Resources Policy 54 (2017) 167–175

Contents lists available at ScienceDirect

Resources Policy

journal homepage: www.elsevier.com/locate/resourpol

Innovation, learning and competence building in the mining industry. The case of knowledge intensive mining suppliers (KIMS) in Chile

Lilia Stubrin[a,b,*]

[a] Centro de Investigaciones para la Transformación (CENIT), Callao 353, 3er piso B, Ciudad Autónoma de Buenos Aires PC 1022, Argentina
[b] Universidad Nacional del Litoral (UNL), Moreno 2557, Santa Fe PC 3000, Argentina

ARTICLE INFO

Keywords:
Mining
Innovation
Mining suppliers
Chile
Natural resources
Copper

ABSTRACT

This paper explores the opportunities for innovation and diversification that can be opened in association to mining activities in developing countries. In particular, the paper focuses on Knowledge Intensive Mining Suppliers (KIMS) in Chile. Using case study methodology, results show that Chilean KIMS firms entered dynamic segments of the Chilean copper value chain either by customizing products and services to local productive specific conditions or by utilizing new technologies as a platform to develop unique solutions to unresolved mining problems. In the former case, Chilean KIMS are small to large firms with a family origin which entered consolidated markets dominated by large international supplies, whereas in the latter one these suppliers are small young firms which were created as scientific or corporate spin-offs that opened new market niches. Linkages with leading mining firms that governed the mining value chain have been crucial for Chilean KIMS to learn about industry needs. However, there is no evidence that indicates that these linkages have been significant in helping local suppliers to construe their technological and innovative capabilities. Instead, Chilean KIMS innovated in isolation and only occasionally received technological assistance from extra-industry organizations. Experimentation in mine sites is the most important bottleneck for Chilean KIMS´ innovation strategy. Governments seeking to support the expansion of KIMS need a good understanding of these companies' innovation trajectory, competitive environment, threats, risks and opportunities.

1. Introduction

Chile is a world leader copper producer, accounting for 35% of world production and 40% of total world exports. Copper mining is also the country´s most important economic sector contributing to 15% of Chilean GDP and 50% of total exports. A key developmental question is, thus, how mining can become a platform for Chilean diversification, innovation, and growth. The development of a sector of knowledge intensive mining suppliers (KIMS) is envisaged, in both Chile's academic and policy spheres, as a possible and desired development path to capture more value from natural resources (NR). Accordingly, a recent report from the Chilean Government declares the objective of promoting the creation of 250 local suppliers to the mining sector by 2035, which are expected to generate knowledge and technology intensive exports for around US$ 10 billion (Comisión Minería y Desarrollo de Chile, 2014).

This policy objective is inspired on the international experience which shows that in association with a diverticalization of large mining firms since the 1980s, a sector of local KIMS has emerged and consolidated in many developed countries (Urzúa, 2011; Scott-Kemmis, 2013; Kaplan, 2012; Morris et al., 2012). Australia's case is usually showcased as the most successful example. In this country, a highly innovative, dynamic and competitive sector of software suppliers has developed, providing solutions to over 60 per cent of mining operations worldwide (MTSAA, 2002; Scott-Kemmis, 2013). However, the real possibilities of replicating these successful stories in other countries are very much conditioned by the type of innovation opportunities that suppliers in those locations can still take. This paper contributes to shed light on this issue by exploring innovation opportunities taken by local KIMS in the Chile's copper value chain.

Using case study methodology nine Chilean KIMS were studied in depth. The cases selected were used to understand the type of innovation opportunities Chilean KIMS exploited, the type of ventures that are taking these innovation opportunities, and how Chilean KIMS have built their innovative capabilities. The analysis contributes to an emerging body of research within innovation literature that studies the opportunities to innovate that emerge in association to NR-based activities (see Pérez, 2010; Marin et al., 2015; Andersen, 2015). In

* Correspondence address: Centro de Investigaciones para la Transformación (CENIT), Callao 353, 3er piso B, Ciudad Autónoma de Buenos Aires PC 1022, Argentina.
E-mail address: lstubrin@fund-cenit.org.ar.

http://dx.doi.org/10.1016/j.resourpol.2017.10.009
Received 13 October 2017; Accepted 13 October 2017

addition, results also contribute to the Global value chain (GVC) literature (Humphrey and Schmitz, 2002; Kaplinsky and Fitter, 2004; Gereffi et al., 2005). This framework is used to understand the possibilities for firms in developing countries to learn and enhance their technological and productive capabilities through linkages with foreign firms that tend to govern the chains. This paper provides new empirical evidence that explores whether Chilean KIMS´ linkages with mining firms have helped them, and in what way, to learn and build up their technological capabilities. Finally, the study also informs innovation and industrial policy design.

The paper is structured as follows. In Section 2, an overview of copper mining in Chile is presented. Then, in Section 3, the opportunities for innovation in NR, and in mining in particular, are discussed. In Section 4, the data and methodology of the research are presented. Section 5 presents the main results of the study. This section is divided into two subsections. In the first one, the innovation opportunities that Chilean firms have taken are explored and discussed, together with an analysis of the characteristics of Chilean KIMS. In the second subsection, how Chilean KIMS build their capabilities, learn and innovate is explored. In the last section, I discuss the main conclusions of the research.

2. Copper mining in Chile: a brief overview

Mining is the foremost productive sector in the Chilean economy: (i) it contributes to 15% of Chile's GDP, 6% of fiscal revenues, and 50% of total exports, (ii) it explains almost a third of physical capital investment and (iii) it accounts for 8,6% of direct and indirect total employment. Copper is by far the most important Chilean mining product accounting for 90% of mining production -US19.548 million- and 91% of mining exports (Consejo Minero, 2017). Its production is highly concentrated. Large scale mining accounts for 93,9% of copper production in the country, the five largest firms produce 82% of Chilean copper, and CODELCO, the state-owned mining company and the largest copper producer in the world, represents a third of Chilean copper production (Korinek, 2013).

One of the salient features in Chile's mining industry organization is large mining firms´ outsourcing inputs and services from mining suppliers (Korinek, 2013). Today, about 60% of Chilean large mining firms´ operational costs, excluding energy, correspond to goods and services provided by suppliers (Fundación Chile, 2014). The most complex and technologically advanced provided by foreign suppliers (Katz et al., 2001; Urzua, 2011; Benavente and Goya, 2011; Ramos, 1998; Meller, 2013; Cochilco, 2014a). In the last decade, however, increasing interest has been placed in promoting the creation of local KIMS in the country. On the one hand, the National Commission for Mining and Development of Chile declared the strategic objective of creating 250 knowledge intensive suppliers in the mining sector by 2035 (Comisión Minería y Desarrollo de Chile, 2014). On the other hand, increasing mining costs (between 2005 and 2014 Chilean mining costs have increased by 111%), stagnation in productivity and increasing pressure to reduce environmental impact and mitigate conflicts with local communities (Cochilco, 2013; COCHILCO, 2015) encouraged many large mining companies to create the World Class Supplier Program (WCSP). The goal of the WCSP is to encourage the development of local suppliers that are able to export knowledge intensive services and technology to other mining countries and sectors of the Chilean economy. This program, founded by the mining company BHP Billiton in 2008, creates a sort of “market to solve problems”. Mining companies specify and formally communicate productive and technological challenges, and then, they select local suppliers which could help to solve those problems (Korinek, 2013; Barnett and Bell, 2011).

Despite the different initiatives to encourage Chilean KIMS, they are still limited. Only 3% of local mining suppliers design, replicate and improve existing technologies, around 67% have low innovative capabilities and 30% have average capabilities related to adapting available technologies (Ipsos, 2009). The low innovative level of Chilean suppliers is also reflected in their poor level of internationalization. A survey of 597 SMEs in the Antofagasta Region, one of Chile's most important mining regions, shows that only 10% of mining suppliers exported overseas (Arias et al., 2014). According to Bravo Ortega and Muñoz (2015) the low level of innovation activities among Chilean suppliers can be attributed to shortage of human capital, fierce local rivalry and competition, and mining companies' risk aversion. However, a better understanding of Chilean KIMS innovation opportunities is needed.

In the next section, based on theoretical insights, I discuss innovation opportunities that local KIMS in Chile can take to enter into dynamic segments of the mining value chain.

3. Understanding innovation opportunities for KIMS

In the last 40 years or so the vast literature on innovation and industry dynamics has been overwhelmingly focused on understanding the process of learning, capability building and innovation in the manufacturing industry. Meanwhile, little attention has been paid to NR activities. Presumably, the lack of research on NR activities has been influenced by the idea that these activities contribute poorly to countries' sustained growth and development. This view was largely based, on the one hand, on the claiming that there are macroeconomic and institutional challenges associated to NR activities which create substantial barriers for development (see the “resource curse literature”, e.g. Sachs and Warner, 1995, 1999; Auty, 1993; Gylfason et al., 1999; Ross, 1999).[1] And, on the other hand, on the microeconomic and industrial dynamics of these activities. Typically, NR activities were considered inferior to manufacturing in terms of their potential to promote innovation, learning and linkages to other sectors.

An important body of research, however, based on historical evidence of developed NR-rich countries, questions the idea that NR are inherently bad or inconvenient for development (see for instance David and Wright, 1997; Smith, 2007; Torvik, 2009; Ville and Wicken, 2012). Experiences of developed and rich countries such as the US, Australia or the Scandinavian countries show that NR activities can also foster learning, innovation and linkages. The question is not so much whether or not resources are bad for growth and development and why, but under which conditions they might help trigger these processes.

In the particular case of mining, there is an open debate regarding the potential of the industry to trigger economic development in developing resource-rich countries. A large body of literature warns about the negative effects of extractive industries on regional development on the grounds of its poor contribution to industrial upgrading and diversification, increasing well-being or reducing social inequality in developing regions (Prebisch, 1950; Cardoso and Faletto, 1969; Auty, 1993, 2001; Innis, 1956). Recent evidence of the Chilean regions of Antofagasta showing that mining activity adopts a form of industrialization with characteristics of enclave supports this industry's pessimistic view (Phelps et al., 2015; Arias et al., 2014).

However, other strand of literature challenges this negative view of extractive industries arguing that the huge transformation in the industrial organization of the mining industry since 1980s has opened up new opportunities for innovation, diversification and linkages in mining regions (Urzúa, 2011; Morris et al., 2012; World Bank, 2002; Bloch and Owusu, 2012). Large mining corporations, which used to be completely vertically integrated, adopted a more decentralized way of operating, increasing outsourcing of activities that are not related to their core capabilities. This process fostered the creation of a sector of

[1] More recently, however, studies have started to challenge the dominance of the resource curse thinking (see e.g. Lederman and Maloney, 2008; Cuddington, 1992; Bravo-Ortega and Gregorio, 2005).