“World Class Suppliers Program: The case of the mining cluster policy in Chile.”

Miguel Atienza, PhD. in Economics; Economics Department; Universidad Católica del Norte (Antofagasta, Chile). miatien@ucn.cl (Corresponding author).

Mary Valdés, Master in Business Administration; Management Department, Universidad Católica del Norte (Antofagasta, Chile). mvaldes02@ucn.cl

Abstract

Despite the importance of Chile as the world main copper producer, with more than a third of global production, the Chilean mining service supplier’s industry, especially knowledge and technology intensive activities, is relatively underdeveloped. Following the successful experience of the Australian mining industry, BHP Billiton started in 2009 the program “Mining Cluster: World Class Suppliers” with the aim of promoting a competitive and innovative Chilean mining supplier’s industry by means of the collaboration and knowledge transfer between large mining companies and local services suppliers. This program is currently part of the national mining strategy and is supported by the main mining companies in Chile, most of them multinational companies. The objective of this article is to analyze the design, evolution and results of this program. Special emphasis is made on the role of mining multinationals as global pipelines for knowledge creation, and on the impact of this program in the mining regions of the country. For this purpose, 18 interviews were conducted among government and public entities managers, related to the program, mining cluster program managers and mining services supplier’s firms. These interviews were analyzed according to the grounded theory. Results show that the program is contributing to transfer knowledge to the mining supplier’s industry in Chile but, at the same time, could be reinforcing a hierarchical structure of geographical location of the mining industry in the country, concentrating the majority of innovations at the capital of the country and not creating a cluster in mining regions.

Keywords: global pipelines, cluster, mining, Chile

Introduction

Since the beginning of the nineties, the promotion of clusters has been suggested as a means for the development of regions specialized in the mining industry, both in developed and developing countries (Upstill and Hall, 2006; Warrian and Mulhern, 2009; Lydall, 2009; Lagos and Blanco, 2010; Arias, Atienza and Cademartori, 2014; Söderholm and Svahn, 2015). Mining industry is dominated by a small number of some of the largest multinationals and public companies in the world that traditionally were vertically integrated. In the last three decades, however, mining companies have increasingly externalized their production and the number of specialized mining services suppliers has shown a significant increase (Bridge, 2008; Dicken, 2011). This change in the organization of production has been considered as an opportunity for mining regions to increase the linkages of local firms with mining companies (Morris, Kaplinsky and Kaplan, 2012). From this perspective, mining companies, mostly multinationals, can be considered as global pipelines that act as technological gatekeepers connecting the mining regions to external knowledge and diffusing it among their services suppliers (Graf, 2011).

It is not clear, however, to what extent mining regions can benefit from large mining multinationals acting as global pipelines for the promotion of clusters. Despite the need of proximity to the mineral deposits, the productive network of mining companies is globally extended (Bridge, 2008; Dicken, 2011) and usually shows a marked hierarchy of places. Core functions and more knowledge intensive activities tend to be subcontracted to specialized suppliers that are also globally competitive multinationals and are located either abroad or in the main urban agglomerations. In contrast, ancillary and more routine tasks are subcontracted to the firms at the mining regions (Phelps, Atienza and Arias, 2015). Most of these mining suppliers offer generic services and are easily substitutable among them. From this multiscalar perspective, the cognitive and organizational distances between mining companies and local suppliers could become a limitation for the collaboration between them and reduce the diffusion of knowledge expected from the global pipelines.

Despite the importance of Chile as the world main copper producer, more than a third of global production (COCHILCO, 2015), the Chilean mining service suppliers industry, especially knowledge and technology intensive activities, is relatively underdeveloped (Gobierno de Chile, 2014; Urzúa, 2012). In 2009, BHP Billiton started the program "Mining Cluster: World Class Suppliers" with the aim of promoting a competitive and innovative Chilean mining suppliers industry by means of the collaboration and knowledge transfer between large mining companies and local services suppliers. This program is currently part of the national mining strategy and is supported by the main mining companies in Chile, most of them multinationals. The objective of this article is to analyze the design, evolution and results of this program in order to understand to what extent the mining companies are acting as global pipelines for knowledge transfer at a regional and a national scale. Special attention is paid to the impact of this program in the mining regions of the country. This article contribution is, first, to extend the analysis of the literature on global pipelines, usually focused on the industry and high technology sectors, to the extractive industry and, second, to consider, from a multiscalar perspective, the role that the functional position in the global production network can play in the effectiveness of global pipelines, as technology gatekeepers in peripheral regions.

The analysis is based on 18 interviews conducted among mining companies, mining cluster program managers and mining services suppliers firms participating in the program "Mining Cluster: World Class Suppliers". These interviews were analyzed according to the grounded theory. Results show that the program is contributing to the upgrading of mining suppliers industry in Chile but, at the same time, could be reinforcing a hierarchical structure of geographical location of the mining industry in the country, concentrating the majority of innovations in the capital of the country and not contributing to the creation of a cluster in mining regions.

The article is divided into five sections. The first section analyzes the relevance of "global pipelines" as technological gatekeepers in mining regions. The second section describes the organization of the mining production network in Chile and the evolution of mining cluster policy in Chile, with special attention to the "Mining Cluster: World class suppliers" program. In the third section we describe the methodology of the study. Afterwards, we present the main results of the study and finally, we report the main conclusions and policy implications of the research.

1. Global pipelines, multinationals and clusters in mining regions

1.1. Multinationals as technological gatekeepers

Local interaction between firms and other actors was traditionally considered in the cluster literature as the main origin of knowledge transfer by means of Marshallian externalities (Markusen, 1996). This tyranny of proximity has been challenged in the last two decades. On the one side, if cognitive distance between the members of the cluster is too short, local interaction could lead to lock-in due to the scarcity of new flows of ideas, as happens in mature clusters (Boschma, 2005); on the other side, Bathelt, Malmberg and Maskell (2004) proposed that local "buzz" understood as "the information and communication ecology created by face-to-face contacts, co-presence and co-location of people and firms within the same industry and place or region" was not the only source of knowledge creation in clusters and emphasize the role of external linkages to create and spread innovation and growth in clusters by means of long distance interaction. These external linkages, called "global pipelines", are conscious and systematic connections between local agents and global partners that usually are costly and require long term relationships. The interaction of local "buzz" and "global pipelines" is a complex one. The "global pipes" can contribute to introduce more radical innovations in the clusters but, at the same time, require some level of local "buzz" to spread that knowledge locally and make local firms more competitive (Bathelt et al., 2004; Fitjar and Rodríguez-Pose, 2011). At the same time, it is widely acknowledged that a certain level of absorptive capacity at the firm and the local level is necessary to be able to profit from the external knowledge coming through "global pipelines" (Graf, 2011; Morrison, Rabellotti and Zirulia, 2013; Fijtar and Huber, 2015).

"Global pipelines" can take the form of formal and informal inter-firm networks and projects, but also, can take place by means of international contacts in trade fairs, conventions, exhibitions and other professional gatherings (Maskell, Bathelt and Malmberg, 2006; Fitjar y Huber, 2015). In this article we will focus on the networks and projects

between local firms and multinationals as sources to gain access to external knowledge. In this sense, the role of multinationals is twofold: this type of firms has traditionally made intensive use of "global pipelines" to get access to local knowledge by stablishing branch plants and offices and by means of joint ventures and other type of agreements (McCann and Mudambi, 2004, 2005; Iammarino and McCann, 2013). At the same time, however, multinationals can act as technological gatekeepers in host regions, contributing to the access and diffusion of external knowledge within the local system (Giuliani and Bell, 2005; Graf, 2011). In the same vein, Gary, Golob and Markusen (1996b) considered that the hub-and-spoke industrial districts, dominated by the presence of multinationals, have "long arms" that reach far beyond local boundaries and act as sensors for innovation, enabling the adaptation of new ideas.

1.2. Global pipelines in mining regions

Multinational location decisions are increasingly complex and strategically oriented to gain access to the technological expertise of the different host regions where they are located. This multinational´s innovation networks are organized as a hierarchy of clusters and regional centers functionally differentiated and whose role depends on their strategic relevance (Iammarino and McCann, 2013). The role that multinationals can play as technological gatekeepers of external knowledge is not guaranteed and differs depending on the activity and the characteristics of the clusters. In other words, this type of global pipelines can be limited to certain groups of regions depending, among other factors, on their functional specialization and absorptive capacity. This analysis is particularly relevant in the case of mining regions, usually peripheral and remote areas where there is a dominant presence of multinationals.

The degree of concentration in the mining industry has increased in the last two decades through a series of multinational mergers and acquisitions (UNCTAD, 2007; Dicken, 2011). Furthermore, since the nineties, mining companies had experienced a transformation from a strong vertically integrated form of production, to an increasing externalization of tasks and a significant growth in the number of specialized suppliers (Dicken, 2011; Morris et al., 2012). Due to this new form of organization of production, proximity to the mineral deposits is no longer necessary for many of the service suppliers that could be located at a long distance from the mining regions. Mining industry has also experienced a "technological renaissance" in the last two decades (Urzúa, 2012). Mining, traditionally considered a mature activity, has increasingly incorporated high technology and innovation in the production processes. This transformation in the mining industry – growing outsourcing and "technological renaissance" – have been considered an opportunity for increasing linkages and knowledge transfer from mining multinationals to local services suppliers (Morris et al., 2012; Urzúa, 2012).

The analysis of mining multinationals as potential gatekeepers for knowledge transfer has been fundamentally made at a national scale (Morris et al., 2012). The multiscalar location strategies of these companies and their service suppliers have not been taken into account and it is not clear to what extent mining regions can currently profit from this transformation in the mining industry. This is particularly relevant because the global production network of the mining industry shows a marked hierarchy of places functionally differentiated (Phelps et al., 2015): core functions tend to be either maintained within the mining companies or

subcontracted to multinational that are already world leaders in their area. These firms are located abroad and in the main urban agglomerations of the host country (Dicken, 2011). In contrast, ancillary functions and generic services that require proximity to the deposits are predominantly located in mining regions.

Mining regions are generally remote and peripheral areas that tend to have high levels of specialization and medium and small size urban agglomerations that, in many cases, have been considered as enclaves (Fernández and Atienza, 2011; Arias et al., 2014). The organization of production in mining regions resembles hub-and-spoke type of industrial district where large mining companies, either multinational or public firms, are hubs surrounded by a network of small and medium service supplier firms organized as multilayer supply chains (Markusen, 1996; Arias et al., 2014). Due to this type of organization the role of mining companies as "technological gatekeepers" for external knowledge is essential for the creation of a mining cluster. However, long term collaboration agreements between mining companies and local services suppliers face many constrains. Mining regions usually take the form of an "industrial complex" type of cluster (Gordon and McCann, 2000; Arias et al., 2014) where knowledge exchange takes place through formal long-term agreements managed in the framework of a bilateral monopoly. Consequently, this type of agreements are more likely between mining companies and their strategic and specialized suppliers, generally located out of the mining regions, than in the case of generic service suppliers, usually small and medium firms located close to the deposits (Atienza, Aroca, Stimson and Stough, 2016). Due to the monopsonic position of the mining companies and the cognitive distance that exists between these companies and their generic services suppliers, their relationship is highly asymmetric and there are few incentives for the vertical transfer of knowledge through collaboration.

Many mining countries such as Australia, United States and Chile (Upstill and Hall, 2006; Morris et al., 2012; Söderholm and Svahn, 2015) have adopted mining development policies based on the promotion of mining suppliers though the creation of "win–win linkages", where mining companies and local suppliers have a common interest and there is an objective of actively promoting suppliers capabilities (Morris et al., 2012). Most of these programs have been designed at a national scale. If we consider the functional specialization and the characteristics of mining regions, it is not clear to what extent these type of "global pipelines" could contribute to the development of mining clusters in these areas. Finally, the lack of a regional scope in this type of collaboration partnerships could reinforce the position of the main urban agglomerations and perpetuate the situation of mining regions just as extraction places.

2. Towards a mining cluster in Chile

2.1. The development and location of mining services suppliers in Chile

In 2014, mining industry represented 11.2% of the Chilean GDP and 56.2% of national exports (SERNAGEOMIN, 2014). The country is specialized is metallic mining and particularly in copper that reaches almost 91% of metals exports in 2014, representing 32% of world copper production (COCHILCO, 2015). Mineral deposits tend to be highly concentrated in the northern regions of the country and especially in the Antofagasta Region, that represent more than 50% of copper output (COCHILCO, 2015) and has been considered historically the "mining capital of Chile". Other mining regions in Chile are Tarapacá, Atacama and Coquimbo in the north of the country and O´Higgins in the center, where almost 40% of copper deposits are located[1] (Map 1).

Map 1. Chilean Mining Regions

Source: Authors.

[1] Mining regions were defined using location quotients (Q) of the regional mining output. Location quotient measures the relative specialization of a region in mining activity, as the ratio of the share of mining in a region and the share in the country. Values of Q over 1 imply regional specialization. To define mining regions we consider a value of Q over 2, which means that the share of the mining output in this type of regions is more than twice the average share in the country.

Since the beginning of the nineties, the Chilean mining industry has experienced a significant transformation due to the arrival of massive FDI and some of the largest mining multinationals in the world. One of the main characteristics of this transformation is the progressive transition from a vertically integrated form of production to increasing outsourcing of tasks. At the beginning of the nineties, only 11.7% of the mining workers were subcontracted, while in 2014, there were more than two thirds (SERNAGEOMIN, 2014). This rate of outsourcing is significantly higher than in other mining countries such as Australia, Canada and South Africa, where subcontracted workers do not exceed 26% of the whole mining labor force (Pérez and Villalobos, 2009). One of the main consequences of this transformation was a significant growth in the number of mining service suppliers. According to the Rating System of Supplying Companies (SICEP[2]), a commercial platform that matches mining companies with their suppliers, there were around 4,000 mining services suppliers in Chile in 2014.

The regional distribution of mining services suppliers is remarkably different from the location of production. The headquarters of these firms are predominantly located in the Metropolitan Region that represents 54.2% of the mining services suppliers and only 7.1% of copper output (Table 1)[3]. In contrast, only 25.8% of the mining services suppliers are located the Antofagasta Region that produces more than half of copper output. The same pattern is found in the rest of mining regions that in total represent 87.2% of copper production and only 37.4% of services suppliers (Table 1). Something similar happens in the case of the headquarters of the main mining companies, both private and public, that are predominantly located in the Metropolitan Region, while operations are located in the mining regions through subsidiaries.

Table 1. Regional distribution of mining services suppliers and copper output

Region	N	%	% Copper output 2013
Arica and Parinacota	21	0.6%	0.0%
Tarapacá*	234	6.1%	10.0%
Antofagasta*	985	25.8%	52.1%
Atacama*	62	1.6%	7.2%
Coquimbo*	113	3.0%	9.9%
Valparaíso	182	4.8%	5.6%
Metropolitan Region (Santiago)	2,067	54.2%	7.1%
O´Higgins*	29	0.8%	8.0%
Maule	8	0.2%	0.0%
Bío Bío	92	2.4%	0.0%
Araucanía	6	0.2%	0.0%
Los Lagos	10	0.3%	0.0%
Los Ríos	0	0%	0.0%
Aysén	0	0%	0.0%

[2] Acronym of "Sistema de Calificación de Empresas Proveedoras" in Spanish.

[3] Other sources such as Fundación Chile (2014) report even higher levels of concentration of mining services suppliers. According to this source, 62% of mining services suppliers is located in the Metropolitan Region.

Magallanes	2	0.1%	0.0%
Total	3,811	100%	100%

Source: Authors based on SICEP and SERNAGEOMIN
*Mining regions

This spatial pattern, that could seem paradoxical, is the result of the location strategies that currently characterize the production network of the mining industry in Chile. Due to the reduction in transport costs and the consequences of the development of information and communication technologies, proximity to the mining deposits is no longer necessary. Many mining services suppliers, especially the larger ones, try to benefit from the location advantages of the main urban agglomeration, while only those services that require proximity to the mineral deposits remain located in the mining regions. As a result, the production network of the mining industry in Chile has two main nodes: on the one side, the Metropolitan Region, where Santiago is located, offers access to urbanization economies, higher international connectivity, a larger and more diversified labor market, besides the proximity to the political and economic decision centers; on the other side, the Antofagasta Region, as the main mining hub of the country, offers basically advantages of proximity to the mineral deposits.

The hierarchy of places that characterizes mining services supply in Chile in terms of firm´s location is even more pronounced when we consider their functional specialization. Table 2 compares the functional specialization of mining regions and the Metropolitan Region using a classification of 16 types of mining services based on SICEP categories. For this purpose, we calculate location quotient using a 95% confidence interval according to the test proposed by Moineddim, Beyene and Boyle (2003)[4]. Results show that mining regions are significantly specialized in generic and ancillary tasks such as minor projects of construction, maintenance and repair, and renting services. Furthermore, the industrial fabric of these regions is predominantly composed of small and medium firms, with relatively low qualified workers and innovation capacity (Atienza, 2012). In some mining regions like Atacama, Coquimbo and O´Higgins, there are more subsidiaries of firms located in the Metropolitan Region than local mining services suppliers[5]. In contrast, the Metropolitan Region mining suppliers are specialized in more knowledge intensive activities such as exploration, environmental, information technology and engineering services and in core functions such as energy and strategic supplies, electrical equipment and instrumentation, and mining operations (Table 2).

Despite the importance of Chile as the world main copper producer and the recent development of the mining services suppliers industry, it is widely acknowledged that the Chilean services suppliers, specially knowledge intensive services, have not been able to be internationally competitive and to integrate themselves successfully in the global mining production network (Urzúa, 2012; Arias et al., 2014; Gobierno de Chile, 2014). Most of these firms are not innovative and simply establish relationships with mining companies

[4] This test allows us to estimate when the location quotient is significantly over the value 1 which implies productive specialization.
[5] Calculations of table 2 were also made considering the supply of services of both headquarters and subsidiaries and the results do not change.

based on sales of products or services of little value added. The lack of competitiveness and innovation of the mining services suppliers and the reduced knowledge transfer from the mining companies to the local firms have been at the basis of the mining cluster policies that started in Chile at the beginning of this century.

Table 2. Functional specialization of the main services suppliers regions (Headquarters). (Q)

Activity	Tarapacá	Antofagasta	Atacama	Coquimbo	O´Higgins	M. R.
Fuel, Energy & Strategic Supplies	1	0.7	0.2	0.8	1.3	1.2***
Construction (major projects)	1.3***	1.0	0.9	1.2	1.4	0.9
Construction (minor projects)	1.6***	1.4***	0.9	1.6***	1.3	0.7
Electrical Equipment & instrumentation	0.7	0.6	0.1	0.2	0.9	1.3***
Exploration	0.3	0.5	1.3	2.0***	2.3	1.3***
Maintenance and repair	1.3***	1.3***	1.6***	0.9	1.2	0.8
Mining Operations	0.7	0.8	1.4	1.5***	1.1	1.1***
Generic support services	0.9	1.2***	1.1	1.0	0.5	0.9
Plant process	1.1	1.0	0.9	0.8	1.0	1.0
Industrial safety	1.3	0.9	0.0	1.0	0.5	1.1
Environmental services	0.4	0.6	1.5	0.1	0.4	1.3***
Renting services	1.4***	1.5***	2.2***	1.7***	1.0	0.6
Information technology services	0.5	0.6	0.3	0.7	0.7	1.3***
Engineering and professional services	0.7	0.8	0.5	0.5	1.0	1.2***
Transport	1.3	1.2	2.0	1.3	0.5	0.7
Sales	0.9	0.7	0.0	0.5	0.8	1.0

Source: Authors based on SICEP
*** 95% Confidence interval

2.2. Origins of the mining cluster policy.

In the middle of the nineties, after the arrival of massive FDI and a transformation in the form of mining production, the idea of promoting a mining cluster started in the Antofagasta Region, the main copper producer of the country. After five years of local discussion, this idea was formally introduced in 1999 as part of the "Regional Development Strategy 2000–2006". One of the axis of this strategy was the creation of a "Mining, Manufacturing and Services Productive Complex" in Antofagasta with the objective of "improving the strength and quality of the linkages of local services suppliers with mining companies" (Gobierno Regional de Antofagasta, 1999). This idea was adopted by the National Government that in 2003 started the "Mining Cluster Program: Antofagasta Region 2003-2006" coordinated by the Chilean Corporation for Productive Promotion (CORFO). Despite the objective of promoting backward linkages of regional services suppliers with mining companies, this program was fundamentally based on the promotion "local buzz" and the idea of creating "global pipelines" to spread external knowledge and innovation within the cluster was secondary. In fact, the involvement of mining companies, both multinational and public, in this program was very limited.

A significant change in the mining cluster policy took place in 2007, when the Chilean Government started a new "National Competitiveness Strategy" based on the promotion of

clusters in different parts of the country. The idea of consolidating a mining cluster persisted, but, with a national geographical scope and not exclusively located in the Antofagasta Region. This strategy, that pays more attention to the creation of "global pipelines", was only active up to 2009. Under the Piñera's government, between 2010 and 2014, the promotion of cluster as a national competitiveness strategy was dismantled. Paradoxically, in this period, the idea of the mining cluster was adopted by the mining multinationals. In 2009, BHP Billiton started the "Cluster program: World class suppliers" declaring the sustainability of mining communities as an objective of this program.

2.3. The "Cluster program: World class suppliers"

The development of tailored solutions to improve production processes and the efficient use of resources, is key to the mining industry sustainability. In this regard, it is relevant the case of Australia, where many of the innovations that have allowed mining became highly efficient and competitive, come from solutions created by specialized suppliers which were able to identify and develop, in collaboration with mining companies, innovative solutions that increase the productivity, sustainability and competitiveness of the whole industry (Scott- Kemmis, 2011). Inspired in the Australian experience, BHP Billiton started the "Cluster program: World class suppliers" in 2009 in response to a call made by the Chilean government to the mining multinationals present in the Antofagasta region to build technological capabilities in the local mining suppliers. Afterwards, CODELCO, the biggest copper mining company in the world, Fundación Chile, CORFO, and progressively other mining companies joined the program.

The main objective of the program is to develop a critical mass of suppliers able to create solutions that significantly and positively impact the productivity and operational performance of the mining companies (Fundación Chile, 2012). The design of the program seeks to generate knowledge transfer from the mining companies to the services suppliers through the development of innovative solutions to a portfolio of problems identified by the mining companies in the production processes. Collaborative work between the operational area of the mining company and the supplier is considered one of the main channels to achieve the creation of solutions and innovations. It is expected, therefore, that the mining companies become technological gatekeepers that contribute to the consolidation of a mining cluster and to the development of the mining industry. The initial goal of the program was to incorporate more than 250 "world class" suppliers to the program in 2014. This goal was recently extended until 2020. Subsequently, although it has not been officially declared, the program Alta ley, which currently defines the Chilean mining strategy for the next twenty years, further extended the deadline up to 2035, and has established as a goal for the mining industry to achieve USD $ 10,000 MM of mining services and products exports. Currently, this sector exports are below USD $ 0.5 MM (Fundación Chile, 2014).

The mining companies decide, either internally or with the support of Fundación Chile, which operational problems might be a good project to be solved through a "cluster project", considering the following criteria: impact, cost, benefit and importance. Afterwards, the supplier firms apply to solve the problems launched as "challenges". The selection of the suitable candidate to develop the solution to the problem considers the strategy of efficient

solution to the challenge and the skills, capital and man-hours that the supplier firms are willing to contribute to the project. When a "challenge" is adjudicated to a supplier firm, the conditions of the project are negotiated and formalized through a letter of intent and a contract that fixes the KPI of the projects, the stages and their deadlines, performance indicators, the type of financing and the commitment of both sides in generating an innovation. The project includes the pilot and the test implementation in operation and stipulates that the intellectual property of the innovation achieved is assigned to the mining service supplier.

During the development of the project, the service supplier follows the so called "World Class Route". In this route, the mining supplier identifies the stages of improvement in collaboration with a consultant, in order to achieve the "world class" status. During the "World Class Rout" the mining suppliers are audited, advised and monitored by indicators associated with the standards to be achieved. Beyond the development of innovations, the program also aims that the mining suppliers achieve quality standards in production, compatible with the leader of the segment in which they operate; export more than 30% of its production; and integrate into the global production chain, which involves being able to compete internationally and to flexibly respond the demands of its clients. When the service supplier achieves these milestones, it attains the "world class" status.

While there are no minimum requirements established to apply, the nature of the "challenges" imposes high entry barriers. First, the suppliers firms must be highly innovative and able to develop an innovation to solve a technologically complex operating problem, within a maximum period of 18 months. The suppliers firms also need to have a strong financial backing since they will not receive any direct profit during the stages of design, development and industrialization of the innovation, which in some cases take up to four years. Furthermore, the costs and the risks of the project are shared between the mining company and the supplier firms. The extent to which the mining company is willing to finance part or the whole project is negotiated on a case-by-case basis and depends on several factors such as the cost of the project and its strategic importance. In this regard, the supplier firms must deliver a detailed economic proposal that explains all the costs of the solution proposed, which is the initial basis to negotiate the contract conditions. Mining suppliers can also apply for funds to public institutions such as CORFO through its various lines of competitive funding. In this case, these projects compete without any privilege with other innovation or development projects.

The program was initially called "Cluster Program", and many people still refer to it using this name, but afterwards changed the name to "World class suppliers program". Despite declaring the sustainability of mining communities as an objective, the geographical scope of the cluster concept used in the program is fundamentally national and can be consider a part of the national strategy for mining development. In fact, applications to solve the "challenges" are open to mining services suppliers from the whole country and even from abroad.

3. Methodology

The article methodology is based on an exploratory and descriptive, in-depth case study, namely the "World class supplier program", based on primary and secondary information. The "World class supplier program" was chosen as a case study because, due to its characteristics and application, provides a powerful example and illustration to achieve a better understanding of the extent to which peripheral mining regions can benefit from large mining multinationals acting as global pipelines for the promotion of clusters through formal inter-firm projects. Due to the scarcity of studies examining this topic and the lack of public information about the results of this program, an exploratory and descriptive approach is the most appropriate to answer our research question and to understand how the program is working (Yin, 2009).

The work is based on both secondary and primary sources of information. Secondary information comes from public sources of the Chilean mining industry and the program under study and is used for a descriptive quantitative analysis of the program and also of the number and type of participating companies, the type of projects and their location. Primary information was gathered from 18 in-depth semi-structured interviews with people responsible for the program in the government and other institutions involved (6), the mining companies that had participated in the program (4) and an strategically sample of the supplier firms participating in the program (8) located within the mining regions and also in the Metropolitan region, that had different experiences successfully completing the program, and falling in the completion in different stages of the project realization. These interviews were qualitatively analyzed using the Grounded Theory of Glaser and Strauss (1965), whose strategy consist in a constant comparison of the data collected, identifying the similarities and differences in their opinion about the program in several topics. It were coded and analyzed simultaneously, trying to find categories on the information and properties for those categories, to suggest interrelationships trough the hypothesis emerged from the data, reorganizing according those hypotheses till it saturation, to collected them later within a theory that allowed to identify the phenomena occurring in the program, it origins and the consequences that this phenomena will brings not just for the program success, but also to the mining industry. In this sense the study will be based on the triangulation of different data collection techniques with different sources (Yin, 2999).

4. Results.

This section analyzes the main results of the study and is divided into three parts: first, we analyze the performance and the collaboration conditions of the "Cluster program: World class suppliers"; afterwards, we study its geographic scope and the participation of mining regions; finally, we study to what extent the program has acted as a technological gatekeeper promoting external knowledge flows to the Chilean mining services suppliers.

4.1. Program´s performance and collaboration conditions.

During the initial years of implementation, the "World class suppliers program" became the flagship of the cluster policy. Recently, however, it is widely acknowledged that the program

has lost strength. In fact, the number of “challenges” awarded by the mining companies fell significantly in the last three years. Consequently, the goal of developing 250 “world class” suppliers in 2014 has been systematically postponed to 2020 and now to 2035. Considering the available resources and the number of participants, the goals seems to be too ambitious and the program faces growing difficulties to achieve them. From the demand side, the program has failed to involve more mining companies. From the supply side, it seems that there are few mining services suppliers in Chile able to qualify for the current requirements of the program and there is a low participation of universities and technological development centers in the projects. Furthermore, multiple changes experienced in the conception and processes of the program as well as the lack of consistent evaluation methodologies, have limited and discouraged the participation of suppliers that potentially meet the requirements.

After more than six years, approximately 85 suppliers have participated or participate in the program, of which only a few have managed to successfully complete the proposed solutions and it is even smaller the group that has managed to have a supply contract with the mining companies. While some companies have failed in the development of projects, they acknowledge that experience of participating in the program has served to position themselves as innovative companies and gain prestige in the market. Some of these firms have begun to export goods and services with high value added, which would allow long-term insertion into mining global supply chains. It is difficult, however, to measure the results of the program with certainty due to the ambiguousness of the term "world class” supplier makes.

The program creates an “innovation market” where knowledge is negotiated. The mining companies (demand) have, through the program, a mechanism for the selection of supplier companies (supply), which will face the “challenges”. This knowledge exchange is contractually formalized and not only depends on the technical solution offered by the supplier, but also on the cost and risk sharing conditions. While the program has no income requirements declared, most respondents indicate that suppliers need prior mining experience, successful track record and financial stability as a basis for passing the first selection filter. Accordingly, the program could be selecting predominantly mining suppliers that do not need to be supported because they already have the necessary skills installed in the organization. In fact, the program has tended to incorporate many mining service suppliers that are already “world class”, including some multinationals that represent around 15% of the participants. This would imply a misallocation of resources that would not be used to increase the capacities of local service providers with undeveloped innovation potential.

Mining companies acknowledge, in this respect, their risk-averse culture. For these companies, participating in the program represents a challenge and a commitment to make organizational changes, develop internal capabilities and be willing to risk and invest resources. For these companies, operational and industrial safety is a priority, coupled with a strong pressure to produce immediate results. Consequently, it is difficult for the mining companies to establish “challenges” that meet the requirements of being attractive to them in terms of return, feasibility and safety. The active participation of user areas involved with the innovation is another problem for the implementation of the program, because their main objectives and performance indicators are based on productivity, which is not necessarily

affected in the development of an innovation project. These problems are aggravated since 2011 due to the fall in the copper prices.

As a result of the previous circumstances, the collaboration conditions of the program tend to be highly asymmetric in favor of the mining companies. The contract terms are set by these companies that establish and determine strict protocols that must be met by the suppliers, coordinating the form of relationship. When a "challenge" is awarded, there is no guarantee that the project will be developed. This requires a negotiation process that can take months, due to the rigidity and bureaucracy of the mining companies to set the terms of the contract. In this negotiation, the suppliers must show their costs structure openly to the mining company, which review and discuss in detail item by item each cost in the proposal. The supplier ends paying the difference and leveraging costs apparently covered by the mining company. Moreover, the supplier must cover extra costs that were not contemplated at this stage. The asymmetrical relationship is also reflected in the development of technical commitments. Service suppliers depend on the user area of the mining company to develop the projects. Some projects have had months of delay either because it is not possible to paralyze the mining operation or because the equipment for testing was not available. These delays are especially costly for suppliers that do not get any direct return on investment during the development of a project.

Financing is one of the major barriers of the program. This difficulty affects all participants transversally, but becomes more critical as the size of the company decreases. Costs start from the application to the "challenge" that usually requires hiring specialists and forming multidisciplinary teams to design a viable and attractive proposal, without any guarantee that the solution will be chosen. When the "challenge" is awarded, supplier firms must co-finance the industrial development of the service and any additional costs arising in the process. Public funds available for this type of projects are few and small compared to the costs involved and are not generally oriented towards large-scale of mining. Financing becomes a more serious problem when companies have already succeeded in developing the solution. The scalability of the solution as a standardized product, capable of being marketed internationally, requires investment amounts that are beyond the possibilities existing of public funding. In some cases, solutions to the "challenges" have not been finally commercialized.

4.2. Geographic scope of the program. Where do the "global pipelines reach"

Since its inception, the program was born linked to the promotion of a mining cluster in Chile. The use of this concept by the program was confusing in at least two senses. First, it did not take into account the complexity of economic, institutional, cultural and historical factors that lead to the formation of a cluster. Second, it was not clear the geographic scope of the mining cluster concept. However, the idea of consolidating a regional or local cluster in mining regions through the "Cluster program: World class suppliers" became diluted. In fact, the program lost any kind of territorial focus and changed its name to "World class suppliers program". The approach of the program took a national character and became part of the mining development strategy with the aim of integrating Chilean service suppliers in the global chains and networks.

The selection of "challenges" by the mining companies has been fundamentally based on the capabilities installed in the services suppliers. As a result, the Metropolitan Region concentrates almost 60% of the participating companies, while Antofagasta Region, the so called "mining capital of Chile", represents 9% of participants, even below the multinational companies that account for 15% of participants. The results show a higher level of concentration of than "challenges" in the Metropolitan Region than its relative participation in the total number of suppliers (54.2%). In contrast, the participation of the Antofagasta Region in the program is significantly below its share of mining suppliers (25.8%). Remarkably the participation of other mining region in the program is almost insignificant, below 5% of the total "challenges".

According to a significant group of respondents, the Metropolitan Region has many traits that facilitate the development of enterprises, as infrastructure, universities, research centers and the presence public and private organizations providing financial, managerial and technological support. These conditions are not found in Antofagasta neither other mining regions. Respondents find difficult to think in the development of a mining cluster in these areas when the main public and private organizations related to the mining industry have their headquarters in Santiago, where important decisions are taken. Furthermore, respondents indicate that starting a business is easier in the Metropolitan Region than in the mining regions. Some of the mining services suppliers interviewed point out that to be located in the mining regions, and particularly in the Antofagasta Region, is too risky due to the instability that characterizes the mining industry. Furthermore, the fall in the copper prices that started in 2011 increases the lack of interest of being located in the mining regions where suppliers firms only depend on a small number of large customers. In this sense, many of the respondents consider that incorporating regional scope in the program would be inefficient taking into account that the mining regions do not have enough technological companies of innovative base and very few are able to qualify for the program, because they do not meet the expected requirements.

It seems, therefore, that the market mechanism, open to the competition among all mining services suppliers of Chile, that coordinates the allocation of projects in the "World class suppliers program" tends to reproduce or even to increase the existing spatial inequalities between the core regions and the peripheral mining regions. In other words, the "global pipelines" created by the program are essentially reaching the supplier firms located in the Metropolitan Region, while their effects in the mining regions seem to be very weak due, among other factors, to the location advantages of the core region and to the excessive cognitive distance between mining multinationals and local services suppliers and to their specialization in generic services. It is important, however, to analyze to what extent the "World class suppliers program" is contributing to the diffusion of external to the mining services suppliers.

4.3. Knowledge exchange.

The type of collaboration between the participants in the "World class suppliers program" has been very formal and strictly limited to the terms of the contracts. In these sense, it is perceived that the form of relationship has been fundamentally asymmetric and that services suppliers made the more important commitments and assumed the higher risks. At the same time, however, the respondents recognize that the program has allowed a bi-directional

exchange of knowledge between mining companies and the service suppliers. Knowledge flows has gone in both directions and the interaction has benefited mining companies and services suppliers in terms of learning. It is widely recognized that suppliers companies have been able to improve the processes and to identify inefficiencies in the mining operations that were not previously observed as problematic by the mining companies.

It is perceived, however, that the design of "World class suppliers program", based on the demands of solutions by mining companies and the selection of potential suppliers of these solutions, make the flow of knowledge going from the service supplier to the mining larger than in the opposite direction. Usually, mining companies request that the solutions to the "challenges" to be previously validated at least as a laboratory test or a prototype to be awarded. In some cases, services suppliers have had to develop an industrial prototype independently, to demonstrate the validity of the solution, before the mining company agrees to finance the project. These demands affect not only the distribution of risk between both parts but also limit the interaction between the mining company and the supplier and the amount of knowledge transferred by the mining company. In this respect, it is illustrative a case where the service supplier finally decided to sell the solution to the mining company without participating in the program.

The interaction between the mining companies and the service supplier is also strictly limited to the development of the contract. In the initial stages, the program has recently incorporated consultants called "business accelerators" to be responsible for the selection process and support in the design of proposals. This measure has not been well received by most of the suppliers interviewed, that consider these "business accelerators" as a new counterpart that reduce the direct interaction with the mining companies, affecting the learning process. Furthermore, suppliers consider that the dissemination activities of this "business accelerators" is highly selective, reducing the transparency of the project and limiting the number of new firms potentially innovative. When a mining supplier achieves a solution to the "challenge" and attains the "world class" status, there is no guarantee that the relationship with the mining company will continue and do not imply long term contracts with the mining company. In this sense, the program encourages forms of occasional and very specific collaboration instead of long term interaction which could reinforce the role of "global pipelines" as source of external knowledge.

An interesting and positive result is that some supplier companies participating in the program have developed networking and partnership among them, in addition to the collaboration with the mining companies. This sort of "local buzz" has contributed to speed up the learning processes and to generate knowledge exchange. This type of learning has not arisen from the contractual relationship, but rather as a by-product of the wealth of the interaction between them during the projects development and the support process where these firms have participated, allowing services suppliers to identify their gaps, work on them and to increase their capabilities.

5. Conclusions

The article analyzes the role of mining multinationals as potential technological gatekeepers for knowledge transfer and their contribution to the creation of a mining cluster in Chile from a multiscalar perspective, paying special attention to the situation of the mining regions. The article extents the literature on "global pipelines" to the extractive industry, and analyzes the evolution and results of the "Cluster program: World class suppliers" designed as part of the national mining strategy to build technological capabilities in the local mining suppliers and to promote a mining cluster by means of inter-firm projects with the mining multinationals.

The results show that the program´s performance has been poor in its first six years of implementation. The goals of the program have been systematically postponed due to the lack of projects, the small number of firms that attain the "world class" status" and the scarcity a critical mass of mining services suppliers able to apply. Furthermore, the program design has maintained the strongly formal and asymmetrical type of relationship between the customers and suppliers that characterizes the mining industry. This asymmetric interaction could also have affected the knowledge flow between the mining companies and the service suppliers. Despite it is widely recognized that the program has allowed a bi-directional exchange of knowledge, the process of selection of the projects and the strict conditions stablished by the program to the participants could limit the knowledge flows from the mining companies to the services suppliers. Furthermore, collaboration is occasional and constrained to the project development and does not tend to promote long term interactions.

From a geographic perspective, the "World class suppliers program" has tended to reproduce or even to increase the existing spatial inequalities between the core region and the peripheral mining regions. The participation of mining regions in the program is very reduced, even in the main mining hub of the country, the Antofagasta Region, where the mining cluster policy was initially proposed. Due to the location advantages of the core region and to the excessive cognitive distance between mining multinationals and local services suppliers in the mining regions and to their functional specialization in generic services such as minor projects of construction, maintenance and repair, and renting services, "global pipelines" created through this project has not reached these regions.

The "World class suppliers program" seems to be too ambitious both in their expectations and the conditions established to the participants. The degree of technological development of Chilean mining services suppliers is probably lower than expected and this program should be complemented with national and especially regional policies oriented towards the improvement of the absorptive capacity of the small and medium supplier firms by means of the incorporation of highly educated workers and investment in R&D among other factors and also by means of programs oriented to promote not only the development of the mining suppliers, but also the development conditions of each territory. Furthermore, the "World class suppliers program" could introduce some changes in its design such as the adaptation of the type of innovations expected by the program; the reduction of the asymmetrical relationship between mining companies; the creation of long term relationships; and the incorporation of mining services suppliers from the mining regions. These changes need also to take into account the existing spatial differentiation of the mining production network and

the different capacities installed in each region, something evident in Chile. Otherwise, mining region could be condemned to remain just as extracting places and enclaves. This transformation in the mining policy would indeed imply a higher compromise on the part of mining companies, particularly CODELCO the largest mining company in Chile whose role as public company in the promotion of the capabilities of service suppliers in the mining regions could be very significant. Furthermore, the effect of other types of "global pipelines" in the mining industry such as international contacts in trade fairs, conventions, exhibitions and other professional gatherings need also to be explored.

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