Large Mining Enterprises and Regional Development: Between the Enclave and Cluster

Martin Arias
Miguel Atienza
Jan Cademartori

Serie de Documentos de Trabajo en Economía - UCN
https://sites.google.com/a/ucn.cl/wpeconoma

Identificador: WP2012-01
Antofagasta – Marzo 2012
Large Mining Enterprises and Regional Development: Between the Enclave and Cluster

Martín Ignacio Arias.
Departamento de Economía, Universidad Católica del Norte
Núcleo Milenio en Ciencia Regional y Políticas Públicas

Miguel Atienza.
Departamento de Economía, Universidad Católica del Norte
Núcleo Milenio en Ciencia Regional y Políticas Públicas

Jan Cademartori.
Departamento de Economía, Universidad Católica del Norte
Núcleo Milenio en Ciencia Regional y Políticas Públicas

Resumen

Varias regiones han propuesto recientemente la creación de cluster en torno a la gran minería. Sin embargo, hasta los años ochenta, las regiones mineras fueron consideradas, en su mayoría, enclaves mineros. Este artículo analiza el caso de la Región de Antofagasta, la principal región minera de Chile. Se realiza un análisis descriptivo, en el que se establecen los tipos ideales de cluster y enclave minero, usando como criterios de comparación los mecanismos que propuso Marshall como fuente de las economías de aglomeración. A pesar de su fuerte crecimiento, se encuentra que la Región de Antofagasta sea aproxima más al tipo ideal del enclave que al del cluster. Este resultado implica la necesidad de revisar y adaptar el concepto de enclave a la realidad actual.

Palabras clave: enclave, cluster, multinacionales, regions mineras.
Código JEL: O13, O19, Q32, R5.

Abstract

Various regions have recently proposed the creation of clusters around large-scale mining. However, until the 1980s, mining regions were predominantly considered productive enclaves. This article analyzes the case of the Antofagasta Region, the main mining region in Chile. A descriptive analysis is put forward that addresses the ideal types of the mining cluster and enclave, establishing as criteria of comparison the mechanisms proposed by Marshall as sources of agglomeration economies. Despite strong growth, the Antofagasta Region approximates more a mining enclave than a cluster. This implies the need to revise and adapt the concept of enclave to the current reality.

Key words: enclave, cluster, multi-national corporations, mining regions.
JEL classification: O13, O19, Q32, R5.
1. Introduction

Over the last decades, a controversy has persisted on the role of multinational corporations (MNCs) in regional development. In the 1990s MNCs were seen predominantly as drivers of regional development (Dunning, 1997; Ramos 1998). However, since the end of the 20th century, several studies have emphasized that Foreign Direct Investment (FDI) can be counterproductive for host regions (Martin and Sunley, 2003; Phelps, 2008). In this debate, research on mining regions in developing countries has been scarce. Nevertheless, the evolution of this type of region has been predominantly linked to the presence of MNCs. Traditionally, mining regions were productive enclaves dominated by MNCs that do not contribute to a sustainable form of development (Weisskoff and Wolff, 1977; Aulty, 1979; Emerson, 1982; Cardoso and Faletto, 1969; Girvan, 1970). Recently, however, several regions have proposed development strategies based on promoting mining clusters where MNCs would be the main actors.

Both the mining enclave and cluster have high growth rates and a strong export orientation. However, they have contrary impacts on the host region. The mining enclave leads to unsustainable development (Phelps, 2008; Cademartori, 2008), while a cluster generates a process of endogenous development that is beneficial for the region (Ramos, 1998; Markusen, 1996; Cruz and Teixeira, 2009). Several works have contrasted the enclave and cluster models (Lagos and Blanco, 2010; Rodríguez-Clare, 1996; Phelps, 2008; Barrow and Hall, 1995; Cademartori, 2008; Melese and Helmsing, 2010), but there is no descriptive theoretical proposal to study this difference in concrete cases. This is the main contribution of this work as applied to mining regions with a major presence of MNCs.

The objective of this article is to provide an analytical framework to investigate whether a mining region approximates more a mining cluster or an enclave. To do this, the ideal types of the mining enclave and cluster are contrasted. The principal dimensions of analysis are the three basic mechanisms that, according to Marshall (1890), lead to increasing returns to scale in a specialized region as a result of localization economies: the division of labor, the existence of a thick labor market and the existence of knowledge transference channels. This analytical framework is applied, through a descriptive analysis, to one of the main mining regions in Latin America, Antofagasta in northern Chile, based on a varietal of primary (a survey of 597 local SMEs) and secondary sources. Since 2001 this region has attempted to promote a mining cluster and has been considered by CEPAL (2009) and the OECD (2009) as a leading region and example of economic growth and development.

The results show that despite a strong growth rate, the Antofagasta Region maintains many of the characteristics of enclaves. This evidences the need to review and update the concept of mining
enclave as a useful analytical category to study mining agglomerations with a major presence of MNCs. It also shows the risk of implementing universal cluster policies without considering the regional context (Martin and Sunley, 2003), and the need to design regional development policies that counteract the logic of internalization of the MNCs (Phelps, 2000, 2008).

The article is divided into five parts. The first part presents the mining cluster and enclave ideal types. Following this, we describe the case study of the Antofagasta Region and then explain the methodology of the study and the main results. Finally, we provide the conclusions, highlighting implications for regional development policies.

2. Between the enclave and the cluster

2.1. Mining and MNCs: What type of cluster?

Marshall (1890), in his analysis of industrial districts in Britain in the 19th century, identified three mechanisms that explain the productive advantages derived from physical proximity among businesses with similar activities: the existence of a thick labor market, the division of labor and knowledge spillovers. This idea was revived a century later owing to the influence of authors such as Porter (1990) and the “cluster” concept became a panacea of public policies, thanks to the promise of producing more competitive regions (Martin and Sunley, 2003). Since the beginning of the 1990s, the promotion of clusters has been proposed in several mining regions around the world, such as Yanacocha and Tamboraque in Peru (Kuramoto, 2001a and 2001b), Sudbury in Canada (Ritter, 2000), South Africa and Mozambique in Africa (Economic Commission for Africa, 2004), the Australian mining cluster (Enright and Roberts, 2001), and Antofagasta in Chile (Buitelaar, 2001; Atienza, 2009).

Mining operations are not organized as a network of small and medium enterprises specialized in the same activity, as is the case for Marshallian industrial districts (Markusen, 1996). On the contrary, mining regions are characterized by the presence of large companies, normally MNCs that dominate the local economy. Consequently, the first question to be answered is: What kind of cluster can emerge around mining operations? A useful typology in answering this question is that proposed by Markusen (1996)\(^1\), based on an inductive analysis drawing on the experience of several countries. Markusen noted that industrial districts could have distinct productive structures. From this perspective, the ideal type that is best adapted to the characteristics of mining is that termed as hub-and-spoke district, characterized by the presence of one or more large companies, normally MNCs, which form the “hubs” of the productive system. These companies have a high degree of vertical integration and dominate regional production. They are export-oriented and have around them a set of local suppliers of goods and services that are organized as the spokes, with a high level of subcontracting.

To explain how agglomeration economies allow for the productive diversification and economic sustainability of this type of cluster, Markusen (1996) used two analogies, namely a productive

\(^1\) For a more complete view of this typology, see Markusen (1996).
system with “wide shoulders” and “long arms”. The “wide shoulders” refers to stimulus on the part of the hubs to consolidate a set of small and medium supplier firms, which in the long-term should allow for the creation of new hubs or clusters. The “long arms” refers to the access MNCs have to advanced technologies from their headquarters and the vertical transfer of knowledge toward the spokes of local firms (Gray et al 1996). Both characteristics activate the classic mechanisms of the Marshallian triad, generating a competitive and sustainable form of development.

This model emerged in a context of industrial regions, but can be extended to mining regions where large mining MNCs can be found surrounded by small supplier firms, and can generate a virtuous process similar to that described by Markusen (1996). Therefore, this work adopts the hub-and-spoke industrial district model as the most suitable to a mining cluster.

2.2. The mining enclave

Traditionally, mining regions in underdeveloped countries had an economic enclave structure characterized by the presence of MNCs in the area of mineral extraction, with weak productive linkages to the local firms, foreign ownership of capital and the export of goods with low or no value added (Phelps, 2008; Girvan, 1970, Emerson, 1982; Cademartori, 2008). The enclave implied a vicious circle for local development (Conning and Robinson, 2009; Weisskoff and Wolff, 1977; Auty, 1979; Cardoso and Faletto, 1969). Nevertheless, the enclave was adopted as a development strategy by underdeveloped countries rich in natural resources, above all in Latin America, at the end of the 19th century and the beginning of the 20th. Strong growth in output and exports created an image of development that proved to be illusionary, resulting in profound social, political and economic crisis in the host regions (Girvan, 1970; Conning and Robinson, 2009; Cardoso and Faletto, 1969).

The mining enclave also presents a hub-and-spoke structure, but has specific characteristics that differentiate it from other forms of regional organization. The feature most often referred to is the lack of linkages to the local firms (Rodriguez Clare, 1996). We also note the high concentration of foreign capital, the mono-producer and mono-exporter character of the enclave and the dependence on overseas. The latter is evidenced in the imports of technology to supply the mining sector, the asymmetry of negotiating power between the MNCs and the government and local firms, as well as the sensitivity to the demand shocks of international markets. As well, the enclave has a high level of labor productivity because of capital-intensive operations, which implies that aggregate demand is below the threshold required to stimulate the local production of manufactured goods (Auty, 1979). In general, salaries in the enclave are higher than in the agricultural or industrial regions, consequently the enclave receives migrants and commuters from other regions. One particular feature of the mining enclave is that the barriers to exit are high, due to the fixed character of natural resources. This obliges MNCs to interact with the region given that the negotiating power of the social actors in this type of enclave, although weak, is greater than in any other type (Ramírez, 2005; Zapata, 1977). However, this does not prevent EMNs exporting profits to international headquarters and the capture of public goods, leading to a non-sustainable form of development (Phelps, 2008; Cademartori, 2008).

The concept of enclave was progressively abandoned during the 1970s. As the concept was broadened out from its original geographic and economic scope, it lost precision (Hojman, 1983).
However, several works have recently revived the concept with the original economic focus owing to the limited benefits obtained by local economies with a strong presence of MNCs (Conning and Robinson, 2009; Ramírez, 2005; Phelps, 2008; Melese and Helmsing, 2010; Heller and Rueschemeyer, 2009).

2.3. Ideal types of the mining cluster and enclave

The enclave and the cluster have opposite long-term results, but can occur in regions with similar characteristics. Consequently, several works have compared them (Lagos and Blanco, 2010; Rodríguez-Clare, 1996; Phelps, 2008; Barrow and Hall, 1995; Cademartori, 2008; Melese and Helmsing, 2010).

The dimensions used by Markusen (1996) to construct her typology of industrial districts confirm that the mining enclave and cluster share many characteristics. Among these are the hub-and-spoke structure, the high rates of growth and export orientation, the presence of internal economies of scale, the specialization of local firms in services, the low level of cooperation between suppliers and clients and the cooperation of the hubs with companies outside the agglomeration. At the same time, there are important differences between the two models, given that in the enclave the key investments are decided upon in the headquarters of the MNCs, contracts are short-term and there is a high proportion of workers from other regions, while in the cluster model, key investments are decided locally, contracts are long-term and large companies are supplied by the local labor market.

In the construction of ideal types presented in this work, we emphasize the dimensions related to the mechanisms that Marshall described as sources of localization economies, given that these mechanisms over time configure an “industrial atmosphere” and permit sustainable local development⁴. It should be kept in mind that in dealing with ideal types, the particular cases observed in reality present mixed characteristics. As well, while both types develop dialectically (Sánchez de Puerta, 2006), this does not imply that mining regions can present other forms of organization. The comparison between the two types is based on the fact that they have been the main strategies proposed for development in mining regions.

Based on the established dimension of analysis, a mining cluster is understood as a specialized agglomeration in the production of minerals, with a strong presence of MNCs and the following characteristics:

1) *Division of labor*: as a result of specialization, mining has strong forward and backward linkages with local firms that lead to significant multiplier effects and reduce the costs of inputs and final outputs. This stimulates the creation of new businesses and strengthens clusters of new activities. This is related to what Markusen (1996) called “wide shoulders”.

2) *Thick labor market*: local qualified workers can find employment in the region and companies can find the workers they require within the region without drawing upon the labor markets from other regions. This supposes the presence of a market for trained labor and a relatively

---

⁴ This atmosphere includes cultural, institutional and political aspects that are not studied in this work.
high level of turnover of workers among companies that facilitates the transference of knowledge (Scott, 2006).

3) **Knowledge spillovers**: supposes the existence of knowledge transfers outside of market relations, based on the interactions among workers, employers and members of other public and private organizations. Knowledge transfer would be fundamentally exogenous (originating from MNC headquarters) and vertical in character, related to what Markusen (1996) called “long arms”, which promotes the innovative capacity and competitiveness of local firms.

In contrast, a mining enclave is understood as an agglomeration specialized in mining with a high level of participation of foreign capital and the following characteristics:

1) **Lack of a division of labor and weak productive linkages**: The MNCs maintain weak linkages with the local economy given that such linkages are mainly established with the outside world. This limits the development of industrial activities (“wide shoulders”) and productive diversification. Linkages with the local firms are usually related to activities with low added value and high levels of subcontracting.

2) **Non-thick labor market**: MNCs look to other regions to meet a significant part of their labor requirements through commuting and shift work systems. As well, the occupations conducted within the enclave are fundamentally manual, physical and routine, while the managerial and more professional functions are largely located outside the region (Buckley and Ghauri, 2004).

3) **Limited knowledge spillovers**: Knowledge spillovers from MNCs to local firms are limited. R&D activities in the region are marginal and the productive process undertaken locally is routine, which leaves little space for innovation (Crone and Roper, 2001). Patents are normally internalized by the MNCs. Activities focused on generating knowledge transference to local supplier firms are not attractive to mining MNCs. These would only occur where the MNC perceives some benefit, such as improving quality or lowering costs (Dunning, 1993, p.456). All of this limits the competitiveness of local firms and their export capacity.

These characteristics result in the lack of an “industrial atmosphere”, which compromises regional sustainability in the context of a possible flight of FDI.

Comparing the two ideal types, Table 1 provides an analytical framework that helps resolve the problem of observational equivalence between the mining cluster and enclave that can occur in some mining regions because the two phenomena share several dimensions, among them the hub-and-spoke structure and high rates of growth and exporting.
Table 1. Comparison between the ideal types of mining cluster and enclave

<table>
<thead>
<tr>
<th>CLUSTERS</th>
<th>ENCLAVES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Division of the Labour</strong></td>
<td></td>
</tr>
<tr>
<td>‘Wide shoulders’.</td>
<td>‘Narrow shoulders’.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Labour Market</strong></td>
<td></td>
</tr>
<tr>
<td>Thick.</td>
<td>Thin.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Knowledge Spillovers</strong></td>
<td></td>
</tr>
<tr>
<td>High.</td>
<td>Low.</td>
</tr>
<tr>
<td>‘Long arms’.</td>
<td>‘Short arms’.</td>
</tr>
</tbody>
</table>

Source: Authors.

The case of Antofagasta

The Antofagasta Region is located in the Atacama Desert in northern Chile. It has a population of 569,634 inhabitants, which represents 3.4% of the country’s population (CASEN, 2009). Mining is the main economic activity and the Region has the largest deposits of copper, iodine and lithium in the world, as well as major reserves of silver and molybdenum (USGS Minerals Commodities Summaries, 2011).

Historically the Antofagasta Region has had a high presence of mining MNCs. Between the 1880s and 1930s, Chile was the world’s largest producer of nitrates, which meant a significant level of dependence of the national economy on this sector\(^3\), and considerable remittances of profits overseas (mostly to the United Kingdom) by the British nitrate MNCs. In Antofagasta, these companies formed the traditional mining enclaves organized as company towns (Kerr and Siegel, 1954) where the company provided all the goods and services to the workers, such as housing, police and even money. However, the employment conditions were extremely precarious, favored by flexible labor legislation. This period ended abruptly at the beginning of the 1930s due to the invention of synthetic nitrates, which led to one of the most serious economic and social crises in the history of Chile and to the progressive disappearance of company towns (Salazar and Pinto, 2002; Meller, 2007).

---

\(^3\) Nitrate production accounted for more than 70% of Chilean exports and around 30% of GDP (Meller, 2007).
Since the 1940s, and thanks to the incorporation of US investment, copper became the driver of regional and national growth. Following the nationalization of the copper sector in 1971, the National Copper Corporation of Chile (Corporación Nacional del Cobre de Chile - CODELCO), was created and became the main copper producer nationally and globally (COCHILCO, 2009). This public enterprise is still active, but since the beginning of the 1990s and thanks to tax, labor and environmental legislation extremely favorable to FDI, the Antofagasta Region has become the focus for a large number of international mining projects. Between 1990 and 2008, the region received between 15% and 30% of all FDI in Chile, for a total of US$ 9.228 billion dollars (Comité Inversiones Extranjeras), representing the second highest level of FDI to a single region of the country after investment in the Metropolitan Region.

Among the most important mining projects are the mines Escondida, Zaldívar, Mantos Blancos, Spence, Lomas Bayas and El Abra (Figure 1), all property of large MNCs, such as BHP Billiton, Anglo American, Xstrata and Barrick Gold. The copper production of these MNCs grew from 24% of the national output in 1990 to 68% in 2009 (COCHILCO, 2009) as a result of the high copper prices in the last decade and growing FDI in mining. Output has also been stimulated by recent free trade treaties signed with China, the US, South Korea and Canada, which together account for around 50% of the world copper imports (COCHILCO, 2009).

**Figure 1. Region of Antofagasta: Main cities and mining companies**

1.- El Abra
2.- Radomiro Tomic
3.- Chuquicamata
4.- Spence
5.- Michilla
6. El Tesoro
7.- Gaby
8.- Mantos Blancos
9.- Lomas Bayas
10.- Zaldívar
11.- Escondida

Source: Authors based on Lagos and Blanco (2010).
This situation has generated a new form of dependence of the Antofagasta Region on large copper mining MNCs, with important differences with respect to the nitrate epoch. The most evident transformation is the abandonment of the company town model, replaced by a roster system in which the workers live at the mine for a certain number of days, and then return to their homes. This has favored commuting from other regions (Aroca and Atienza 2008, 2011).

Three cities stand out in the urban system of the region (Figure 1): Antofagasta, regional capital, the center of economic activity and the main port for mineral exports, with a population of approximately 300,000 inhabitants (60% of the region); Calama, the neighboring community of the Chuquicamata open pit mine of Codelco, with 130,000 inhabitants (28% of the region); and Tocopilla, which benefits from thermoelectricity and has port facilities, with around 25,000 inhabitants (5% of the region).

Currently, 55% of the product of the Antofagasta Region comes from mining sector, which represents 50% of Chilean mining production (Banco Central de Chile). This percentage is relevant if we consider that Chile is the largest producer of copper worldwide, with 35% of total production and 40% of exports (COCHILCO, 2009). Some 96% of exports from the Antofagasta Region are minerals, notably copper, which also represents 30% of the national exports (COCHILCO, 2009).

During the last two decades the Antofagasta Region has had an average annual output growth rate of 6% (Banco Central del Chile), because of which different international organizations have considered Antofagasta to be an example of a winner region in South America (CEPAL, 2009; OECD 2009). At the same time, these results have led to proposing a development strategy around mining operations in the region. According to this strategy, since 2001 efforts have been made to promote a mining cluster that in turn would encourage the development of a goods and services supplier industry able to compete internationally and to maintain the high growth rate of the region.

**Methodology**

The concepts of cluster and enclave present analytical difficulties because they refer to complex and multidimensional phenomena. The study of their presence in a territory raises problems of observational equivalence and obstacles to empirical comparison. The concept of cluster has been considered “confusing”, “ambiguous” and “chaotic” (Martin and Sunley, 2003; Markusen, 2003; Gordon and McCann, 2000; Phelps, 2008) due to the loss of conceptual clarity, the large number of cases it describes and its arbitrary use to explain any type of agglomeration of economic activity. The same occurred with the concept of enclave, which was progressively abandoned during the 1970s because it had lost its original geographic and economic character and was being used to address any manifestation of unbalanced growth (Hojman, 1983). Both are “fuzzy concepts” characterized by the lack of clarity in their content and by the adaptation of their definitions to the objectives of researchers or politicians, with the consequent difficulty to identify them empirically (Markusen, 2003).
One way to solve some of the problems presented by “fuzzy concepts” is to establish typologies that clarify the diversity of phenomena being addressed (Martin and Sunley, 2003). In this work, we elaborate ideal types of the mining cluster and enclave, with the aim of clarifying the characteristics of each and to determine to which ideal type the Antofagasta case is closest to. While the two ideal types have common characteristics, they differ in the mechanisms that determine their economic sustainability. In a mining cluster, the local economy becomes independent of MNCs, promoting sustainable growth in the region. In contrast, in the enclave model, the local economy is incapable of surviving if the MNCs abandon the region, which implies unsustainable growth. The Marshallian triad brings together the mechanisms used as operational criteria to compare the two proposed ideal types.

A descriptive analysis is made of each of these mechanisms based on primary data from a survey of 597 local SMEs in 2007 and 2009, as well as a variety of secondary information from public agencies and prior research in Chile detailed in Table 2. The objective of the analysis is not to estimate the agglomeration economies, given that there is not sufficient information to do this with all the components of the Marshallian triad. Rather, the objective is to determine whether the conditions that the literature has traditionally considered favorable to agglomeration economies through Marshallian mechanisms exist.

<table>
<thead>
<tr>
<th>Marshallian triad</th>
<th>Mechanisms</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division of labor</td>
<td>1. Linkages.</td>
<td>1. Input output matrices. Source: INE, 1996</td>
</tr>
<tr>
<td></td>
<td>2. Local Patents</td>
<td>2. Bas and Kunc (2009)</td>
</tr>
</tbody>
</table>

Source: Authors.

**Results**

1. **Division of labor: “Wide shoulders”**.

In a mining cluster a broad range of local supplier firms have strong linkages with regional hubs that, over time, allow for the development of new local industries and a more diversified growth. In contrast, mining enclaves are characterized by weak linkages and the lack of diversification. To evaluate the degree to which the Antofagasta Region has an economy with “wide shoulders”, we
first estimated the linkages of the mining sector with the other local economic activities. We then analyzed the evolution of productive diversification; and, finally, we evaluated the characteristics of the productive relationships between mining hubs and their local suppliers, with special emphasis on the increasing reliance on subcontracting.

### 1.1. Backward and forward linkages

To estimate the forward and backward linkages of mining in Chile, we followed the methodology proposed by Sonis and Hewings (2009), based on the regional input-output matrices for 1996\(^4\) from the Banco Central de Chile. These results were contrasted to those of Aroca (2001) and Cademartori (2008). The major forward and backward linkages in copper mining in Chile are found in the Antofagasta Region, which turns mining into a “key sector”\(^5\) for this Region. This result was expected, given the high degree of specialization of Antofagasta on mining. However, these linkages are weak compared to the “key sectors” of the other Chilean regions\(^6\) (Figure 2). Both the forward and backward linkages of copper mining in the Antofagasta Region are below the average of the “key sectors” of other regions of the country, indicated with lines in Figure 2.

#### Figure 2. Linkages of the key sector in the Chilean regions

![Figure 2](image)

Source: Authors based on the Banco Central.

---

\(^4\) The Banco Central de Chile calculates the national input-output matrices every ten years. Those available correspond to the years 1977, 1986, 1996 and 2003, although the latter has not been regionalized yet.

\(^5\) According to Sonis and Hewings (2009), those sectors whose forward and backward linkages are higher than one are considered “key sectors”

\(^6\) Figure 2 presents the first two “key sectors” of all the Chilean regions, compared to the mining sector of the Antofagasta Region, represented by the circle.
This result reflects that mining activity in Antofagasta exports almost all of its output and local purchases of inputs to other sectors of the economy are low compared to the level of production (Aroca, 2001). The Antofagasta Region does not produce goods that use copper as a raw material and mining represents 96% of local exports\(^7\). The backward linkages of the mining sector are also weak and are related to Financial and Business Services, Electricity, Gas and Water, Construction and Commerce (Aroca, 2001). There is also notably the delocalization of the backward linkages in the mining sector. According to Bas and Kunc (2009) 89% of the main suppliers in the Chilean mining sector are located in Santiago (the capital of Chile), of which 65% do not have branches outside of the capital.

### 1.2. Evolution of the productive structure

The lack of “wide shoulders” in the Antofagasta Region is confirmed when we consider the evolution of industrial diversification. Between 1986 and 2006, the degree of sectorial concentration of output, estimated with the Hirschman-Herfindahl coefficient\(^8\), has been the highest in the country, using the International Standard Industrial Classification (ISIC) at one digit level (Table 2). Output from the Antofagasta Region continues to be highly dependent on the mining sector, which represented 56% of regional GDP between 1985 and 2006. Likewise, the location quotients\(^9\), also calculated at one digit ISIC (Table 3), show that during the last twenty years the region has maintained a productive structure that is seven times more specialized in mining than the rest of country and that has developed new specializations in construction and in utilities like electricity, gas and water.

**Table 3. Regional Hirschman - Herfindahl index 1985-2006 (based on GDP)**

<table>
<thead>
<tr>
<th>Region</th>
<th>1985</th>
<th>1995</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tarapacá</td>
<td>0.11</td>
<td>0.11</td>
<td>0.18</td>
</tr>
<tr>
<td>Antofagasta</td>
<td>0.33</td>
<td>0.31</td>
<td>0.33</td>
</tr>
<tr>
<td>Atacama</td>
<td>0.19</td>
<td>0.21</td>
<td>0.20</td>
</tr>
<tr>
<td>Coquimbo</td>
<td>0.11</td>
<td>0.09</td>
<td>0.10</td>
</tr>
<tr>
<td>Valparaiso</td>
<td>0.17</td>
<td>0.14</td>
<td>0.13</td>
</tr>
<tr>
<td>M. R.</td>
<td>0.14</td>
<td>0.14</td>
<td>0.15</td>
</tr>
<tr>
<td>O’Higgins</td>
<td>0.10</td>
<td>0.08</td>
<td>0.07</td>
</tr>
<tr>
<td>Maule</td>
<td>0.11</td>
<td>0.09</td>
<td>0.10</td>
</tr>
<tr>
<td>Bio Bio</td>
<td>0.17</td>
<td>0.16</td>
<td>0.17</td>
</tr>
<tr>
<td>Araucania</td>
<td>0.13</td>
<td>0.11</td>
<td>0.10</td>
</tr>
<tr>
<td>Los Lagos</td>
<td>0.10</td>
<td>0.09</td>
<td>0.10</td>
</tr>
<tr>
<td>Aisén</td>
<td>0.19</td>
<td>0.13</td>
<td>0.11</td>
</tr>
<tr>
<td>Magallanes</td>
<td>0.21</td>
<td>0.15</td>
<td>0.19</td>
</tr>
<tr>
<td>Chile</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Source: Authors based on the Banco Central

---

\(^7\) In Chile, only 3% of copper cathodes production is sold to local manufacturers (Bas and Kunc, 2009).

\(^8\) This coefficient is calculated as the sum of the squares of the share of each industry within total employment.

\(^9\) This quotient measures the relative specialization of a region in an industry, as the ratio of the share of an industry in a region and the share in the country.
Between 1992 and 2002, location quotients calculated using employment at two digit ISIC show only three areas where specialization increased above a value of 1.3 (Chemical Products, Fabrication of Metals and Metal Products), while the degree of specialization in Machinery and the majority of services related to mining decreased. These results show the lack of expansion of the local “productive shoulders” and raise doubts about the sustainability of the region in the case of a crisis in the mining sector.

Table 4: Location quotients of the Region of Antofagasta 1985-2006.

<table>
<thead>
<tr>
<th>Activity</th>
<th>1985</th>
<th>1995</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>0.03</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Fishing</td>
<td>1.06</td>
<td>1.06</td>
<td>0.41</td>
</tr>
<tr>
<td>Mining</td>
<td>7.18</td>
<td>7.76</td>
<td>7.08</td>
</tr>
<tr>
<td>Manufactures</td>
<td>0.29</td>
<td>0.28</td>
<td>0.26</td>
</tr>
<tr>
<td>Electricity, gas and water</td>
<td>0.33</td>
<td>1.03</td>
<td>1.26</td>
</tr>
<tr>
<td>Construction</td>
<td>0.68</td>
<td>0.78</td>
<td>1.62</td>
</tr>
<tr>
<td>Commerce, restaurants and hotels</td>
<td>0.57</td>
<td>0.47</td>
<td>0.38</td>
</tr>
<tr>
<td>Transport and communications</td>
<td>1.08</td>
<td>0.89</td>
<td>0.54</td>
</tr>
<tr>
<td>Financial and technical serv.</td>
<td>0.30</td>
<td>0.36</td>
<td>0.28</td>
</tr>
<tr>
<td>Real state</td>
<td>0.57</td>
<td>0.57</td>
<td>0.47</td>
</tr>
<tr>
<td>Personal services</td>
<td>0.49</td>
<td>0.52</td>
<td>0.43</td>
</tr>
<tr>
<td>Public services</td>
<td>0.67</td>
<td>0.61</td>
<td>0.52</td>
</tr>
</tbody>
</table>

Source: Authors based on Banco Central.

1.3. Subcontracting

Some authors (Lagos and Blanco, 2010) have noted the strong increase in subcontracting in mining as an indicator of a growing division of labor and, consequently, of the development of a mining cluster. In fact, mining was a vertically integrated sector in the 1980s and, currently, subcontracts almost two-thirds of the workers in this sector (Figure 3). Large mining companies have increasingly tended to externalize activities related to their productive processes and, on average, there are almost five subcontracted firms for every client firm in the mining sector, (SERNAGEOMIN, 2009). Furthermore, this practice is significantly widespread than in countries like Australia, Canada and South Africa, where mining clusters have been promoted and where the percentage of subcontracted workers does not exceed 26% of the total (Pérez and Villalobos, 2009).

While the development of subcontracting contributes to a greater division of labor, it is doubtful that in the case of the Antofagasta Region it has resulted in more competitiveness of local companies. According to the survey of a sample of 597 regional SMEs in 2007 and 2009, subcontracted firms in the mining sector maintain traditional forms of management, make little effort to modernize and have higher rates of failure than other firms (Atienza, 2009). Almost 90% of these firms lack any form of international certification and only 1% declare having exports overseas. In particular, differences with respect to direct mining suppliers are remarkable in terms of the incorporation of workers with university degree and in the use of new technologies.
Figure 3: Share of subcontracted workers in the mining industry - 1975-2004.

The results show the lack of “wide shoulders” in the Antofagasta Region. The linkages with the mining sector are weak and productive diversification has been very limited in the last twenty years, while the increase in subcontracting does not appear to contribute to encouraging the competitiveness of local firms.

2. Labor market

To evaluate the degree of thickness of the labor market in the Antofagasta Region, we first analyzed the percentage of workers from the region that do not live there and commute from other regions. We then studied the type of functional specialization of the region, that is, the degree to which the region presents a structure of occupations that is adjusted to its industrial mix and the spatial division of work that characterizes mining activity.

It is worth noting that according to the 2009 CASEN survey, the labor market in the Antofagasta Region has the highest turnover rate of workers and the shortest time to find a job in Chile. The first of these indicators is ambiguous as a proxy of thickness of the labor market (Rosenthal and Strange, 2004), and in any case, neither of the indicators showed significant differences from the rest of country.

2.1. Commuting among regions and mining

Aroca and Atienza (2008, 2011) showed that the Antofagasta Region has the highest net rate of regional commuting in the country, that is, the region receives the highest percentage of workers who live in other region. According to their estimations, in 2002, 10% of the workers in the region were commuters from other regions, a figure that confirms the 2009 CASEN survey. Around 75% of
these workers are concentrated in Mining, Construction and Financial Services (the latter two activities strongly related to mining). The high level of commuting is favored by the shift work system that characterizes mining and is also related to some characteristics specific to the region, such as the high cost of living, the geographic location and the high level of FDI in large-scale mining projects in the last two decades. These projects increase the local demand for labor, pay higher average salaries and offer better benefits to their workers, which makes the region an attractive place to work, but not to live.

The high rate of reception of commuters raises doubts about the degree of thickness of the labor market in the Antofagasta Region. At the same time, importing workers from other regions reduces the multiplier effect that the spending of these workers would have on incomes and employment. According to Aroca and Atienza (2008), the multiplier effect of commuting in the Antofagasta Region supposes losses of US$ 120 million in income and 7,082 new jobs, which represents almost 5% of the labor force in the region and, at the same time, hinders the process of productive diversification via multiplier effects.

2.2. Spatial division of labor

Chile has a pattern of the spatial division of labor characterized by the functional specialization\(^\text{10}\) of the Metropolitan Region in occupations that require a higher level of human capital, such as managers, professionals and technicians, while the other regions of the country, such as Antofagasta, are functionally specialized in occupations of a routine and physical type that require a medium or low level of qualification (Atienza et al, 2010). The functional specialization of the Metropolitan Region is accentuated in the mining sector, with a higher presence than expected of 65% in “Managers”, 43% in “Professionals” and more than 15% in “Technicians” in 2002. In this sector, Antofagasta was notable for presenting a lower than expected presence of “Managers” of 45%, and a slightly higher than expected percentage of “Professionals” and “Technicians” (Atienza et al, 2010).

This pattern of the spatial division of labor raises doubts about the thickness of the labor market of the Antofagasta Region in relation to more qualified occupations and is related to the strong concentration of the headquarters of large mining MNCs in the Metropolitan Region, where they can benefit from the technological externalities of large agglomerations and from better access to international markets and suppliers. At the same time, the branches and production centers of these large companies are located at the points of mineral extraction where they undertake logistical, operative and more routine functions. This form of organizing production limits the arrival to the Antofagasta Region of more qualified workers with decision-making power and adds to the high rate of commuting to the Antofagasta Region, resulting in a labor market that lacks thickness.

3. Knowledge spillovers: “long arms”

The presence of large MNCs linked to headquarters that undertake R&D represents an opportunity for a vertical transfer of knowledge within a hub-and-spoke structure. Diverse studies (McCann and

\(^\text{10}\) This functional specialization is estimated using the index proposed by Barbour and Markusen (2007).
Mudambi, 2004 and 2005) have indicated that the organization strategy of MNCs leads them to locate in regions that take the form of “industrial complexes” where the exchange of knowledge takes place through formal long-term agreements managed in the framework of a bilateral monopoly. In this sense, given that a monopsonistic structure predominates in mining regions, it is not probable that this type of exchange occurs, giving rise to a situation closer to that of an enclave where vertical knowledge spillovers are weak. To evaluate the existence of channels for knowledge transference between mining MNCs and their suppliers in the Antofagasta Region, we first analyzed cooperation agreements between the both groups of firms, then the evolution of mining patents in Chile and, finally, the export capacity of regional SMEs as an indirect indicator of their innovative and competitive capacity.

3.1. Cooperation agreements between SMEs and MNCs

According to the survey of a sample of SMEs in the Antofagasta Region in 2009, 36% of the companies that supply the mining industry have made some type of cooperation agreement with other organizations in the last two years. The SME mining suppliers prioritize their relationships with large mining companies, and 20% of the local suppliers have made agreements with their clients. However, the majority of these agreements seek the commercialization of products, focusing on establishing alliances to access new markets, while there are few agreements oriented to developing new products and processes. On the other hand, and as could be expected in a hub-and-spoke structure, the SME mining suppliers have weak horizontal cooperation relationships with other suppliers, as well as with other companies and universities.

The scarcity of agreements between SMEs and MNCs and the orientation of existing agreements to commercialization supposes a strong limitation for the transference of knowledge from overseas to the local economy, putting into question the existence of “long arms”. It appears there are no incentives for MNCs to transfer the knowledge and technological innovations developed in their headquarters to the local firms.

3.2. Number of patents

Bas and Kunc (2009) measured the results of innovation in copper mining in Chile in terms of the number of patents within what they called the mining “cluster”, considered at a national level. Between 1976 and 2006, 9% of the companies belonging to the “cluster” have patents registered with the USPTO11, of which 99.74% are attributed to MNCs and only 0.26% to Chilean companies (Table 5). According to the authors, this is because MNCs undertake research in their headquarters, leaving research centers located in Chile with the task of adapting products, technologies and organizational strategies created in more developed countries, thus impeding the emergence of what Markusen termed “long arms” in the local economy.

This situation also reflects the lack of a culture of patenting innovations. Despite a specific tax on mining established in Chile with the aim of contributing funds for research and development projects in 2005, it is considered insufficient by experts in patenting since the existing funds do not cover even half the costs implied in patenting an innovation, which added to the length of time that

11 United States Patent and Trademark Office, considered the most important market for knowledge-based innovations.
the patenting process requires and the costs of taking out patents, discourages local companies from following this path as a business strategy. To this is added the absence of professionals trained on intellectual property in the region and the country, as well as the existence of clauses in mining MNCs contracts stipulating that innovations made by any of their workers is the property of the company.

Table 5. USPTO patents in the copper mining - 1976-2006.

| Total number of actors in the mining industry | 501 | 100% |
| Total number of firms and suppliers with patents | 46 | 9% |
| Total number of patents | 1519 | 100% |
| Number of patents assigned to Chilean companies | 4 | 0.26% |
| Number of patents assigned to foreign firms with operations in Chile | 1515 | 99.74% |

Source: Bas and Kunc, 2009.

3.3. Exports

The local mining suppliers in the Region of Antofagasta are characterized by their limited export capacity and their high level of imports, demonstrating a lack of competitiveness and dependence on foreign technological advances. According to the survey of 597 SMEs in the Antofagasta Region, only 10% of suppliers to the mining sector stated having exported overseas. On the other hand, 66% of the suppliers import solely to meet the needs of large mining companies (Bas and Kunc, 2009). This implies that the mining industry is a net importer of knowledge, owing to the incapacity of suppliers to produce goods and services that the large mining companies need. However, despite the low levels of exports among the local SMEs, when these are compared to what was reported by the Longitudinal Business Survey for all of Chile (Centro Microdatos, 2010), the Antofagasta’s SMEs has a greater level of export orientation than the rest of the country, which could be considered a characteristic specific to a mining cluster (Atienza, 2011).

On the other hand, mining MNCs prefer to source services with low added value, such as transport, food and cleaning services, especially through subcontracted firms. Goods and services that require a higher level of human or technological capital are acquired in foreign markets, above all in developed countries with high levels of research and development, which limits the possibility of local suppliers offering these types of services given the high barriers to entry.

Conclusions

The strong economic growth of the Antofagasta Region in the last two decades does not appear to be related to the formation of a mining cluster. On the contrary, the mechanisms pointed out by Marshall as generators of increasing returns to scale in a specialized agglomeration show scarce

---

12 According to Bas and Kunc (2009), the total amount of exports from Chilean firms supplying the mining sector reached only 0.35% of total copper exports.
levels of development in the region. Local companies have weak linkages to mining activities and have not diversified in a manner to generating “wide shoulders” around mining hubs. As well, the regional labor market is not very thick and depends to a significant degree on outside workers functionally specialized in routine physical tasks with limited decision-making capacity. Finally, the indirect indicators used show a limited transference of vertical knowledge from the headquarters of the mining MNCs to the local firms. All these results situate the Antofagasta Region closer to the ideal type of a mining enclave and, consequently, raise serious doubts about the sustainability of regional growth in the long term and lead us to think that the region could suffer a major economic and social crisis in the context of external shocks to the mineral market, as occurred with the nitrate crisis in the 1930s.

Indeed, the Antofagasta Region today has very different characteristics from that of the nitrate enclave described by Meller (2007), but the persistence of the basic features of a mining enclave raises the need to review and update this concept, considering the economic transformations caused by the process of globalization. The results obtained in this article support the idea that concept of enclave is still useful as a category of analysis of mining regions with a major presence of MNCs. It also raises the need to review the development strategies followed by many of these regions where promoting clusters has been adopted without taking into account their particular circumstances.

A key aspect in relation to development policies for mining regions relates to the role of the state. The policies to attract FDI since the 1990s have supported favorable institutional frameworks for large mining MNCs. Phelps (2000, 2008) argued that it is through the direct intervention of the State, that the internalization logic and capture of public goods by MNCs can be counteracted, with the aim of promoting agglomeration economies present in a cluster. Phelps found evidence suggesting that regional policies should focus on promoting and supporting local firms given that MNCs contribute more effectively to the generation of externalities when there are already agglomerations where local firms are important. In the case of mining, public intervention presents fewer problems of delocalization of MNCs due to the fixed character of the raw material, because of which the actions of the State can be more effective than in other type of regions. As well, there are large public enterprises in the Antofagasta Region, such as CODELCO, which can serve as a driver of development for the local firms.

The evolution of the life cycle of clusters has been studied deeply in the literature. However, there is no literature about the evolution of the enclave, even though there may be new expressions of it in the extractive regions, as we showed in this paper. Because of this, several lines of research remain open based on this work, such as: first, rethinking and updating the precise form that the mining enclave can take, considering the changes over time from the company town to a commuting system, due to the decrease in the transport cost caused by globalization. Second, to examine in greater depth aspects related to the logic of the MNCs behavior and their influence on the observed results, considering the asymmetric bargaining power that these firms have over the regional institutions, which facilitate the capture of value and the exports of rents. Third, to take into account the impact of the MNEs strategy and the subsidiary autonomy in the extractive sector. Even though this issue has been discussed for manufacturing and service sectors (Phelps & Fuller, 2000), there is a gap in the literature regarding extractive regions that should be filled. Fourth, to incorporate the bargaining model in the analysis, addressing how it may be shaped by external forces in the international sphere.
Bibliography


Centro de Microdatos (2010). *Primera encuesta longitudinal de empresas. Presentación general y principales resultados*. Departamento de Economía, Universidad de Chile


OECD (2009). OECD Territorial Reviews: Chile, OECD, Chile.


Ramírez B. (2005). El Enclave Minero y el Desmejoramiento en los Niveles de Vida de los Pueblos de la Cuenca Alta del Río Rimac, Investigaciones Sociales, 14, 179-211.


Salazar G. and Pinto J. (2002). Historia Contemporánea de Chile III La Economía: Mercados, Empresarios y Trabajadores. LOM Ediciones, Chile.


