EXTENDED ABSTRACT

Title: "Impact of KIBS Agglomeration on the Chilean Mining Sector Productivity"

Authors and e-mail of all: Kenneth Castillo Hidalgo (kenneth.castillo@autonoma.cat)

Department: Department of Applied Economics

University: Universidad Autónoma de Barcelona

Subject area: Economy of knowledge and geography of innovation

Abstract:

In recent times, the natural resource extractive sector experienced important changes in economic terms. Active firms in this sector have implemented different new industrial strategies to allow them for gaining more productivity and competitiveness in a way to consolidate their presence in national and international markets. The principal strategy has been to move from a single to a network productive system. Each firm stopped acting individually and, rather, it became part of a local productive networks in which the other nodes are usually suppliers of engineering process know-how, public sector institutions, and local communities (Katz & Pietrobelli, 2018). Mining sites, for instance, are not about holes in the ground, peaks, and shovels anymore. There has been increasing use of technology throughout the mining processes, from exploration to transportation, with the final aim to achieve higher levels of productivity. Moreover, these transformations in productive capacity and efficiency have gone hand in hand with changes in organizational structures. The trend of splitting different productive stages within companies' production process to improve productivity and efficiency has led to the emergence of specialized service suppliers, allowing mining firms to focus on their core activities. This strategy also led to the consolidation of both suppliers of more routine services with lower technological content (e.g., cleaning, maintenance, catering), and knowledge- and technology-intensive service suppliers that had steadily increased their presence in the industrial tissue around extractive activities.

In general, knowledge-intensive business services (KIBS) have nurtured great attention in the innovation, development, and economic geography literature. KIBS participate to regional dynamics as contributors or facilitators of innovative changes or co-producers of innovation (Shearmur & Doloreux, 2008). Under these circumstances, the study of the economic relevance of KIBS for mining industry in Chile is fundamental for understanding the economic results they achieved. In this developing country, mining sector has a historically relevant role, both for national and local economic growth. This sector influenced the shaping of the location of economic activity (Badia-Miró, 2015) and it has been key for per capita income growth in Chile since 20th Century (Meller, 2000). In the last decade, the share of mining activity in GDP was, on average, 10.7%, and 12.5% during 2020. Moreover, mining exports represented 58.7% of total exports in 2020, of which roughly 87% correspond to copper exports. Chile is the World's leading copper producer, reaching a production of 5.77 million fine metric tons in 2020, equivalent to 28.5% of global production. However, from a geographical perspective, Chilean mining activity is not evenly distributed but highly concentrated around the Atacama Desert. In particular, copper production is highly concentrated in the Antofagasta Region, in Northern Chile, where more than 53% of the national copper production is originated (SERNAGEOMIN, 2021; COCHILCO, 2021). Chilean mining sector is not exempt from the global trends of outsourcing, and indeed the cooper industry has propelled the growth of demand for knowledge-intensive mining services (KIMS) in the last decades (Urzúa, 2012). Therefore, the study of both the determinants and the effects of location and agglomeration of KIBS acquires significant relevance for Chilean mining industry.

Studies on the impacts of location and agglomeration of KIBS have led to mixed conclusions. Some studies suggest weak impacts of location decisions of KIBS firms on clients' performance (O'Farrell & Moffat, 1995), and the economic development of urban areas (Shearmur, 2010). Nevertheless, KIBS agglomeration has been associated with benefits in peripheral zones or multi-industrial clusters in the form of knowledge spillovers (Shearmur, 2010; Liu et al., 2019), increases in regional exports level (Kamp & Ruiz de Apodaca, 2017), and urban productivity (Zhang, 2016).

The increasing demand for commodities and the emergence of specialized knowledge-intensive services for natural resource activities led to the formalization of the idea of

extractive activities as potential sources of growth and development for natural resource-rich countries. In contrast to resource curse-driven proposals about encouraging structural changes away from the economic dependence on natural resources, Marin et al., (2015) put forward that there could stem economic benefits from the coexistence of knowledge-intensive activities and natural resources capabilities. This setting is even more relevant when thinking of changes in global markets and advances in science and technology as opportunities for developing countries to transit to science-based production schemes in natural resource-based activities. This transition can be considered a 'major revolution' with a strong significant long-term impact across Latin America (Crespi et al., 2018). On the other hand, studies from the linkages approach and economic geography literature have set a more pessimistic point of view stemming from this natural resource-intensive development strategy at local level, in particular when referring to the Chilean mining sector. Whereas mining activity is highly concentrated in Northern Chile, suppliers of mining services with high knowledge and technology content tend to concentrate in the Metropolitan Region, where Santiago is settled. The lack of knowledge-generating proximity and policies targeted to local industry development led to an uneven potential development around the mining sector (Atienza, et al., 2021) lacking from this strategic interdependence, which calls into question the sustainability of economic growth in Chilean mining regions.

Nevertheless, to the best of our knowledge the current literature has not brought evidence about the impact, if any, of the agglomeration of knowledge-intensive services suppliers on the natural resource extractive sector, such as mining, referring to the canonical approach of agglomeration economics. This paper aims to filling up this research gap by focusing on the Chilean mining sector productivity in the last two decades. According to the fundamentals of the agglomeration economies (Combes & Gobillon, 2015), it is expected that the geographic concentration of KIBS would have an effect on the productivity of mining sector. The suggested channel through which this could have place would be associated with the increasing outsourcing of knowledge-intensive, non-core tasks, which are prone to fuel productivity and efficiency enhancing innovation. The scope of this study is to provide new empirical evidence about this channel by analyzing the impact of the *comuna*- (namely municipality) level industrial specialization in KIBS on both the economic output of the

comuna itself and on the level of labor productivity of workers (approximated by their level of wage), proxying the Chilean mining sector.

This analysis is run by exploiting an original panel data encompassing the period 2006-2020. Longitudinal data on mining sector wages and individual characteristics were obtained from the Public Unemployment Insurance (PUI) database, provided by *Superintendencia de Pensiones*. Since October 2002, affiliation to PUI is compulsory for dependent, over-18-year-old, private sector workers with a contract regulated by the Labor Code. According to data from the National Socioeconomic Characterization surveys (*CASEN*), these criteria are met by at least 91% of mining sector workers in the studied period. With respect to data on companies by economic sector and geographic location, these were extracted from Chile's internal revenue service *Servicio de Impuestos Internos* (*SII)*. In order to identify firms from KIBS industries, the classification put forward by Miles et al. (2018) is employed. The rest of data on macro- and meso-level controls employed in the analysis were obtained from several governmental institutions, such as the national customs service *Servicio Nacional de Aduanas*, the national geological and mining service *SERNAGEOMIN*, the Central Bank of Chile, and the national statistics institute *INE*. The total sample comprises data for 35,452 unique IDs and 182,342 observations, covering 320 of the 346 *comunas* that compose the Chilean territory. Exploratory results suggest the existence of a positive effect of KIBS agglomeration on individual productivity, whereas our results are inconclusive about the potential outcome at aggregate level for each *comuna*. One potential insight is that the KIBS externalities can be captured at individual level because they target to the improvement of the level of labor productivity at individual level, whereas they fade away at aggregate level. In this wake, this contribution will also explore the possibility to assess the different impacts of direct and indirect effects of KIBS at territorial level.

This paper's contribution is twofold. First, it estimates the effects of the spatial concentration of knowledge-intensive services on the productivity of a natural resource sector, suggesting the existence of a kind of 'inter-sectoral agglomeration economies' from KIBS to the mining sector, in the context of a developing economy. This methodology is applicable to other extractive industries where outsourcing practices are also intense, as well as non-extractive industries, such as the manufacturing sector. Second, this study contributes to the discussion on local development strategies by

means of the policy implications derived. The suggested positive impacts of spatially concentrated knowledge-intensive activities on natural resource industries would point to a potential mechanism for firms' performance enhancement. But, in addition, this incentive would also propel the creation of new specialized services that are prone to innovation and, thus, support the approaches regarding the potential of the extractive sector as a vehicle for economic transformation towards a knowledge-based economy.

The remainder of the paper is structured as follows. Section 2 provides the theoretical framework on agglomeration economies underpinning this study, followed by a revision of the related literature on KIBS agglomeration and the Chilean mining sector. Section 3 details database and selected variables. Section 4 outlines the empirical strategy. Section 5 presents results. Finally, Section 6 concludes and outlines some policy implications and further development steps in this research line.

Keywords: *KIBS, Mining, Agglomeration, Chile*

JEL codes: R11, R12, R19

References:

Atienza, M., Lufin, M., & Soto, J. (2021): Mining linkages in the Chilean copper supply network and regional economic development. *Resources Policy, 70*. doi:https://doi.org/10.1016/j.resourpol.2018.02.013

Badia-Miró, M. (2015): The Evolution of the Location of Economic Activity in Chile in the Long Run: A Paradox of Extreme Concentration in Absence of Agglomeration Economies. *Estudios de Economía, 42*(2), 143-167.

COCHILCO. (2021): *Anuario de Estadísticas del Cobre y Otros Minerales 2001-2020.* Santiago: Comisión Chilena del Cobre.

Combes, P.-P., & Gobillon, L. (2015): The Empirics of Agglomeration Economies. In G. Duranton, J. V. Henderson, & W. C. Strange (Eds.), *Handbook of Regional and Urban Economics* (Vol. 5, pp. 247-348). doi:https://doi.org/10.1016/B978-0-444-59517-1.00005-2

Crespi, G., Katz, J., & Olivari, J. (2018): Innovation, natural resource-based activities and growth in emerging economies: the formation and role of knowledge-intensive service firms. *Innovation and Development, 8*(1), 79-101. doi:https://doi.org/10.1080/2157930X.2017.1377387

Kamp, B., & Ruiz de Apodaca, I. (2017): Are KIBS beneficial to international business performance: Evidence from the Basque Country. *Competitiveness Review, 27*(1), 80-95. doi:https://doi.org/10.1108/CR-07-2015-0066

Katz, J., & Pietrobelli, C. (2018): Natural resource based growth, global value chains and domestic capabilities in the mining industry. *Resources Policy, 58*, 11-20. doi:https://doi.org/10.1016/j.resourpol.2018.02.001

Liu, Y., Lattemann, C., Xing, Y., & Dorawa, D. (2019): The emergence of collaborative partnerships between knowledge-intensive business service (KIBS) and product companies: the case of Bremen, Germany. *Regional Studies*, *53*(3), 376-387. doi:https://doi.org/10.1080/00343404.2018.1510178

Marin, A., Navas-Alemán, L., & Perez, C. (2015): Natural Resource Industries As a Platform for the Development of Knowledge Intensive Industries. *Tijdschrift voor Economische en Sociale Geografie, 106*(2), 154-168. doi:https://doi.org/10.1111/tesg.12136

Meller, P. (2000): El cobre y la política minera. In P. Meller (Ed.), *Dilemas y Debates en Torno al Cobre* (pp. 17-77). Santiago: Dolmen-CEA.

Miles, I., Belousova, V., & Chichkanov, N. (2018): Knowledge intensive business services: ambiguities and continuities. *Foresight*.

O'Farrell, P., & Moffat, L. (1995): Business services and their impact upon client performance: an exploratory interregional analysis. *Regional Studies*, *29*(2), 111-124. doi:https://doi.org/10.1080/00343409512331348843

SERNAGEOMIN. (2021): *Anuario de la Minería de Chile 2020.* Santiago: Servicio Nacional de Geografía y Minería.

Shearmur, R. (2010): Scale, Distance and Embeddedness: Knowledge-Intensive Business Service Location and Growth in Canada. In R. Shearmur, M. Freel, & R. Shearmur (Eds.), *Knowledge Intensive Business Services: Geography and Innovation* (pp. 43-74). Ashgate Farnham.

Shearmur, R., & Doloreux, D. (2008): Urban hierarchy or local buzz? High-order producer service and (or) knowledge-intensive business service location in Canada, 1991-2001. *The Professional Geographer, 60*(3), 333-355.

Urzúa, O. (2012): Emergence and Development of Knowledge-Intensive Mining Services (KIMS). *Working Papers in Technology Governance and Economic Dynamics*(41).

Zhang, C. (2016): Agglomeration of knowledge intensive business services and urban productivity. *Papers in Regional Science, 95*(4), 801-8018. doi:https://doi.org/10.1111/pirs.12204