EC are designed to provide representative results at the regional level (*regions* and *provinces*, respectively). In addition, CH15, CH17, and EC15 allow for the estimation of representative statistics of economic activity by region. However, in the case of Chile this is only in highly aggregated sectors (primary, secondary, and tertiary activities).

Finally, the cases of PA14 and the DR need to be considered carefully, since these surveys are not designed to (or at least do not claim to) allow representative estimations at any specific subsample level.

3.4. Questionnaires

3.4.1. Design

It is well known that, in surveys in general, the order in which questions are placed in a questionnaire may affect the responses (McFarland, 1981). Although IS in our sample have a similar structure, differences in the order of the modules are worth noting. We present, in Table 11, some of these differences in three of the core modules of the typical IS. Another important source of differences is related to the share of firms that are subject to each question, defined by the presence of filter questions (Table 12). Furthermore, as Galindo-Rueda and Van Cruysen (2016) report, responses may be affected by the way a questions is phrased and its location in the questionnaire. To the best of our knowledge, none of the IS included in this database has tested these issues.[9] We are not able to provide a guide regarding how or to what extent differences in phrasing questions may affect the comparability of variables.

3.4.2. Filters

There exist three types of filters applied in the IS of our sample. Questions can be limited to innovation-active firms (IAF), to innovative firms (IF), and to non-innovative firms (NIF). IAF corresponds to firms that invested in innovation activities, whether they have achieved innovations during the reference period or not. IF are firms that have achieved one or more innovations during the reference period,[10] and NIF are those that did not engage in innovation activities nor report innovations in the period. Table 12 details the filters applied to the main sections of IS.

[9] In Chile, the preparation of the 2019 IS included the cognitive testing of the new questionnaire, a first for the country.
[10] We make and use these definitions only for the sake of explaining the different questionnaire filters in this section.

4. Variables in LAIS and the Harmonization Process

4.1. General Characteristics

One of the main constraints of using IS data to understand the determinants of innovation is the lack of variables that describe the characteristics of non-innovative firms (Mairesse and Mohnen, 2010). However, many of the IS included in LAIS include questions that characterize non-innovative firms, departing somewhat from early versions of CIS-type questionnaires. We have included in LAIS general characteristics variables that are available for at least two countries. To obtain this information, we rely on the comparison of similar questions and, when available, we also use administrative records from the original dataset to impute the desired variables. When data refers to a specific year, the name of the variable ends with a suffix indicating the year of the period of the IS. Thus, when the variable name ends with "_Y1" the data refers to the first year of the period covered by the survey.[11] The general characteristics in LAIS and country/wave availability are presented in the following sections.

4.1.1. Age of the firm

LAIS contains a variable indicating the year in which firms started operations. Although in IS manuals it is often mentioned that this variable needs to refers to the start of operations in the country in order to correctly measure the domestic experience of foreign-owned firms or multinationals' subsidiaries, only EC, ES, and PA14 explicitly specify this in the question. This variable is not available in AR nor CO.

4.1.2. Number of employees

In general, the number of employees reported in IS includes contracted and subcontracted employees. This variable is constructed for each year of the reference period whenever the information is available. ES, PA, and PE do not specify whether subcontracted employees are included in the total. PA, UR07, and UR10 only provide employment data for the last year of the period covered by the IS. ES, PE, and PR provide the number of employees for the first and last year of the three years covered. AR, CH, CO, EC, UR13, and UR16 record data of employment for each of the years included in the reference period of the IS. DR does not provide data about employment.

4.1.3. Website

This variable is a dummy that informs whether the firm owns a website. In the surveys of AR, DR, PA09, and PE15, this question is asked directly, while in ES and PR it refers to firms that declare that they have designed or maintained a website during the period of reference. This variable is not available in CH, CO, EC, PA14, PE12, and UR.

[11] Therefore, all variables ending with "_Y3" in CH and CO are missing, since these IS only cover a period of two years.

4.1.4. Foreign capital

LAIS has two variables measuring foreign capital in the firm. The first one is a continuous variable indicating the percentage of foreign capital in the firm and is available for the last year of the reference period in CH, EC, ES, PE, PR, UR07, and UR10. It is also available for the first year of the reference period in PE15.

The second variable is a dummy that indicates the presence of foreign capital in the firm. We have built this variable to allow comparison with AR, UR13, and UR16. In AR, we have built the dummy from an original categorical variable measuring the share of domestic capital. In UR13 and UR17, the dummy has been built for each year of the reference period, starting from an original variable indicating the first year in which the firm had foreign capital.

4.1.5. Group

This variable is a dummy regarding whether the firm has belonged to a corporate group during the reference period. The question does not refer explicitly to any specific year except in PE, where the question refers to the last year of the reference period. This variable is not available in AR17 nor CO.

4.1.6. Sales

Sales are measured in most surveys included in LAIS. The variable refers to the total annual income from sales. In AR, EC, PE, and UR, there is an explicit instruction not to include value-added taxes or similar, while in CH, ES, and PA, the question refers directly to “net sales.” In CO and PR, the question asks for total sales, with no reference to excluding taxes. It is also worth mentioning that in CH and EC the instructions of the questionnaire emphasize that income from exports must be accounted for in sales. In this regard, CO and PA ask for domestic sales only while measuring income from exports in a separate variable; therefore, we sum up both variables to estimate a measure of sales comparable to the rest of the database. Finally, in AR, ES, PE, PR, and UR, there is no mention to account (or not) for export income in the sales variable. Sales are measured for every year of the reference period in CH, CO16, CO17, EC, PE15, UR13, and UR16; for the first and last year in ES, PE12, and PR; and only in the last year in CO12, CO13, CO14, CO15, PA, UR07, and UR10.

4.1.7. Exports

Income from exports is registered in all surveys that also measure sales, whether directly or as a percentage of sales as in PR16 and UR. The exception is in AR data, where we can only create a dummy variable of export activity from an original variable indicating the geographical location of its clients. For the sake of comparability, we also calculate a dummy indicating if the firm has exported using the income from export data for the rest of the countries.

4.1.8. Investments

Few IS in LAIS measure investments made by the firms. In all surveys, this variable refers to investments in *fixed capital*. Only AR, EC, and PE15 include this variable for every year in the

period of reference, while ES, PA, and PR measure investments in the first and last year of the period of reference.

As with sales and exports, investment variables are reported in local currency. We also provide the equivalent in current USD.[12] DR does not provide information on any of these variables. Table 13 provides more information about the availability of general characteristics data in LAIS.

4.1.9. Capacity utilization

The variable on capacity utilization is continuous and corresponds to the average percentage of production capacity utilization of the firm each year. PE12 and UR report this value for the last year of the reference period while PA and PR16 have information on the first and last year of the reference period. Finally, PE15 provides information on the three years of the reference period.

4.1.10. Economic activities

The harmonization process also consists of harmonizing the classification of the economic sectors of the IS included in the sample. The IS in our sample are almost equally distributed between those using ISIC Rev. 3/3.1 and ISIC Rev. 4. In countries using the ISIC Rev. 4 classification, the economic activity is disaggregated at the Class and Group level, yet only at the Division level in those countries using ISIC Rev. 3/3.1. For this reason, we decided to harmonize the information on economic activity from ISIC 4 to ISIC 3.1. We make use of the official correspondence table between ISIC Rev. 4 and ISIC Rev. 3.1 developed by the United Nations Statistics Division.[13] Table 5 present the sectoral classifications available for each IS.

4.1.11. Human resources

LAIS has information on the distribution of employees according to the type of occupation (professional and technician) and the maximum level of formal education attained. A higher level of detail is also available for employees with tertiary education by describing the field of study.

Only AR, CH09, CH11, and UR provide data regarding the percentage of the labor force classified as professional and technician. The disaggregation by the maximum level of formal education attained is more common, available in CH13, CH15, CH17, CO, EC, ES, PA, PE, and PR. The main differences arise in the classification of post-secondary non-tertiary education. While in some countries this category is labeled as “technical,” in others it is “non-university/vocational.” Nevertheless, we treat it as the same category. Table 14 presents the details.

The share of employees with at least an undergraduate level of education is also classified according to the fields of study. Although not all original questionnaires offer the same classification, we organize it in the following seven variables: Natural and Exact sciences, Engineering and Technology, Natural Sciences and Engineering, Social Sciences, Medical and

[12] We use the historical exchange rate provided by World Development Indicators (2020).
[13] https://unstats.un.org/unsd/classifications/Econ/ISIC.cshtml

Health Sciences, Agricultural Sciences, and Humanities and Others. Table 15 presents the availability of these variables and the main differences between IS.

4.2. Knowledge Activities

4.2.1. R&D

LAIS has two types of variables related to the organization of R&D in firms. One variable is a dummy that takes a value of 1 when the firm has a formal R&D department and 0 otherwise. This variable is present in all surveys but CO and PA14. LAIS also captures the number of employees (head count) engaging in R&D activities in the firm, regardless of the organizational formality of those activities. In the case of AR, CH13, and PA09, this variable is only available for firms with a formal R&D department. On the contrary, CO registers the number of employees on R&D activities but not the existence of a formal R&D department. Finally, only in CH11 are both variables missing.

4.2.2. Engineering and design

As with R&D, engineering and design activities are measured by the number of employees and the existence of a formal department in charge of these activities. The dummy variable is available in CH13,[14] CH15, CH17, EC, ES, PE, PR, and UR. The number of employees is available for those same surveys and PA14.

4.2.3. Information and systems

LAIS also has two variables measuring the number of employees working on information and systems in the firm, and a dummy indicating if that area is formal. Both variables are only available in CH13, CH15, CH17, EC, ES, PE, and PR.

4.3. Innovation Activities

4.3.1. Innovation expenditures

In all surveys, the firm is asked whether it has conducted a specific innovation activity during the period of reference (a filter question), and then it is asked to report the amount spent in the corresponding year. CH15 is the exception, as no filter question is included. In most of the IS in our sample, questionnaires capture innovation expenditures for each year of the period covered. The exceptions are ES, where only the first and last year are detailed, and DR, PA14, UR07, and UR10 in which only data for the last year is provided.

It is important to note that while in AR, CH, CO, PA, PE12, and UR, innovation expenditures refer to activities developed to introduce any type of innovation, in DR, EC, ES, PE15, and PR the objective is restricted to product or process innovations.[15] In the latter group of surveys, total expenditures on organizational and marketing innovations are captured in separate variables.

[14] Only for innovative firms.
[15] As defined in the 2005 edition of the Oslo Manual.

Firms that have ongoing innovation activities and those that abandoned innovation projects are measured in two different variables, available in CH15, CH17, CO, DR, EC, and PE15.

Innovation expenditure variables are continuous and reported in local currency. We include a dummy variable that measures if a firm declares expenditures in any of the innovation activities presented in the correspondent questionnaire. We also provide the expenditures by innovation activity in current USD. The details about data availability are presented in Table 16. We provide further details on the definitions and comparability below.

a. In-house and external R&D

   In all IS the definition from the Frascati Manual (OECD, 2002) is followed. In-house and external R&D are captured in separate questions. In most surveys, the R&D expenditures are measured in the local currency. In CH13, CH15, and CH17, these expenditures are measured as a percentage of annual sales. We use these percentages and the total sales to calculate expenditures in R&D.

b. Machinery, equipment, and ICT

   Machinery and equipment

   - Although the underlying concept is the same, some IS refer to "machinery and equipment" and others to "capital goods." In CH, expenditures in this activity are included in the same question with hardware and software for innovation.

   Hardware and software

   - In AR, DR, UR07, and UR10 investments in hardware and software are included in the same question, but in the rest of the IS in LAIS, the two types of expenditures are measured through separate questions. We provide three variables: hardware, software, and both together. The latter is the sum of the two variables for those countries with separate hardware and software variables.
   - We also build another variable that aggregates the investments in machinery, equipment, hardware, and software for innovation, to allow the comparison of CH data with the rest of the IS.

c. Knowledge acquisition

   Innovation investments related to the acquisition of disembodied technology are one of the topics where there is less consensus among IS. We have found four non-exclusive main concepts that are applied: Technology Transfer, External Knowledge, Disembodied Technology, and Consultancies and Technical Assistance. In general, the first three concepts refer to the acquisition of patents, licenses, know-how, and other forms of intellectual property. We include all these concepts in LAIS under the label of Technology Transfer. Expenditures in consultancies for innovation can be exclusively identified in AR, CO, EC, ES, PA, and PR. In PE and UR, consultancies are included in the same question as Technology Transfer. It is worth mentioning that in DR, this

category also includes “other sources of knowledge developed by other firms and organizations.”

d. Training
Since the wording and definition of this question are relatively homogenous across the IS in LAIS, and it is present in all of them, we do not modify this variable.

e. Engineering and design
In the entire LAIS sample except for CH, this question refers to expenditures in engineering and industrial design activities for innovation. In CH09 and CH11, there was no question in these areas, while in CH13, CH15, and CH17 a question only about expenditures in design is included. We use the latter as a measurement of engineering and design expenditures in those IS, but it needs to be considered as a lower boundary.

f. Market research
This variable encompasses firms’ investment in market research for innovation. Unlike the previous innovation activities listed in this section, the presence of this concept is less frequent in the IS in our sample. Questionnaires in AR, PA, UR07, and UR10 do not include market research as part of the set of innovation activities. While the wording of this question is similar among the remaining IS, in CH and DR the concept used is broader, including marketing in the former and other activities required for the introduction of innovations in the latter.

g. Others

The questionnaires of CH and DR include a category where other innovation expenditures (needed for the introduction of innovations) that are not listed in the set of activities provided in the questionnaire should be included. In CH09, CH13, and CH15, there is an explicit focus on *tooling up*.

In all IS that have other types of innovation activities that cannot be harmonized, we aggregate those variables in this category. In PA09, it is the case of Management, while in PA14, Quality Management, Environmental Management, and Technological Surveillance Activities have been added. In UR, investments in Organizational Design and Management for Innovation are also included in this category.

4.3.2. Sources of financing

All IS in LAIS include at least one category of the source of financing of innovation expenditures. We classify all different types of answers into four main categories: Public, Bank, Own Resources, and Other. All IS have information regarding the use of public sources, most of them through a direct question regarding the use of public funds, except for AR, where the firm is asked about the use of a set of public programs. CH11, CH13, CH15, and CH17 only have data on public sources. Details on the availability of this variable in LAIS are presented in Table 17.

4.3.3. Innovation output

All IS in LAIS follow the four innovation categories and their definitions from the third edition of the Oslo Manual (OECD/Eurostat, 2005).

One of the lasting discussions regarding IS questionnaire design is the use of definitions (of innovation) as an introduction to the questions, or as a part of the question itself. In this regard, most LAC countries have converged in phrasing innovation outputs questions using the definition rather than the concept of innovation itself, that is, asking about "the introduction of new or significantly improved…" rather than "introduction of innovation(s)."

Only PA and UR ask directly about the introduction of a product, process, organizational, and marketing innovation, while AR does the same for the two latter innovation outcomes. The rest of the IS in LAIS phrase questions about innovation outputs by making use of the wording in the definitions of innovation from the Oslo Manual of 2005.

EC, ES, PE, and PR use separate questions for new goods, new services, improved goods, and improved services. CH and DR capture new and significantly improved goods in one question, and the same for services in another. Meanwhile, AR and CO ask separately about new products and significantly improved products.

Most commonly, process innovation is measured through two questions that distinguish new from improved processes. CH11, CH13, CH15, CH17, and DR ask separately for new or improved (a) methods of production, (b) logistics, and (c) supporting activities. In PE15, each of these three types of process innovation is also separated between new and improved.

Organizational innovation is measured by asking separately about the introduction of new business practices, new methods of organizing work responsibilities, and new methods of organizing external relations, in CH, DR, EC, and PE.[16] ES and PR include the same three types of organizational innovation but as part of one question.

Marketing innovation is measured by four questions in CH11, CH13, CH15, CH17, EC, and PE, while a single question, aggregating the four types of marketing innovations, is used by ES and PR. In CH09, only two of the four types of marketing innovation were included.

In the final database, we build and make available innovation outputs variables that allow for comparison between most of the IS waves. The details are available in Table 18.

4.3.4. Innovation scope

The scope, or degree of novelty, of the innovations is measured for product and process innovations, except in CO where the variable is available for product innovation only. Most IS include three possible novelty degrees: the firm, the domestic market, and the international market. The exception is CH, where only two degrees of novelty are recorded: the firm and the market. LAIS includes one variable for novelty degree of product innovation and another for process innovation, separating between new-to-the-firm, new-to-the-domestic-market, new-to-the-international-market, and new-to-the-market.

4.3.5. Product innovation turnovers

Information on product innovation turnovers is defined in terms of:

- Share of sales from new-to-market product innovations,
- Share of sales from new-to-firm product innovations,
- Share of exports from new-to-market product innovations, and
- Share of exports from new-to-firm product innovations.

Most IS from our sample ask the firm to provide information on product innovation turnovers, except AR and DR.

In most surveys, this question refers to the last year of the reference period (CH,[17] CO,[18] ES, PA, PE, PR, and UR). Only in EC, the question applies to the share of sales and exports of the entire reference period.

4.3.6. Innovation impacts

This set of variables captures the firm's perception of the importance of different innovation impacts. Most IS include these types of questions except AR, ES, PE15, and PR. A Likert scale measures the effects of innovations.[19]

Not all IS capture the same innovation effects or ask questions in the same way. We keep all effects that can be directly compared between two countries or more. We also create variables that aggregate some effects in a broader category that allows for the comparison of data from at least two countries. Table 19 provides details on the availability of innovation impacts in LAIS.

4.3.7. Motivation for innovation

This set of variables refers to the motivations behind the decision of the firm to innovate. These variables are available only in AR, DR, EC, ES, PE, and PR. Table 20 presents the details of the innovation effects available in LAIS. Data from DR comes originally from a Likert scale response, restricting answers to "low," "medium," and "high" level of importance for each motivation. For comparability, we transform this variable into a dummy that takes the value of 1 if the level of importance is "medium" or "high."

4.3.8. Innovation obstacles

Obstacles to innovation are available in all IS in LAIS. These questions are addressed to all firms in each sample except in PA09, where the question is only to be responded to by NIF. It is captured by a variable that records the importance of each type of obstacle in terms of a four-

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[16] However, the wording of each of these alternatives varies between countries.
[17] In CH09 and CH11 the question refers to each year of the reference period.
[18] This variable is not available in CO09, CO10, and CO11. Although available in the original data source, the way this variable was recorded is not comparable with the rest of LAIS.
[19] The Likert scale is defined such that a value of 1 denotes a high importance, 2 a medium importance, 3 a low importance, and 4 no importance. In CO, the level "low importance" is not available, and in PA14 there is no "medium importance" alternative.

level Likert scale.[20] When aggregating two or more obstacles in one variable, for harmonizing purposes we impute as the importance of the created variable the highest level of importance between the aggregated obstacles. In AR, innovation obstacles are measured only by a binary variable that captures whether a firm has experienced a particular innovation obstacle.[21] To be able to compare AR with the rest of the sample, we add a dummy variable that takes the value of 1 if the firm considers an innovation obstacle of high, medium, or low importance, and 0 otherwise. Detailed information regarding innovation obstacles is presented in Table 21.

4.3.9. Cooperation

All IS in LAIS include a module related to cooperation for innovation. The cooperation variables provide information on firm cooperation for innovation with third parties, the type of partner, and the objective of cooperation. In most surveys, the cooperation question refers explicitly to innovation activities, except in ES, PA, PE15, and PR, where the question refers to the existence of cooperation without referring to a specific goal. Table 22 provides details on cooperation partners. The objectives of cooperation are also available. While the type of partners varies from one survey to another, the category of objectives of the cooperation is relatively homogenous across the surveys: R&D; Engineering and Design; Training; Technical Assistance; Information; Product Testing; Financing; and Organizational Changes. Table 23 provides information on the availability of each type of cooperation objective in LAIS. In UR13 and UR16, firms are asked to select the three most important partners, limiting the comparability to other surveys.

4.3.10. Information sources

Two types of variables measure the perceived importance of the information sources for innovation. The first group of variables corresponds to the importance of each type of information source in terms of a four-level Likert scale,[22] available in CH, DR, EC, PE, and UR. The second group consists of dummy variables informing on whether the firm has used information from a variety of sources, available in AR, CO, ES, PA,[23] and PR. We build the dummy variable from the Likert scale, taking the value of 1 if the firm considers the information source of a high, medium, or low importance, and 0 otherwise.

Information sources are subdivided into internal and external. Despite the relative homogeneity of the set of information sources considered in the IS, differences in the level of aggregation limit the comparability. We keep the most disaggregated groups that can be comparable for two countries or more. Also, when needed, we construct aggregated variables to improve

[20] The Likert scale is defined such that a value of 1 denotes a high importance, 2 a medium importance, 3 a low importance, and 4 no importance. In CO and PA14, the level “low importance” is not available. In DR, categories “low importance” and “no importance” are aggregated. In CH09, the Likert scale includes five levels (high, medium, low, irrelevant, none). In that case, we consider the levels “irrelevant” and “none” to be the same level, corresponding to “not important.”

[21] In the case of AR13, the firm is asked to select the three most important obstacles within the firm, and the three most important obstacles in the firm environment.

[22] The Likert scale is defined such that a value of 1 denotes a high importance, 2 a medium importance, 3 a low importance, and 4 no importance.

[23] PA14 is limited to the seven most important sources of information only.

comparability. Table 24 and Table 25 provide further details on the set of variables considered and on the availability of information in the innovation surveys.

4.3.11. Intellectual property rights

LAIS provides two types of variables that measure the use of IPR. The first group is variables that measure actions the firm takes regarding IPR in the period of reference of the IS. We assume that the different ways these questions are phrased refer to the same underlying action. The most common phrasing is to ask if firms have "used" IPR to protect their innovations (EC, ES, PA14, PE12, PR, UR10,[24] UR13, UR16[25]). In AR, the IS refers to IPRs that have been "implemented," while in CH15, CH17, PE15, and UR07 the question explicitly refers to "applied for" IPR. In DR, it is IPR "applied for or used." Finally, in CH09, CH11, and CH13 the variables record IPR that has been "applied for or granted," and exclusively "granted" in CO and PA09. Researchers need to keep in mind that long processing times in local IPR offices, especially regarding patents, can introduce significant differences in the comparison between patents "granted" and "applied for." Patents granted during the period of the IS are very likely the output of innovation activities and application processes conducted before the period of reference of the IS. Besides patents, LAIS also includes data about the use of trademarks, utility models, industrial design, copyrights, geographical indicators, and plant variety rights (see Table 26).

The second group of variables measures the stock of IPR in the firm. There are fewer differences in how these variables are captured because all IS with this data ask for valid IPR in the period of reference of the IS. Data is available in CH09, CH11, CH13, CO12, CO13, CO14, CO15, CO16, CO17, EC, ES, PE15, and PR. Table 27 presents the details on IPR included, and availability in each IS.

Also, LAIS provides information on the use of trade secrets and nondisclosure agreements between firms and employees, clients, and other businesses, as a mean to protect innovations (Table 28).

4.3.12. Business strategies to protect innovations

LAIS provides data on business strategies implemented to complement or as an alternative to IPR to protect innovations. AR, EC13, ES, PE, PR, UR13, and UR16 provide between three and five strategies each, including "controlling distribution network," "first to reach the market," "scale of production," "complex design," and "segmenting the production process." CO also provides a variable about the use of "complex design" only. Details on data availability are presented in Table 29.

[24] For patents, the question uses "applied for."
[25] UR13 and UR16, in the case of patents, the question specifies "applied for or granted."

5. Anonymization and cleaning

5.1. Anonymization

To the best of our knowledge, only the IS microdata from AR has been significantly modified for anonymization purposes. Employment data in AR13 is upper-truncated at 400, and observations between 201 and 400 employees have been micro-aggregated. Data on annual turnover and innovation expenditures have also been micro-aggregated for those observations above a certain threshold. Some variables about the general characteristics of the firm have also been dropped.[26] In AR17 variables related to turnover, sales, expenditures, and employment have been upper-truncated, while characteristics such as year of the start of operations, foreign ownership, and type of firm have been micro-aggregated.[27]

The data from Chile do not include the variable indicating the geographical region because it has been previously dropped from the original dataset as part of anonymization procedures. The datasets, including the regional variable but excluding the variable on the economic sector, can be found at the website that hosts Chile's IS data.[28]

To ensure the anonymization of the full database, we exclude from the database any direct identificatory—that is, variables that are susceptible to enabling the full identification of a firm, which we have found in a few of the original raw data inputs. In some countries, the availability of certain variables may allow data users to identify firms. The identification is facilitated when there exists a unique type of firm in a country, and such unique characteristics are also available in the dataset. We take precautions in this regard; hence the most detailed level of economic activity classification that we provide is the Division level of the ISIC, except for IS which are publicly available with a higher level of details on economic activity.

5.2. Cleaning and data consistency

We have run some data quality checks searching for some basic inconsistencies, and we have modified the original data in the following way:

- We drop all observations with a missing expansion factor.
- The year of starting operation is set to "missing" for firms reporting starting operations after the last year of coverage of the IS (10 cases in CH13, 3 cases in PA09, and 1 case in PA14).[29]
- The share of undergraduates in year 3 is set to 100 when the variable is slightly above 100 (1 case in PA09 and 1 in PA14). Reported values for undergraduate and postgraduate are weighted and imputed to add up to 100 (2 cases in PA09 and 3 cases in PA14).

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[26] More details can be found in Guariniello and Rotondo (2015).
[27] More details can be found in Secretaría de Gobierno de Ciencia, Tecnología e Innovación Productiva (2019).
[28] http://www.economia.gob.cl/category/estudios-encuestas/encuesta-nacional-de-innovacion-en-empresas
[29] Because all these firms report data on variables on the period of observation, we assume the year registered as a starting operation is a data-entry error.

- The R&D Department variable is set to 0 when firms report having a formal R&D department but no R&D expenditure (in-house nor subcontracted).
- If export income is higher than sales in the same year by more than 10 percent, we set the export data to missing.[30] If the difference in favor of exporting is below 10 percent, we set the value of export income equal to the sales value in that same year.[31]

[30] There are 13 observations in CH13 and 2 in PR13, in Y_1; 10 in CH13 in Y_2; and 2 in PR13 and 3 in PR16 in Y_3.
[31] There are 7 observations in CH13 in Y_1; 2 in CH13 in Y_2; and 2 in PR16 in Y_3.

6. Descriptive Statistics

In this section, we present a series of indicators estimated with LAIS, highlighting the potential use of the data and avenues to conduct new research. First, we present statistics related to the distribution of firms by size and the incidence of foreign ownership and exporting activities in each country. We then look at two of the main indicators to measure innovation at the country level: innovation investments and innovation intensity. Finally, we provide more details regarding R&D investments, especially the incidence and characteristics of the top R&D performers in the region. We restrict the analysis to manufacturing and services, when available, for companies reporting an annual average of 10 employees or more.

Figure 1. Firm Size Distribution in Manufacturing

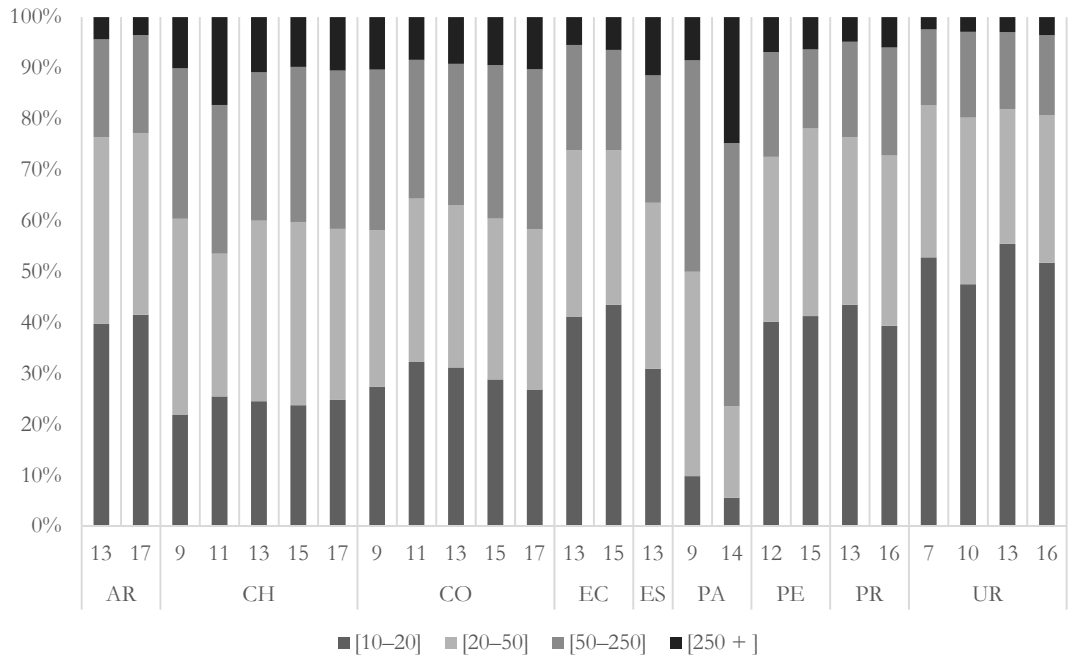
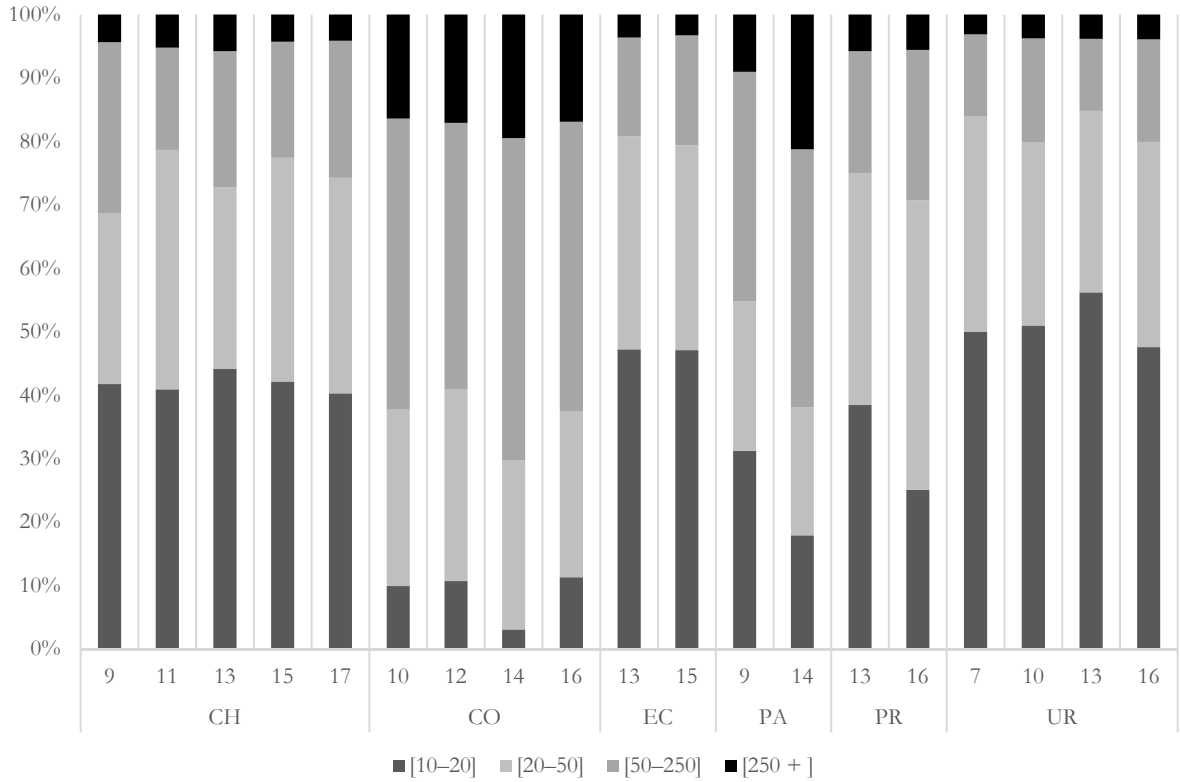


Figure 1 shows the size distribution of firms according to the number of employees in the manufacturing sector. We see that small firms (fewer than 50 employees) represent most firms in each country, and that proportion shows little variation over time. UR has the highest share of small firms, representing at least 80 percent of the industry. Similar patterns are shared between AR, EC, PE, and PR, where the presence of small firms ranges between 73 and 78 percent. Then, in CH, CO, and ES, the share of small firms varies little—around 60 percent. When considering large firms (250 employees or more), the similarities between countries remain. UR consistently has the lowest share of large firms in the economy. AR, EC, PE, and PR follow with shares of large firms between 4 and 6 percent, then CH, CO, and ES with a share of large firms around 10 percent. It is worth mentioning that PA follows a very different pattern, especially regarding the low share of firms with less than 20 employees and a significantly higher share of large firms in 2014, both phenomena attributable to the particular sampling frame used in these surveys. Distribution of firm size in the services sector (Figure 2) is similar to manufacturing, but even more

concentrated in small firms. CO is the exception because, as was explained in Section 3, the target population includes larger firms in services than in manufacturing.

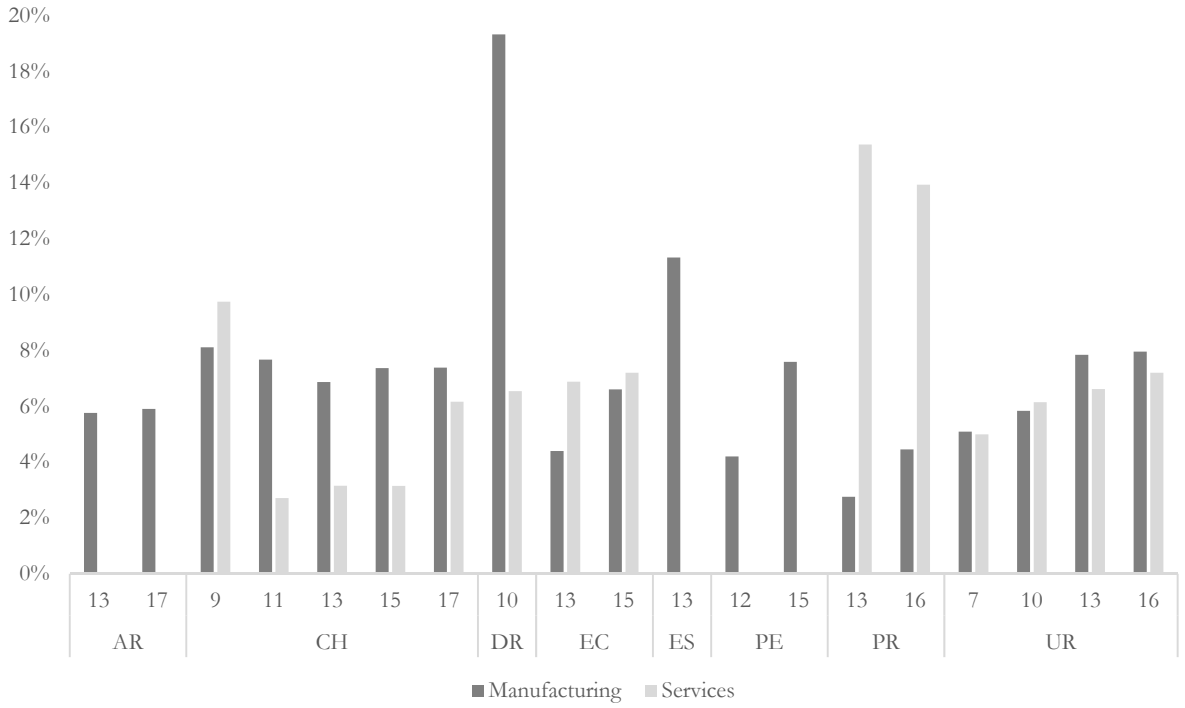
Figure 2. Firm Size Distribution in Services



Besides the size of the firm, linkages with international markets tend to be related to higher innovation capabilities. We look first to the incidence of foreign capital in firms in manufacturing and services (Figure 3). In general, 6–8 percent of the manufacturing firms have some foreign capital. That figure has been stable in AR, CH, and UR, while in EC and PE that figure was reached more recently. PR is the country with the lowest share of manufacturing firms with foreign capital (2.8 percent in PR13 and 4.5 percent in PR16), while DR and ES have the highest share of this type of firm in their economies (19.3 percent and 11.3 percent, respectively), likely reflecting the importance of *maquila* industries in the domestic economy.

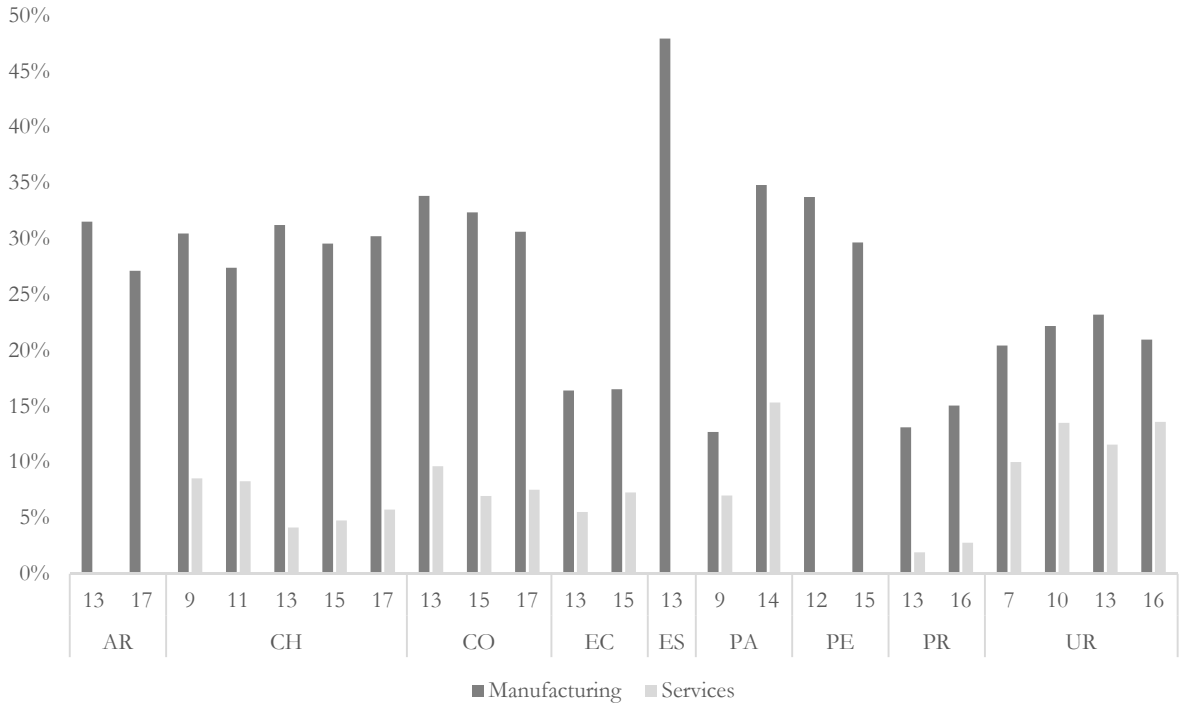
The presence of foreign capital tends to be more common in manufacturing than in services, except in EC and PR. The case of PR draws attention because of the significantly high share of service firms with foreign ownership, which may be reflecting the nature of the selected service sectors included in the target population (as discussed in Section 3).

Figure 3. Share of Firms with Foreign Capital



Next, in Figure 4, we look at the presence of exporting firms. First, exporting is significantly more common in manufacturing than in services. Roughly one of every three manufacturing firms exports in AR, CH, CO, PA14, and PE, while that figure goes to nearly 50 percent in ES. In UR, the share of manufacturing firms exporting is around 20 percent. EC and PR have an even lower share of exporting firms, close to 15 percent. In services, UR has the most active sector, with no less than 10 percent of services firms exporting. PA14 also registers a relatively high share of exporting services firms. In the rest of the countries, the share of exporting service firms moves between 5 and 7 percent, with PR being the exception with 2 percent of services firms exporting.

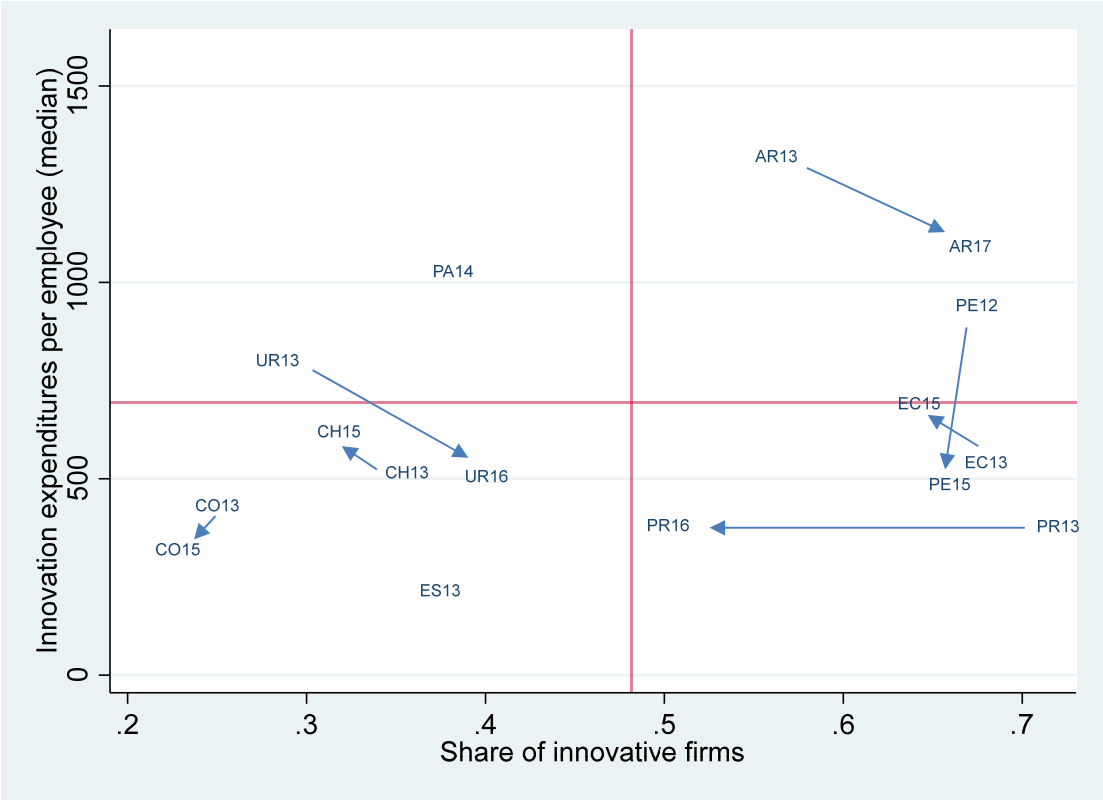
Figure 4. Share of Exporting Firms



In general, LAC countries tend to have relatively high innovation rates (UNESCO-UIS, 2017) while underperforming in aggregated statistics related to innovation such as expenditures on R&D, scientific publications, and patents (Crespi, Navarro, and Zuñiga, 2010). To study both aspects with LAIS, we plot the observed innovation rate, covering the extensive margin of innovation, and the median of the innovation expenditures per employee, the intensive margin, in Figure 5. We restrict the analysis to the manufacturing sector.

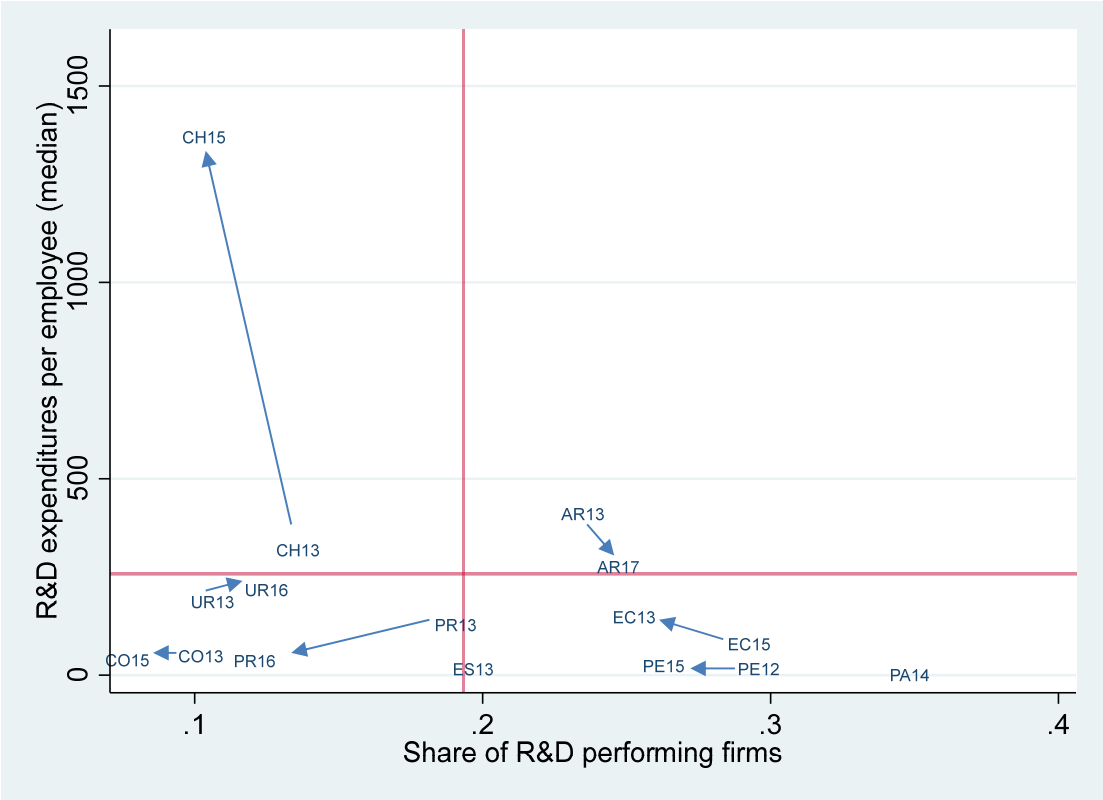
In this graph, we find four types of profiles. In AR and PE12, an above-average share of innovative firms is observed together with median investments significantly above the average of the rest of the countries in the sample. Between the two periods covered, AR increased in the extensive margin but decreased in the intensive margin. PE practically maintained the innovation rate, but the median investment almost halved between surveys in 2012 and 2015. Hence, firm performance in PE in 2015 is more similar to firms in EC and PR, with relatively high innovation rates but below-average innovation investments. In this quadrant, EC moved between 2013 and 2015 by reducing the innovation rate and increasing innovation expenditures. In PR, from 2013 to 2016, the share of innovative firms decreased by almost a third, and the intensity of innovation investments remained at the same (low) level.

Figure 5. Innovation Incidence and Expenditures



PA14 and UR13, while showing a low innovation rate, have a median investment level significantly above average. UR16 shows a significant increase for UR in the extensive margin but lowered innovation investments below the average of the sample. CH, CO, and ES are also in an area of low innovation investments and innovation rates. Between 2013 and 2016, CH slightly reduced the innovation rate but increased innovation investments closer to the regional average. In the same period, CO showed almost no variation on innovation rate but reduced investments by almost 25 percent—still above ES, the country with the lowest observed innovation expenditures per employee.

Figure 6. R&D Expenditures and Incidence



We look at country performance on R&D investments in Figure 6. The quadrants are also drawn by using the between-countries average of the median R&D expenditures per employee, and the innovation rate. The position of AR, as the country with higher innovation rates and investment level, is maintained when looking at R&D. It is the only country with above-average values in both variables. EC and PE also show a relatively high incidence, but low levels of investments per employee.

One of the countries where there is a significant (relative) variation is PA. In contrast to innovation performance, it has a relatively high share of firms conducting R&D but with significantly low investments. On the other hand, CH maintains a relatively low share of incidence, but it is investing significantly more in R&D than the rest of the countries. UR is at the same level of incidence of R&D performing firms as CH, but with lower R&D expenditures. CO, ES, and PR are the countries with a lower share of R&D performing firms and R&D expenditures in the region. We can also see that in CO and PR both, the incidence and the investments went down between the two periods measured. In this period, UR was the only country to increase both R&D expenditures and share of R&D performing firms.

Since R&D expenditures tend to be highly concentrated in a few firms, it is interesting to understand the characteristics of these top R&D performers in LAC. We identify 25 percent of the

firms with higher investments per employee in R&D and its country of origin. We look at this subsample of firms, characterizing it by the general variables already presented in this section.

Figure 7. Characteristics of Top R&D Performers

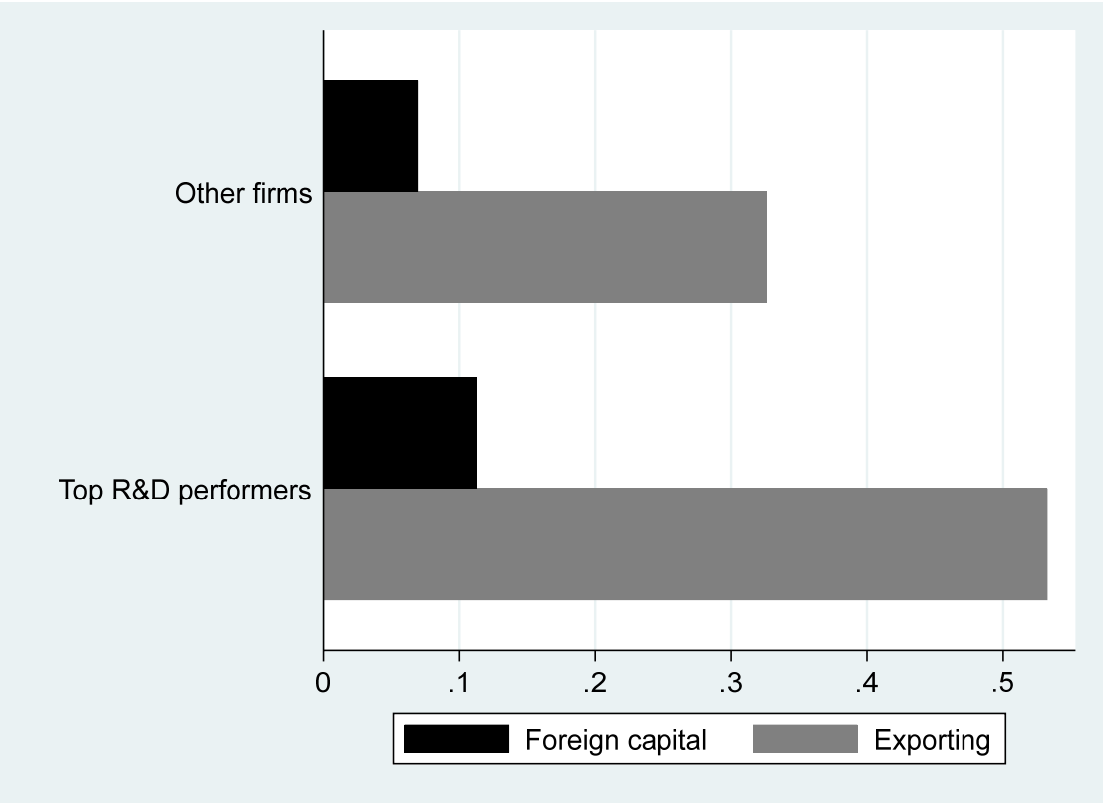
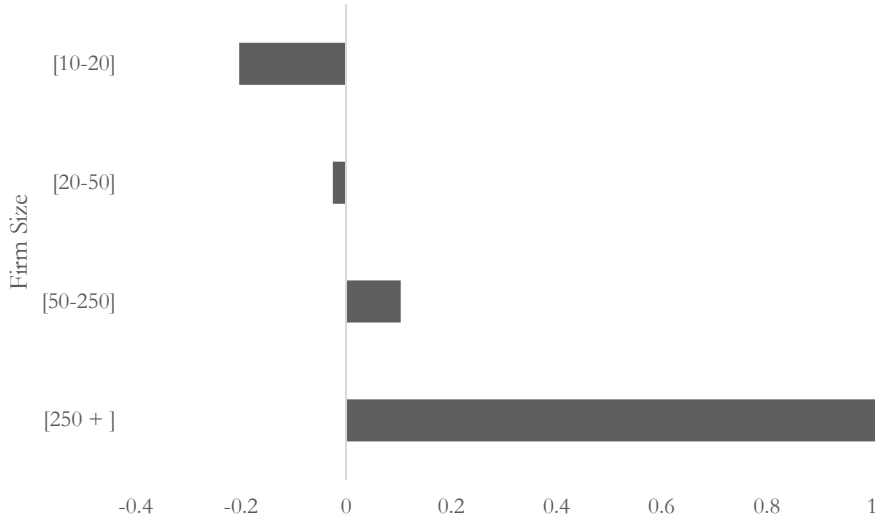


Figure 7 shows that consistent with previous studies (Crespi et al., 2014), top R&D performers tend to be firms connected to international markets, whether by ownership or markets. Of the top R&D performers, 12 percent have foreign capital, while that figure is 7 percent in the rest of the firms. Also, 57 percent of the top R&D performers are exporting firms, while that share is 35 percent in the rest of the firms.

In Figure 8, we depict the importance of the size of the firm, by showing the over/under-representation of firms of each size in the sample of top R&D performers, relative to the firm size proportionate to the population. By this, we show that large firms are almost twice as prevalent among top R&D performers than in the economy. The “excess” of firms is also visible in medium-sized firms, while smaller firms tend to be underrepresented in the group of firms that invest more intensively in R&D.

Figure 8. Top R&D Performers by Size



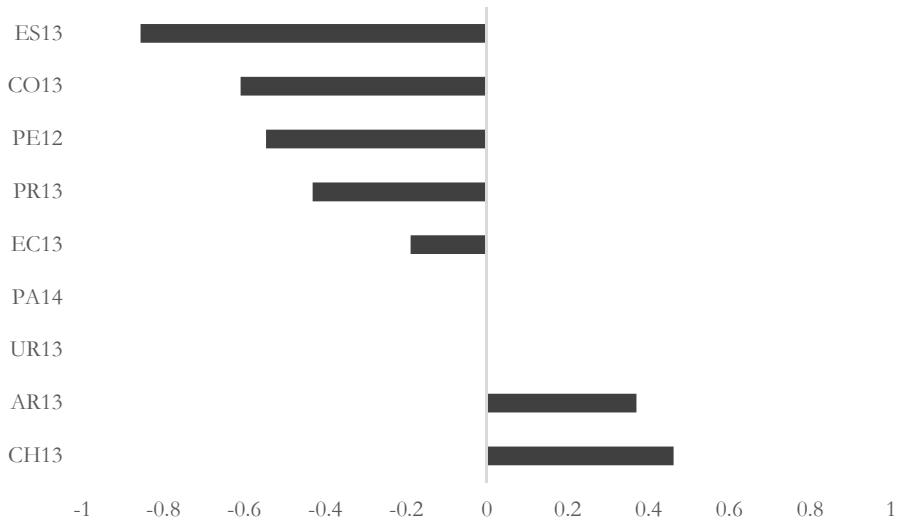
Note: X axis represents an over- or under-representation index. If the index is above (below) 0, the category of firms is over (under) represented in top R&D performers compared to its proportion in the population.

We apply the same logic to understand country-level differences—that is, to what extent the presence of firms from a particular country among the top R&D performers is above or below what can be expected according to the size of its industry. If all countries are performing equally in R&D, we should observe that the share of top R&D performers per country reflects the proportion of its manufacturing sector in the sample. What we find is presented in Figure 9, where we can see that CH and AR "produce" 46 and 37 percent more top R&D performers in LAC than the size of their manufacturing sectors may suggest, respectively. This finding is in line with what is shown

in Figure 5, suggesting that firms from both countries tend to invest more than the rest at all levels of the distribution.

PA and UR have a share of top R&D performers in line with what is expected from the size of their manufacturing sectors. In contrast, EC, ES, PA, and PE are producing significantly less top R&D performers.

Figure 9. Top R&D Performers by Country



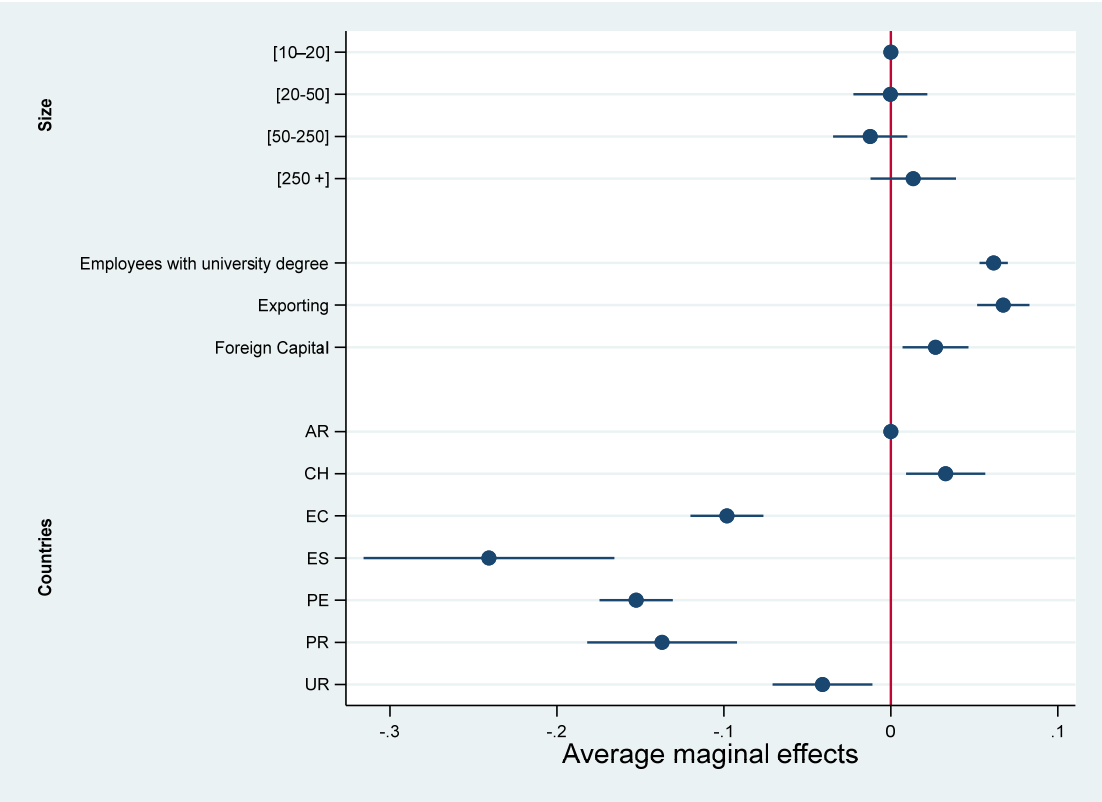
Note: X axis represents an over- or under-representation index. If the index is above (below) 0, that category of firms is over (under) represented in top R&D performers compared to its proportion in the population.

Tackling the roots of these differences is a clear research avenue for users of LAIS. Here we present the results of a probit estimation of the likeliness of a firm being a top R&D performer in the region, controlling by the share of employees that have a university degree, international linkages, size, country, and a time dummy.[32]

Comparing to the previous descriptive statistics, the most important result is that after controlling for firm characteristics, the size of the company is not a strong determinant of being a top R&D performer. Exporting firms are 7 percent more likely to be top R&D performers, slightly higher than the marginal effect of an extra point on the share of employees with a university degree. Firms with foreign capital are nearly 3 percent more likely to be top R&D performers.

[32] Equal to 1 if the survey was conducted between 2012 and 2014, 0 otherwise.

Figure 10. Probability of Being a Top Performer on R&D



Note: CO and PA are excluded from the regression because these surveys do not have data on foreign capital, and level of education of employees, respectively.

Finally, the estimation allows us to rank countries according to the probability of "producing" top R&D performers. Even after controlling for firm characteristics, the ranking found in Figure 9 remains unaltered. Manufacturing firms in CH are three points more likely to be top R&D performers than in AR, while in UR, that probability is 4 points below AR. EC follows UR, and PR and PE show no significant differences between them. Finally, at the bottom of the sample, in ES, everything else being constant, a firm is around 27 percent less likely to be a top R&D performer than in CH.

7. Concluding Remarks

The increasing importance of innovation policy in the LAC region has gone hand in hand with an improvement in innovation data availability. Building on attempts to measure innovation in the 1990s in some pioneering countries, a significant number of countries of the region currently have at least one wave of IS. Despite being based on well-known international standards for measuring innovation in companies, early waves of IS in LAC countries were highly heterogeneous, hampering comparability between countries and the production of innovation indicators. The current trend of convergence in questionnaire design has allowed for the production of the LAIS dataset.

LAIS is the first micro-level dataset that combines data from IS applied in several LAC countries. Through data harmonization efforts described in this paper, researchers and practitioners have a better tool to feed innovation policy analysis and research agendas. The dataset has nearly 687 variables that describe the general characteristics of the firm and several aspects of innovation behavior such as expenditures, financing, sources of information, collaborations, motivations, outputs, and effects. The LAIS dataset contains information on 119,900 observations, from ten LAC countries, in surveys conducted between 2007 and 2017.

Despite the harmonization efforts, some differences in survey design and methods remain and need to be considered when using and interpreting the data. Special attention needs to be paid to differences regarding sectoral coverage and targeted population when estimating country-level statistics. Unobserved differences in quality may also arise when comparing data produced by organizations with different statistical capabilities and experience in the production of IS or the use of different types of sampling frames.

Nevertheless, by providing the LAIS dataset to the community, we expect to contribute to the discussion on the production of new and improved innovation indicators in LAC countries, to spur research on innovation in firms, and also to facilitate the entry of researchers with a background in other regions to the study of LAC countries. Descriptive analysis conducted in this paper depicts some of the advantages of using LAIS for conducting comparative analysis in innovation between countries. We will continue to work on LAIS by harmonizing and including new waves of IS of countries already included in the database, and we will try to add new data from countries, both those with currently restricted access to IS microdata and those with no official IS yet.

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Annex: Tables

Table 1. Policy Access to the Latin American Innovation Surveys

Public access	Access must be requested	Access through the IDB	On-site access
Chile Colombia Ecuador Peru	Argentina Uruguay	Dominican Republic El Salvador Panama Paraguay	Brazil Costa Rica Mexico

Table 2. Basic Characteristics of IS Included in LAIS

Country	Wave	Reference period	Number of observations		Country	Wave	Reference period	Number of observations
AR	2013	2010–2012	3,691		**DR**	2010	2007–2009	532
	2017	2014–2016	3,944		**EC**	2013	2009–2011	2,815
CH	2009	2007–2008	4,443			2015	2012–2014	6,275
	2011	2009–2010	3,653		**ES**	2013	2010–2012	574
	2013	2011–2012	4,614			2016	2013–2015	n/a
	2015	2013–2014	5,620		**PA**	2009	2006–2008	709
	2017	2015–2016	5,876			2014	2011–2013	665
CO	2009	2007–2008	7,683		**PE**	2012	2009–2011	1,124
	2010	2008–2009	3,662			2015	2012–2014	1,452
	2011	2009–2010	8,643		**PR**	2013	2010–2012	477
	2012	2010–2011	5,038			2016	2013–2015	573
	2013	2011–2012	9,137		**UR**	2007	2004–2006	1,760
	2014	2012–2013	5,848			2010	2007–2009	1,946
	2015	2013–2014	8,835			2013	2010–2012	1,814
	2016	2014–2015	8,056			2016	2013–2015	2,494
	2017	2015–2016	7,947		**Total**	…		119,900

Table 3. Economic Activities Coverage

Country	Wave	Agriculture	Fishing	Mining	Manufacturing	Services	Other
AR	13/17				x		
CH	09/11/13/15/17	x	x	x	x	x	
CO	09/11/13/15/17				x		
CO	10/12/14/16					x	
DR	10		x	x	x	x	
EC	13/15			x	x	x	
ES	13				x		
ES	16				x	x	
PA	09			x	x	x	
PA	14	x	x	x	x	x	x
PE	12/15				x		
PR	13/16				x	x	
UR	07/10/13/16				x	x	

Note: “Other” includes groups L, M, P, and Q of ISIC Revision 3.1.

Table 4. Service Activities Coverage

Country	Wave	Electricity, gas, and water supply	Construction	Wholesale and repair trade	Hotels and restaurants	Transport, storage, and communications	Finance	Real estate and business activities	Health and social work	Other services
CH	09/11/13/15/17	x	x	x	x	x	x	x	x	x
CO	10/12/14/16	x	x	x	x	x	x	x	x	x
DR	10	x	x		x	x			x	x
EC	13/15	x	x	x	x	x	x	x	x	
ES	16					x	x	x		
PA	09	x	x	x	x	x		x		x
PA	14	x	x	x	x	x	x	x	x	x
PR	13/16							x		
UR	07/10	x			x	x		x	x	
UR	13/16	x				x		x	x	

Table 5. Sectoral Classification

Country	Wave	ISIC 4				ISIC 3/3.1			
		Section	Division	Group	Class	Section[a]	Division	Group	Class
AR	13/17					c	x		
CH	09					x			
CH	11/13/15					x	x		
CH	17	x	x						
CO	10/12/14					c	x	x	
CO	09/11/13					c	c	c	x
CO	15	c	c	c	x	c	c	c	x
CO	16	c	x	x					
CO	17	c	c	c	x	c	c	c	c
DR	10					x			
EC	13/15	c	c	x					
ES	13	c	c	c	x	c	c		
PA	09					c	c	x	
PA	14	c	c	c	x	c	c		
PE	12/15	c	c	c	x	c	c	c	c
PR	13/16	c	x						
UR	07					c	c	c	x
UR	10/13/16	c	c	c	x	c	c	c	c

Notes: An “x” means that the information is available directly from the IS. A “c” is used when the variable has been constructed using the original source and the corresponding ISIC-UN Correspondence Tables.
[a] There is an artificial Section, number 18 (“Others”), only in use in DR10. It aggregates Sections A, J, N, and O.

Table 6. Length of the Reference Period

Two years	Three years
CH, CO	AR, DR, EC, ES, PA, PE, PR, UR

Table 7. Forcefully Included Firms in the Sampl[a]

Country	Wave	Criteria
AR	13	Firms in strata of less than 20 firms
AR	17	Firms in strata of less than 20 firms, and firms with 500 employees or more
CH	09/11/13/15/17	Mining and Electricity, Gas, and Water (EGW) sectors, and the largest firms of each stratum[b]
CO	09/11/13/15/17	Firms with 10 or more employees or annual value of output above an annually defined threshold[c]
CO	10/14	All firms in Division 73 and Classes 6511 and 6512. Firms with 20 employees or more in Divisions 40, 41, 62, and 90, and Groups 602 and 604. Firms with 20 employees or more and annual turnover above USD$0.5M in Group 805. Firms with 40 employees or more and annual turnover above USD$1.5M in Groups 551, 552, 641, 642, and 921. Firms with 50 employees or more and annual turnover above USD$2.5M in Division 52. Firms with 75 employees or more and annual turnover above USD$1.5M in Division 72. Firms with 100 employees or more and annual turnover above USD$7.5M in Divisions 50 and 51. Firms classified as “high complexity institutions” in Group 851 (ISIC Rev. 3).
CO	12	All firms in Division 73 and Classes 6511 and 6512. Firms with 20 employees or more in Divisions 40, 41, 62, and 90, and Groups 602 and 604. Firms with 20 employees or more and annual turnover above USD$0.5M in Group 805. Firms with 40 employees or more and annual turnover above USD$1.5M in Groups 551, 552, 641, and 642. Firms with 40 employees or more and annual turnover above USD$1M in Group 921. Firms with 50 employees or more and annual turnover above USD$2.5M in Division 52. Firms with 75 employees or more and annual turnover above USD$1.5M in Division 72. Firms with 100 employees or more and annual turnover above USD$7.5M in Divisions 50 and 51. Firms classified as “high complexity institutions” in Group 851 (CIIU Rev. 3).

CO	16	All firms in Division 73. Firms with 20 employees or more in Divisions 40, 41, 62, and 90, and Groups 602 and 604. Firms with 20 employees or more and annual turnover above USD$0.5M in Group 805. Firms with 40 employees or more and annual turnover above USD$1.5M in Groups 551, 552, 641, 642, 851, and 921. Firms with 50 employees or more and annual turnover above USD$2.5M in Division 52. Firms with 75 employees or more and annual turnover above USD$1.5M in Division 72. Firms with 100 employees or more and annual turnover above USD$7.5M in Divisions 50 and 51 (CIIU Rev. 3).
DR	10	None
EC	13	Firms with 500 or more employees and operational margins of USD$5M or more[d]
EC	15	Firms with 500 or more employees, or annual turnover of USD$5M or more
ES	13/16	Firms with 100 or more employees, and firms that received public support for innovation
PA	09	Firms linked to technological activities, firms considered strategic[e] in the national economy, firms with an annual turnover of US$16M or more, and Mining and EGW sectors
PA	14	Firms linked to technological activities
PE	12	Firms that account for 81% of the total net annual sales in the sampling frame
PE	15	Firms that account for 82% of the total net annual sales in the sampling frame
PR	13/16	Firms with 250 or more employees, firms from the Knowledge-Intensive Business Services sector, firms in strata with less than 20 firms, and the eight largest firms of Divisions 10 and 20 (ISIC Rev. 4.0)
UR	07	Firms with an annual turnover of US$1M[f] or more, or with 50 or more employees
UR	10	Firms with an annual turnover of US$5.3M[g] or with 100 or more employees
UR	13/16	All firms included in the sample of the IS 2010. Firms with an annual turnover of US$5.3M (approx.) or with 100 or more employees that started operations after 2008.

[a] M" stands for "million."
[b] In 2009 and 2011, the threshold is defined by the 2 percent of the total accumulated sales and an undisclosed maximum sampling error and number of observations per stratum. In 2013 and 2015, the threshold is undisclosed. In 2019, the largest firms are selected by applying the Hidiroglou method.
[c] COP$127M of 2008 for 2009, COP$130.5M of 2008 for 2011, COP$136.4M of 2012 for 2013, and an undisclosed amount for 2015 and 2017.
[d] Operational margins are defined as annual turnover minus total expenditures.
[e] This decision was made in agreement between INEC and SENACyT.
[f] US$1M corresponds approximatively to 25M Uruguayan pesos of 2005.
[g] US$5.3M corresponds approximatively to 120M Uruguayan pesos of 2008.

Table 8. Stratification

Country	Wave	Strata
AR	13	Economic activity and firm size
AR	17	Economic activity, firm size, and region
CH	09/11/13/15/17	Economic activity, firm size, and region
DR	10	Economic activity, firm size, and region
EC	13/15	Economic activity, firm size, and region
ES	13/16	Economic activity and firm size
PA	09/14	Firm size
PE	12/15	Firm size
PR	13/16	Economic activity and firm size
UR	07/10/13/16	Economic activity and firm size

Notes: In the case of Peru, firms are stratified into two groups according to their size in terms of net yearly sales. One group is forcefully included (see Table 6 for details), while simple sampling is applied to the remaining group. In the case of Colombia, there is no stratification because of the characteristics of the IS.

Table 9. Firm Size Strata

Country	Wave	Unit	Micro	Small	Medium	Large	Very large
AR	13/17	Number of employees		[10–25]	[26–99]	[100–499]	≥ 500
CH	09/11/13/15/17	Annual turnover (UF)		[2,401–25,000]	[25,001–100,000]	> 100,001	
DR	10	Number of employees		[10–49]	[50–249]	≥ 250	
EC	13/15	Number of employees and annual turnover		[10–49]	[50–499]	≥500 and annual turnover ≥ US$5M	
ES	13/16[a]	Number of employees		[10–50]	[51–100]	> 100	
PA	09	Annual turnover (Balboas)		[150,001–1M]	[1,000,001–2.5M]	[2,500,001–15,999,999]	≥ 16M
PA	14	Annual turnover (Balboas)	≥ 150,000	[150,001–1M]	[1,000,001–2.5M]	[2,500,001–15,999,999]	≥ 16M
PR	13/16	Number of employees		[10–49]	[50–99]	[100–249]	≥ 250
UR	07	Number of employees		[5–19]	[20–99]	≥ 100	
UR	10/13/16	Number of employees and annual turnover	[5–9]	[10–19]	[20–49]	[50–99]	≥ 100 and annual turnover > 120M[b] pesos

Note: "M" stands for "million."
[a] In 2016, the classification by size also included criteria based on annual turnover: between USD$0.12M and USD$1.25M for small firms, between USD$1.25M and USD$7M for medium firms, and above USD$7M for large firms.
[b] 240M for commercial firms.

Table 10. Economic Activity Strata

Country	Wave	ISIC	Sector strata
AR	13	3	30 strata. Classes: 1511, 1520, 1552, 2423, 2921, 2930, 3410, 3420, 3430. Divisions: 16–23, 25–28, 33, 35–37. Special aggregations: (i) 1512–14, 1531–1533, 1541–1549, 1551, 1553, and 1554; (ii) 2411–2413, 2421, 2422, 2424, 2429, and 2430; (iii) 2911–2919; (iv) 2922–2929; (v) 30–32.
AR	17	3	30 strata. Classes: 1511, 1520, 1552, 2423, 2921, 2930, 3410, 3420, 3430. Divisions: 16–22, 25–28, 33, 35–37. Special aggregations: (i) 1512–14, 1531–1533, 1541–1549, 1551, 1553, and 1554; (ii) 2411–2413, 2421, 2422, 2424, 2429, and 2430; (iii) 2911–2919; (iv) 2922–2929; (v) 30 and 32.
CH	09	3	43 strata. Sections: C, E, F, G, H, J, N. Divisions: 01, 02, 05, 15–31, 33–36, 60–64, 70–74, 90, and 92.
CH	11	3	20 strata. Sections: A, B, C, E, F, G, H, I, J, K, N, O. Divisions: 15, 20, 21, 24, 27, 28, 31, and an aggregation of Divisions 16–19, 22, 23, 25, 26, 29, 30, 32–35.
CH	13	3	33 strata. Sections: C, E, F, G, H, J, N. Divisions: 01, 02, 05 15, 20, 21, 24, 27, 28, 31, 33, 36, 62, 64, 70–74, 90, 92. Special aggregations of Divisions: (i) 16–19; (ii) 22, 23, 25 & 26; (iii) 29 & 30; (iv) 34 & 35; (v) 60, 61 & 63.
CH	15	3	33 strata. Sections: C, E, F, G, H, J, N. Divisions: 01, 02, 05 15, 20, 21, 24, 27, 28, 31, 33, 62, 64, 70–74, 90, 92. Special aggregations of Divisions: (i) 16–19; (ii) 22, 23, 25 & 26; (iii) 29, 30 & 32; (iv) 34 & 35; (v) 36 & 37; (vi) 60, 61 & 63.
CH	17	4	40 strata. Sections: D, E, G, H, I, K, L, N, P, Q, R, S, T. Divisions: 01, 02, 04,[a] 07, 12, 16, 17, 18, 20, 21, 24–29, 31, 41, 72. Groups: 031, 032. Special aggregations of Divisions: (i) 05, 06 & 08; (ii) 10 & 11; (iii) 42 & 43; (iv) 58–60; (v) 61–63; (vi) 69–71 & 73–75.
DR	10	3.1	7 strata. Sections: A, C, D, F, H, I, and a specific aggregation of Sections E and O.

EC	13	4	175 strata. Each Group in Sections B, C, D, E, F, H, I, J, K, L, and O, and in Divisions 45, 46, 69–74, 77, and 82.
EC	15	4	14 strata. Sections: B, C, D, E, F, G, H, I, J, K, L, M, N, Q.
ES	13	4	24 strata. Divisions: 10–32, 58.
ES	16	4	49 strata. Divisions: 10, 11, 13–33, 36, 38, 51–53, 55, 56, 59–62, 64, 68, 70, 72–74. Class: 3510, 3530, 5811, 5813, 5820, 6311, 6399, 7110, 7120.
PA	09/14	3.1	n/a
PA	13/16	4	29 strata. Divisions: 10–33, 61–63, 71, 72.
PE	12/15	4	n/a
UR	07	3	117 strata. Divisions: 15–36.
UR	10	4	106 strata. Each Group in Sections C, D, E, H, I, J, E, M, N, Q (excluding 87 and 88).
UR	13/16	4	190 strata. Each Group in Sections C, D, E, H, I, J, E, M, N, Q (excluding 87 and 88).

[a] This is a specific code of ISIC Rev. 4 in Chile, which represents “Mining and processing of copper.”

Table 11. Order of Sections

Country	Wave	General characteristics	Innovation outputs	Innovation activities
AR	13/17	1st	3rd	2nd
CH	09/11/13/15/17	1st	2nd	3rd
CO	09/10/11	n/a	1st	2nd
CO	12/13/14/15/16/17	2nd	1st	3rd
DR	10	1st	2nd	3rd
EC	13/15	1st	2nd	3rd
ES	13/16	1st	3rd	2nd
PA	09/14	1st	3rd	2nd
PE	12/15	3rd	2nd	1st
PR	13/16	1st	3rd	2nd
UR	07/10	3rd	2nd	1st
UR	13/16	1st	3rd	2nd

Notes: In AR, part of the question on general characteristics is at the beginning of the questionnaire. In the surveys of EC and DR, "innovation outputs" refer only to the innovation of product and process. The question relative to organizational and marketing innovation is at the end of the questionnaire, after modules about general characteristics and innovation activities.

Table 12. Filters

Country	Wave	Innovation activities	Innovation output	Motivations	Obstacles	Impacts	Cooperation	Information sources	Intellectual property
AR	13	All	IAF	IAF	All	n/a	All	IAF	IF
AR	17	All	All	IAF	All	n/a	All	IAF	IF
CH	09/11/13	All	All	n/a	All	IF	IAF	All	All
CH	15/17	All	All	n/a	All	IF	IAF	All	All
CO	09/10/11/12/13/14/15/16/17	All	All	n/a	All [a]	IF	All [a]	All	All
DR	10	All	All	IAF	All	IAF	IAF	IAF	All
EC	13	All	All	IAF	All	IAF	IAF	IAF	All
EC	15	All	All	IAF	IAF	IAF	IAF	IAF	All
ES	13	All	All	IAF	All	n/a	All	IAF	IF
ES	16	All	All	IAF	All	All	All	IAF	IF
PA	09	All	All	n/a	NIF	IF	All	IAF	All
PA	14	All	All	n/a	All	IAF	IAF	IAF	IF
PE	12	All	IAF	IAF	All	IF	All	All	IF
PE	15	All	All	IAF	All	n/a	All	All	All

PR	13	All	All	IAF	All	n/a	All	IAF	IF
PR	16	All	All	IAF	All	n/a	All	IAF	All
UR	07/10	All	IAF	n/a	All	IF	IAF	All	IF
UR	13/16	All	IAF	n/a	All	IF	IAF	IAF	IF

[a] Although there is no explicit filter in the questionnaire, most non-innovative firms do not answer this section.

Table 13. General Characteristics of the Firm

Country	Wave	Start of operations	Employees	Website	Foreign capital	Group	Sales	Exports	Investments	Capacity utilization
AR	13		x	x	x	x	x	x	x	
AR	17		x	x	x		x	x	x	
CH	09/11/13/ 15/17	x	x		x	x	x	x		
CO	09/10/11		x							
CO	12/13/14/ 15/16/17		x				x	x		
DR	10	x		x		x				
EC	13/15	x	x		x	x	x	x	x	
ES	13/16	x	x	x	x	x	x	x	x	
PA	09	x	x	x		x	x	x	x	x
PA	14	x	x			x	x	x	x	x
PE	12	x	x		x	x	x	x		x
PE	15	x	x	x	x	x	x	x	x	x
PR	13	x	x	x	x	x	x	x	x	
PR	16	x	x	x	x	x	x	x	x	x
UR	07/10/13/ 16	x	x		x	x	x	x		x

Note: An “x” means that the information is available directly from the IS.

Table 14. Employment by Occupation and Educational Level

Country	AR	CH	CH	CO	EC	ES	PA	PA	PE	PE	PR	PR	UR
Wave	13/17	09/11	13/15/17	09/10/11/ 12/13/14/ 15/16/17	13/15	13/16	09	14	12	15	13	16	07/10/13 /16
Professionals	x												x
Technicians	x												x
Professionals and Technicians	c	x											c
PhD			x	x	x		x	x				x	
Master			x	x	x		x	x				x	
Postgraduate			c	c	c	x	c	c	x	x	x	c	
Undergraduate			x	x	x	x	c	c	x	x	x	x	
University degree	c		c	c	c	c	c	c	c	c	c	c	c
Post-secondary non-university			x	x	x	c		x	c	x	x	x	
Secondary or less			x	x	x	c	c	c	c	c	c	c	

Notes: An “x” means that the information is available directly from the IS. A “c” is used for variables that are constructed using other raw variables.

Table 15. Employees with Tertiary Education by Field of Study

Country	Wave	Natural and exact sciences	Engineering and technology	Natural sciences and engineering[a]	Social sciences	Medical and health sciences	Agricultural sciences	Humanities and others
AR	13			c	x	x		x
AR	17	x	c	c	x	x		x
CO	09/10/11/12	c	x	c	x	x	x	x
EC	13/15	x	x	c	x	x	x	x
ES	13/16	x	x	c	x			
PE	12	x	x	c	x	x	x	x
PE	15	x	x	c	x	x	x	c
PR	13	x	x	c	x			
PR	16	x	x	c	x	x	x	
UR	07/10/13/16	c	c	c	c	x	x	x

Notes: ES and EC only refer to "Engineering." An "x" means that the information is available directly from the IS. A "c" is used for variables that are constructed using other raw variables.
[a] In AR13 this also includes "Industrial design." In CO and in UR, "Architecture and urban planning."

Table 16. Innovation Activities

Country	AR	CH	CH	CH	CO	DR	EC	ES	ES	PA	PE	PE	PR	UR	UR	UR
Wave	13/17	09/11	13	15/17	09/10/11/12/ 13/14/15/16/17	10	13/15	13	16	09/14	12	15	13/16	07	10	13/16
In-house R&D	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Subcontracted R&D	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Machinery and equipment	x				x	x	x	x	x	x	x	x	x	x	x	x
Hardware							x	x	x	x	x	x	x	x		
Software							x	x	x	x	x	x	x	x		
Hardware and software	x				x	x	c	c	c	c	c	c	c	c	x	x
Machinery, equipment, hardware, and software	c	x	x	x[a]	c	c	c	c	c	c	c	c	c	c	c	c
Technology transfer	x	x	x	x	x	x	x	x	x	x	x	x	x			
Consultancies	x				x		x	x	c	x			x			
Technology transfer and consultancies	c				c		c	c	c	c			c	x	x	x
Training	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Engineering and design[b]	x		x	x	x	x	x	x	c	x	x	x	x	x	x	x
Market research[c]		x	x	x	x	x	x	x	x		x	x	x			x
Others		c	c	c		c				c				c	c	c
Ongoing				x	x	x	x					x				
Abandoned				x	x	x	x					x				
Organizational innovation expenditures							x	x	x			x	x			
Marketing innovation expenditures							x	x	x			x	x			

Notes: An "x" means that the information is available directly from the IS. A "c" is used for variables that are constructed using other raw variables.
[a] The 2017 IS asks for "machinery, equipment, hardware, software, and buildings."
[b] In the case of CH and DR, this variable only includes "design activities."
[c] For EC, PE, PR, ES, and UR, this variable refers explicitly to "Market research," while for CH, CO, and DR it also includes other activities for the introduction of new products to markets.

Table 17. Sources of Financing

Country	Wave	Public	Bank	Own resources	Other
AR	13	c	c	x	c
AR	17	c	x	c	c
CH	09	x		x	x
CH	11/13/15/17	x			
CO	09/10/11/12/13/14/15/16/17	x	x	x	c
DR	10	x	c	x	c
EC	13/15	x	x	x	c
ES	13/16	x	x	x	x
PA	09/14	x	x	x	x
PE	12/15	x	x	x	c
PR	13	x	x	x	x
PR	16	x	x	x	c
UR	07/10	x	x	c	c
UR	13/16	x	x	x	c

Notes: An “x” means that the information is available directly from the IS. A “c” is used for variables that are constructed using other raw variables.

Table 18. Innovation Output

Country	AR	CH	CH	CO	CO	DR	EC	ES	PA	PE	PE	PR	UR
Wave	13/17	09	11/13/15/17	09/11/12/13/14/15/16/17	10	10	13/15	13/16	09/14	12	15	13/16	07/10/13/16
New goods							x	x		x	x	x	
New services							x	x		x	x	x	
New products	x			c			c	c		c	c	c	
Improved goods							x	x		x	x	x	
Improved services							x	x		x	x	x	
Improved products	x			c			c	c		c	c	c	
Goods innovation		x	x			x	c	c		c	c	c	
Service innovation		x	x			x	c	c		c	c	c	
Product innovation	c	c	c	c	c	c	c	c	x	c	c	c	x
Methods of production			x			x					c		
Logistics and delivery			x			x					c		
Process supporting activities			x			c					c		
New processes	x						x	x		x	c	x	
Improved processes	x						x	x		x	c	x	
Process innovation	c	x	c	x	x	c	c	c	x	c	c	c	x
Business practices			x				x			x	x		

Methods for responsibilities			x				x			x	x		
External relations		x	x				x			x	x		
Organizational innovation	x	c	c	x	x	c	c	x	x	c	c	c	x
Packaging		c	x			x	x			x	x		
Product promotion			x			x	x			x	x		
Distribution and placement		x	x			x	x			x	x		
Pricing			x			x	x			x	x		
Marketing innovation	x		c	x	x	c	c	x	x	c	c	c	x

Notes: An “x” means that the information is available directly from the IS. A “c” is used for variables that are constructed using other raw variables.

Table 19. Innovation Impacts

Country	CH	CH	CO	CO	DR	EC	ES	PA	PE	UR
Wave	09	11/13/15/17	09	10/11/12/13/14/15/16/17	10	13/15	16	09/14	12	07/10/13/16
Increase range of products	x	x	x	x	x	x	x	x	x	x
Improve quality of products	x	x	x	x	x	x	x	x	x	x
Increase market share			x		x	x	x	x	x	x
Maintain market share			x	x			x	x	x	x
Enter new markets				x		x	x	x	x	x
Increase market share or enter new markets	x	x			c	c	c	c	c	c
Improve flexibility of production						x	x	x	x	x
Increase the capacity of production					x	x	x	x	x	x
Increase capacity or improve the flexibility of production		x				c	c	c	c	c
Reduce unit production costs	x	x	x		c	x	x			
Reduce unit labor costs			x	x	x		x	x	x	x
Reduce consumption of energy			x	x			x	x	x	x
Reduce consumption of materials			x	x			x	x	x	x
Reduce the consumption of materials and energy	x		c	c		x	c	c	c	c
Reduction of environmental impacts or improvement of health and safety	x	x			x	c	x	x	x	x
Compliance with regulations and standards at the national level					x		x	x	x	x
Compliance with regulations and standards at the international level					x		x	x	x	x
Compliance with regulations and standards			x	x	c		c	c	c	c

Improve the use of staff skills								x	x	x
Other			c	c	c		c		x	

Notes: An “x” means that the information is available directly from the IS. A “c” is used for variables that are constructed using other raw variables.

Table 20. Motivations for Innovation

Country	AR	AR	DR	EC	ES	PE	PR	PR
Wave	13	17	10	13/15	13/16	12/15	13	16
Increase production capacity	x		x					
Reduce production cost	x		x					
Improve production process	c	x	c					
Identification of unsatisfied demand				x	x	x	x	x
Meet the needs of clients or suppliers	c		c					
Improve quality	x	x	x					
Exploiting a new idea or new scientific knowledge and techniques				x	x	x	x	x
Threat of competition			x	x	x	x	x	x
Entering new markets	x	x	x					
Laws and regulations		x	c	x	x	x	x	x
Change in IP regulations				x	x	x	x	x
Certifying processes				x	x	x	x	x
Technical problem				x	x	x	x	x
Exploiting new ideas generated inside the company				x	x	x	x	x
Exploiting government incentives					x	x		x
Others	c	c	c		x	x	x	c

Notes: An “x” means that the information is available directly from the IS. A “c” is used for variables that are constructed using other raw variables.

Table 21. Innovation Obstacles

Country	AR	AR	CH	CH	CO	DR	EC	ES	PA	PE	PR	PR	UR	UR
Wave	13	17	09	11/13/15/17	09/10/11/12/13/14/15/16/17	10	13/15	13/16	09/14	12/15	13	16	07	10/13/16
Cost	x	x		x		x	x			x				
Period of return	x	x	x			x		x	x		x	x	x	x
Expected return			x		x	x								
Innovation uncertainty[a]						x		x	x		x		x	x
Demand uncertainty			x	x	x	x	x			x		x		
Technical risk[b]			x		x							x		
Internal financing			x	x	x	x	x	x		x	x	x		
External financing	c	x	x	x	x	x	x	x		x	x	x	x	x
Qualified employees in the firm	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Qualified employees in the country						x	x	x			x	x		
Cost of training						x			x					
Market information			x	x	x	x	x		x	x		x	x	x
Technology information			x	x	x	x	x		x	x		x	x	x
Cooperation partners			c	x	x	c	x		x	x			x	x
Organizational Rigidity	x					x			x	x			x	x

Dominated market			x	x		x	x			x		x		
Market structure								x	x		x			
Market size								x	x	x	x	x	x	x
Protecting innovation	x		x		x	x		x	x	x	x	x	x	
IPR system					x	x		x	x		x	x	x	x
Infrastructure								x	x	x	x	x	x	x
STI policy						x			c	x			c	x
Lack of government incentives			x			x		x			x	x		
Regulation	x		x	x	x	c				x				
Sectoral technological dynamic						x		x	x		x		x	x
No need to innovate	x	x		c		c	c							
Other	c	c	c		c	c		c		c	c	c	c	c

Notes: An "x" means that the information is available directly from the IS. A "c" is used for variables that are constructed using other raw variables.
[a] DR and PR13 refer to "uncertainty," while ES refers to "uncertainty and risk."
[b] CO refers to "uncertainty" instead of "risk."

Table 22. Cooperation Partners for Innovation

Country	AR	AR	CH	CO	CO	DR	EC	ES	PA	PE	PR	PR	UR	UR
Wave	13	17	09/11/13/15/17	09/10/11/12/13/14/15	16/17	10	13/15	13/16	09/14	12/15	13	16	07	10/13/16
Headquarters						x			x				x	x
Other firms of the group						x			x					
Group	x	x	x	x	x	c	x	x	c	x	x	x		
Related firms							x	x			x		x	
Clients			x	x	x	x	x	x	x	x	x	x	x	x
Suppliers			x	x	x	x	x	x	x	x	x	x	x	x
Competitors				x	x	x	x	x			x	x		
Other firms	x	x							x				x	x
Competitors and other firms			x							x				
Consultants		x		x	x	x	x	x	x	x	x	x	x	x
Business associations										x		x		
Consultants and business associations	x									c		c		
Laboratories										x			x	x
Laboratories and R&D firms						x	x	x	x		x	x		
Consultants, laboratories, and private R&D organizations			x			c	c	c	c	c	c	c		

Public R&D organizations	x	x	x			x				x				
R&D organizations				x	x					c				
Universities	x	x		x	x		x	x	x	x	x	x	x	x
Tertiary non-university institutions									x				x	x
Universities and other tertiary institutions			x			x			c				c	c
Technology intermediaries				c	c				c	c			c	c
IP office							x	x			x	x		
Public institutions of support to STI							x	x	x	x	x	x	x	x
Government	x				x	x								
Other	x	c		c	c	x		x			x	x	c	c

Notes: In UR13 and UR16, variables measure only the three most important cooperation partners. An “x” means that the information is available directly from the IS. A “c” is used for variables that are constructed using other raw variables.

Table 23. Cooperation Objectives

Country	Wave	R&D	Engineering and design[a]	Training	Technical assistance	Information	Testing	Financing	Organizational change	Other
AR	13/17	x	x	x			x		x	c
CH	09/11/13/15/17									
CO	09/10/11/12/13/14/15/16/17	x	x	x	x					c
DR	10	x					x			
EC	13/15	x	x	x	x	x	x	x		
ES	13/16	x	x	x	x	x	x	x		
PA	09/14	x	x	x	x	x	x	x	x	
PE	12	x	x	x	x	x	x	x		
PE	15	x	x	x	x	x	x	x		x
PR	13	x	x	x	x	x	x	x		
PR	16	x	x	x	x	x	x	x		x
UR	07/10/13/16	x	x	x	x	x	x	x	x	

Notes: An "x" means that the information is available directly from the IS. A "c" is used for variables that are constructed using other raw variables.
[a] PA and UR include only design activities.

Table 24. Internal Information Sources for Innovation

Country	Wave	Firm or group	Group	Group areas		Firm	Firm areas							
				Headquarters	Firms of the group		R&D	Production	Marketing	Distribution	Management	Systems	Administration and finance	Other areas
AR	13/17	c	x			c	x	x	x		x			x
CH	09/11/13/15/17					x								
CO	09/10/11/12/13/14/15/16/17	c	c	x	x	c	x	x	x		x			c
DR	10	c	c	x	x	c		x	x		x			c
EC	13/15		x				x	x	x	x		x	x	
ES	13/16	c	x			c	x	x	x	x		x	x	x
PA	09/14						x	x	x		x		x	c
PE	12/15	x												
PR	13/16	c	x			c	x	x	x	x		x	x	x
UR	07/10/13			x		x								

Notes: An “x” means that the information is available directly from the IS. A “c” is used for variables that are constructed using other raw variables.

Table 25. External Information Sources for Innovation

Country	AR	AR	CH	CH	CH	CO	CO	DR	EC	ES	PA	PE	PR	PR	UR
Wave	13	17	09	11	13/15/17	09/10/11/12	13/14/15/16/17	10	13/15	13/16	09/14	12/15	13	16	07/10/13
Clients			x	x	x	x	x	x	x	x	x	x	x	x	x
Suppliers			x	x	x	x	x	x	x	x	x	x	x	x	x
Suppliers and clients	x	x	c	c	c	c	c	c	c	c	c	c	c	c	c
Competitors	x								x	x	x		x	x	x
Competitors and other firms		x	x	x	x	x	c					x			
Related firms									x	x			x		
Consultants	x	x	x			x	x	x	x	x	x		x	x	x
Public research institutions	x	x	x	x	x							x			
Research organizations			c			c	c	x							
Laboratories and R&D firms									x	x			x	x	
Consultants, labs, and research organizations				c	c							c			
Universities	x	x				x	x	x	x	x			x	x	
Universities and other tertiary institutions			x	x	x							x			
Universities and research institutions						c	c	c			x		c	c	x
Internet	x	x			x	x	x	x	x	x		x	x	x	x
Conferences and events	x	x			x	c	c	c	x	x	x	x	x	x	x
Articles and journals	x	x			x	x	x		c	x		x	x	x	x
Business and professional associations	x	x			x	c	c	x				x		x	

Conferences and events, articles and journals, business and professional associations	c	c	x	x	c	c	c					c		c	
Databases						x	x			x			x	x	x
IP						c	c		x	x	x		x	x	
Public institutions of support to STI									x	x			x	x	
Other	x	x				c	c	c		x	x	x	x	x	

Notes: An “x” means that the information is available directly from the IS. A “c” is used for variables that are constructed using other raw variables.

Table 26. Intellectual Property Rights

Country	Wave	IPR[a]	Patent	Trademark	Utility model	Industrial design	Copyright	Geographical indication	Plant variety rights
AR	13		x	x	x	x	x		
AR	17	c	x	x	x	x	x	x	x
CH	09/11/13	x							
CH	15/17	c	x	x	x	x	x		x
CO	09/10/11/12/13/14/15/16/17	c	x	x	x	x	x		x
DR	10		x	x		x	x		
EC	13/15		x	x	x	x	x	x	
ES	13/16		x	x	x	x	x	x	
PA	09		x						
PA	14		x	x	x	x	x	x	
PE	12/15		x	x	x	x	x	x	
PR	13/16		x	x	x	x	x	x	
UR	07		x						
	10/13/16		x	x	x	x	x	x	

Notes: An "x" means that the information is available directly from the IS. A "c" is used for variables that are constructed using other raw variables.
[a] Patents, plant variety rights, copyrights, and industrial design.

Table 27. Stock of Intellectual Property

Country	Wave	IPR[a]	Patent	Trademark	Utility model	Industrial design	Copyright	Other
CH	09/11/13	x						
CO	09/10/11/12/ 13/14/15/16/ 17	c	x	x	x	x	x	c
EC	13/15		x	x	x	x		x
ES	13/16		x	x	x	x		x
PE	15		x	x	x	x	x	x
PR	13/16		x	x	x	x		x

Notes: An "x" means that the information is available directly from the IS. A "c" is used for variables that are constructed using other raw variables.
[a] Patents, plant variety rights, copyright, and industrial design.

Table 28. Confidentiality Agreements

Country	Wave	Nondisclosure agreements with employees	Nondisclosure agreements with other companies	Nondisclosure agreements with employees or companies	Trade secret
AR	13/17	x	x	c	
CH	15	x	x	c	x
CO	09/10/11/12/ 13/14/15/16/ 17	x	x	c	x
DR	10				x
EC	13/15	x	x	c	
ES	13/16	x	x	c	
PA	14	x	x	c	
PE	12/15	x	x	c	
PR	13/16	x	x	c	
UR	10				x
UR	13/16			x	x

Notes: An “x” means that the information is available directly from the IS. A “c” is used for variables that are constructed using other raw variables.

Table 29. Business Strategies to Protect Innovations

Country	Wave	Controlling distribution network	First to reach the market	Scale of production	Complex design	Segmenting the production process	Other
AR	13/17	x	x	x			c
CO	09/10/11/12/13/14/15/16/17				x		
EC	13	x	x	x	x	x	
ES	13/16	x	x	x	x	x	
PE	12/15	x	x	x	x	x	x
PR	13/16	x	x	x	x	x	x
UR	13/16	x	x	x	x	x	

Notes: An “x” means that the information is available directly from the IS. A “c” is used for variables that are constructed using other raw variables.

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