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Innovation and Competitiveness in Mining Value Chains

The Case of Argentina

Institutions for Development Sector

Competitiveness, Technology, and Innovation Division

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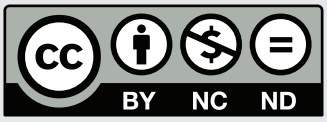

Innovation and Competitiveness in Mining Value Chains

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ABSTRACT

Argentina has outstanding mineral potential, with substantial amounts of unexplored and unexploited geological resources. Despite this potential, the nonenergy mining sector is still small-scale, representing 0.5 percent of the country's GDP and 3.0 percent of total exports, and is concentrated mainly in a few regions of the country. This document investigates the metal mining value chain in Argentina, in particular the opportunities and challenges that domestic companies find to participate in it. It provides policy recommendations that can help improve the chances of these firms entering and then expanding, growing, and diversifying their clients and markets.

JEL Codes: D02, D04, D22, H41, L10, L19, L25, L38, L61

Keywords: mining value change, Argentina, linkages, productive policies, innovation

1. INTRODUCTION

Argentina has outstanding mineral potential, with substantial amounts of unexplored and unexploited geological resources. Despite this potential, the nonenergy mining sector is still small-scale, representing 0.5 percent of the country's gross domestic product (GDP) and 3.0 percent of total exports, and is concentrated mainly in a few regions of the country. This report aims to contribute to better understanding of the challenges and opportunities the country's mining sector faces to further develop and to contribute to a process of diversification, innovation, and growth through the development of local innovative suppliers.

To explore the proposed research questions, this report focuses on the exploration, construction, and operation stages of the copper, gold, and silver mining value chain in Argentina. A selection of local strategic mining suppliers was studied in depth through field research. Researchers explored the main challenges suppliers face when entering mining value chains and which entry strategies have been successful. We studied the main capabilities and resources suppliers have developed to enable entry and to maintain themselves as suppliers, as well as the challenges they face to expand.

One focus of this project is to develop policy recommendations that can help improve the chances of domestic firms entering the mining value chain and then expanding, growing, and diversifying their clients and markets. The institutional context for mining in Argentina was, therefore, investigated. Both desk research and interviews with mining companies, mining suppliers, government institutions, and other key informants in the sector were important to fully understand the institutional framework of mining and the main laws and regulations that govern the sector in Argentina. Through these interviews, we mapped the metal mining value chain in Argentina, singled out the main stakeholders, and identified the main features and micro-, meso-, and macro-level barriers that hamper the development of the mining supplier sector in the country.

Questions about local suppliers' development potential—the focus of this study—are inherently linked to questions about the development of the sector. As a result, some of the policy recommen-

dations go beyond the development of suppliers to address the development of mining activity in the country more generally.

The document is organized as follows:

- The first section briefly discusses the conceptual framework and development of the research questions, and presents the methodology.
- The second section is an overview of the mining sector in Argentina.
- The third section analyzes the main evidence related to local firms' supplier development collected during the fieldwork.
- The fourth section summarizes the main challenges in developing domestic mining suppliers in Argentina at the micro, meso, and macro levels.
- Finally, the fifth section concludes the research and provides policy recommendations.

2. THEORETICAL FRAMEWORK, RESEARCH QUESTIONS, AND METHODOLOGY

Theoretical Framework and Research Questions

A key question for the development strategy of natural resource–rich countries is how to take advantage of those resources to diversify their economies to include more innovative activities. The successful experience of some advanced natural resource–rich countries (e.g., Canada, Australia, and the United States) in diversifying and growing through natural resources is useful for learning how this kind of expansion has happened in the past. However, markets, regulations, and other conditions have changed substantially in past decades, so the path followed by those countries cannot be replicated in Argentina. Recent innovation studies have emphasized the need to understand the current opportunities and challenges that have emerged in association with changes in global demand, technologies, and regulations to use natural resource activities as a platform from which to develop new sectors (Andersen, Johnson, Marin, et al., 2015; Andersen, Marin, and Simensen, 2018; Marin, Pérez, and Navas-Aleman, 2015; Pérez, 2010). These factors seem crucially important to provide informed inputs for public policy.

This report explores existing opportunities and challenges with the aim of encouraging new innovative productive and technological activities by developing domestic mining suppliers. The mining sector has traditionally been considered to have very low potential to support diversification through supplier development because the industry has long operated as an enclave. However, three major transformations that have been taking place since the 1970s suggest greater potential for the sector to serve as a platform to develop linkages with other sectors:

- A combination of industry growth, international relocation, and increased innovation occured to counterbalance exhaustion of high-grade resources

- A process of technological rejuvenation in which a large number of technological innovations and improvements in exploration, mining, and mineral processing have been driving industry development
- A move in the organization of production toward less vertical integration and more internationalization of large mining companies, and the emergence of specialized, highly knowledgeable suppliers in many advanced and emerging countries (Bloch and Owusu, 2012; Figueiredo and Piana, 2016; Meller and Parodi, 2017; Molina, 2018; Morris, Kaplinsky, and Kaplan, 2012; Stubrin, 2017; Urzúa, 2011)

As a result of these transformations, mining companies are mirroring other large multinational companies in how they organize their global value chain, sourcing inputs and services from a wide array of countries and providing opportunities as well as challenges for developing countries to become suppliers.

This report provides new evidence and analyses. The aim is to contribute to the understanding and improvement of the possibilities of developing domestic suppliers to the metal mining sector in Argentina.

With this general aim, the report:

- maps the metal value chain in Argentina, identifying the types of actors, activities, and institutions involved, as well as their main features and characteristics;
- identifies the stages of or activities in the mining value chain that have domestic suppliers;
- explores entry opportunities and barriers for domestic suppliers;
- examines the degree of development of innovation in and managerial capabilities of domestic suppliers;
- identifies obstacles to innovation and potential public policies to overcome them; and
- explores how linkages within the value chain limit or increase suppliers' growth and acquisition of innovative capabilities.

The study excludes suppliers of commodities such energy, transport, or catering services.

To address these objectives, the theoretical framework combines insights from two streams of literature: innovation and global value chains.

Innovation studies provide very useful insights to understand differences across firms related to innovative performance and the process of increasing capabilities (Bell and Pavitt, 1992, 1995; Lall, 1992, 2001). The literature extensively covers the kind of internal efforts firms need to make to expand technological and innovation capabilities. One of the main conclusions to be drawn from the literature is that efforts to learn, use, and generate new knowledge are central to explain a firm's success. Linkages and interactions with other actors, such as other firms and science and technology institutions, are also crucially important to develop technological and innovation capabilities. The literature also emphasizes the importance of distinguishing between sectors and technologies to understand the kind of efforts required, and also the potential firms have to grow. Some sectors are considered more innovative than others, and thus provide more technological opportunities and potential for growth.

The global value chain literature also explores the possibilities of technological learning and upgrading within firms, but emphasizes the importance of power relationships between them when explaining different rates of success (Gereffi, 1994, 1999). According to Gereffi, Humphrey, and Sturgeon (2005), firms, particularly small- and medium-sized enterprises, from developing countries that connect with global value chains can upgrade their production and technological capabilities by being part of these chains.

However, not all global value chains provide the same learning and upgrading opportunities. A chain's type of governance has a major influence on the distribution of tasks and capabilities—and therefore also profits—among the participating firms (Gereffi, Humphrey, and Sturgeon, 2005; Kaplinsky and Morris, 2001; Navaz-Aleman, 2011; Pietrobelli and Rabelotti, 2011). In the case of the mining sector, power issues seem crucially important since large firms tend to dominate the value chain and there is an important power asymmetry between large mining firms from developed countries and local suppliers in developing countries.

The innovation and global value chain literature provides a comprehensive view of how factors operating at the global/regional and internal firm levels interact to explain the possibilities of developing domestic suppliers' capabilities.

Based on the literature, we consider four types of company capabilities that seem important for innovation and competitiveness among local suppliers in the mining industry:

1. technological capabilities
2. the ability to negotiate with other firms (horizontally, upward, and downward)
3. the ability to negotiate with both national and regional governments
4. the ability to negotiate and build trust with local communities

Recent studies that focused on the mining global value chains in Peru, Chile, and Brazil explored how domestic firms' learning efforts and issues of governance affect the opportunities of local providers for growth (Molina, 2018; Pietrobelli, Marin, and Olivari, 2018; Stubrin, 2017). These studies identified a number of domestic firms in those countries taking advantage of new opportunities provided by new technologies such as information technology and biotechnology. However, this research also emphasized that innovation opportunities tend to be constrained by the limited support that leading mining companies provide to domestic suppliers. The hierarchical governance of the mining value chains identified in these studies does not favor quality linkages between lead firms and suppliers, reducing suppliers' learning and innovation potential.

Another constraint on the development of these suppliers was the lack of nontechnological capabilities required to exploit innovations in local and foreign markets, such as the ability to negotiate with policymakers and managers of large companies and skill in accessing external resources (such as space to test their innovations).

This study digs more deeply into these issues based on evidence from Argentina.

Methodology

To tackle the objectives of the study, field research was carried out in Argentina from November 2018 to November 2019. During fieldwork both quantitative and qualitative evidence was gathered

through interviews with representatives of mining companies, mining suppliers, and government institutions and with other key informants in the sector. The fieldwork encompassed an initial exploratory stage (November 2018–May 2019). This work was key to obtaining a general understanding of the mining value chain in Argentina and of the main characteristics of the sector and its institutional framework in the country. The exploratory stage also identified local strategic domestic suppliers. This stage included 12 interviews with chambers of commerce, state institutions, and other key informants and 31 interviews with private companies (5 mining firms and 26 suppliers; see Appendix 1). During this stage we also attended specialized events in Argentina (e.g., Arminera 2019), reviewed sectoral reports and documents, and designed the data collection questionnaires.

Three criteria were used to identify local strategic mining suppliers: (i) they had to provide specialized goods or services critical to the mining value chain in terms of monetary value, (ii) they had to have a certain degree of discretionary power, and/or (iii) they had to have developed unique knowledge and production capabilities to identify or extract minerals.

Suppliers that are strategic in terms of value are those whose products or services represent an important share of mining exploration and extraction costs (e.g., heavy machinery). Suppliers that are strategic in terms of discretionary power are those such as laboratories with certifications that are critical for the activity to continue. Suppliers that are strategic in terms of their unique knowledge and production capabilities are those with knowledge to repair specialized machinery or develop parts and components for such machinery.

In this report, any supplier that meets some or all of these criteria is called a potentially innovative supplier. Companies supplying generic products or services such as transport or catering were excluded from the study.

The selection process was innovative. First, we identified supplier firms based on a review of documentation and consultation with key informants during the exploratory work. We used snowball sampling (getting interviewees to refer us to other firms suitable for the study), which is a classic technique proven to help build a sample and is often used with hidden populations such as the mining supplier sector in Argentina. We developed a list of 78 potentially innovative suppliers that met the three criteria (see Appendix 2), 26 of which were interviewed using the data collection questionnaire. For the firms selected that were not interviewed, we gathered some information about their activities, capabilities, and characteristics through secondary data and interviews with other informants.

Of the 26 interviewed strategic mining suppliers, 17 specialized in services and 9 in manufactured goods (see Table 8 in Appendix 3, which summarizes key information about these suppliers). Service companies provide a wide range of services, including drilling, heavy machinery repair, blasting, mine construction, communication, lab analysis, and environmental impact and geology studies. Manufacturing suppliers mostly specialize in fabricating metal parts for heavy machinery, while others provide, for example, steel cables, mining facilities, ventilation sleeves, and mill linings.

The supplier firms analyzed were diverse in terms of age, size, and location in the country. Six were founded during the first period of import substitution in Argentina (up to the 1970s); the oldest firm dates back to 1939. Ten firms were created during the 1980s and 1990s, and 10 were founded after 2000, when import substitution policies were introduced again. Among the oldest firms, those

dedicated to manufacturing heavy machinery parts tend to prevail. Service suppliers tend to be younger—15 of the 17 service firms studied were created after the 1990s.

In terms of size, half of the suppliers studied had more than 100 employees, 5 had between 50 and 100 employees, and 7 had fewer than 50. Among the largest firms, service companies tended to predominate (7 of 13). These firms were dedicated to drilling services, earth-moving, and mine construction. Other more specialized service firms, providing geological, hydric, or telecommunication services, tended to be smaller (fewer than 50 employees).

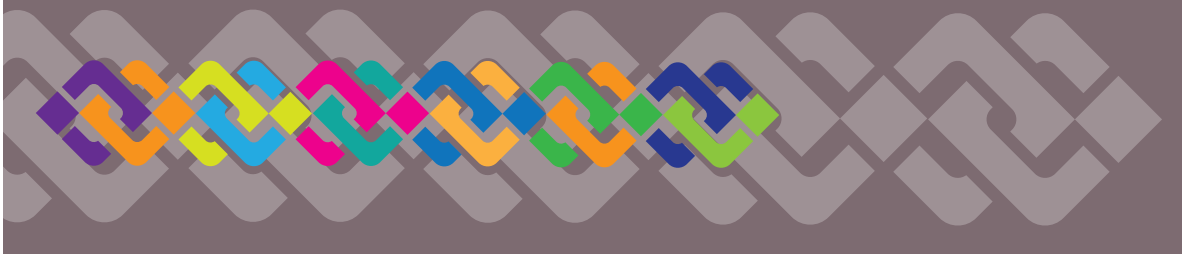
The study found that suppliers were located in both mining and nonmining regions. Of the suppliers interviewed, 18 were located in San Juan, the northern provinces of the country (Salta and Jujuy), and Santa Cruz, all regions with mining activity. Suppliers located in nonmining provinces were found in Mendoza, Santa Fe, and Buenos Aires. In contrast to suppliers located close to mines, those situated in nonmining regions tended not to be specialized mining suppliers, also providing inputs and services to other sectors, such as agriculture.

In addition to mining suppliers, we interviewed five mining companies: Barrick Gold (San Juan), Newmont Goldcorp (Santa Cruz), Minera Santa Cruz (Santa Cruz), Fortuna Silver Mines (Salta), and Aldebaran Resources—a junior exploration company (San Juan). These interviews aimed to obtain information about the mining firms' supplier development programs and policies to better understand the type of relationships mining firms want with their suppliers and to understand mining firms' main activities in the country, their investment plans, and their vision of the Argentine mining sector.

Finally, we carried out open interviews with public policy agencies. Interviews with regulatory and state agencies involved in mining policy in Argentina were key to fully understanding the institutional framework of mining in the country and the main laws and regulations that govern the sector (see Appendix 4).

3.

THEORETICAL FRAMEWORK, RESEARCH QUESTIONS, AND METHODOLOGY



This section provides background information and analysis to understand the possibilities for developing domestic suppliers associated with metal mining in Argentina. First, we offer some indicators of the importance of mining in the country; second, we provide an overview of the main institutions and legal framework associated with the sector.

Magnitude, Main Features, and Location

In Argentina, in terms of GDP growth or exports, mining has very little aggregate economic impact.

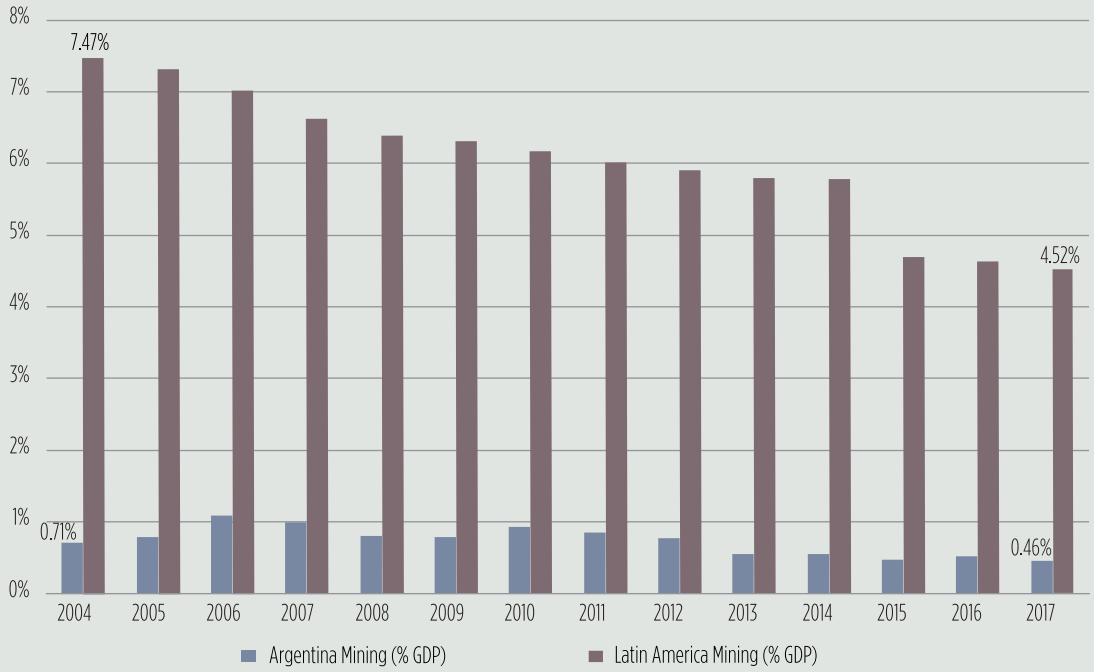
Extraction of nonenergy minerals and metals accounts for 0.5 percent of the country's GDP[1] and 3.0 percent of total exports[2] (less than US$3 billion, according to official data). Comparison with other countries reveals the limited scale of the activity in Argentina. For instance, looking at the size of mining relative to GDP, the sector in Argentina is one-tenth the average for Latin American countries (Figure 1). Looking at exports, in 2017, mining's share of total exports from Argentina (3 percent) is insignificant compared with regional peers such as Chile (55 percent), Peru (55 percent), and Brazil (12 percent) (Figure 2).

Already a small sector in Argentina, mining has experienced sustained decline following the general downward trend in the region since 2004, falling from 1.1 percent of GDP at the peak of mining activity in 2006 to 0.5 percent in 2017. Exports have decreased in a similar way since 2012. In 2012, total mining exports were valued at more than US$5.5 billion, compared with less than US$3.4 billion in 2018 (Figure 3). This decline is partly explained partly by decreasing metal prices and partly by the diminishing exports of Bajo de la Alumbrera, the only copper-mining project in the country.

1 Argentine Mining Suppliers Chamber (CAEM) data for 2017.

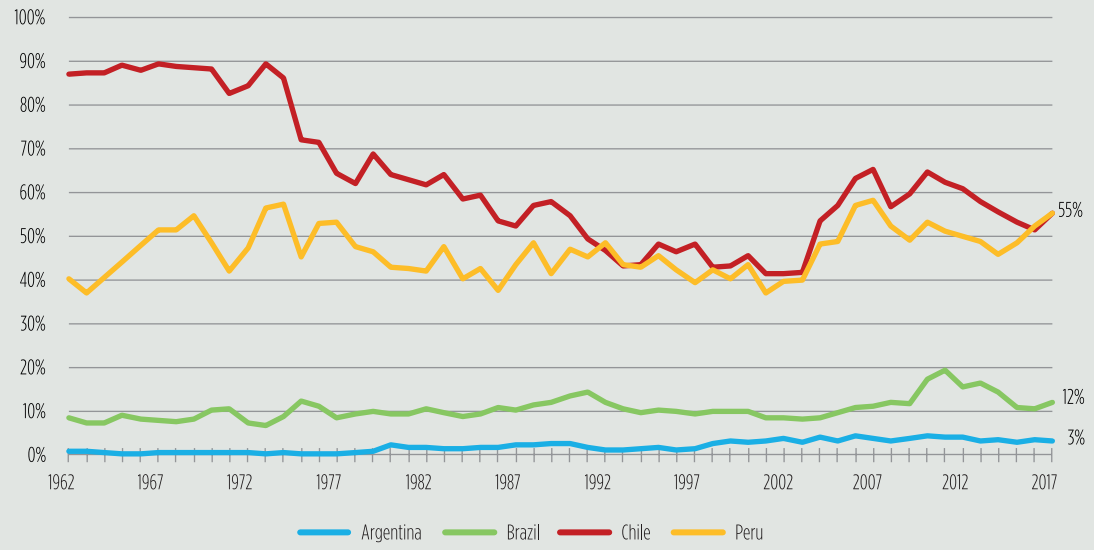
2 World Bank data.

Figure 1. Share of Mining in Gross Domestic Product: Argentina and Latin America (percent of GDP)



Source: Authors' calculations based on CEPAL, the Statistical Yearbook of Latin America and the Caribbean for Latin American values, and CENAM-17 for Argentina's numbers.

Figure 2. Mining Share of Exports Among Regional Peers



Source: Authors' calculations based on World Bank open data.

Figure 3. Argentine Mining Exports (Free on Board)

Source: INDEC data: FOB value for export chapters (HS-2) 26, 28, and 71.*
* The Harmonized System (HS) is an international nomenclature defined by the World Customs Organisation (WCO) for the classification of products.

Mining activity in Argentina concentrates mostly on metallic minerals, which represented 73 percent of total mining production in 2016 (US$1.8 billion of a total of US$2.4 billion, according to official statistics[3]) (Figure 4). The three main metals produced in 2016, by value, were gold (49 percent), copper (37 percent), and silver (14 percent). Copper production, however, declined significantly in the last yearsdue to the mineral reserves at Argentina's sole copper-producing mine (Bajo de la Alumbrera, operated by Glencore) played out and the mine began closure in 2018. In July 2019, Glencore, Yamana Gold, and Newmont Goldcorp announced positive potential economic results at Agua Rica, a project through which copper-rich ore could be extracted at a nearby deposit and processed in Bajo de la Alumbrera's facilities. Yet, it is still unknown when and if the Agua Rica project could move on to the feasibility stage.

Therefore, the near future for metal mining in Argentina lies in gold and silver in the San Juan, Santa Cruz, and Salta provinces. In addition, lithium is undergoing a boom.

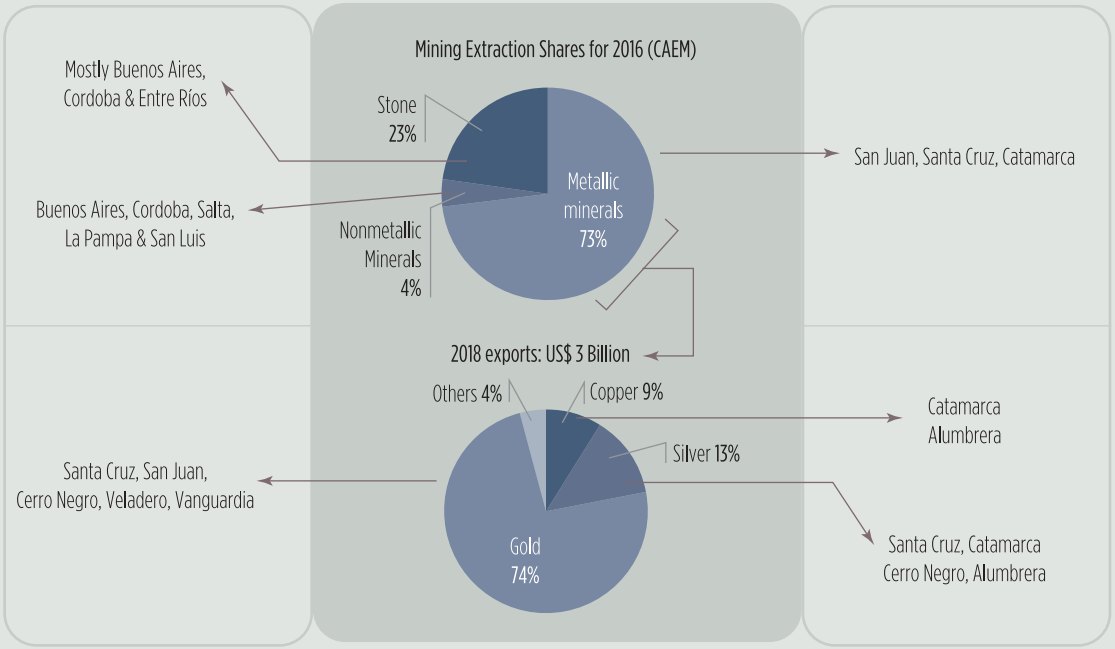
If we look at the regional distribution of mining, in 2017, 17 mines were active, 70 percent of which were in three provinces: Santa Cruz (35 percent), Catamarca (25 percent), and San Juan (11 percent) (Figure 5).[4]

Figure 6 shows the main metal mining projects and their geographical distribution. The most significant projects, which are in Santa Cruz and San Juan, are gold and silver mines. The key companies are Newmont Goldcorp, Barrick Gold, Glencore, and AngloGold Ashanti.

3 CENAM17 (last available Argentine mining census).

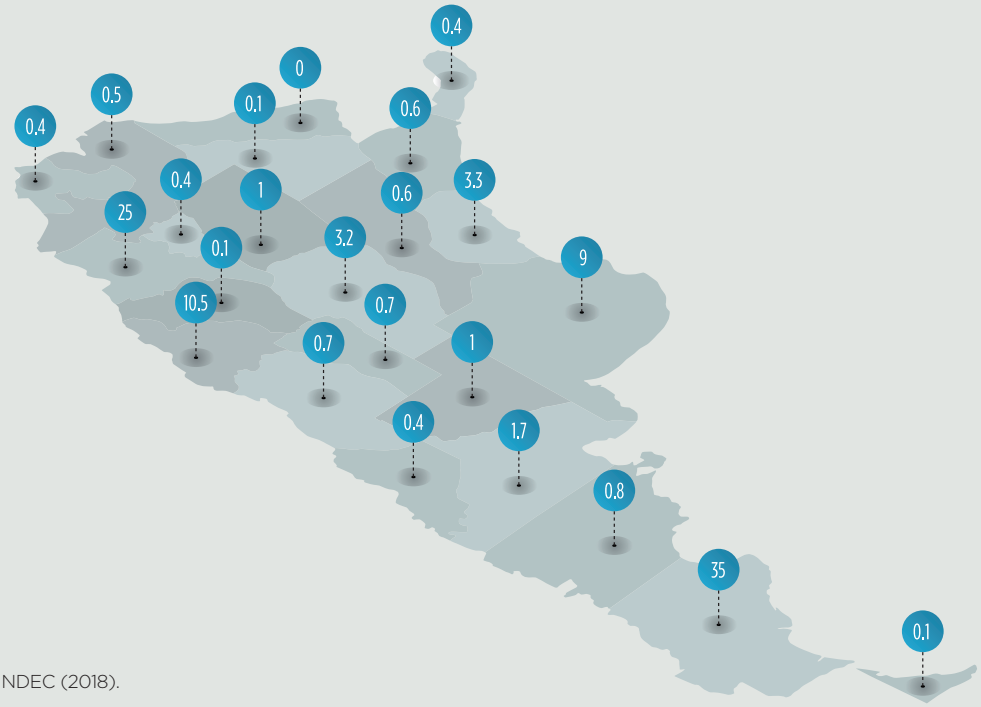
4 In 2019, the Secretary of Mining Policy stated that about 16 mines were in production. See http://cima.minem.gob.ar/assets/datasets/2019-10%20Potencial%20Minero%20argentino%20%20(metal%C3%ADfero,%20litio%20y%20uranio).pdf.

Figure 4. Main Minerals in the Argentine Mining Sector, by Province



Source: INDEC (2018)
Note: Mining segment shares are from CENAM-17, metallic shares are from exports.

Figure 5. Provincial Distribution of Mines in Argentina (percent of total production)



Source: INDEC (2018).

Figure 6. Main Mining Projects by Geographical Area

#	Province	Project Name	Minerals	Project Stage (November 2019)
1	Catamarca	Farallón Negro y Alto de la Blenda	Au, Ag	Operating
2	Catamarca	Mina Fénix (Salar Hombre Muerto)	Li, K	Operating
3	Catamarca	Bajo de la Alumbrera / Bajo el Durazno	Cu, Au, Ag, Mo	Closed
4	Jujuy	Salar de Olaroz	Li, K	Operating
5	Jujuy	Chinchillas	Ag, Pb, Zn	Operating
6	Jujuy	Mina El Aguilar	Pb, Ag, Zn	Operating
7	Neuquén	Andacollo	Au	Operating
8	San Juan	Valle de Chita	Cu, Au, Ag, Mo	Exploration (advanced)
9	San Juan	Altar	Cu, Au, Ag	Exploration (advanced)
10	San Juan	Gualcamayo	Au	Operating
11	San Juan	Veladero	Au, Ag	Operating
12	San Juan	Casposo	Au, Ag	Operating
13	Santa Cruz	Manantial Espejo	Ag, Au	Operating
14	Santa Cruz	Cap Oeste	Au, Ag	Operating
15	Santa Cruz	Cerro Morro	Au, Ag	Operating
16	Santa Cruz	Cerro Vanguardia	Au, Ag	Operating
17	Santa Cruz	Don Nicolás	Au, Ag	Operating
18	Santa Cruz	San José – Huevos Verdes	Au, Ag	Operating
19	Santa Cruz	Cerro Negro	Au, Ag	Operating
20	Santa Cruz	Lomada de Leiva	Au	Closed

Source: Secretary of Mining Policy.
Note: Au = gold, Ag = silver, Cu = copper, Mo = molybdenum, Li = lithium, K = potassium, Pb = lead, Zn = zinc.

Despite the small scale and high concentration of mining in Argentina, there is consensus that the sector has huge potential, based on both known deposits and significant unexplored and unexploited geological resources. In Argentina, mining rights by the Ministry of Energy and Mining have been granted to only 35 percent of the country's areas of high mining potential, and only a few of those areas where rights have been granted have managed to develop mining operations. Put differently, 65 percent of the areas with high mining potential have not yet been assigned mining rights (Table 1).

Table 1. Mining Rights Granted Compared with High Mining Potential Areas in Argentina, 2018

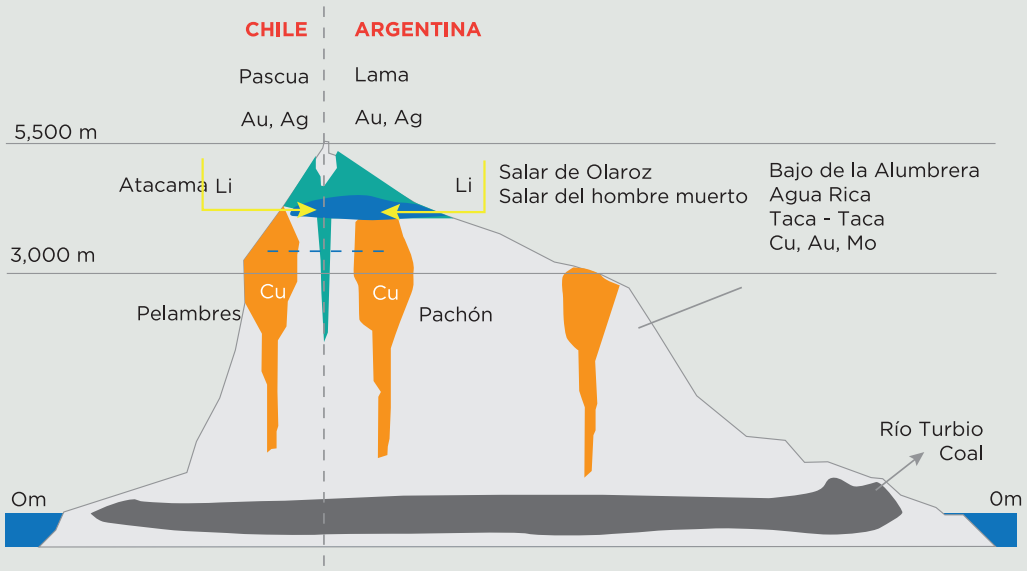
Province	Mining Rights Granted (km^2)	Areas of High Mining Potential (km^2)
Catamarca	34,900	> 75,000
Chubut	33,365	> 75,000
Cordoba	2,400	> 40,000
Jujuy	10,000	> 30,000
La Rioja	12,065	> 50,000
Mendoza	18,300	> 75,000
Neuquén	17,000	> 50,000
Río Negro	16,000	> 70,000
Salta	29,700	> 65,000
San Juan	53,815	> 60,000
San Luis	2,200	> 25,000
Santa Cruz	34,650	> 75,000
Tierra del Fuego	1,600	> 10,000
Other	—	> 10,000
Total	**265,995**	**> 750,000**

Source: Argentina Ministry of Energy and Mining

The importance of this unexploited potential can be illustrated by a comparison with Chile, the main mining country in Latin America. Chile and Argentina share the Andes Mountains, where most of Chile's mineral resources are found. The geological process that formed some of the large copper deposits being exploited in Chile (e.g., at Pelambres, the 12th largest copper mine in the world) created similar large deposits in Argentina. One example is the Pachón copper deposit in San Juan, which is a huge deposit discovered in the 1960s next to the Pelambres deposit in Chile. Another example is the Pascua-Lama gold and silver deposit, which spans the border between the countries (though most of the resource is located in Chile) (Figure 7).[5] Despite having these potential resources, according to the Ores and Metals Exports (World Bank data), in 2017, Chile's mining sector exported 20 times more than Argentina's.

5 Pascua-Lama was planned as the first binational project to be implemented under the bilateral Mining Treaty between Argentina and Chile. Construction began on the facilities but was suspended in 2013 because of Chile's Supreme Court ruling halting construction and imposing sanctions on mining firms for violating conditions in the environmental permit.

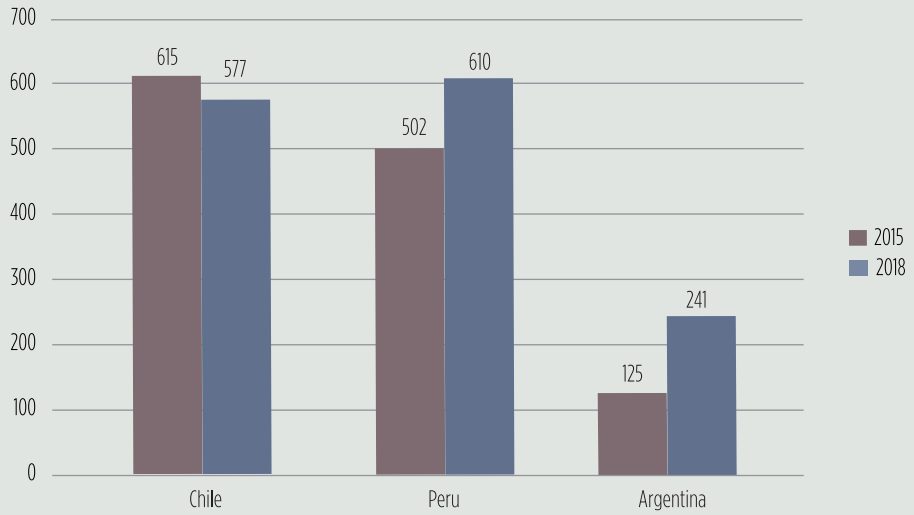
Figure 7. Topographic-Geologic Cross Section



Source: Secretary of Mining Policy.

One reason mining activities are not expanding in Argentina is the country's low level of investment in the sector. Figure 8 compares Argentina, Chile, and Peru. In 2015, Chile and Peru received more than four times the investments that Argentina received. The gap decreased in 2018, but was still large, with exploration investments in Chile and Peru more than double those in Argentina (Figure 8).

Figure 8. Investments in Exploration in Argentina, Chile, and Peru (US$ millions)



Source: Government of Argentina (2018).

As in any other sector in Argentina, the low level of investment in mining is to some extent due to the high level of economic and institutional uncertainty. But the mining sector faces additional challenges related to the history of mining in the country, to regulatory problems, and to lack of social acceptance. These factors are discussed later in this report.

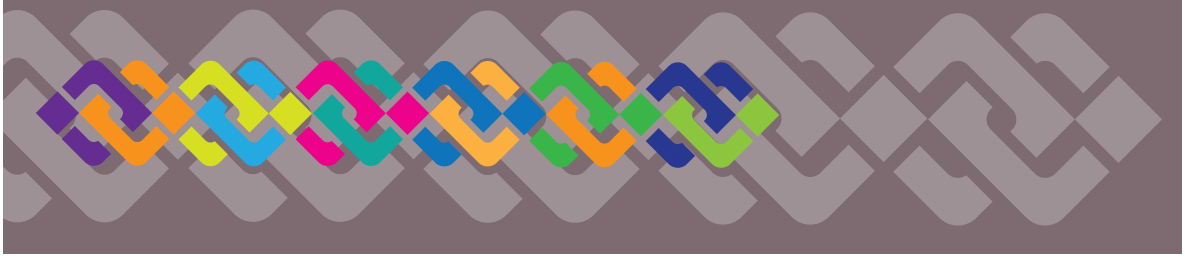
Main Institutions and Legal Framework

Both federal and provincial governments have institutions and regulations that govern the mining sector in Argentina, which is constitutionally organized as a federal republic. The national government provides the general regulatory framework for mining and, since the constitutional reform in 1994, the provinces own the natural resources in their territory. The provinces are responsible for granting exploration and extraction rights (i.e., issuing and revoking permits), for charging royalties and other nonfiscal contributions for mining activity, and for ensuring compliance with the environmental regulatory frameworks (e.g., environmental controls and audits). Each province has its own mining procedural law, which may be a mining administrative law or a mining procedural code.

Because of the institutional setup in Argentina, with each province having its own rules and institutions, coordination of policies and regulations requires constant effort and presents multiple challenges for mining companies. As a result, the Federal Mining Council (COFEMIN) was created to design, execute, and follow up on the national mining policy. The mission of the related Federal Environmental Council (COFEMA) is to coordinate national and provincial environmental policies and exchange information. Besides COFEMIN and COFEMA, the multi-stakeholder group formally established in 2018 is becoming more important. This group is in charge of implementing the Extractive Industries Transparency Initiative in Argentina. The three most fundamental regulations underpinning the mining sector nationwide are the Federal Mining Code, the Mining Investment Law, and the law for the Environmental Protection of Mining Activities (see Appendix 5). Finally, the legal framework governing the mineral sector in the provinces is characterized by provincial "local content policies" of diverse scope and nature, where "local" refers to the province; that is, the policies apply to companies that have a legal domicile in the province (see Appendix 6).

4.

LOCAL STRATEGIC MINING SUPPLIERS: ANALYSIS OF EMPIRICAL EVIDENCE



This section maps domestic mining suppliers within the value chain in Argentina. We examine the main barriers to entry, the opportunities domestic suppliers are taking advantage of, and the nature of suppliers' strategies to enter the chain. This section also focuses on aspects of the interactions between mining firms and domestic suppliers, including the policies of mining firms that relate to domestic suppliers' development, the kind of contracts they use, and the different kinds of linkages they have developed locally. Finally, the section looks at domestic firms' innovation efforts and results.

Mapping Domestic Suppliers Within the Mining Value Chain: What They Do and Don't Do

Suppliers Linked to Exploration

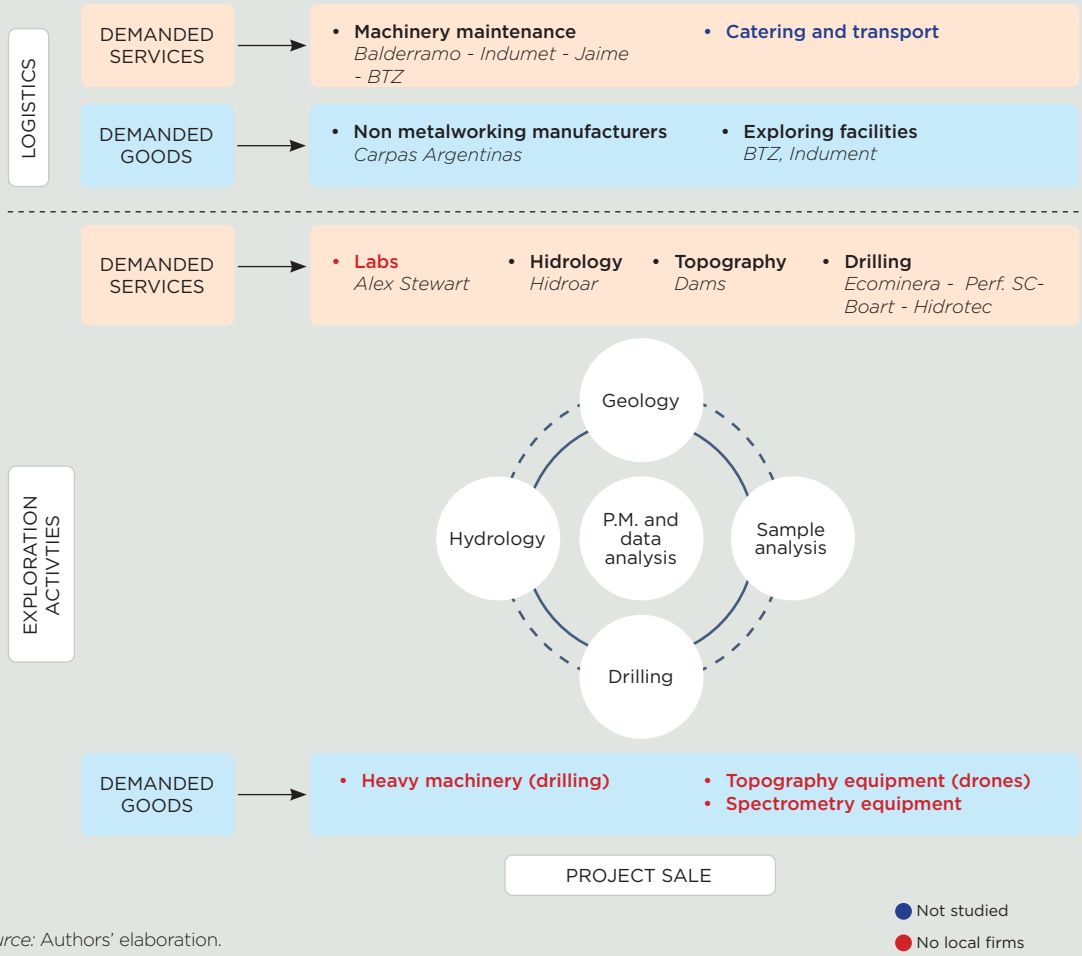
The exploration stage of mining encompasses all activities related to identifying mineral deposits and evaluating the economic viability of their extraction. Exploration companies identify, evaluate, and quantify available resources at a given mineral deposit. During the initial stages of exploration, especially in greenfield areas (areas with no active mines and where no known mineral deposits indicate with higher certainty that a deposit could be found), junior companies commonly perform the research work.[6] When a mine is already operating, it is more common for exploitation companies to do the exploration work themselves, generally in the areas surrounding the main operation (brownfield exploration). Once exploration is well advanced, specialized international firms (consultancies) complete the project design stage and assess potential economic feasibility. These consultancies

6 Junior companies are too small to undertake mining exploitation and in most cases cannot bear the costs of the most intensive parts of the exploration stage. However, they play a huge role in identifying sites with potential and take the first prospecting steps and then sell the project either to a major firm that can continue exploration activities or to an exploitation firm.

employ certified professional personnel (often termed "qualified people"). Junior exploration companies may participate in this stage somewhat or not at all.

The main goods and services required for exploration activities fall into the logistics and mineral exploration categories (Figure 9). Logistics encompasses services such as machinery maintenance, catering, and transport, and goods such as nonmetal manufactured items and exploration equipment, such as tents. Mineral exploration activities encompass services such as labs for sample analysis, hydrology studies, topography studies, and core sampling, and goods such as heavy machinery, and spectrometry equipment.

Figure 9. Exploration Value Chain and Domestic Product and Service Providers



Source: Authors' elaboration.

It is worth noting that no domestic companies are supplying complex or sophisticated goods (e.g., heavy machinery) related to exploration. We could identify and interview just one firm that provided goods for exploration. The company, Carpas Argentinas, is located in the Province of San Juan, where it produces and supplies thermal tents for exploration camps. On the other hand, other

than lab analysis, domestic firms supply all the main services essential to exploration, including geology, hydrology, and core sampling.

The analysis of the subsoil samples extracted during the exploration stage is done exclusively by foreign lab subsidiaries. Since funding typically comes from international sources, the backing of internationally recognized firms is required. Domestic labs can perform most of the required analysis, but they are not recognized or certified internationally, so their results cannot be used to certify exploration results. Certification is an essential precondition to credibly offer and sell a project abroad. Therefore, we interviewed a representative from Alex Stewart International Argentina, an international lab located in Mendoza. Alex Stewart International Argentina is an important business unit of a foreign company that started work in the country in the agricultural sector in 1998 and diversified into mining as part of an expansion in the 2000s.

Only a few domestic companies provide geology services and they are very small. We interviewed two. In San Juan, we spoke with a representative from DAMS, a new venture that works with drones and other new technologies to support geophysics, topography, and magnetometry for exploration and provides general engineering services. In Salta, we interviewed Aminco, which sells specialized exploration equipment and software for 3D geological exploration and modeling, resource estimation, and mine planning. Two other Argentine companies that supply geology services are DroneXplora and Hytech Ingeniería, but we could not get interviews.

Geology services are an important, knowledge-intensive area that large exploration companies typically perform in-house with the support of local professionals (e.g., geologists). However, small specialized domestic firms are developing to supply these services to junior companies, large operators, and first-tier suppliers that have not developed or maintained these services in-house. Additionally, as these emerging providers invest in specialized equipment such as drones that make resource identification more efficient, they are starting to supply large mining companies that have in-house capabilities but find it convenient to subcontract this kind of specialized service. So although geology services is a very small segment in Argentina, there is great potential for local suppliers to develop in innovative areas such as knowledge-intensive services.

The exploration activity for which we found most of the more developed domestic suppliers was drilling. In this segment, five firms were interviewed, four of them domestic: Perforaciones Santacruceñas, Hidrotec Perforaciones, AGV Falcon Drilling, and segment leader Eco Minera. One company was a subsidiary of foreign firm Boart Longyear. Drilling companies are typically large and own specialized drilling machinery adapted to different kinds of soil and terrain, and for specific process requirements, such as depth. Some of these companies have diversified to provide other exploration services, such as transport and road building. One good example of these types of firms is Eco Minera, which offers comprehensive complementary services related to drilling. Others specialize (e.g., Perforaciones Santacruceñas), aiming to offer more complex and sophisticated services with very specialized equipment.

Some service suppliers are dedicated to machinery repair and developing facilities for exploration. Though these firms work mainly for clients doing exploitation, they also supply firms whose exploration activities have expanded. From this group we interviewed Red Balderramo, Indumet, Metamecánica Jaime, and BTZ Minera.

Finally, we interviewed the only fully developed knowledge-intensive service provider linked to exploration activities that we could identify in the mining supplier segment, Hidroar. This company provides hydrology and environmental impact and remediation services.

Suppliers Linked to Exploitation

The exploitation stage of mining, which starts after exploration is finished, consists of activities related to extracting minerals, preparing mineral concentrates, and commercializing the final products. It is important to distinguish between the first phase of exploitation—construction and mine startup—and the second phase, during which the mine is operating.

Construction entails a great deal of investment for activities such as earth-moving (site preparation), constructing roads and facilities, building tailings storage facilities and waste dumps, preparing mine camps, developing the infrastructure required to access services to run the mine (e.g., electricity and water), opening pits or shafts/galleries (depending on whether the mine is open, underground, or a combination), transporting equipment and machinery to the mine, and building facilities to transport materials within the mine site.

Key operation-phase activities include maintaining and controlling production facilities (e.g., primary and secondary crushers, mine waste stockpiles, tailings storage facilities, and ancillary facilities), providing generic supplies (e.g., electricity, fuel, water, explosives, and tires for vehicles), providing supplies required to maintain the machinery and equipment (e.g., spare parts and consumables such as mill balls and chemical reagents), and offering contracting services (e.g., environmental management, residue management, personnel and materials logistics, catering, security, healthcare, and cleaning).

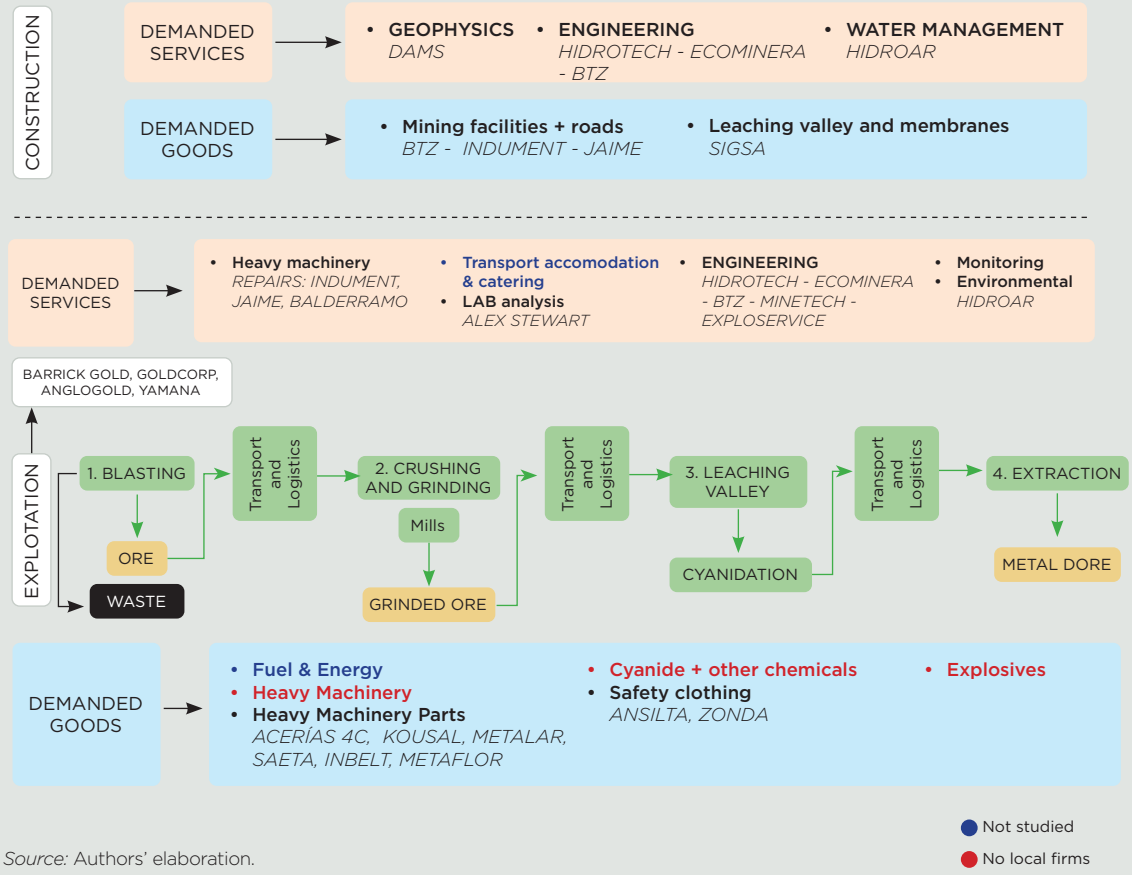
Some of these activities are performed by mining companies themselves. Typically, all processing plant controls, management of waste dumps, health and safety, environmental controls, truck driving, maintenance, and administration are taken care of in-house. Other specialized services, such as communications, road design and construction, assembly and maintenance of parts and facilities, and nonspecialized services such as logistics, catering, security, and cleaning, are often outsourced.

Figure 10 shows goods and services required during the exploitation stage of a mining project. During construction, geophysics, engineering, water management, and heavy machinery repairs are the most relevant services. Mining facilities, including leaching valleys (when necessary) and membranes, fuel, and heavy machinery and heavy machinery parts, are the most relevant goods. When it comes to exploitation activities, heavy machinery repairs, transport, accommodation and catering, engineering, and environmental monitoring are the most relevant services. As for goods, fuel and electricity, water, chemicals, heavy machinery and parts, explosives, and safety clothing and equipment are the most important.

As with the exploration stage, local suppliers were identified in all activities except heavy machinery, where international suppliers tend to prevail, and in some sensitive areas such as the production of cyanide and explosives, where mining companies trust only global suppliers.

Among domestic service providers, we interviewed three engineering firms that provide numerous services, such as construction (facilities and roads), tunneling, geological services, construction of

Figure 10. Exploitation Value Chain and Domestic Goods and Service Providers



Source: Authors' elaboration.

leaching valleys, and underground mining: Eco Minera and BTZ Minera from San Juan and Hidrotec from Salta. We also interviewed three companies that repair machinery, a relatively well-developed field in the Argentina: Indumet, Jaime, and Red Balderramo. Indumet and Jaime repair heavy machinery parts, such as diggers, and are among the few suppliers that have managed to work inside the mines with some kind of contract. Red Balderramo is fully dedicated to repairing engines.

Finally, in exploitation services, we interviewed Exploservice, a company that organizes blasting for mining companies, and MineTech, which provides information and communications technology (ICT) services for underground mining. They were unique in their segment.

An important segment among domestic manufactured goods is machinery parts. In this segment we interviewed five companies—Acerías 4C, Kousal, Metalar, Saeta, and Inbelt—but there are many others. Parts manufacturing is the segment with the most domestic suppliers, mostly small and medium-size metal fabricators with long histories supplying other sectors. Some of these firms date back to the 1950s, when they started supplying other industries, and have moved to mining recently following the expansion of the sector that began in the 1990s.

In contrast to drilling companies, fabricators are typically diversified in terms of sectors, serving agriculture, food production, oil and gas, and building, among others, as well as mining. In this group, only Inbelt is not exclusively a metal fabricator: its most important business unit develops rubber parts for mills.

No other major segment of manufactured goods suppliers for mining includes a significant number of domestic suppliers. Thus, we interviewed a few successful companies identified by key informants: MineTech, produces shelters for underground mining, and IPH , which produces steel cables.

Despite the importance of digital technologies in mining, it is noteworthy that no domestic companies were identified that supply services to support the automation of mining. As well, no companies were found that develop solutions based on new technologies such as biotechnology (e.g., bioleaching).

Suppliers were classified as one of four types:

1. Comprehensive service suppliers (AGV Falcon Drilling, Jaime, Eco Minera, BTZ Minera, Hidrotec, MineTech)
2. Specialized service suppliers (Hidroar, DAMS)
3. Metal fabricators (Saeta, Acerías 4C, Metalar)
4. Other manufacturers (MineTech, Carpas)

This classification is descriptive only and is used to simplify presentation of the information.

We wanted to answer two important groups of questions to understand the possibilities of domestic firms expanding to enter the mining value chain.

First, why have some key segments not been occupied by domestic firms? Why are there not more companies in the segments occupied by domestic suppliers? What are the main barriers to entry?

Second, how have domestic companies already in the chain overcome those barriers? Which opportunities have these companies taken advantage of? Which strategies did they use?

We explore these questions in the next subsections.

Entering the Mining Value Chain: Barriers, Opportunities, and Strategies of Domestic Suppliers

Entering the mining value chain is challenging for domestic firms for two main reasons. First, mining companies are large, global, and mostly foreign. They typically procure relatively complex goods and services through global contracts with other large, global providers with which they have a long tradition of working together in many other countries (e.g., Caterpillar). Global suppliers have experience and good reputations. According to our interviews with operation and exploration companies, their contracts with global suppliers, although often expensive, certainly help mining firms reduce risks significantly. Given the huge magnitude of extra costs a mining failure might bring, mining companies prefer to increase costs, lose efficiency, and sacrifice innovation potential using proven solutions rather than risk trying new solutions provided by domestic firms that are in principle unknown (this is called “known inertia”). As argued by several interviewees, “a procurement

manager of a large mining company never gets fired because of buying Caterpillar, but if he decides to buy from local firms and something fails, he is responsible."

The second reason it is difficult for domestic firms to enter the value chain is that the first tier of suppliers comprises just a few large global firms, in many cases even larger and more powerful than the mining companies. For instance, the mining machinery segment is dominated by three global firms: Caterpillar, Komatsu, and Liebherr (see Box 1).

Box 1. Heavy Machinery Concentration

Three firms, Caterpillar (United States), Komatsu (Japan), and Liebherr (Switzerland), provide 90 percent of the heavy machinery used in mining. They also own subsidiary companies that produce and sell original spare parts and repair services. For example, Caterpillar owns Finning, the default company to which mining firms send their machinery for repairs. Finning often then hires local firms to help with specific tasks but retains the majority of control and fees.

Caterpillar-Finning has agreements with multinational mining corporations to use its machinery and maintenance services in numerous countries. Additionally, it imposes other barriers, such as codification of its parts to make replicability more difficult.

This means that beyond the difficulties that domestic suppliers have to face to reach global mining firms, given the inclination those firms have to contract global suppliers, local suppliers also have to face the typical challenges firms face to enter very concentrated markets, where leaders are very large and powerful. Companies in dominant positions in concentrated markets typically set prices and standards and often use anticompetitive practices to prevail. In the interviews for this study, both mining companies and suppliers described some of these practices.

One example of anticompetition practices that emerged in the interviews related to the codification of machinery parts by global suppliers. According to some of the interviewees, Caterpillar uses a complex codification system to identify spare parts and change it often. This makes it difficult for mining firms to replace parts through other suppliers, since first, it is difficult to understand the identification system, and second, mining companies often do not have enough time to evaluate which parts could be produced locally and to communicate with local suppliers before the part-numbering system changes. Mining companies interviewed suggested that these practices have no apparent purpose other than making it difficult for domestic suppliers to develop spare parts.

Similar to what is observed in other natural resources sectors, domestic mining suppliers that have managed to enter the value chain have done so by taking advantage of three types of opportunities: (i) localization, (ii) the need for adaptation to local specificities, and (iii) the need for new or specialized knowledge (Marin and Stubrin, 2015; Stubrin, 2017; Pietrobelli et al., 2018).

In the first case, crucial factors are flexibility, rapid response, and costs. Local suppliers have the advantage of geographical proximity and are much more flexible and less bureaucratic than large multinational suppliers. These attributes are very attractive for mining companies when they need a solution quickly.

Box 2. Minexus: Solving the Problem of Asymmetric Information

To address the challenge of lack of Information, a novel local initiative, Minexus from San Juan, is developing a comprehensive and easy-to-read dataset for both mining firms and suppliers. It will include information about all potentially required spare parts and their physical characteristics.

Led by a former employee of Barrick Gold, the initiative is reading and decoding all heavy machinery part-numbering systems with the purpose of providing useful descriptions for suppliers. The idea is that removing problems with asymmetric information between potential local suppliers, mining firms, and international suppliers would benefit both mining firms (which would pay less because machinery parts production would gain competitiveness) and local suppliers (which would gain key information about specifications of heavy machinery parts and thus be able to produce and offer them).

The final product would be an online platform to which local suppliers could upload information about their alternatives to international manufacturer parts, and then mining firms would be able to easily know that local alternatives exist and could compare prices. The global suppliers, however, have no incentive to collaborate and this creates an important challenge for Minexus, at least until domestic policies address the problem.

In the second case, what is important is knowledge of local conditions and the capacity to reverse engineer, adapt according to the needs of mining company, and eventually innovate. Unlike other sectors, natural resources exploitation has characteristics that vary according to the geographical region where the activity is located. Some products or services developed by global suppliers to work in one environment do not necessarily work well in the conditions under which mining is performed in San Juan or Santa Cruz, at high altitudes. Domestic suppliers know these specificities and have the capacity to adapt to take advantage of them.

In the third case, what is crucial is the capacity to identify and understand new knowledge or technological opportunities to develop products and services that solve traditional or new mining problems in a novel way.

Most of the service providers interviewed entered the value chain almost exclusively by taking advantage of localization—being close to the operations. They may provide a relatively standard service, such as drilling or machinery repair, but they can outcompete large global suppliers because they are close by. They are also smaller than global providers and therefore are more flexible and less bureaucratic. They can respond quickly to specific demands. In many cases, they are also cheaper.

The following quotation from the owner of the knowledge-intensive service provider Hidrotec is an example of opportunities opened by geographical proximity: "...the manager of the mining company just sent us a message saying that the machine is delayed and the message reached me directly, the owner of the company (...) so the solutions are much faster. I am, as the owner, involved in the whole operation. When they work with other companies with the shareholder group in Canada any economic or technical response takes a long time."

The importance of being close, flexible, and able to provide a rapid response is multiplied in times of crisis, which has opened a door for many local firms. The metalworking firm Indumet, for instance, originally a supplier to Finning (Caterpillar's official parts provider), was for a long time unsuccessful in trying to supply directly to mining firms but managed to enter the value chain by taking advantage of two crisis situations. First, Barrick Gold had a technical problem that stopped the plant. Indumet managed to quickly and effectively fix the problem, and Barrick noticed the company. Then, there was a major cyanide leak at the Barrick's Veladero mine in San Juan, and again Indumet managed to quickly and effectively produce a set of tubes and connectors for a specific type of tank that stopped the leak. In doing so, Indumet's owner interacted (at the time unknowingly) with the head of maintenance of Barrick Gold, and the relationship changed drastically. The volume of work Indumet did for Barrick increased exponentially. Now Indumet is one of the few firms with a long-term maintenance contract with Barrick and with facilities at the mine. The work with Barrick also meant that other mines in San Juan started working with Indumet because of the reputation it had built with Barrick.

The following statement from the owner of Indumet summarize the events:

> San Juan is far from everything. That's a big disadvantage, but it also creates opportunities for us who are here. The response to a broken machine is very slow if you have to go, for example, to the United States and come back. And we are here. And that's what happened: at one point a machine broke down and the plant stopped. And as a matter of urgency they asked the head of general maintenance within the mine who could repair it. The head of general maintenance came. When he arrived, he saw the company and the components that we supplied to Finning. They didn't know that we supplied Finning. He ended up asking us why we didn't work with them. I replied that we would like to work with them, that we had gone a thousand times, and we couldn't enter. When that happened, they made the decision to stop working with Finning, and hire us directly.

The complex service company Hidrotec specializes in drilling and providing water. Again, after several attempts to enter the mining value chain through visits to mining companies, Hidrotec took advantage of an urgent demand from a mining firm. "One Friday night, a mining company from Salta called us and told us 'a pump broke, we have 300 people without water, I need you to be here tomorrow to give us a solution.' That night we [juggled] management and the next day we were there. And when we arrived, the person in charge of purchases told us, 'look, the other companies won't even answer our phone calls.'"

Suppliers of manufactured parts have also entered the value chain because they are close to the mine site, flexible, and respond quickly to the demands of mining companies, but in almost all cases, they also provide items that are adapted to local conditions. Examples are parts of heavy machinery such as diggers adapted to work at high altitudes and very low temperatures. Typically, according to the interviewees, when original parts are damaged during use and the mining company does not have replacement stock, the companies order parts locally to quickly replace the damaged ones without stopping the mine. It is common that some of these parts work better than the originals

because they are adapted to local conditions. Domestic companies can thus become permanent suppliers to the mining firms.

Again, Indumet is a good example: "For Barrick we developed a component for a machine, we modified it with respect to the original. We told them to pay us if the product lasted longer than the original one. And it lasted almost three times as long. Then they began to buy that product from us, and even the brand of the original product copied our development for the other machines."

Though less common, in some cases service providers adapted their equipment bought in international markets to work in the local extreme climate and conditions or at high altitudes. Hidrotec, for instance, performs this kind of adaptations to their drilling equipment:

> There is equipment that is standard. With the experience we have, instead of struggling with the standard equipment that was produced for somewhere else in the world but does not work well here, we adapt it to the local climatic conditions and to the operational and sociocultural level of the operators here. We modify everything so that it is more effective to use here and perform better. Many things are related to security requirements that are local. It can be something simple or more complex which is not required by security standards in India or Brazil. Here we elevate the standard of security. Even modifying a rig so that it drills with 25°C.

Eco Minera also claims to adapt most of its equipment. With this objective, and given the volume of work, the company has developed a metalworking department internally.

In Argentina, few domestic firms were observed that have taken advantage of new knowledge or technological opportunities to enter the mining value chain. Just a few service providers, such as Hidroar, DAMS, and MineTech, appear to have done so.

The nature of the service Hidroar provides usually requires development of new knowledge:

> ...to give water to the mine ... or to make the engineering to move the water to the mine we need to do research to understand how to depress the aquifers in cases of working underground and to ensure that there is water to exploit the mineral. All this leads to an important development of knowledge: there is a lot of drilling work, hydraulic tests, etc. And you need people who can interpret all that—think of them as 20- or 30-year projects ... Each new project is a research project, you can even say it's pure research in some cases. Sometimes there are important findings. For example, at the Navidad project we discovered an aquifer and that is already an important finding because that aquifer can be used for many other things.

A common problem that all supplier firms face, independent of the particular opportunity they take advantage of to enter the value chain, is asymmetric information. Mining companies do not know about the suppliers, their level of capability, or the kind of products or services they can develop. At the same time, domestic suppliers do not know the needs and specific requirements of mining companies. In the absence of established mechanisms (such as supplier development programs) to connect suppliers and mining companies to solve the problems of

asymmetric information,[7] domestic firms have to deploy very proactive strategies to become known to mining firms.

The most common strategy is for suppliers to knock on the door of mining companies to obtain an interview or a visit to offer their services or products. When they manage to arrange a meeting, it is typically with the purchasing department. This was the first contact many of the firms studied had with mining firms and it is the way they got their first contract or purchase order. Obtaining these meetings is not straightforward, however. The firms interviewed report trying several times to contact the mining firm through phone calls, emails, or informal contacts until they succeeded.

Additionally, some firms may succeed with this type of strategy with one mining firm but not another. For example, the cluster of oil and gas and mining companies in Córdoba organize structured visits to different mining companies by the firms that belong to the cluster, which typically supply the automotive industry but are attempting to diversify their clients. Despite the active lobby the cluster has created, this strategy has not been useful for many of the firms.

Less common, but effective in some cases, is gaining contacts through business associations. Metal fabricator Kousal entered the value chain this way. When a first-tier U.S. supplier to the Bajo de da Alumbrera mine was in charge of the engineering to assemble the ore concentrator, it needed to find a local supplier that could help manufacture the anchor bolts for the columns that would then form the main body of the concentrator. To find a local supplier, the firm consulted with business associations, which gave the company a list of local metallurgical companies. The company selected Kousal, considering it had previous experience working with heavy industries.

To avoid the negative consequences of asymmetric information, it is important for domestic suppliers to have the capacity to test their solutions. Mining firms are reluctant to adopt or buy untested solutions, but uncertainty is reduced if domestic firms can show that their solutions work well. Red Balderramo, which specializes in repairing engines, asserted that being able to test that an engine works well after repair at the mining company was a key to becoming trusted by mining firms and thus entering the mining sector.

Another significant restriction that all firms need to overcome when first attempting to cater to the mining value chain is the lack of previous experience in the sector. For example, to win a tender, firms need to prove they are experienced in the industry. This requirement clearly benefits incumbents (and particularly experienced foreign firms) and generates an important entry barrier to local firms in a country like Argentina, where mining is a relatively new activity.

However, some assets and initiatives have helped local firms demonstrate their capabilities to mining firms in other ways. First is having a track record in other related and unrelated sectors. All metal fabricators, with the exception of Saeta (from San Juan), have previous experience working in other sectors. Before entering the mining sector, Di Bacco, Kousal, and Metalar worked for decades in the agriculture and food production sectors. Two service providers, Alex Stewart International and Jaime, also started in those industries and then moved to mining. Some companies also have built capabilities in the petroleum sector, including Hidroar and Acerías 4C, which now supply both

7 In 2017, Barrick Gold organized a hackathon that provided knowledge-based firm DAMS, which specializes in drones, an important opportunity to enter the value chain. DAMS proposed a geophysics method using thermal sensors and drones to determine sectors with gold in the valley to address the problem of locating the surplus gold from the leach valley. The idea was that the hackathon winner would have a chance to attend another Barrick hackathon in Las Vegas and position themselves within the industry. This was an isolated event, however, and was directly oriented to one type of service. More systematic and comprehensive programs are not available in Argentina.

sectors. Eco Minera and Inbelt started supplying other mining activities; SIGSA and Indumet previously supplied public infrastructure works.

For some interviewed firms, providing services or inputs to first- or second-tier suppliers has also proven to be a useful strategy to gain both expertise and visibility within the value chain. Comments from the complex service supplier Di Bacco illustrate this type of entry:

> We started making attempts everywhere, until finally we started with the Chilean company Orica, a first-tier supplier in charge of making the explosives plant that was going to supply the mine. Based on our work, when an Australian official from the mining company saw what we had done, he gave us a very big vote of confidence: he called us to do an expansion of the mine. That was something completely atypical, to the point that we were audited by the owners of La Alumbrera, who were from Canada, Australia, and Switzerland (about 2001, 2002). The reason was that he saw that there was a technical capacity and he was able to overcome the prejudices that existed. As he said, 'if these people are capable of solving these problems, they have to be able to solve these others.' This was a very strong milestone that installed us in the mining world and opened doors to other operations. We were suppliers and accessed other parts of the company.

Another important way of signaling capacity is to have standard quality certifications (e.g., ISO 9000). These types of certifications are very much valued and, in many cases, even demanded by mining firms.

Finally, in many cases, companies have taken advantage of policies to encourage local or national provision of goods. However, service suppliers face a trade-off because they also benefit from free trade if this means accessing machinery and parts internationally easily and at a low cost. Several metal fabricators, such as Di Bacco, Kousal, Metalar, and Saeta, entered mining through these import restrictions.

The owner of Saeta described how the firm benefited from substitution policies:

> We began by developing drill rotation heads for Barrick. At the time, there was a lot of pressure to develop local products, which was when imports were limited. Then, there were monthly meetings with the National Ministry of Industry. At these meetings there were suppliers and there were buyers, like Barrick. And there they were asked to sign a commitment to buy locally. Then they gave us a a previously imported product to develop. We spent 16 months doing that development. We worked with INTI (National Institute of Industrial Technology) and the university. Beyond reverse engineering, we were able to make a modification to the product so that it did not break anymore. And we were able to sell five boxes of those. They also gave us a Caterpillar fan to replicate. We completed it over six months. It was manufactured and also, we introduced some improvements to the original. All the fans that Caterpillar makes in the world are manufactured in the U.K. It was the first time that one of those was manufactured elsewhere, and not by Caterpillar. It was successful, they tested it, it worked very well. We sold 18 in the last few years—essentially nothing—but mining products are like that. At that time, it was a good business for us. Today, our product would be more expensive than the one they can import.

Saeta, in contrast to other metalworking enterprises that benefited from import substitution policies, found it difficult to deal with trade liberalization introduced during the last administration; it suffered a large drop in demand and had to reduce its number of employees significantly. To a large extent, however, this was due to a lack of managerial skills since the owner has high technical capabilities but no management experience. For instance, it emerged from the interviews that Saeta made large investments to produce the required parts without negotiating with the mining companies for the quantity of parts they would need or considering how many would need to be produced to recover its investments. At the moment, the company is trying to serve other sectors, such as oil and gas, but the final outcome is still uncertain. Saeta presents a clear example of how, once barriers to entry have been softened by policy, other challenges related to linkages with mining companies appeared.

Next, we explore how mining company policies relating to domestic suppliers are helping or challenging the entry of domestic firms and/or their capacity to expand.

Supplier–Client Linkages

The global value chain literature states that in value chains dominated by very large buyers, the characteristics and supply policies of those companies determine both entry to and development of local suppliers within the chain. This section summarizes what we learned about mining firms' supplier development policies in Argentina and the contractual agreements mining firms tend to use. This analysis reveals a very poor situation for domestic suppliers. We conclude with the best-case scenario that domestic suppliers can manage in this context.

Mining Firm Policies for Developing Domestic Suppliers

According to our interviews, no mining companies in Argentina have programs, departments, or specific policies to develop local suppliers. As one mining company manager asserted, "we do not have corporate incentives to prefer buying local. The mandate is to lower costs but also to save time in the delivery and to increase safety."

Between 2012 and 2015, when the country had import substitution policies, some mining companies took some initiatives to create regulations to increase their share of local purchases. For example, Minera Santa Cruz created a specialized department to manage the substitution policy. When these policies were interrupted during the Cambiemos administration, many of these efforts were limited or reoriented.

Companies argue that the drop in initiatives was due to problems of policy design. In the case of the Veladero Project in San Juan, the manager of Barrick Gold's supply department argued that some local suppliers were developed in that period, but because the policy was not flexible or practical, the company in some cases had to buy the same product or service twice: once from their usual international supplier and once from a local supplier.

Programs to develop local suppliers have in most cases been dropped or reduced to one person with no resources. Instead, other much less ambitious initiatives have emerged. For instance, in relation to the Cerro Negro project, the Superintendent of Community Relations & Communication of Newmont Goldcorp mentioned using a purchasing system called the INFOSYS system (https://www.infosysbpm.com/) for a few months. This system allowed purchasers to set options for the preference of local suppliers and to provide feedback to suppliers that did not win the tenders.

At Fortuna Silver Mines' Lindero project, the purchasing department, which is in charge of searching for suppliers, gives extra points to local suppliers when running tenders. However, the department does not actively search for potential domestic suppliers. The company argues that without a specific office fully dedicated to finding local suppliers, it is difficult to get to know new local suppliers beyond the ones they already use. The best they can do is to work closely with the Chamber of Suppliers of Mining Companies of Salta (CAPEMISA) to enhance the number of local suppliers and to organize roundtables for that purpose.

The manager of the purchasing department of the Veladero project put forward similar arguments. In the interview, they argued that, despite the company's willingness to increase its use of local suppliers, in the absence of a department in charge of developing domestic suppliers, the purchase department, which has a different objective, does not have enough resources to actively look for new local suppliers. However, they argued that "the company welcomes those suppliers that knock on the door, trying to schedule interviews to get to know them better."

Therefore, efforts to buy locally, when they exist, merely respond to local content policies and the need to gain social credibility (in relation to their corporate social responsibility policies). Efforts focus on local procurement of simple goods and services such as transport, energy, catering, and clothing. This situation clearly works against the purchase of more complex services or products that could spur the development of more sophisticated local suppliers, such as those supplying knowledge-intensive services.

Mining firms recognize this problem, but in the absence of support from their global corporations they argue that coordinated efforts at the national level are required to encourage the development of innovative domestic suppliers. National efforts exist in other countries. For instance, in Chile the World-Class Supplier Program, led by a group of mining firms and supported by the government, aims to catalog the needs, problems, and requirements of mining firms and make them visible to suppliers with the aim of solving the problem of lack of information. But evaluations of this program show limited results, suggesting that an effort of this type—even though potentially useful—should be carefully designed to solve not only problems of information but also other important challenges (Pietrobelli, Marin, and Olivari, 2018).

A second important challenge for the development of domestic suppliers in Argentina, beyond the absence of serious systematic policies and resources directed at local procurements of complex products and services, is the contracts mining companies use. Arms-length relationships tend to prevail, with short, flexible contracts being the norm. Long-term formal agreements are almost nonexistent. Based on interviews with suppliers, we could differentiate three types of contractual arrangements between mining companies and local suppliers, which vary mainly according to the type of product or service the suppliers offer: contracts to provide services, purchase orders, and contracts for tailor-made or specific products or services.

Contracts to Provide Services

Local firms providing services typically become mining suppliers by winning tenders. The length of the contract can vary from weeks to several years, depending on the type of service the supplier provides. Renewal of the contract is, however, always uncertain, and the new contract could be for a period radically different from that of the original contract.

The case of the metal fabricator Jaime illustrates this issue. The supplier signed a contract with Barrick Gold to repair blades at the Veladero project for three years. To provide the service, Jaime invested in three specially equipped trucks and hired personnel to be housed at the mine site to do the repairs in situ when needed. After the first three-year contract expired, the contract was renewed every 30–60 days at most. This situation generates a great deal of uncertainty for the local supplier, giving it the feeling of having "one foot inside and one foot out," as the manager of the local company asserted.

Purchase Orders

Suppliers of standardized products are usually offered purchase orders. Typically, these orders establish the maximum amount of a certain product that the mining firm could purchase from the supplier during a certain period. According to the contract, to avoid sanctions the supplier is obligated to provide the number of products specified in the contract any time the mining firm requires them. Local firms usually need to make a specific investment in machinery, purchase specialized inputs, and hire extra personnel to be able to meet the terms of the contact. However, purchase orders are a very unbalanced type of contract because mining companies have the right to buy all, some, or none of the items specified in the contract. This type of arrangement can be highly problematic for small firms, which usually lack the financial resources, are of small scale, and may lack the managerial skills to successfully deal with this type of contract. As the manager of a metalworking firm asserted, "I cannot invest 6 million Argentine pesos in new machinery if the mining firm does not guarantee to purchase."

Contracts for Tailor-made or Specific Solutions

A third type of arrangement sees mining firms ask a local supplier for a specific or tailor-made solution. Typically, this type of contract is used either when a piece of important equipment suddenly breaks down and the mining firm cannot import the needed part(s) or when an unexpected problem arises at the mine. In those cases, mining firms look for local firms that can quickly provide a solution.

According to the interviews with local suppliers, mining firms do not participate in the development of solutions, give technical assistance, or finance the development of local firms. For machinery repair or even the development of local innovations, the procedure is typically the following: a mining firm gives the part or machinery in question (or blueprints) to the local supplier so the latter can reverse engineer to repair it or to make a similar or improved part. The capabilities and investments required are provided fully by the supplier. This procedure entails important financial risks for the supplier since the local firm has no guarantee that the mining company will actually purchase the new part. This is especially true in cases in which developments or repairs demand the acquisition of specialized machinery or capabilities.

The case of the metal fabricator Saeta illustrates these types of risks. Between 2010 and 2014, Saeta had a business agreement (not a contract) with Barrick to locally produce and replicate certain products. Saeta produced a range of 480 products of different levels of technical complexity for Barrick not specializing in any one type of product. The agreement was that if the quality, costs, and times of Saeta products were accepted by Barrick, Saeta would be prioritized as a supplier. However, this type of agreement required that Saeta incur investments and costs that could not then be recovered. For example, one product took 16 months to develop through reverse engineering plus incremental innovation and Barrick only bought five. The owner of the company claimed "(...) we did not earn any money despite running with the risk and making the innovation effort. Those five machines were used for a while, and then not used anymore by Barrick." Seata also reverse engineered a Caterpillar fan and something similar took place. They only sold 18 units, which was not nearly enough to recover the six-month investment.

During the development stage, suppliers' interactions with mining firms are reduced to responding to technical questions from the mining company and being auditing and certified by mining firms. Thus, mining firms actively certify local suppliers' processes and regularly audit local suppliers. In the audits, the mining firms verify what is done in the supplier's factory, even photographing and filming the work.

For service providers, mining firms tend to provide very detailed specifications of the characteristics of the service they expect. The owner of BTZ Minera, a firm specializing in mine construction, said, "The company gives us a thousand pages with specifications and then we check whether we can meet them or not."

Development of Ideal Linkages Between Mining Firms and Local Suppliers

Ideally, interactions between mining firms and local suppliers evolve as follows: First, domestic firms contact the mining firm's purchasing department. When they start to interact with this department regularly and become part of the purchaser's worksheet (planilla de compras), local firms feel they have become "official mining suppliers." This is the first step. An important transition occurs when a supplier starts to interact with technical departments or the departments that actually use the parts or service.

Comments from the manager of ICT company MineTech illustrate this issue: "At Barrick, where they already know me, I interact with the technical area, the commercial area, and also with the administrative area. In other mining companies, I only interact with the purchasing department, because this is the first area you interact with." When asked about which area of the mining company the firm interacts with, the manager of the metal fabricator Acerías 4C responded, "with the purchasing department for now."

Having direct access to the engineers or technical staff of the mining company enables local suppliers to provide more sophisticated products or services. Through contacts with the purchasing department they typically provide simpler, less risky products or services (e.g., equipment maintenance or welding services). Interacting with the technical staff enables suppliers to start to provide products or services of higher value.

The type and degree of interaction with the technical departments of mining firms depend, however, on what the supplier does. Drilling companies, for example, are in constant contact with the mining firm geologists because they are the ones who manage and provide, for example, the precise location where drilling needs to be done. Other activities, such as maintenance and repair of equipment, require less ongoing interaction with technical departments.

Having permission to enter the mine site is the next step in an "upgraded" relationship between local suppliers and mining companies. Visiting the mine site is not only a sign of "belonging"; suppliers also argue that being there enriches their opportunities to strengthen personal and professional linkages with the mining company's technical personnel, to obtain feedback and discuss technical matters with the engineers, and to find out about other possible requirements they could start fulfilling. For local firms whose main activity is providing services in situ—such as maintenance or repair of mining machinery—working inside the mine is perceived as one the most important achievements. The manager of the metalworking firm Jaime, which provided maintenance services at Barrick's Veladero project, asserted proudly: "We no longer work inside the mine, but we were the only San Juan company to work there for 16 years without interruption."

In sum, linkages with mining firms do not contribute substantially to the development of local suppliers because mining companies do not favor entry to the value chain nor do they contribute to the upgrading of relationships once firms have entered the chain. Entering the value chain provides some certainty of becoming a provider, which is essential for suppliers to make investments in products they will need to supply the mining firm. Contracts are very poor for suppliers and the significant exchanges of information and knowledge required for product and service development exist only when domestic firms manage to enter mine sites, which very few firms we interviewed did. Despite this unfavorable scenario, domestic suppliers have developed different degrees of capabilities based on internal production and technological efforts. We analyze these efforts and their outputs next.

Domestic Suppliers' Resources and Capabilities

Local suppliers that have managed to enter mining value chains in Argentina typically innovate through informal mechanisms. In fact, if conventional indicators of innovation inputs and outputs are considered, such as a strict definition of research and development (R&D)—that is, one that assumes firms conduct R&D only in formal departments within the enterprise—one could argue that just one of the firms interviewed made this type of effort (Di Bacco).

In the same way, if only conventional indicators of innovation are considered, such as patents, none of the firms interviewed have innovated within the sector. Only two interviewed firms have patents in the metalworking segment—Kousal and Metalar—but these patents were not applied for products developed for the mining sector. Looking at publications, only Hidroar is active.

Therefore, we explore qualitative indicators of innovation by suppliers and other kinds of innovation and capabilities. We distinguish these indications of innovation by company type, meaning different types of firms are expected to have higher or lower levels of innovation as an intrinsic characteristic of their activity. We begin with outputs and results, then explore efforts and finally other relevant issues that emerged.

Outputs or Results

Starting with suppliers of goods, we identified just a few product developments that, according to the interviewed companies, were novel to the world or the market. One example was provided by Inbelt, whose owner told us, "Our coating of mills is innovative: before they were clad in stone; we were the first in the world to use metals. It is a new development for the Inbelt market." Metalar reported, "Recently, we developed a new alloy for a mine that had a loss in the gold smelter. This development was new to the market."

These were exceptional cases, however. The most common form of innovation identified in the cases analyzed were custom-made developments or adapted products, created by the suppliers to solve specific problems of the mining companies.

Again, a good example was described by Metalar: "To replace parts that break often in the operation, we developed a product so that it does not break and that then serves the rest of the customers, such as vacuum pumps. These new developments ... are good because they give us the chance to do the piece and then repair them." Another example was provided by MineTech, as described by one of the owners: "We have the first underground mining shelter factory, and we have built the first rescue capsule adapted to local conditions."

A similar pattern is observed for service providers. Just two companies had developed new or highly adapted services or solutions for mining companies operating in Argentina: Hidroar and MineTech. As described by one of the owners of MineTech, "...recently there were cyanide solution spill problems in San Juan ... We developed an online water quality measurement system because real-time measurements were needed. The good thing is that the system is scalable: you can add new systems, new variables. The system is new: someone asked us for a system to measure cyanide, it did not exist, so we developed it." Hidroar noted that, "Each project is a research project; the results are therefore new to the world's knowledge and services (e.g., in the project Navidad they discovered an aquifer basin)."

In general, domestic service suppliers provide a standard solution but they differentiate themselves on factors such as quality, security, and adaptation. In effect, in some cases they adapt machinery to provide a better solution so that the quality of the service improves, as in the case of MinTech quoted above. Key resources here are investments in specialized machinery and in the development of skills to operate them. Certifications are also very important.

The services local suppliers provide also differ in scope. Some companies offer very specialized services while others provide integrated solutions solving several problems related to the specific one they specialize in. This is the case for Eco Minera, which offers almost all complementary services required for drilling. Perforaciones Santa Cruz, in contrast, seeks to provide very specialized drilling services for which it acquired highly specialized machinery.

Local suppliers also differ in terms of the complexity of the tasks and problems they can solve. The most advanced companies, like Eco Minera, have the equipment and capability to drill to different depths, to deal with different kinds of materials, and to solve other problems related to drilling.

Based on categories described in the literature on innovation in local firms, it could be argued that domestic suppliers of goods and services to mines in Argentina are generally at the level of operational and adaptive capabilities. That level of operation is understood as, first, the ability to

operate existing technologies following standard procedures, or, second, to adapt or improve those technologies so they work better in the local context or according to what clients need. There are very exceptional cases of innovative capabilities—the ability to develop products new to the world.

The literature maintains that firms in developing countries can reverse the life cycle of industries, starting with operational capabilities and moving toward innovation capabilities. But, firms will only succeed in this reversal if they make explicit efforts to build capabilities by investing in R&D, skills, and linkages, among other activities conducive to innovation. The composition of these investments and efforts changes according to the industry, of course; nevertheless, it is not possible to develop these capabilities being passive. Learning and developing capabilities requires particular kinds of effort adapted to differences in contexts and industries, examined below.

Efforts and Resources

As mentioned, just one of the companies interviewed had a formal R&D department: Di Bacco. A few others, including Red Balderramo, Eco Minera, and Kousal, had informal teams of professionals in charge of decisions about product and process developments.

The two most common internal efforts firms made to learn about and improve their products or services were hiring skilled workers and buying machinery and new equipment. Certifications were also important.

Almost all companies interviewed had invested heavily in specialized and generic equipment (the only exception being Carpas Argentinas, a company that still used handmade techniques). This suggests significant investment in equipment is required to enter the mining value chain. For instance, drilling services cannot be provided without very expensive specialized machinery, which must be purchased since a rental market for it does not exist. Metal fabrication requires different kinds of equipment, such as milling machines, spectrometers, testing machines, and furnaces.

One typical way interviewed companies upgraded linkages with mining firms was to invest in new equipment and the capacity to operate it to provide a better, more sophisticated, or new service. For instance, Perforaciones Santa Cruz managed to enter the exploration segment of the value chain (after several years of supplying only the exploitation segment) with a new-to-the-country drilling machine that allows the company to drill both vertically and horizontally.

Companies like AGV Falcon Drilling and Eco Minera are constantly incorporating new equipment into their operations. The quality and performance of this equipment is so important that they have developed metal fabricating capabilities within their companies to maintain and adapt it. Aminco made a very expensive new investment for the country: a LiDAR sensor, which allows for higher-precision topography.

In terms of the proportion of skilled professionals on staff, DAMS (with 100 percent of staff deemed skilled professionals), Aminco (100 percent), Hidroar (70 percent), and MineTech (40 percent) stand out with the highest proportions, but this is not surprising because they are knowledge service providers. What is interesting, however, is how interdisciplinary their teams are. In all cases they have a combination of disciplinary backgrounds that varies according to the kind of service provided and the expected evolution of the company. For instance, Hidroar has professionals in geology, hydrogeology,

engineering, hydraulics, civil engineering, environmental biology, agricultural engineering, and geophysics. DAMS has professional in geophysics, earth sciences, topography, civil engineering, finance, and business administration.

Metal fabricators have staffs that include between 8 and 10 percent professionals. Service providers have more variability: small service providers such as Red Balderramo include around 30 percent, while large providers such as Eco Minera and Hidrotec include between 10 and 15 percent. An exception is AGV Falcon Drilling, a large company with 30 percent professionals. Inbelt has 20 percent professionals.

Some companies (e.g., SIGSA and Exploservice) bring technical workers from mining countries such as Peru and Chile.

Certifications are crucially important for companies providing sensitive goods or services such as laboratory analysis or geomembranes to isolate soil and water from toxic materials (e.g., SIGSA has ISO 9001, ISO 14001m, and OHSAS 18001 certification). Almost all companies interviewed had some form of certification or are in the process of obtaining them.

An important asset for some companies is having their own testing equipment or facilities, which serve as a way to provide pretested parts or services to mining companies, eliminating the need to test inside the mine. Red Balderramo, for instance, has its own testing bench, used to test repaired engines before putting them into operation in the mine. Acerías 4C and other metal fabricators also have their own equipment and facilities to test their products.

Local mining suppliers interviewed do not interact much with local or international scientific or technological institutions. Linkages with this type of institution tend to have the following characteristics:

- **Few in number:** Supplier firms reported links with three scientific or technical organizations at most, although the majority of firms interviewed either did not set up this type of linkage at all or interacted with only one scientific or technical institution.
- **Very informal:** Only one firm had formal long-term agreements with universities (the knowledge-based company Hidroar, specializing in hydrology services). Other firms tended to prefer signing specific service, advisory, or training contracts.
- **Local:** No interaction was found between a local supplier firm and an international scientific or technical institution.
- **Unidirectional:** There is no joint research or co-development of products or processes between local suppliers and scientific institutions.

Knowledge-based interactions are of three types: technical assistance, knowledge services, and training. For technical assistance and services, typically local mining suppliers either receive technical advice from experts that work for universities or technical institutions, or they use university infrastructure to test their developments (e.g., carrying out tests in a materials lab). Local suppliers tend to set up these types of linkages with nearby universities or with INTI, a federal extension agency in charge of generating, adapting, and diffusing technologies, knowledge, and learning procedures for the industrial sector. Especially among the manufacturing firms studied, INTI is the technical institution with which local suppliers interact most often. INTI's main activities related to the local suppliers studied were auditing firms' processes, providing technical assistance, and giving technical certifications.

Another important type of knowledge linkage relates to training. Training is usually provided by the local supplier to university students. Many local firms—mostly metal fabricators—often hire students on internships. As Indumet stated in relation to the University of San Juan, "their students use our ultrasound machines, which the university doesn't have and we needed material tests and the university provided us with the service."

The reasons local suppliers did not interact at all, or very little, with scientific institutions were related to a perception that universities are very bureaucratic and are too slow to respond to suppliers' demands.

An outlier in terms of knowledge linkages with scientific institutions was Hidroar, which specializes in hydrology services. Founded by a team of professionals from the National University of La Plata, Hidroar has a scientific profile: its key staff members teach at the Faculty of Natural Sciences at the University of La Plata. These staff members publish scientific articles and attend both national and international conferences. The publications have discussed relevant studies or discoveries the company has made. The firm has a long-term research agreement with the National University of La Plata, and every time the company goes to work in a new location, it tries to set up links with the local university.

Finally, in terms of how decisions are made on important matters, we identified three types of firms.

1. In family companies, typically the owner, other family members in managerial positions, plus some professional staff make all decisions about product and process improvements, as well as other strategic decisions (e.g., related to certifications).
2. The most knowledge-intensive companies, which are relatively small (e.g., Hidroar, MineTech, and DAMS) were created by groups of professionals. These partners, who also manage key areas such as product development or marketing, make all strategic decisions. This is common in very small companies, but decision-making typically changes when a company grows and its organization becomes more complex.
3. In less-advanced companies, all decisions depend on the wisdom of the owners. Owners do not share decision-making or have formal or informal professional teams to help them make strategic decisions.

Figure 11 summarizes the indicators of productivity and technological capabilities and classifies firms according to how they perform in relation to these indicators. This is an approximation only because it is based on qualitative information. Classification is relative to the group. For instance, though Aminco and Hidroar are among the firms with the highest technological capacities, in absolute terms, their level of technological capabilities is not high.

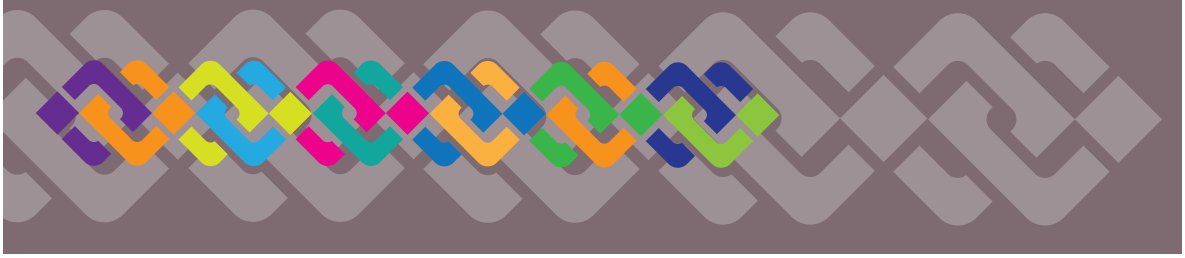
Figure 11. Classification of Firms According to Technological Capability

	High Innovation	Medium High Innovation	Medium Low Innovation	Low Innovation
Indicators of Innovation capabilities	• Has a dedicated R&D team • Developed a new to market innovation • Strong in certifications • Top skills firm in its group	• Investments in specialized equipment • At least one certification • Adaptative innovations • Highly skilled relative to its group	• Reports efforts in innovation efforts of different kinds • Is in the process of aquiring certifications • Only processes innovations • Owner centric managerial structure	• No tangible innovation results or efforts
Indicators of managerial capabilities	• Professional managerial structure	• Professionalizing managerial structure	• Owner centric managerial structure	• No clear management
Firms	Aminco Di Bacco Alex Stewart Hidroar DAMS Inbelt IPH	Ecominera Perforaciones SC AGV Hidrotec Balderramo Indument Kousal Metalar SIGSA Minetech	BTZ Exploservice Acerías 4C Jaime Remolques Ombú Minexus SAETA	Carpas Argentinas

Source: Authors' elaboration.
Note: To belong to a category, a firm must meet most of the innovation indicators for the category and must have an appropriate managerial structure. In cases where the innovation indicators category differed from that of the managerial capabilities, the firm was put in the lower of the two (e.g., if a firm's innovation indicators place it at Medium High but its managerial capabilities indicate it should be at Medium Low, it is placed in Medium Low).

5.

MAIN CHALLENGES IN DEVELOPING DOMESTIC MINING SUPPLIERS



This section discusses the main challenges in the development of domestic mining suppliers in Argentina. We start by summarizing micro- and meso-level challenges that emerged from the analysis in the previous section, and then describe some key macro challenges that are limiting the potential of mining activity in Argentina.

Micro- and Meso-level Challenges

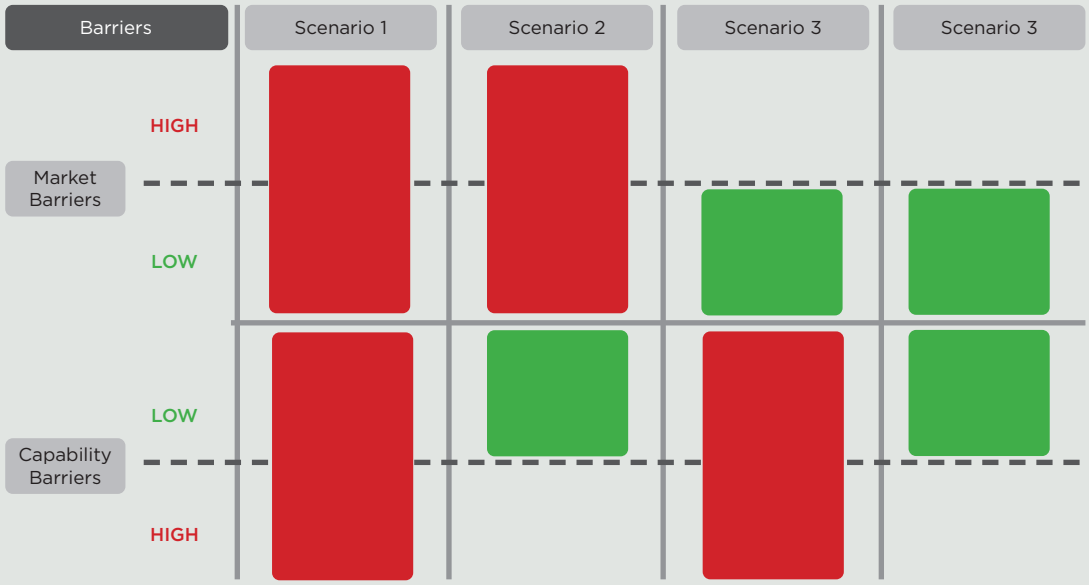
Figure 12 summarizes the main barriers to entering and growing within the mining value chain in Argentina (and elsewhere), dividing these barriers in two types: market and capabilities. Market barriers are related to the structure of markets, the practices of global firms, and regulations. Capabilities barriers are related to the resources and capabilities domestic firms need to enter, stay in, and expand within the value chain. For simplicity, barriers are classified as high or low.

The most important market barriers are the policies and practices of global firms, mining companies, and major suppliers that do not favor the development of domestic suppliers. These practices include the extended use of global contracts with global providers for procurement of key complex inputs and services, the anticompetitive practices of first-tier providers, the lack of policies to develop domestic suppliers, and the poor quality of contracts used when hiring domestic suppliers, among others. Some barriers also derive from local, provincial, and national governmental policies.

Some market barriers affect entry to the value chain, while others affect growth and upgrading within the value chain. For instance, the prevalence of global contracts with international suppliers makes it difficult to enter the market, but the poor quality of contracts makes it challenging for firms already part of the value chain to upgrade.

Capability barriers include not only of the amount and complexity of the efforts required to develop the solutions mining companies demand, they also include the time required to accumulate

Figure 12. Typology of Market and Capability Barriers that Local Suppliers Face Entering the Mining Value Chain



Source: Authors' elaboration.

the necessary capabilities. In certain areas, firms that are already global providers have decades of capability-building, since the assets and capacities necessary to develop the required solutions cannot simply be bought on the market—they must be built through years of experience. This applies to both technological and nontechnological goods and services.

One way to break in to supply segments with high capability barriers is to adapt solutions. Global providers, pursuing economies of scale, tend to develop standard solutions that work in several countries. However, such solutions do not work well in all locations, providing opportunities for domestic suppliers to enter the market by adapting solutions or developing tailor-made ones to address local conditions. Then the challenge changes to becoming less dependent on one firm or one value chain—moving from tailor-made or adapted products into standardized products that can be produced with economies of scale.

As the owner of Kousal, a metalworking firm, put it, "We are doing engineering work. However, most of the time they are individual projects. It's not that you develop a machine that turns out to be a wonder and you sell it all over the world. It can happen, but it's not normal. It's normal for you to solve specific things every day."

Saeta almost went out of business because of its inability to standardize products and sign favorable contracts, which led to huge losses (see Box 3).

The combination of market and capability barriers changes according to the segment of the mining value chain. One example of very high barriers to entry on both fronts is specialized heavy machinery, where difficulties entering and staying in the value chain derive from both market and

Box 3. The Saeta Case

For several years, Saeta, a metal fabrication company from San Juan, supplied parts to Barrick Gold's Veladero project. During Argentina's import restriction period, Saeta produced a large number of heavy machinery parts. Some were straightforward and easy to produce (e.g., special screws). Others, however, were highly sophisticated and required big investments in professionals, machinery, and other inputs. Saeta's strategy was to continue investing and developing products for Barrick in an effort to prove itself and develop the distant relationship it had with this major client.

This was risky because Saeta's competitiveness relied on import restrictions. Further, there were no contracts to guarantee Barrick's demands, which often changed without notice. For example, Barrick changed machines for which Saeta was producing parts without letting Saeta know about it in advance, rendering certain product developments, and the highly specialized machinery required to produce them, obsolete overnight.

A clear example was one of Saeta's biggest product developments: a rotation head for a special type of drill. Barrick gave the part to Saeta to replicate. Saeta worked with public institutions such as INTI and San Juan's university for 16 months, invested a great deal of capital, and improved the product's reliability. The company sold five rotation heads to Barrick, but then, without notice, Barrick changed its whole drilling machinery lineup, making Saeta's development obsolete.

Saeta faced this dynamic in many other instances, and when import restrictions were made more flexible, Barrick opted for original parts, leaving Saeta completely out of the market. Because Saeta was 100 percent invested in mining, particularly working with Barrick, these events left the firm almost out of business, causing the need to reduce personnel by 80 percent. The company is currently diversifying to oil and gas and is starting to again supply some parts to Barrick Gold.

capability barriers. The market for heavy machinery supply is highly concentrated, with a few global competitors dominating, setting prices, practices, and quality standards and forging the main innovation paths. Therefore, domestic suppliers can only be followers in a game where all the rules are introduced by the global giants. The major mining firms have a long history of working with these global suppliers and they very rarely try new, unknown firms or their products and services.

At the same time, the capabilities and resources needed to enter the specialized heavy machinery segment are extensive. It takes a long time for firms to develop the ability to produce these machines and the amount of investment required is huge. This is why it is so difficult to find domestic suppliers to this segment, not only in Argentina but also in other developing countries with more developed mining sectors, such as Chile and Peru.

More research is required to understand differences within the mining sector to see if the level and type of barriers differ by segment of the value mining chain or if there are new, less concentrated segments being developed where new.

A good example of where market barriers are high but barriers related to capabilities are less important, at least for firms in Argentina, is laboratory certifications. Here difficulties entering and

staying in the chain derive more from market requirements, since global firms will not hire domestic suppliers that are not recognized internationally even though they have the capabilities to perform all the tests. Other examples are the provision of explosives and dangerous chemicals such as cyanide.

Most domestic firms we interviewed provided products or services in segments with lower market barriers but higher capability barriers—for example, drilling services, specialized machinery repair, knowledge-intensive services, metal fabrication, and other specialized goods. In these segments, mining firms are keener to look for local solutions, but domestic suppliers can enter the chain only with a certain degree of technological and managerial skills development.

Finally, the segments with low market and low capability barriers were not covered in the study: transport, standard construction, catering, and energy, among others, and most domestic suppliers are in these segments.

Interestingly, for new solutions based on new technological opportunities or knowledge, market and capability barriers might be lower. On one hand, mining firms do not have solid links with global suppliers in these areas because the fields are relatively new. On the other hand, the capabilities required to develop these new solutions are being developed by all possible entrants. Discovery and market creation challenges exist, but there are no firms that have accumulated capacities over time.

Policies can positively or negatively influence the nature and degree of barriers. For instance, for domestic firms in nonmining regions that find entry to the mining value chain difficult because of regulations that require buying local at the provincial level, policies have created high market barriers even in the absence of barriers caused by mining firm policies. At the same time, some local content policies can reduce market barriers for local firms, and policies that support innovation or require links between global and domestic suppliers to foster learning might reduce capability barriers.

Macro-level Challenges

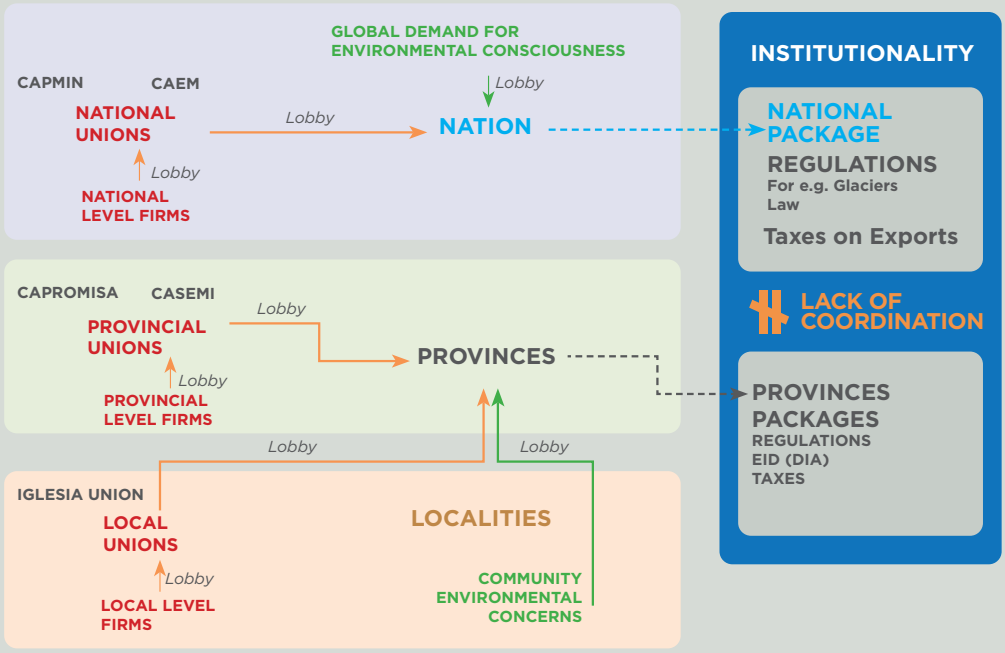
Argentina has enormous mining potential and therefore the potential to develop a rich resource in the way of domestic suppliers. For this resource to develop, mining activity must expand; however, the development and further growth of mining face important challenges that can be grouped into two categories: institutional instability, and social acceptance and social conflicts.

Institutional Instability

The federal regime that regulates the mining sector in Argentina carries an inherent institutional complexity because regulations are imposed and implemented by both the federal and provincial governments. Figure 13 shows the different actors at different levels that are involved in and lobby for regulations: national, provincial, and local.

A federal scheme of regulation requires adequate and fluent coordination and harmonization of policies and laws between the federal and provincial goverments to articulate a strategy of

Figure 13. Levels of Institutions and Regulations in Argentina



Source: Authors' elaboration.

competitiveness under a sustainability framework. What is required is "federalism of cooperation" (*federalismo de concertación*) with agreement on key issues underpinning competitiveness, as evidenced in the preparation of the new Federal Mining Agreement signed in 2017. Yet research reveals that very little coordination has actually taken place. On the contrary, redundancy, contradictions, and overlaps between the national, provincial, and municipal levels tend to prevail.

As an example, COFEMIN, which aims to be the institution in charge of articulating policies between the country and the provinces, has been inactive through much of its existence since 1991. During our interview with the secretary general, he mentioned that COFEMIN has not played any role, for example, in import substitution policies that were implemented during 2012–15 and affected the mining sector. In 2016, COFEMIN was "born again" in theory, but still is far from filling its intended role.

The lack of coordination between federal and provincial policies can also be illustrated by the implementation of local content policies by many mining provinces, such as San Juan and Santa Cruz. Through provincial legislation, mining firms located in these province are obligated to acquire a certain amount of inputs from suppliers physically located in the province. This type of policy has generated an environment of competition among provinces instead of cooperation. There exists a kind of dispute between provinces about who has the right to benefit from supplying mining companies in the territory, which means that firms "foreign" to the provinces where the mines operate—for instance, firms from Córdoba or Mendoza in San Juan—may face restrictions to entry. For instance, we interviewed firms from the oil and gas cluster in Córdoba that are strong in key segments like metal fabrication. They noted that thet faced huge difficulties entering mining value chains mostly

because of provincial regulations that make it difficult for them to supply mining companies unless they are local to the provinces where the mining activity is performed.

These policies go against cooperation initiatives such as the creation of FAPMIN, the Federal Chamber of Mining Suppliers, which aims to enable suppliers in engaging in joint ventures to participate in tenders issued by mining companies.

Local procurement laws were criticized by many of our interviewees because such laws set quantitative targets that are difficult to satisfy based on existing availability of domestic capacities. Laws were heavily criticized, especially by representatives of the mining sector in Catamarca and Santa Cruz. They argued that the laws "convey the message to local suppliers that they have a right to charge more for an input or service only because they are located close to the mine." According to a former high-ranking manager of a mining company in Santa Cruz, "The 'buy local' law may be used by local suppliers in bad faith as they are companies without employees, simply registered in Santa Cruz, but buying supplies outside of the province and selling them to mining companies for double the price." For those companies with high capabilities and good faith, but not located in provinces where mining activity is taking place, this type of policy generates a big barrier to becoming a mining supplier. In extreme cases, these types of firms have to open an office and hire local people in the province where the mining operation is to obtain the chance to become a supplier.

As a result, though local content policies at the provincial level can be powerful and effective tools to support the entry of domestic suppliers, they need to be designed to encourage cooperation and learning across provinces and to avoid competition and conflict.

It is also problematic that institutions and regulations at several levels change often (Table 2 and Figure 14). During the 1990s, a set of "mining friendly laws" were approved that gave fiscal benefits to mining firms and, most importantly, established that the government was to maintain fiscal stability for mining companies over 30 years. In 2007, however, the federal government introduced export taxes, breaking this commitment.

Likewise, the federal government has repeatedly changed the foreign exchange policy, closing and opening the possibility for companies to freely repatriate dividends. One example of this type of policy was the "*cepo cambiario*" introduced in 2011, which for a time limited the capacity to convert Argentine pesos to U.S. dollars. This policy was dismantled in 2015, but was reintroduced at the end of 2019. Something similar happened with export duties, which have been introduced and removed several times over 20 years (Box 4).

Box 4. Instability in National Fiscal Policy for the Mining Sector: Export Duties

The cycle of imposition and elimination of export taxes or duties (*retenciones*, also called "withholdings") has triggered much controversy and uncertainty in the mining sector and among potential investors. Following the economic and financial crisis of 2001, the Law of Public Emergency 25,561 (2002) delegated to the Executive Power the power to establish export duties. By Resolution 11/2002 and subsequent amendments the then Ministry of Economy and Infrastructure (under mandate of the Executive Power) set out export duties for 5 to 10 percent of the FOB value of exported minerals. While these duties would not affect companies that had obtained certificates of fiscal stability before

enactment of the law, the joint Resolutions 288 and 130 issued in 2007 by the Secretariat of Commerce and by the National Secretariat of Mining mandated the National Customs Office to collect export duties from those companies from 2007 onward.

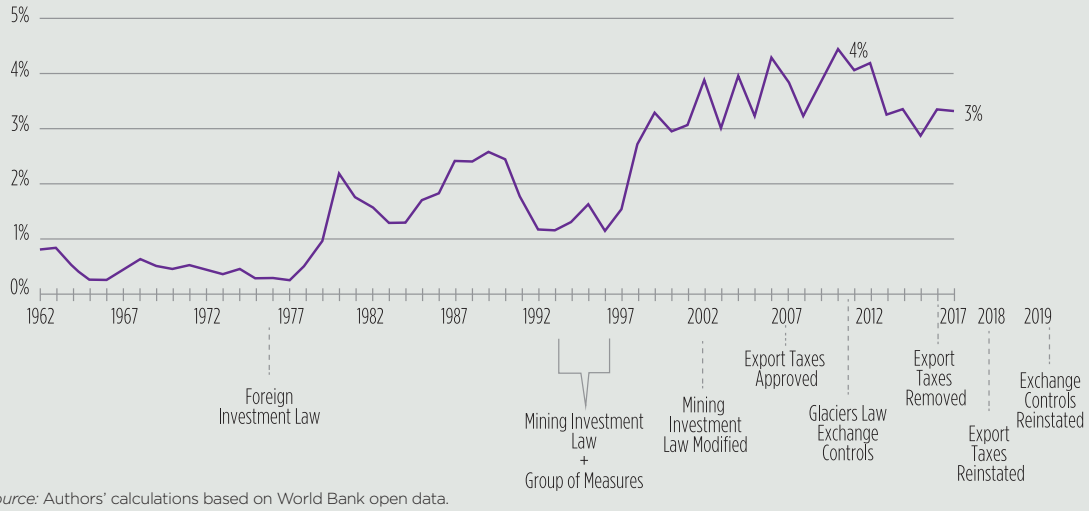
Despite appeals from companies, duties were charged during 2007–15 until they were eliminated after President M. Macri took office at the end of 2015. Yet, in September 2018 duties were resumed temporarily until 2020.

Table 2. Regulations and Changes in Regulations Affecting Mining

Regulations that Boosted the Sector	Regulations and Factors that Limited the Sector
Law 21,382 – Foreign Investments (1976)	5% export taxes (2007)
Law 24,196 – Mining Investments (1993)	Glaciers Law
Law 24,224 – Mining Reordering (1993)	Provincial laws
Law 24,227 – Bicameral Mining Commission (1993)	Mining projects on hold because of social protests
Law 24,228 – Federal Mining Accord (1993)	Limits on buying foreign currency
Law 24,402 – Value Added Tax Financing (1994)	Export tax reinstatement 2018
Law 24,498 – Mining Update (1995)	
Law 24,585 – Mining Code Modifications (1995)	
Law 25,161 – Mining Investments Modifications (1999)	
Export tax removal (2016)	

Source: Authors' elaboration.

Figure 14. Institutional Changes and Evolution of Metal Exports as a Percent of Merchandise Exports, 1962–2017



Source: Authors' calculations based on World Bank open data.

A recent regulation that is generating controversy is the *Glaciers Law* (Law 26,639) enacted by the National Congress in 2010. The law limits mining activities near glaciers, where significant shares of known mineral resources are located (Table 3). The law's objective is to preserve these areas (glaciers and the periglacial environment) as strategic reserves of water for human consumption, for agriculture, as supplies for recharging hydrographic basins, for protecting biodiversity, as a source of scientific information, and as a tourist attraction. Banning mining is valid both in glacier and periglacial areas as determined by the inventory conducted by the Argentine Institute of Nivology, Glaciology, and Environmental Sciences (Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales, or IANIGLA).[8] This law affected several ongoing exploration and mining projects and investments (Table 3) and sparked much criticism.

Table 3. Examples of Important Projects Delayed or Limited by the Glaciers Law

Province	Project	Target Mineral	Status	Capital Expenditure (US$ millions)
San Juan	Pachón	Copper	Feasibility/delayed	3,000
San Juan	Los Azules	Copper	Prefeasibility/delayed	2,363
San Juan	Altar	Copper	Exploration	1,500
San Juan	Josemaría	Copper	Exploration	1,540
Mendoza	San Jorge	Copper	Prefeasibility/delayed	370
San Juan (extending into Chile)	Pascua-Lama	Gold	Suspended	1,200

Source: Authors' elaboration.

This law seems reasonable to most stakeholders in general terms; nevertheless, in many interviews with mining companies, suppliers, business associations, and even state agencies, the law was criticized for leaving too many gray areas and for raising uncertainty about the current and future viability of mining projects.

The mining sector also questions the need to protect the periglacial environment, as incorporated into the law, particularly rock glaciers (*glaciares de escombro*), arguing that it is a matter of discussion whether they act as water regulators—that is, whether they are important water suppliers, with some glaciologists arguing they are not. At the same time, environmental groups maintain that some important areas have been left unprotected. Dr. Ricardo Villalba, the researcher in charge of the first glacier and periglacial area inventory, is now facing a lawsuit pushed forward by environmental activists accusing him of abuse of authority as a result of his decision to exclude glaciers smaller than one 1 hectare, while the law calls for including in the inventory "all glaciers and periglacial geoforms" (Art. 3).

8 The law prohibits activities that affect the natural processes of glaciers and periglacial areas, in particular (i) the release, dispersion, or disposal of contaminating substances or elements, chemical products, or residues of any nature or volume, including those that develop in the periglacial environment; (ii) the construction of architectural or infrastructure works, except those necessary for scientific research and risk prevention; (iii) exploration, mining, and hydrocarbon exploitation, including activities that develop in the periglacial environment; and (iv) the installation of industries or development of works or industrial activities.

Beyond the specific arguments and debates, which cannot be evaluated here, in terms of the possibility of developing mining activity in Argentina, what is required is the implementation of processes that allow different stakeholders to gain a common understanding of the scope of the law and of the implications for existing and potential mining projects.

The ongoing change in policies and the controversies around them indicate the institutional instability that characterizes mining in Argentina. This instability, together with Argentine macroeconomic instability, negatively affects long-term investments such as those required by mining activities.

Social Acceptance and Social Conflict

Since the opening of the first large-scale metal mine in the country (Bajo de la Alumbrera in 1997), the metal mining sector in Argentina expanded in parallel with growing social conflict. The most emblematic conflict took place in Esquel in the Province of Chubut in 2003. Through a referendum, the population rejected the creation of an open-pit gold and silver project by Meridian Gold. This conflict, the way it was addressed through a plebiscite, and the enactment of Law No. 5,001 on mining prohibition in Chubut had a significant impact nationally.

Following this incident, social movements began in various provinces to demand the approval of this type of restrictive legislation (Murguía and Godfrid, 2019). The conflict was particularly important in nine provinces, and as a result only seven (of 23) have legislation in force that bans open-pit mining, the use of certain chemicals used in mining-related processes, or both within their territories (Table 4).

Table 4. Provincial Laws Banning Mining Activities that Use Certain Techniques or Inputs

Province	Year	Law Number	Restriction
Chubut	2003	5,001	Open-pit mining; use of cyanide for ore processing
Río Negro	2005	3,981*	Use of cyanide or mercury in the extraction of metal ores
La Rioja	2007	8,137*	Open-pit mining; use cyanide, mercury, and other substances for leaching
Tucumán	2007	7,879	Open-pit mining; use of cyanide and mercury in the mining production process
Mendoza	2007	7,722**	Use of cyanide, mercury, and other substances in any extraction method
La Pampa	2007	2,349	Open-pit mining; use of cyanide, mercury, sulfuric acid, and any contaminating chemical substance in exploration or exploitation processes
Córdoba	2008	9,526	Open-pit mining; use of cyanide and other substances under Law No. 24,051
San Luis	2008	634	Use of cyanide, mercury, and other chemicals in any extraction method
Tierra del Fuego	2011	853	Use of cyanide, mercury, and other chemicals in any extraction method

Source: Murguía and Godfrid (2019).
*repealed; **repealed but re-enacted after protests.

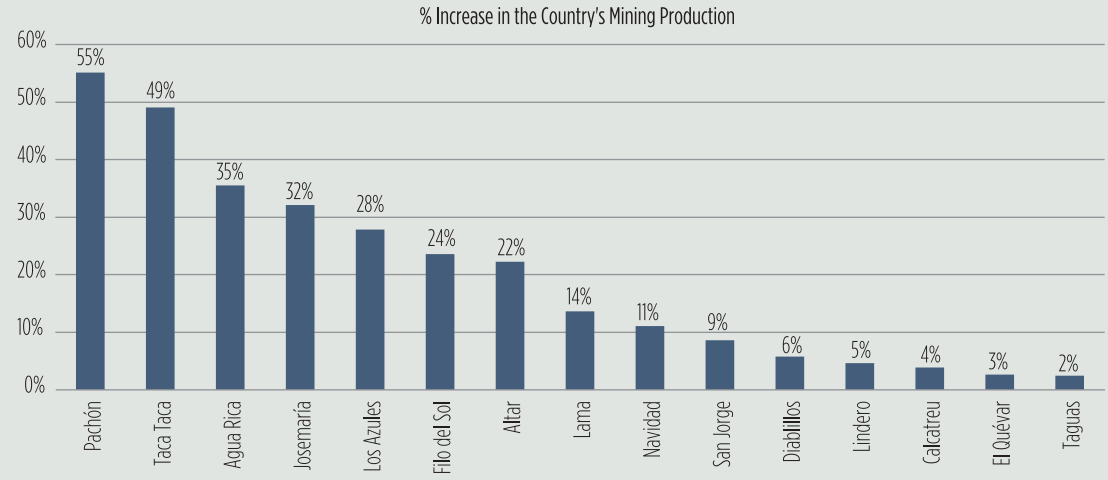
These restrictive laws pose a significant challenge for mining in Argentina. As of 2020, at least 21 mining projects are being delayed by social conflicts, which according to some estimates are preventing investments of at least US$13 billion. At the same time, since the 2000s, several provinces and local communities have banned mining or processes and inputs related to mining (Table 4).

For example, five important projects have been delayed because of social conflict: Pachón,[9] Pascua-Lama,[10] Suyai,[11] Navidad,[12] and Agua Rica.[13] Descriptions of the conflicts related to these projects are found on the global compendium of socio-environmental conflicts Environmental Justice Atlas.

Suyai's case is especially interesting. As mentioned, the Province of Chubut ruled against large-scale mining through Law 5,001. In 2014, in the town of Esquel, the mining company in charge of exploration for the Suyai project proposed switching to mining underground and without the use of cyanide to be able to carry out the activity in a manner compatible with local demands. However, work did not progress, and despite government attempts to promote dialog aimed at achieving social acceptance of the activity, the local communities remained firm in their position.

The Navidad project, also in Chubut, perhaps best represents the current sociopolitical context surrounding mining activity in the country. The government is actively seeking the project's development because it is one of the world's largest undeveloped silver deposits[14] with the president trying to boost acceptance of the project (Ámbito, 2019). However, local protests continue to legitimize and validate provincial anti-mining laws ("Marcha al Ministerio de Ambiente en protesta contra proyectos megamineros," 2020). According to some estimates, this project alone would translate into an increase of more than 11 percent in the sector's total exports, accounting for yearly production of near US$400 million, which would translate to around US$30 million in export taxes.

Figure 15. Projected Economic Impact of Major Mining Projects



9 https://ejatlas.org/conflict/pachon-argentina-chile

10 https://ejatlas.org/conflict/pascua-lama-mine-argentina

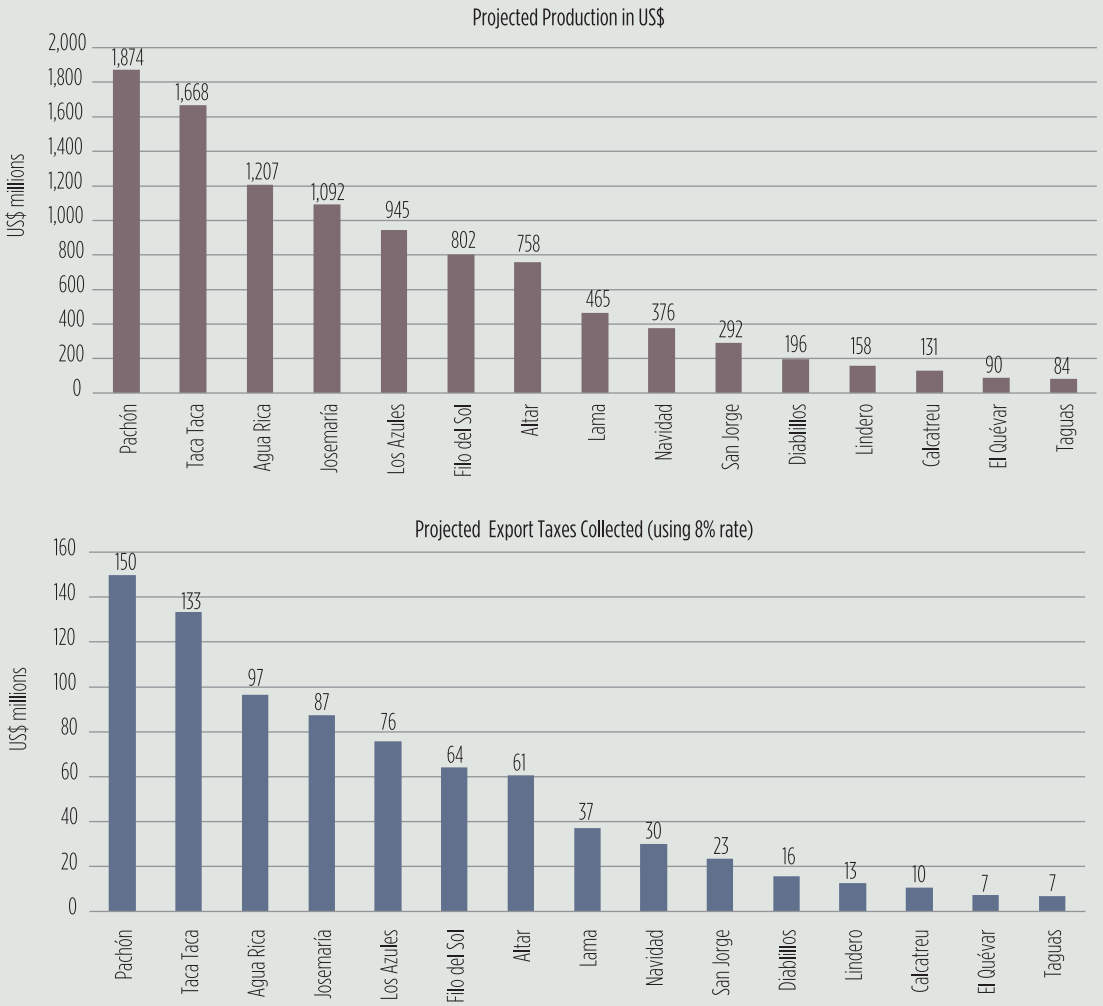
11 https://ejatlas.org/conflict/esquel-meridian-gold-mine-argentina

12 https://ejatlas.org/conflict/navidad-mine-of-pan-american-silver-chubut-argentina

13 https://ejatlas.org/conflict/agua-rica-andalgala-catamarca-argentina

14 For information on Pan American Silver's Navidad project, see https://www.panamericansilver.com/operations/exploration/navidad/.

Figure 15. Projected Economic Impact of Major Mining Projects *(continued)*



Sources: Data on projected yearly production from "Cartera de Proyectos Mineros Metalíferos, Litio y Uranio de la República Argentina" (Portfolio of Metalliferous, Lithium and Uranium Mining Projects of the Argentine Republic) by the Directorate for the Promotion of Mining, Ministry of Production. Authors' calculations using metal prices as of February 2020 from moneymetals.com.

Figure 15 presents projected economic impact metrics for some of the most important mining projects in Argentina that are causing conflict.

A high concentration of activity in a few projects, and enormous potential, and severe conflict and social disagreement characterize the future of mining in Argentina. Specific actions for each conflict could greatly help the development of the sector, but conventional approaches to address this problem are not working. New approaches should be explored and implemented.

6. FINAL REMARKS AND POLICY RECOMMENDATIONS

There is growing agreement that natural resource activities, like mining, can be a platform for the development of other innovative economic activities, based on the development of domestic suppliers. Special interest has been paid to the possibilities that these industries open to develop knowledge-intensive and innovative suppliers. The experience of some advanced countries, such as Australia and Canada, shows that this is possible, but there is much less evidence suggesting this kind of development is happening in developing countries. Developing countries often host strong, important natural resource activities but see only limited development of domestic suppliers in innovative sectors.

This study investigated domestic suppliers to mining activities in Argentina. More specifically, it explored the following questions:

- Is there a sector of domestic mining suppliers in Argentina?
- What do these suppliers do? In which areas are they strong?
- How have suppliers entered mining value chains? Which barriers did they face and how did they address them?
- Which assets and resources have suppliers developed and which challenges to expansion did they face?

To answer these questions, we first characterized and explored existing mining value chains in the country and then identified and studied domestic firms that were part of these chains supplying potentially innovative goods and services. A feature of this study was that it focused on both the exploitation and exploration stages of the mining value chain, which is relevant for Argentina given the low level of development of mining activities and the sector's high potential, making exploration activities very significant.

The research identified two types of significant barriers to entering the mining value chain: barriers related to markets and institutions and barriers related to resources and capabilities. We found

that, despite such barriers, domestic firms that managed to enter the mining value chain did so by taking advantage of three types of opportunities: being close by and flexible; meeting the need for adaptation to local conditions (e.g., to resource characteristics or the local climate), and developing new knowledge. The most common opportunity seized was location and flexibility. Typically, firms that are part of the mining value chain in Argentina are close to the mines and are small or medium sized, enabling them to respond to mining company demands quickly and in some cases more cost-effectively than large multinational suppliers with headquarters in other countries.

Much less common were cases of companies entering the value chain by adapting goods and services or developing completely new solutions based on new knowledge. This finding contrasts with what we found in previous studies of Argentina's other natural resource activities (e.g., agriculture, and oil and gas), where more suppliers entered the value chains because of the need to adapt solutions to local conditions and where it was possible to use new knowledge to develop new solutions.

DonMario is a typical case of a supplier to the agricultural sector. This seed supplier started leading the soybean seed market in Argentina by developing seeds adapted to differences in climate and agro-ecological conditions within Argentina. The business has become a leader in the regional market by adopting a similar strategy in other countries.

In Argentina we found that mining companies and local governments have focused almost exclusively on promoting job creation and supporting existing local suppliers of simple goods and services when designing policies related to production and employment in the mining sector. In fact, suppliers have emerged in more complex segments of the value chaing, in most cases without the explicit support of mining companies or local government policies. The exceptions are firms that have entered the value chain because of local content policies, but these are the minority (11 percent of studied firms).

Governments and mining companies need to focus on and develop policies to support domestic suppliers and new ventures in innovative or potentially innovative sectors and open chain segments. Doing so will help suppliers to take advantage of all opportunities to enter the mining value chain, especially those that can provide a more sustainable advantage. To explore possibilities of and need for policies oriented toward supporting ventures in potentially innovative sectors, we classified policies into two types: (i) those intended to reduce barriers to entry to the mining value chain and (ii) those intended to support local companies that have already managed to become mining suppliers.

Policies to Reduce Barriers to Entering the Value Chain

The most widespread policies used by Argentina to address the problem of entry to the mining value chain are local content policies. Such policies were used at the national level intensively until 2015 and are still implemented by several provinces. These policies establish requirements for mining companies to buy a percentage of their total supplies locally (quantitative targets). Local content policies have shown good results in some cases, as discussed above.

However, the interviews we conducted identified problems with the way these policies have been designed and implemented. Addressing these problems would significantly improve the impact of the policies. One common problem, is that the policies tend not to be very ambitious in terms of the products or services they aim to promote. As a result, they end up focusing on simple goods and services of low complexity (e.g., catering, transportation, cleaning, and laundry). In the eyes of provincial governments, such a focus can be seen as successful because it aligns with the development of domestic businesses. Yet, if the ambition is to develop businesses that can expand beyond the local area—for example, by expanding their market to other provinces, diversifying, and reducing their dependence on one or two nearby mining projects—the common approaches used should be rethought.

Local content regulations are commonly promoted by local and even the national government without dialog, negotiation, or planning with mining companies. As a consequence, the companies tend not to be committed to the policies, limiting their proper use and their impact.

Local and provincial content regulations usually generate important entry barriers for Argentine companies located elsewhere in the country. In this sense, the policies tend to create competition between provinces instead of promoting cooperation among suppliers so they can evaluate the possibility of participating in joint tenders, thus overcoming barriers related to their small scale, to reputation, and other factors.

Local content policies have been criticized for lack of transparency: an import substitution program led by the government should be based on transparent (publicly available) information on progress and how the state is building a database or platform to match potential demand and supply.

Policies should be sustainable over time. In Argentina, import substitution industrialization (ISI) programs have usually been short-lived—restricted to a presidential mandate, for example—which makes it very difficult to find sustainable solutions. In addition, the government should allocate sufficient resources, including for experts (salary is an important variable, though not the only incentive for recruitment). Experts need to thoroughly understand the dynamics of the business and ideally should include people with a background in mining companies (e.g., the Minexus manager) and from the suppliers' side.

Content policies are believed to work better if they are based on incentives, not prohibitions. In Argentina, ISI programs have often been implemented based on strict regulations (e.g., local content policies, ISI laws) and across various sectors (i.e., not sector specific). A more tailored approach that considers the specifics of the value chain's segments and the potential of suppliers, among other factors, is needed. The programs also need to intelligently create incentives to lead mining companies to disclose information and to be interested in local suppliers. A smart mix of regulation and incentives needs to be developed.

Local content policies are usually either static or aim to match demands with existing supplier capabilities in response to requests from mining companies. In this way, policies sometimes deter the development of new capabilities and linkages. An area where linkages need to be developed is information technology and specialized software. Argentina has capacity in this area, but it has not been connected to mining. Mining companies mostly contract IT services from global providers.

The potential for connecting domestic IT capabilities with mining, and for creating new capabilities, seems significant.

It is also crucial to identify and support potential links with more traditional, relatively well developed sectors in Argentina that already have production and technological capabilities but that have not been connected to mining because of market or institutional barriers. Some metalworking firms that have traditionally supplied other sectors, such as food, agriculture, or engineering firms, have already entered the mining value chain. Many, however, have not managed to do so (e.g., firms from the oil and gas cluster in Córdoba). It is therefore necessary to implement policies that help create linkages between mining companies these suppliers. It is also necessary to evaluate which other sectors have potential for links and suppliers with an interest in entering the mining value chain. Policies and programs need to be developed to help them enter.

Provincial purchasing initiatives must be directed to strategic areas where there is local competence, but at the same time enable the entry of companies from other provinces when local capacities are less developed. This could be done using programs and policies that favor forging associations and transferring knowledge. The design of such policies needs to be tailored to the capacities of different firms (i.e., low or high complexity) and to the different segments in the chain, focusing especially on those that are relatively more open, such as exploration support services.

A major limitation for the entry of any supplier—local, provincial, or national—to the mining value chain is the purchasing policies of large mining companies. Companies generally do not have supplier development departments. When they do, they are very limited because they have been developed more as a part of the firm's "social license" or corporate social responsibility policies than to support the creation of domestic supply capabilities. Moreover, mining company employees are given no incentive to promote local procurement; global mining companies typically direct their demand for more complex goods and services to global suppliers.

Most cases of local suppliers entering the mining value chain have been the result of unexpected circumstances that forced mining companies to turn to nearby suppliers in an emergency—for example, to provide sensitive fabricated metal parts. In such cases, local companies that have solved the problems well may have been retained as suppliers. Local mining company managers we interviewed maintain that when they try local alternatives and they work, it is preferable to work with those local companies. However, according to their comments, the problem they face is that global corporations do not encourage the creation of departments to develop suppliers, and thus purchasing departments choose global suppliers, which are less risky.

Clearly intervention is required. If nothing changes, global mining companies will continue to operate the same way. One possibility is to obligate mining firms to have departments to develop local suppliers. There have been short-lived initiatives of this type in the past in Argentina, but they did not work well. The departments mining companies were required to create were, in most cases, dismantled once the obligation was removed.

The challenge now is to review past initiatives and their problems and then to propose new ways to implement them, working with mining firms. Some supply managers of multinational corporations said they would be interested in and willing to participate in initiatives that coordinate supply management, involving both the compliance and technical managers and aiming to promote local buying. Such coordination should be led by the government. These initiatives could be

developed in cooperation with other firms and in collaboration with the government with the aim of developing sectors or technologies identified as priorities based on their potential for innovation, barriers to entry, and existing capabilities. A limitation here is the potential lack of cooperation from large mining companies, which may not be inclined to negotiate with governments. It is very important, therefore, that the federal government take the lead, delineating incentives for mining multinationals to cooperate and support provinces and municipalities in establishing policy priorities and programs.

Another barrier that the federal and provincial governments face when designing local procurement policies is insufficient information from the demand side. Suppliers, like the government (but for different reasons), need to know the potential future demand for goods and services from mining companies—at a minimum, estimates of volume and items required, according ty type (e.g. high-rotation items such as mill balls) for the next five years. Mining companies often treat such information as confidential. Acknowledging that confidentiality, the government could explore ways to provide mining companies incentives to share information (with different degrees of openness) so that local buying promotion policies can be based on data. The supplier initiative Minexus was headed in the right direction while also dealing with the problem of decodification of parts, but we believe that should be the task of government and it should be with a long-term view. Likewise, increased openness could be explored to work using new methods (e.g., neural networks) to optimize the supply chains of multinational companies. Yet, such policy design seems to require advance training of government policy officers in the possibilities now available for such methods.

Governments also face the problem of not having sufficient detailed information about supply side capacities around the country. That level of information gathering and management requires a long-term policy and coordination by the federal government, supported by COFEMIN, provincial governments, and local supplier organizations that are in close contact with their members.

The highly risk-averse nature of mining companies is another barrier for domestic suppliers wanting to enter the mining value chain. Failure when trying a new solution or halting production to try a new process could cause losses in the millions of dollars. Some of the mining suppliers studied invested in their own facilities to test new solutions, but in many cases these investments would be too large for small suppliers. Here there is an opportunity to design cooperative schemes to develop testing facilities that can be used by many suppliers. In some countries, including Chile, there have been discussions about developing experimental mines, but advances have been limited.

Finally, to solve value chain entry problems, it is necessary to work with first-tier suppliers, especially large ones (e.g., Sandvik, Atlas Copco) with strong bargaining power that could be key actors in mobilizing smaller domestic second-tier suppliers. In segments like specialized mining machinery, both high concentration and unfair competition are features that impose restrictions on domestic suppliers. An example of these anticompetitive practices discussed in the report is the complex and changing coding system used by Caterpillar to identify its machinery parts. This system favors the company's own enterprise for machinery parts (Finning), a company that controls most of the mechanical repairs and spare parts commerce and complicates development of domestic suppliers. Some domestic enterprises aim to address this problem (e.g., Minexus), such as by trying to generate databases of machinery parts that update automatically, but they have faced lack of cooperation from mining companies and suppliers. Intervention is necessary in this area.

Policies to Support Local Mining Suppliers to Grow

Having addressed the entry challenges, the second major policy challenge for supplier development is how to support companies that have already entered the chain as they expand and grow. Contracts constitute a very important barrier to the growth of suppliers and to diversification of markets and customers, and in some cases have even meant significant losses for small- and medium-sized enterprises (SMEs) that made large investments. Mining companies usually use purchase orders for goods and tenders for services. Purchase orders commit suppliers to providing a certain number of parts for a specific period (generally one year) but do not require miners to actually buy them. In other words, the local supplier has to make the investments to comply with the order, but the mining company has no obligation to buy. For suppliers that require investments in specific assets for production, this constitutes a huge risk: if the mining company decides not to buy, the supplier is left with parts they cannot sell to other companies and special machinery they cannot use for other applications. This is a huge challenge for suppliers that do not have diversified customers because they have to make large investments to sell low volumes and without a guarantee of purchase. The country's low scale of operations magnifies the problem. The company Saeta illustrates the problems these practices bring to domestic suppliers.

One possible course of action is to help small and medium suppliers develop managerial and investment capacities so they can negotiate more effectively with mining firms and make better investments decisions. SMEs often develop technical and production capacities but lack the managerial skill to make key financial, investment, and contract decisions. This is a major limitation, especially when mining firms do not have supplier development policies.

Specific programs could also be created to help suppliers diversify their clients and markets. Diversified firms have fewer problems than nondiversified firms when dealing with changes in demand. Some of the SMEs that currently provide mining goods and services have capacities that could be used in other sectors, such as oil and gas. In fact, we found that suppliers that entered the mining value chain after being active in other economic sectors had more potential to adapt and deal with changes in demand from mining companies (e.g., many metal fabricators from northern Argentina that previously served the agricultural industry). Diversification should therefore be a goal to support domestic mining suppliers.

Contracts and linkages between mining firms and domestic suppliers are also poor in terms of knowledge exchange, information sharing (e.g., about future demand), and any kind of support to accumulate capabilities or for innovation. Domestic firms typically do not receive any support to face the uncertainty and costs involved in developing new products or processes or making improvements. The value chain literature claims the best type of linkages between large customers and suppliers are those that involve knowledge exchanges and support for innovation. It is assumed that companies in developing countries will benefit if they enter global value chains, to the extent that large global customers demand high quality standards and provide knowledge and financial support for productive development and innovation. But in the mining sector in Argentina, we did not find any case of knowledge exchange or support for innovation. As a result, a much less ambitious short-term goal should be to ensure contracts offer certain guarantees of continuity so that suppliers can make investments. A more ambitious medium-term goal would be for global compa-

nies to be encouraged to support innovation in local suppliers with both knowledge and financing. This does not have to be done individually: some of the managers of the mining companies we interviewed identified working together to develop local suppliers as a possible way to spread the cost and risk among several mining companies.

A major challenge with implementing any policy to develop domestic suppliers is the government's bargaining power with mining companies. Two issues that do not fall within the scope of productive policies, but that are crucial to develop them, play against possible agreements between large companies and the government. One is the lack of continuity in the rules under which companies operate and the other is the lack of coordination between federal and provincial governments. The interviews identified that the biggest problem for mining companies was not the strictness of policy requirements but the lack of certainty due to economic and institutional instability. Another problem is the complications that emerge because of the lack of coordination and sometimes conflicts between provinces, which have different approaches and often compete instead of cooperating to develop a common and sustainable set of policy instruments.

It seems crucial, therefore, to increase the possibility for the government to intervene and establish policies that require commitment from mining companies with the objective of benefiting the long-term development of mining in Argentina, establishing clear rules that remain stable over time. To engage mining firms and make them willing to cooperate in supplier development policies, certainty and clear rules are necessary. With these in place it would become more feasible to identify priorities and challenges and for the government to intervene and regulate companies while encouraging the development of alternative technologies and practices.

The direct participation of the government through a state-owned company directly involved in the mining exploration is one possibility to gain room to maneuver and generate opportunities to intervene not only to develop suppliers but more generally with respect to other crucial aspects of mining activity. Some countries, including South Africa, have pursued this strategy. Given the low level mining activity in Argentina, with most of its resources unexplored, this type of initiative is possible and would be important. It would be necessary, however, to analyze different ways such a company would operate, taking into account technology and the nature of international markets, where financing is often obtained for mining activities, mainly through the Toronto Stock Exchange.

Finally, to develop mining suppliers in Argentina, it is crucial to address the problem of social conflict. Argentina has an underdeveloped mining sector, with potential that is substantially negatively affected by a high degree of social conflict around mining activity. Mining companies that aim to earn so-called (and today highly questioned) "social license" or "license to operate," along with local governments, have begun to make certain concessions: the most common is to offer financial compensation to local people as well as other assistance and benefits. With certain companies and international organizations, a paternalistic view is popular. That approach is based on the idea that what is needed are programs aimed at informing local populations about the supposed benefits of mining. However, these paternalistic approaches are not producing results. Increasingly well-informed, organized, and empowered local populations are less and less interested in limited and ephemeral financial benefits in exchange for risking crucial resources such as land and water, which they have used for centuries as a means of survival. The increase in the number of social conflicts in the region clearly demonstrates this point. According to the map of mining conflicts, conflicts in

the mining countries of Latin America have increased 280 percent, from 59 in 2005 to 229 in 2020 (this includes Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, and Peru). In Argentina alone, the increase was 480 percent for the same period, from 5 conflicts in 2005 to 29 today.

What is showing greater effectiveness in other countries in reducing disputes over natural resources is the creation of processes and institutions that involve civil society both in making decisions about where and how to carry out mining activity and in monitoring activities. This approach seems fairer and potentially transformative. This path, however, requires a strong decision by the state to get involved and lead the process, and it requires the use of innovative approaches that can address the problems of power imbalances between participants, in access to information, and in trust.

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8. APPENDICES

Appendix 1.
Key Informants and Firms Interviewed in the Exploratory Stage of the Study

Table 5. Key Informants

Organization	Type of Organization	Location	Name	Position
National Secretariat of Industry	State	Buenos Aires	Sergio Drucaroff	Undersecretary of Supplier Development Program
National Secretariat of Mining Policy	State	Buenos Aires	Mariano Lamothe	Undersecretary of Mining Development
National Secretariat of Mining Policy	State	Buenos Aires	José Gómez	National Director of Mining Infrastructure
National Secretariat of Mining Policy	State	Buenos Aires	Daniel Jerez	National Director of Mining Promotion
Ministry of Mining, San Juan Province	State	San Juan	Sonia Delgado	Undersecretary of Planning and Promotion of Sustainable Mining Development
Cámara Argentina de Servicios Mineros (CASEMI)	Industry association	San Juan	Alejandro Dona	President
Cámara de Proveedores Mineros de Santa Cruz (CAPROMISA)	Industry association	Santa Cruz	Fernando Paulasa	President
CAPROMISA	Industry association	Santa Cruz	Jorge Arias	Operations manager

Organization	Type of Organization	Location	Name	Position
Córdoba Cluster	Industry association	Córdoba	Karina Corradi	President
Servicio Geológico Minero Argentino (SEGEMAR)	State	Buenos Aires	Julio Ríos Gómez	President
Mining Chamber of San Juan (CMSJ) and Association of Exploring Mining Companies of Argentina (GEMERA)	Industry association	San Juan	Mario Hernández	President
LR Consulting	Private company	San Juan	Laura Rópolo	Private mining consultant; former Undersecretary of Planning and Promotion of Sustainable Mining Development

Source: Authors' elaboration.

Table 6. Firms in the Mining Sector

Location, Date of Interview	Name	Type of Firm	Individuals Interviewed	Activity
San Juan, Apr. 2019	Barrick Gold	Mining firm	Luis Pérez, Supply Chain Director Mariano Gambeta, Contracts Superintendent	Exploitation
San Juan, Apr. 2019	Aldebaran Resources	Junior exploration	Javier Robeto, Country Manager	Exploration
San Juan, Apr. 2019	Minexus	Mining supplier	Augusto Benitez, Manager, previously Senior Purchasing Supervisor at Barrick Gold	Software/supply chain solutions (digital platform)
San Juan, Apr. 2019	Red Balderramo	Mining supplier	Pablo Balderramo, Manager	Engine repairs
San Juan, Apr. 2019	Saeta	Mining supplier	Juan Arce, General Manager	Metal parts
San Juan, Apr. 2019	BTZ Minera	Mining supplier	Jaime Bergé, Lead Manager	Mining services
San Juan, Apr. 2019	Indumet	Mining supplier	Ricardo Martínez, Company Founder Andrés Martínez, Manager	Metal parts
San Juan, Apr. 2019	Carpas Argentinas	Mining supplier	Enrique Ruiz, Founder & Manager	Ventilation ducts
San Juan, Apr. 2019	SIGSA	Mining supplier	Marta González, Head of Human Resources	Soil waterproofing

Location, Date of Interview	Name	Type of Firm	Individuals Interviewed	Activity
Mendoza, Apr. 2019	Alex Stewart International	Mining supplier	Marcelo Tejada, General Manager Ruben Cairo, Manager of Quality & Environmental Management	Lab
Santa Fe, Apr. 2019	Maquinarias Agrícolas Ombú	Mining supplier	Orlando Castellani, President	Heavy machinery and trailers
Cordoba, Feb. 2019	Robótica de Unidades Funcionales (RUF)	Mining supplier	Jessica Nieto	Robotics and automatization
Cordoba, Feb. 2019	Engineering Simulation and Scientific Software (ESSS) Argentina	Mining supplier	Cristian Scarano	Software
Cordoba, Feb. 2019	Hexactitud	Mining supplier	Fernando Gouane	Internet of things
Cordoba, Feb. 2019	Metalúrgica Gerbaudo	Mining supplier	Inés Gerbaudo	Metallurgy
Cordoba, Feb. 2019	Metalúrgica CAMSA	Mining supplier	Roberto Campos	Metallurgy

Source: Authors' elaboration.

Appendix 2.
Strategic Mining Suppliers in Argentina

Table 7. Local Strategic Mining Suppliers in Argentina

Category	Activity	Interviewed Firms	Other Firms	Important Suppliers
Specialized Services	Drilling	Eco Minera	Explorar	Major Drilling
		Perforaciones Santacruceñas	Meyer	Foraco
		Exploservice	MD Perforaciones	Quemantina
		AGV Falcon Drilling	Minera Andina del Sol	
		Hidrotec	Roggio	
		Boart Longyear	Cunnington	
	Topography	DAMS	DroneXplora	Quantec
			Supraimagen	Nit Pinson
			Grupo CuT	
			HyTecAltoAmericas	
			DroneXplora and ConsultoresGIS	
	Blasting	Exploservice	Orica Argentina	
	Laboratory Analysis	Alex Stewart International	Baires Analítica	
	Hydrogeological and Environmental Services	Hidroar	Ausenco	
			SRK Consulting	
			Knight Piésold Argentina	
			BGC Engineering	
	Communications	MineTech		
	Web Platform for Suppliers	Minexus		
	Geomembranes and Geosynthetics	SIGSA	Absorbpad	
Comprehensive Services	Metallurgy and Metalworking	Saeta	Metalúrgica C&G	Caterpillar
		Indumet	Tassaroli	Finning
		Kousal	Jorge Gramillo	Liebherr
		Metalar	Mazzeo	Komatsu
		Jaime	Proyecto Metalúrgico	Conarco
		Acerías 4C	IMSA	
			Acero Corona	
			ACSA	
			Fundición San Cayetano	
			Tantal Argentina	

Category	Activity	Interviewed Firms	Other Firms	Important Suppliers
	Mine Construction	Di Bacco	Cartellone	
		Eco Minera	Techint	
		AGV Falcon Drilling	Siderco	
		BTZ Minera	Compañía Pacífica	
		Jaime	UTE Sandin-FEBISA	
	Geology	Aminco		
Metal Fabrication	Machinery Repair	Metalar	Acer	
		Saeta	BS Servicios	
			INAP	
			MinOil	
			Motores Balderramo	
			Talleres Dominguez	
			Zecin	
			PowerTrain Technology	
Nonmetal Manufacturing	Other	Di Bacco	Aceros Cuyanos	
		Inbelt	Grindar	
		MineTech	Metalfor	
		IPH	Acindar	
		Carpas Argentinas	Lubricación SAIC	
		Ombú	Ebinox	
			GeoPetrol Mining Services	
			Brugg Drako	
			Atlas Copco	
	High Altitude Safety Clothing		Ansilta	
			Zonda	

Source: Authors' elaboration.

Appendix 3.
Strategic Mining Suppliers Interviewed

Table 8. Strategic Mining Suppliers Interviewed: Main Characteristics and Activities

Firm	Year Founded	Number of Employees	Location	Products/ Type of Services	Main Activity	Other Sectors
Complex Services – Diversified						
AGV Falcon Drilling	1992	200–300	Salta	Earth-moving; drilling	Engineering	
Aminco	2015	10–50	Salta	Geology studies	Geology studies	
Boart Longyear	2007	200–300	Mendoza	Drilling; machinery	Engineering	
BTZ Minera	1992	100–200	San Juan	Blasting; mine construction	Engineering	Public infrastructure
Di Bacco	1956	200–300	Tucumán	Heavy machinery parts; general mining support	Heavy machinery parts	Food industry
Eco Minera	1996	>300	San Juan	Drilling; general mining support	Engineering	
Hidrotec	2012	200–300	Jujuy	Drilling; general mining support	Engineering	Air transport
Jaime	1989	100–200	San Juan	Heavy machinery repairs	Heavy machinery repairs; mining facilities	Public infrastructure
MineTech	2010	10–50	San Juan	Communications and monitoring	Monitoring	Oil
Complex Services – Not Diversified						
Alex Stewart International	1998	100–200	Mendoza	Lab analysis	Lab analysis	
DAMS	2015	<10	San Juan	Topography; magnetometry	Geophysics	Oil
Exploservice	1990	50–100	San Juan	Blasting; drilling	Engineering	Public infrastructure
Hidroar	1981	10–100	La Plata	Hydrology; environmental impact analysis	Water management; environmental services	Oil
Minexus	2017	<10	San Juan	Web platform services	Web platform services	
Perforaciones Santa Cruz	2012	50–100	Santa Cruz	Drilling	Drilling	
Red Balderramo	1975	10–50	San Juan	Engine repairs	Heavy machinery repairs	

Firm	Year Founded	Number of Employees	Location	Products/ Type of Services	Main Activity	Other Sectors
SIGSA	1990	10–50	Buenos Aires	Geomembrane placement and maintenance	Leaching valley and membranes	Oil and gas
Metal Fabricators						
Acerías 4C	1976	50–100	Santa Fe	Parts casting	Heavy machinery parts	Oil
Indumet	1989	100–200	San Juan	Parts casting	Heavy machinery parts	Public infrastructure
Kousal	1955	100–200	Tucumán	Parts casting	Heavy machinery parts	Food Industry
Metalar	1949	50–100	Tucumán	Parts casting and repairs	Heavy machinery parts	Food industry
Saeta	2008	<10	San Juan	Parts casting	Heavy machinery parts	Oil
Other Manufacturers						
Carpas Argentinas	2013	10–50	San Juan	Ventilation sleeves	Mining facilities	
Inbelt	1996	50–100	Santa Fe	Internal mills lining	Heavy machinery parts	Food industry
IPH Global	1939	>300	Buenos Aires	Steel cables	Heavy Machinery Parts	Marine transport

Source: Authors' elaboration.

Appendix 4.
Public Institutions and Regulatory Agencies Interviewed

Table 9. Public Institutions and Regulatory Agencies Interviewed

Institution	Location
Servicio Geológico Minero Argentino (SEGEMAR)	Buenos Aires
National Mining Secretariat	Buenos Aires
San Juan Mining Ministry	San Juan
Santa Cruz Mining Ministry	Santa Cruz
Salta Mining Ministry	Salta
Consejo Federal de Minería	Buenos Aires
Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA)	Buenos Aires

Source: Authors' elaboration.

Appendix 5.
Mining Regulations

Argentina's Mining Code establishes the rules and procedures for granting, maintaining, transferring, and cancelling mineral rights. It does so through a concession system whereby the state grants exploration permits and concessions (for exploitation) through an objective, nondiscretionary system that demands compliance with the payment of an annual fee, investment commitments, and the requirement to keep the mine active. Procedural provisions under the Mining Code are implemented by provincial regulations.

The Mining Investment Law (Box 5) is of primary importance because it sets the umbrella law for Argentina's mining investment regime. The Mining Investment Law is complemented by the Foreign Investment Law 21,382 (1993), which grants equal treatment to foreign and domestic investors. The Mining Investment Law is also supported by more than 50 Bilateral Investment Treaties for the promotion and protection of investment with many countries, including Australia, Canada, China, the United States, and South Africa.

Box 5. Summary of Major Benefits Granted by the Mining Investment Law 24,196 (1993) and Amendments

Companies registered under the Law are granted the following:

Exploration phase

- Double deduction of income tax from prospecting or exploration expenses and expenses incurred to assess the technical-economic feasibility of the investment (Art. 12).
- Value Added Tax reimbursement in six months.

Extraction phase

- Fiscal, exchange rate, and tariff stability for 30 years after submission of feasibility study.
- Import duty exemptions for capital goods, spare parts, and inputs for mining companies and mining supplies (Art. 21 and Resolution 112/2000). This provision was valid from the 1990s until 2012–15, when an import substitution policy was in place. The policy was removed from the end of 2015 until October 2019. Since then, permission of the Secretary of Mining Policy has been required to access the exemptions (Res. 89/2019)
- A 3 percent royalty limit (on mine-gate value) for all provinces adhering to the national law.

In 1993 the president and provincial authorities agreed on common measures to increase the competitiveness of the sector. These measures were enacted formally in the Federal Mining Covenant (Acuerdo Federal Minero), ratified by the National Congress under law 24,228. The agreement defined the goals to seek consensus on measures to attract foreign investments and optimize the use of infrastructure and human resources, among others. In 2017 a new and more comprehensive

covenant was signed between the president and most governors, but it was not ratified by the National Congress (see Table 10).

Table 10. Main Federal Laws and Regulations Governing the Minerals Sector

Topic	Law	Summary
Administration, incentives, and federal-provincial coordination	Federal Mining Code	• Establishes rules and procedures for granting, maintaining, transferring, and cancelling mineral rights • Regulates environmental obligations and procedures that apply to all stages of mineral exploration and mining, including sanctions
	Mining Investment Law 24,196/93 (and complementary laws)	• Establishes tax benefits, including fiscal stability for 30 years from the date of feasibility study submission • Establishes import duty exemptions
	Federal Mining Covenant Law 24,228/93	• Ratifies the Federal Mining Covenant
Environmental regulation	Environmental Protection for Mining Activities Law 24,585/95	• Incorporated as an environmental chapter (Title XVIII, sec, 2) of the Federal Mining Code • Indicates the environmental management policies applicable to mining activity • Includes environmental protection and conservation regulations and responsibilities for environmental damage
	General Environment Law 25,675/2002	• Argentina's first federal law of minimum standards (*ley de presupuestos mínimos*) for environmental management • States that authorities should institutionalize consultation procedures or public hearings (not binding) as mandatory for authorization of activities that may generate negative environmental effects
	Minimum Standards Regime for the Preservation of Glaciers and Periglacial Environment Law 26,639/2010	• Establishes minimum standards for protection of glaciers and the periglacial environment to preserve them as strategic water resources for human consumption, agriculture, and recharging river basins, among other uses

Source: Based on Bastida and Murguía (2018).

Regarding environmental regulations, the sector is regulated by the federal Environmental Protection for Mining Law 24,585, incorporated into the Mining Code in 1995. The law establishes the environmental framework for mining in the country and defines the management tools to be applied by provincial authorities at each stage of a mining project. These tools include environmental assessment procedures and determining who is responsible in case of environmental damage, among other provisions. The law also determines that each province must define the applicable authority (in some provinces it is the mining authority, in others the environmental authority).

In 2010 the National Congress enacted Law 26,639 , Minimum Standards for Glacier Protection, which bans mining from glacial and periglacial areas, as defined by the law and as identified in an inventory prepared by the Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA).

Appendix 6.
Provincial Regulations

Table 11. Provincial Regulations to Promote Local Buying and Hiring

Province & Policy	Type	What it Establishes
Catamarca Res. SEM 498/2014	Regulation	• Creates the Registry of Suppliers of Mining Companies (REPEM) and establishes as a requirement to register that natural or legal persons (suppliers) have 2 years of real and legal domicile within the province • Requires mining suppliers to have 70% of their professional, technical, or administrative employees originating from or residents of the province of Catamarca for at least 2 years • Defines a mining company, individuals, or legal entities that are holders of mining rights or mining operators at any stage of the project cycle • Requires mining companies to ensure at least 70% of their total number of annual contracts for work, services, and purchase of goods or supplies are with suppliers registered in the REPEM
San Juan Law 8,421/2013	Regulation	• Creates the mandatory Unique Registry of Mining Company Suppliers (RUPEM) • Defines a "local provider" as a natural or legal person that (i) has a real or social and fiscal domicile in the province of not less than 1 year, (ii) has at least 80% of the payroll to workers with real domiciles in the province of not less than 1 year, and (iii), for legal persons, is constituted and registered in the province and for which corporate composition is at least 50% held by 1 or more partners with real or social domicile in the province, among other provisions • Requires mining companies to ensure the total annual amount of contracted works, goods, supplies, or services be with local suppliers registered in the RUPEM is at least 75% of the total amount contracted • Requires mining companies to ensure at least 75% of their payroll comprises workers who have a real domicile in the province of not less than 1 year
Santa Cruz Law 3,141/2010, modified July 2019	Incentive	• Creates the provincial Unique Registry of Workers in Petroleum, Mining, Fishing, and all other activities • Stipulates that mining operating companies based in the province must hire 70% local labor; workers must have 3 years of residence in the province, as proven by a certificate of identification and certificate of residence issued by the appropriate authority • Article 4 stipulates, "In the absence of qualified local labor … allowing the hiring of personnel from other regions"

Source: Authors' elaboration.


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