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Economic Implications of Long Distance Commuting in the Chilean Mining Industry.

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Abstract

More than 10 percent of the labor force that works in Antofagasta lives in other regions, commuting on average more than 800 kilometers in a shift system that allows working several days in a row followed by several days off. The mining industry is the main contractor of such workers and the impact of the process spreads through the rest of Chilean territory.

Using an input-output approach, this paper shows that a significant amount of resources generated by the mining industries in the Region of Antofagasta goes to other regions in wages earned by commuters who have decided to work in this region but live in another. The commuting process seems to be driven by centripetal forces that support centralization, thus arguing for regional policies to promote the attractiveness of the peripheral regions.

Keywords: Long distance commuting, spillover by labor commuting, labor commuting impact.

Introduction

In comparison to other economic activities, mining is characterized by a high degree of regional concentration owing to the fact that mineral deposits are distributed in irregular concentrations. Consequently, it is not unusual in countries that intensively exploit natural resources that indicators such as localization coefficients and the Gini spatial indices for mining activities present very high values, confirming the high degree of spatial concentration (Ellison & Glaeser, 1999; Holmes & Stevens, 2004; Perloff et al., 1960). At the same time, mining regions have also been distinctive for not having agglomerations of major size. Most cities in these regions are of intermediate size and occupy secondary positions in urban hierarchies. Given that it is evident that the economic impact of mining is not exclusively local, we seek to understand its geographic scope and the mechanisms that lead to spillover effects of this activity in other regions.

Among these mechanisms there is one that is especially relevant for mining regions and that has hardly received any attention, that being the phenomenon of inter-regional commuting. It is common that a significant percentage of the workers of a mining operation do not reside in the place of work, but rather in regions quite far from the mineral deposits (Aroca and Atienza, 2008; Houghton, 1993; Storey, 2001). This article proposes the hypothesis that the effect of the demand arising from these workers in their places of residence is a relevant mechanism in spreading the benefits of mining to the whole country, owing to the multiplier effect of this demand, both in terms of the creation of employment and incomes. As well, we hypothesize that the major beneficiaries of commuting among regions are the main urban centers. We will seek to verify this hypothesis in the case of Chile, and more concretely that of the Region of Antofagasta, where commuting among regions has become a more common phenomenon than migration, especially to the mining regions of the country.

The article is divided into four parts. The first analyses the characteristics of the economies of agglomeration and spillover effects of mining activities, giving special attention to the phenomenon of commuting among regions. The second part describes this phenomenon, its magnitude and implications in the Chilean economy, as well as its relevance in the mining sector. The third part presents the estimation of a model based on input-output matrices that

allow for estimating the impact of commuting among regions as a spillover mechanism of mining activities from the regions more specialized in this activity toward the rest of the country. The conclusions of this work are presented in the final section.

1. The effect of regional commuting on spatially spreading the benefits of mining

Studies on the economic impact of mining have been mainly dedicated to analyzing the way in which this activity affects growth and national development. In this sense, there are numerous works on the “Dutch disease” and the controversy around the so-called “curse of natural resources” and ways to escape its consequences (Arezki and Van der Ploeg, 2007; Auty, 1998; Sachs and Warner, 2001; Stijns, 2005; Van der Ploeg, 2007). However, there are a few studies dedicated to analyzing how the economic effects of mining are spread spatially. Two lines of research are notable from this perspective. The first is focused on the area of mining taxation and its potential territorial effects through redistributive policies. Ross (2008) notes that the large revenues received by mining countries represents an opportunity to alleviate poverty and inequality, but at the same, can be the cause of territorial conflicts and even civil war. Consequently, an appropriate institutional design is recommendable, one that is based on open agreements about manner of distributing public revenues between producing regions and the rest of the country. The second line of research explores the geographic reach of the externalities that can be derived from the agglomeration of productive activities. Rosenthal and Strange (2004) present the most complete work in this respect, based on information about the United States, aggregated for all the sectors. Their results confirm that the effects of agglomeration are attenuated with distance and that agglomerations based on the presence of natural resources, among these very notably mining, have an impact at the state level, but not in smaller geographic units. More specific studies, such as that of Aroca (2001), based on information from the input-output matrices for the Chilean case, confirm these results with the estimation of weak productive linkages between the mining sector and the surrounding region. This result suggests that pecuniary externalities of mining have a broad geographic reach.

None of the aforementioned studies have considered the mobility of the labor factor as a determining element of the agglomeration and its spatial effects. The classical models of regional economies suppose that the mobility of workers among the regions of a country does not have a cost and that, as well, the region of work and the region of residence are one and the same. At present, neither supposition is sustainable and ruling them out has relevant consequences in understanding the impacts of productive processes, especially in the case of mining.

Owing to the progressive decrease in transportation costs, both in terms of time and money, and new forms of organizing production, an increasingly greater separation is being produced between people's place of residence and their place of work. In this sense, commuting, understood as the return travel undertaken by a worker between the place of residence and the place of work, has gone from being an exclusively urban phenomenon to also having a regional character (Aroca and Atienza, 2008). In the past, when travel to the workplace required long periods of travel, migrating to the region of work was always an option. Today, migration is no longer the only option. Recent studies (Cameron and Muellbauer, 1998) show that it is increasingly common to find people whose place of work and residence are separated by great distances, which supposes commuting to other regions.

One of the main origins of commuting among regions, also known as long-distance commuting, is mining activity. The first identified cases are related to practices to reduce the travel time by using airplanes to transport workers to mining areas, from which this phenomenon came to be known as "fly-in fly-out". More concretely, according to Shrimpton and Storey (2001), the "fly-in fly-out" phenomenon began with offshore oil platforms in the Gulf of Mexico in the 1950s and in the North Sea in the 70s. Since then, this form of commuting has extended to regions specialized in extractive activities in several countries, such as Australia, Brazil, Canada, Chile, México, Peru and Russia. Today the concept of "fly-in fly-out" is excessively limited given that improvements in land-based transportation, mainly highways, have allowed for other means of transportation such as buses and high speed trains for commuting among regions. As well, long-distance commuting is extending to an increasing range of activities other than resource extraction.

Reductions in the cost of human transportation have not been sufficient to allow for commuting among regions without it being accompanied by new forms of organizing work. A distinctive aspect of long-distance commuting is shift-work systems where the worker remains in the workplace for a number of consecutive days followed by rest periods in their places of residence. The duration of the shifts varies greatly. The most common in the case of mining is 1/1 patterns (for example, a week at work and a week at home), although asymmetric patterns of 5/2 or 4/3 are increasingly being used (Shrimpton and Storey, 2001)¹. Given that daily flights would be economically unviable; these forms of work organization allow for dividing commuting costs among several working days.

In addition to technological change and the reorganization of work, long-distance commuting to remote mining regions can be explained by unbalanced labor markets that oblige companies to seek workers from beyond the regions where they are located (Spies, 2009). This argument, however, is not convincing in the case of mining regions where medium-sized urban agglomerations have emerged, and seems more appropriate for offshore oil platforms than for other forms of mining. Several authors have argued that the main explanation is the fact that long-distance commuting is cheaper than constructing traditional mining camps next to mineral deposits (Bell and Brown, 2006; Houghton, 1993; Melamid, 1984; Storey, 2001). In this way mining companies save very costly investments and reduce the cost of closing operations, which compensates for the increased cost of transporting personnel. As well, it has been observed that workers under this regime, given their isolation and lack of social contact in the place of work, present lower rates of absenteeism and have more limited potential to unionize, which reduces labor conflict (Shrimpton and Storey, 2001).

Almost all the studies of long-distance commuting have analyzed its impact on workers and their families or on the consequences of this system of work for the localities where mining operations are located. This article has a different objective, that of analyzing how long-distance commuting acts as a mechanism for spreading the benefits of mining to other regions. This aspect has been proposed indirectly by Storey (2001) in what he termed “fly-

¹ These authors mention the extreme case of Polaris in Canada where the worker spends eight weeks at the mine and three or four weeks at his place of residence.

over”, making reference to the resources that escape from the mining region through the workers who are employed in such regions but live in others. While Storey centers his attention on the loss that the mining region can suffer, he also suggests the hypothesis that the main beneficiaries of “fly-over” could be the main urban centers of the country, thus acting as a centripetal force. The current work attempts to verify the hypothesis in the case of Chile. To do so, we have estimated the impact of long-distance commuting linked to mining in the Region of Antofagasta on other regions of the country.

The mechanism through which commuting among regions spatially extends the impact of mining is based on the separation produced between the producing and consuming regions. Given the conditions of isolation under which long-distance commuters work, the major part of the salaries they receive is spent where they and their families live (Aroca and Atienza, 2008; Shrimpton and Storey, 2001). Consequently, attracting commuters from other regions has a weak impact on mining regions, as has been pointed by Storey (2001). The main beneficiaries of long-distance commuting are the sending regions where the impact of new demand via the salaries of the commuters is not only direct, in terms of commerce, educational establishments, the provision of urban infrastructures and other services, but also indirect through the demand for intermediary products on the part of the aforementioned activities, which generate multiplier effects in production, income and employment. In the case of mining, as well, it can be expected that this impact is greater because workers’ salaries in this sector tend to high. Among the benefitting regions it is probable that major national urban centers occupy a notable place. Workers in these cities have access to a more diversified supply of goods and services and the possibility of accumulating more social capital, which reduces the incentive to migrate to mining regions. It should not be forgotten, however, that distance can attenuate the decision to commute, because of which it can be expected that the urban centers that benefit the most from inter-regional commuting are those that are not so distant from mining operations.

2. Commuting among regions and mining in Chile: The case of the Region of Antofagasta

According to the information from the Population and Housing Census of 2002, 2.54 percent of the economically active population commutes among regions in Chile. This figure represents almost 120,000 people and is significantly higher than the annual migration rate of 1.31 percent. Commuting among regions is not limited exclusively to mining, but rather affects virtually all productive activities. However, the activity is more intensive in the mining sector. Some 13 percent of the workers in this sector do not reside in the sector where they work, a figure that is five times as high as the national average (table 1). This sector is followed far behind by Construction, Electricity, Gas and Water and Transportation and Communications. All these sectors are characterized by their strong productive links to mining, because of which it can be assumed that a significant proportion of their commuters are also related to mining activities. Based on the Chilean input-output matrices, the number of commuters linked directly or indirectly to mining is over 10,000 individuals.

Table 1. Percentage of workers who commute by sector and regional concentration

	Workers who commute (%)	Concentration Regional (Herfindahl index)²
Agriculture, Hunting, Forestry and Fisheries	2,6%	0,12
Mining and quarrying	13,0%	0,26
Manufacturing industries	2,0%	0,16
Electricity, Gas and Water	3,5%	0,15
Construction	7,7%	0,13
Commerce	1,5%	0,17
Transportation and Communications	3,1%	0,25
Financial and Business Services	2,5%	0,20
Personal Services	1,4%	0,20
Total	2,5%	0,14

Source: Authors based on the 2002 Census data Elaboration

Another feature of commuting among regions for mining is geographic concentration. This sector presents the highest Herfindahl index³ (table 1), with only three regions receiving

² The Herfindahl index is calculated as the squared sum of the percentages of participation in each region. It oscillates between 0 and 1. The higher the value, the greater the degree of regional concentration.

70% of mining commuters. All three regions are located in the far north of the country, which supposes that the great majority of commuters in this sector travel distances greater than 500 kilometers. Among these regions, Antofagasta is notable for concentrating 50 percent of long-distance mining commuters. This region is 1,400 kilometers from the capital of Chile, Santiago, and is characterized by its desert environment and a strong specialization related to mining, which in turns represents 60 percent of its product. Its net commuting rate, considering all productive activities, is the highest in the country. According to the 2002 Census, Antofagasta received 16,517 workers resident in other regions and sent 2,049 residents to work in other regions. This supposes that in net terms, around 14,500 workers commute from the rest of Chile to Antofagasta, which represents 10 percent of its labor force.

Regional commuting to Antofagasta is concentrated in three sectors that represent 75 percent of the total. In first place is mining, which presents a localization coefficient of 3.3. That is, the region receives more than three times as many commuters from this sector than all of the rest of the country. Following mining in receiving commuters are Construction and Financial and Technical Services, both strongly related to mining, with localization coefficients of 1.6 and 1.3 respectively (Aroca and Atienza, 2008). Of the total of workers who commute to the Region of Antofagasta, and keeping in mind their productive linkages, it is estimated that around 70 corresponds directly or indirectly to mining. As well, notably, the activities in which Antofagasta has a higher level of reception of commuters than any other region are characterized by high salaries. Consequently, it is logical to expect that the impact of commuting on incomes and employment in the regions sending commuters would be significant. In this sense, we consider that the experience of the Region of Antofagasta can be illustrative of the importance that commuting can have as a mechanism

³ The localization coefficient measures the relative specialization of a region in a determined activity. To do this, a comparison is made between how much an activity represents in a region and how much it represents in the country, calculated in the following manner:

$$Q_{ij} = \frac{s_{ij}}{s_j} \bigg/ \frac{s_{ik}}{s_k}$$

where s represents the share of activity i the activity in region j ; while k stand up for the country. This index oscillates between 0 and infinity. If $Q_{ij} \leq 1$ implies that there is no specialization. If $Q_{ij} > 1$ there is specialization, which is greater as the index rises.

for spreading the economic impact of mining across regions. Map 1, shows the geographical distribution of the regions, population and distance from Antofagasta.

Map 1. Region Population and Distance from Antofagasta

MAP OF CHILE	REGION Name	POPULATION	SHARE	DISTANCE
TARAPACA	426,351	2.8%	492
	ANTOFAGASTA	492,846	3.3%	0
	ATACAMA	252,353	1.7%	565
	COQUIMBO	600,363	4.0%	899
	VALPARAISO	1,542,492	10.2%	1,330
	METROPOLITANA	6,038,974	40.1%	1,368
	O'HIGGINS	773,950	5.1%	1,454
	MAULE	904,104	6.0%	1,625
	BIO BIO	1,853,678	12.3%	1,881
	ARAUCANÍA	864,929	5.7%	2,042
	LOS LAGOS	1,061,735	7.1%	2,415
	AYSEN	86,697	0.6%	3,064
	MAGALLANES	151,869	1.0%	3,664

3. Methodology

The methodology to evaluate the spillover effect to other regions of workers commuting to the Region of Antofagasta is based on input-output matrices and has the objective of estimating the direct and indirect effects of commuting on regional demand owing to the separation between place of work and place of consuming. In other words, we seek to evaluate the degree to which commuters that spend their salaries in their regions of origin affects the incomes and employment of those regions.

Input-output models are based on a matrix that summarizes the transactions made during a year, including both those that occur in the productive sectors and those between the productive sectors and final demand, that is, consumption by families, the government, foreign consumers (exports) and investments that enterprises make in capital goods (Hewings, 1985 and Isard *et al* 1998, Miller and Blair, 2008).

Input-output matrices allow for estimating several types of effects, such as the consequences of variations in final demand. For example, direct effects measure the impact of increased final demand on the inputs provided by the different sectors of the economy in response to the rise in demand. On the other hand, indirect effects are derived from the process of feedback to produce these additional inputs, which also require more inputs provided by the same sector and by other sectors of the economy.

The impacts of changes in final demand are generally measured through factors that are termed multipliers because they capture the linked effects resulting from the productive interaction among economic sectors. The three multipliers most often used are output, workers' incomes and employment.

An extension of the input-output model applied by Aroca (2001) and Aroca and Atienza (2008) to the Region of Antofagasta is used in this work. In this extension to the other regions, information is aggregated about commuting among regions, gathered from the 2002 Census and the input-output matrices for each region of Chile, estimated for 1996 by the National Institute of Statistics (Instituto Nacional de Estadística - INE) and the Ministry of Planning (MIDEPLAN).

Despite the time difference of the two sources, the literature about the stability of the technical coefficients agrees in indicating that the multipliers and the effects calculated on the basis of multipliers are very stable over periods of five years or even longer. Consequently, it is considered that a reliable first approximation can be obtained of the effects of commuting to Antofagasta on incomes and employment in the commuting workers' regions of residence.

Census data and input-output matrices are complemented with INE data about wages of commuters in order to estimate the impact of commuting associated with mining industry. This is the most reliable source available of information on wages associated with specific industries. The CASEN survey also collects data on wages, however, this source considers household location and does not inform about the location of jobs. Evidence shows that there can be significant differences between the average wages paid in a region as compared to those earned by workers living in the same region.

Consequently, to estimate the impact of wages spent in a region where workers commute to Antofagasta, we will assume the average salary level of the mining sector, which is US\$ 26,670 per year (INE, 2009, page 89), considering the average exchange rate of 2007 of 522.69 Chilean pesos per dollar.

4. Results

There are several points of interest in the analysis of the impact of commuting in the Region of Antofagasta. The net surplus of commuters for Antofagasta is the highest in the country and well above the rest. In net terms, close to ten percent of the labor force commutes to the region (see Table 2). Consequently, it can be expected that Antofagasta's consumption lost due to commuting would have a significant impact on the salaries and employment in other regions.

Another interesting point is related to the geographical pattern of commuters' net flows. The regions located in the north and south extremes of the country (Regions I, II and III in

the north and Regions X, XI and XII in the south)⁴ have negative net commuting flows, while central regions (IV, V, VI, VII, VIII and the Metropolitan Region (MR)) present positive net flows. According to this core-periphery pattern, it is plausible to expect that the impact of mining commuters to Antofagasta will predominantly be concentrated in the central area of the country. In fact, around 75 percent of commuters to Antofagasta live more than 800 kilometers far from their place of work.

Table 2: In- and Out-Commuting in Chilean Regions

Region	Out-Commuting	In-Commuting	Labor Force / Labor Pop
North I	2.2%	3.6%	1.01
II	1.4%	10.0%	1.10
III	5.3%	6.1%	1.01
IV	5.0%	2.6%	0.98
V, VI, and MR	1.0%	0.7%	1.00
VII	3.0%	2.4%	0.99
VIII	3.2%	1.9%	0.99
IX	3.8%	2.2%	0.98
X	1.3%	2.4%	1.01
XI	0.6%	5.9%	1.06
South XII	0.8%	3.6%	1.03

Source: Based on Chilean Population Census 2002.

The aforementioned strong productive specialization of Antofagasta in mining is also of particular interest for this work. Commuters who work in Antofagasta carry out diverse activities. However, the region has the highest level of specialization in Chile in the reception of workers. Three activities represent almost 75 percent of the commuters who come to Antofagasta. In first place, as would be expected, is mining whose localization coefficient is 3.3. This is followed by specialization in Construction and Financial and Technical Services, both strongly related to mining (Aroca, 2001).

Given the high rates of commuting and the concentration of commuting in sectors characterized by high salaries owing to direct foreign investment linked to mining, we can expect that commuting has a high impact on the incomes and employment of central

⁴ Antofagasta is also known as Region II.

regions of Chile. In this sense, the experience of the Region of Antofagasta can be illustrative of the spatial impact of the mining activity.

Table 3 shows the regional distribution of commuters to Antofagasta and the estimated total wages earned by these workers. Region IV (Coquimbo) has the highest negative net commuting rate (table 2). This rate is strongly associated to Antofagasta. Around 3,300 workers in Antofagasta live in Coquimbo, while Valparaíso (V), Santiago (RM) and Concepción (VIII), where the largest cities of the country are located, send 7,500 commuters to the Region of Antofagasta.

Commuters to Antofagasta earn more than 440 million of dollars (table 3). This estimation seems to be reasonable taking into account that in 2007 CODELCO paid around 900 million to its workers, while Minera Escondida Limitada paid around 250 million. Furthermore, the payments to the outsourced firms and the others mining companies account for one third of the total regional production.

Table 3: Total Wage Earned by Commuters by Residential Region and FNDR.

Region	Residencial Region	Working Region	Wage Earned by Commuters (US\$ 2007)	FNDR 2007 (US\$ 2007)
		Antofagasta (Workers)		
I	Tarapaca	1,828	\$ 48,752,760	\$ 32,767,329
II	Antofagasta	148,753		\$ 55,537,337
III	Atacama	2,624	\$ 69,982,080	\$ 24,047,670
IV	Coquimbo	3,288	\$ 87,690,960	\$ 53,435,968
V	Valparaíso	1,503	\$ 40,085,010	\$ 41,008,196
MR	Metropolitana	3,530	\$ 94,145,100	\$ 104,110,240
VI	OHiggins	492	\$ 13,121,640	\$ 43,429,704
VII	Del Maule	621	\$ 16,562,070	\$ 51,773,065
VIII	Bio Bio	2,189	\$ 58,380,630	\$ 72,708,714
IX	Araucania	272	\$ 7,254,240	\$ 44,200,321
X	Los Lagos	157	\$ 4,187,190	\$ 87,833,411
XI	Aisen	2	\$ 53,340	\$ 28,763,484
XII	Magallanes	11	\$ 293,370	\$ 34,953,246
	Total	165,270		
	Commuters	16,517	\$ 440,508,390	

Source: Own elaboration based on Census 2002, INE (2009) and SUBDERE 2009.

To put the amount of money transferred to other regions by commuters into some perspective, we compare the 2007 budget for the National Fund for Regional Development (FNDR), the main government funding body to reduce regional disparities, to the average wage for mine workers in 2007 multiplied by the number of commuters to Antofagasta Region. Two observations can be made from this comparison: first, for several regions, the amount of money that commuters bring to the residential region is greater than the amount these regions receive through the FNDR, and secondly, the amount of money leaving Antofagasta Region through commuters is seven times as high as the amount it receives from the FNDR.

In order to measure the impact of this process on the regions, we estimated the effects on local employment in the workers' regions of residence. The impact on each local economy is calculated on the assumption that wages are spent according to the consumption structure captured in the input-output table of each region. This shock in demand pushes production up, thus increasing labor demand. Table 4 shows the results on the level and percentage of employment created by economic activity in the Region of Antofagasta.

Table 4: Direct and Indirect Effect of Commuting on Employment in Residential Regions

Region	Residencial Region	Labor Force in Residential Region	Working in Antofagasta	Residential Region Effects		Direct Effect	Indirect Effect	Total Effect
			Direct	Indirect	Total			
I	Tarapaca	128,303	1,828	3,859	5,687	1.42%	3.01%	4.43%
II	Antofagasta	150,802	148,753					
III	Atacama	74,466	2,624	4,142	6,766	3.52%	5.56%	9.09%
IV	Coquimbo	162,976	3,288	9,162	12,450	2.02%	5.62%	7.64%
V	Valparaíso	442,098	1,503	3,208	4,711	0.34%	0.73%	1.07%
MR	Metropolitana	2,039,487	3,530	7,891	11,421	0.17%	0.39%	0.56%
VI	OHiggins	235,600	492	1,282	1,774	0.21%	0.54%	0.75%
VII	Del Maule	262,024	621	1,339	1,960	0.24%	0.51%	0.75%
VIII	Bio Bio	500,689	2,189	6,647	8,836	0.44%	1.33%	1.76%
IX	Araucania	212,763	272	681	953	0.13%	0.32%	0.45%
X	Los Lagos	309,674	157	398	555	0.05%	0.13%	0.18%
XI	Aisen	32,203	2	4	6	0.01%	0.01%	0.02%
XII	Magallanes	53,878	11	21	32	0.02%	0.04%	0.06%
	Total	4,604,963	165,270					
	Commuters		16,517	38,633	55,150	0.36%	0.84%	1.20%

Source: Own Elaboration

Coquimbo is the region that receives the greatest impact on employment levels. More than 12 thousand workers who live in that region work directly or indirectly in mining activities in Antofagasta, this represents 7.6 percent of total labor force of the region. The total impact of long distance commuting on Coquimbo's economy is larger than the impact on regions closer to Antofagasta, such as Tarapacá and Atacama. It seems, however, that Coquimbo has very attractive attributes for the workers and their families due to its low cost of living, specially housing prices as was shown by Paredes and Aroca (2008).

The MR and the Region of Bio Bio, where the main urban agglomerations of the country are located, are the second group of regions in terms of the size of employment created because of mining workers commuting to Antofagasta. This is an expected result according to the "fly-over" hypothesis made by Storey (1992) and to the labor mobility literature, where it has been proved that the larger the population, the bigger the labor mobility. This result reinforces the concentration process around the largest agglomerations of the country: Santiago and Concepción.

The impact of commuters on Antofagasta's neighboring regions, Tarapacá and Atacama, are in the third place of importance. This impact is particularly high as a percentage of total local workers because the size of labor population in these regions is relatively small.

In summary, the spatial effect of the commuters to the Region of Antofagasta is very significant both in terms of the amount of money involved in the process and in terms of the jobs generated in the residential regions. Most of those commuters are related directly or indirectly to the mining industry and, in this respect, Antofagasta can be considered a natural experiment to analyze this process given its high degree of specialization in the mining industry.

5. Conclusions

The results of this article show that, in Chile, long-distance commuting is a relevant mechanism to understand the spreading of the economic benefits of the mining activity to

other regions within the country. In fact, the impact of long distance commuting measured in terms of the wages earned by mining commuters in the Region of Antofagasta and spent in the commuters' regions of residence is higher than the National Fund for Regional Development, which is the main public instrument oriented to the reduction of regional disparities.

The mining activity, that in the case of Chile is concentrated in the extreme northern regions of the country, presents the highest rate of in-commuting among regions. This phenomenon is particularly intense in the case of the Region of Antofagasta, where more than 10 percent of the labor force lives in other region, commuting on average more than 800 kilometers. The impact of long distance commuting to the Region of Antofagasta has a national geographical scope but tends to be concentrated in certain regions. In this respect, it is possible to find three main groups of regions that predominantly benefit from sending mining commuters to mining regions. The first group consists of the neighboring regions, where commuting is principally due to the effect of proximity. The second group consists of the regions where the main urban agglomerations of the country are located, namely the MR and regions V and VIII. According to the hypothesis made by Storey (2001) regarding the idea of the "flying over", it is reasonable to state that, in Chile, long distance commuting related to mining activity acts as a centripetal force. The third group is just Coquimbo, the region that sends the highest number of commuters to Antofagasta. The case of Coquimbo requires further research because it is a relatively small region and is more than 700 kilometers far away from Antofagasta. Possibly, the Region of Coquimbo is a very attractive area for residents due to its endowment of some amenities like weather, low cost of living and proximity to Santiago.

Two main implications arise from these results: At a national level, long distance commuting related to mining activity could promote concentration, working as a centripetal force, and reduce development opportunities in remote mining regions where the living standards are low and the cost of living tends to be high. Consequently, the design of national policies focused on the reduction of regional disparities should take into account the impact of commuting among regions, otherwise national agreements could be detrimental to the mining areas. At the local level, in regions where the reception of

commuters is as significant as in Antofagasta, one of the main objectives of regional policy should be the promotion of the attractiveness of these places.

References

- Arezki, R. y Van der Ploeg, R. (2007).** Can the Natural Resource Curse Be Turned Into a Blessing? The Role of Trade Policies and Institutions. Oxford Centre for the Analysis of Resource Rich Economies. OxCarre Research Paper 2008-01. University of Oxford.
- Aroca, P. (2001).** Impacts and Development in Local Economies Based on Mining: The Case of the Chilean II Region. *Resources Policy*, 27, 119-134.
- Aroca P. y Atienza, M. (2008).** “La conmutación regional en Chile y su impacto en la Región de Antofagasta”. *Eure*, XXXIV, 102, 97-120.
- Auty, R. (1998).** Resource abundance and economic development. UNU/-World Institute for Development Economics Research. Oxford University, Helsinki.
- Bell, M. y Brown D. (2006).** “Who are the visitors? Characteristics of temporary movers in Australia”. *Population, Space and Place*, 12, 2, 77-92.
- Cameron, G. y Muellbauer, J. (1998).** “The housing market and regional commuting and migration choices”. *Scottish Journal of Political Economy*, 45, 4, 420-446.
- Houghton, D. S. (1993).** “Long distance commuting: a new approach to mining in Australia”. *The Geographical Journal*, 159, 3, 281-290.
- Perloff, H, Dunn, E., Lampard, E., Muth R. (1960).** Regions, resources and economic growth. 1° ed. Baltimore: John Hopkins Press, 470 p.
- Ellison, G. y Glaeser, E. (1999).** The concentration of industry: does natural advantage explain agglomeration? Discussion paper 1862, Harvard Institute of Economic Research, Harvard University.
- Hewings, G.J.D. (1985).** Regional Input-Output Analysis. Sage 1985. Scientific Geography Series; Vol. 7.
- Holmes T. J. y Stevens J. J. (2004).** Spatial distribution of economic activities in North America. Handbook of Regional and Urban Economics, vol. 4, chapter 64.
- INE (2009).** Remuneraciones, Costo de Mano de Obra y Empleo 2007. Publicaciones INE, Santiago, Chile

Isard, W., I.J. Azis, M.P. Drenan, R.E. Miller, S. Saltzman y E. Thorbecke (1998). Methods of Interregional and Regional Analysis. Ashgate, Vermont, USA.

Melamid, A. (1984). “Mining Operations in Underdeveloped Regions”. *Geographical Review*, 74, 4, 468-470.

Miller, R.E. and P.D. Blair (2009). Input-Output Analysis. Foundations and Extensions. 2nd Edition, Cambridge University Press, London, UK.

Paredes, D. and P. Aroca (2008). Metodología Para Estimar un Índice Regional de Costo de Vivienda en Chile. Cuadernos de Economía – Latin American Journal of Economics, Vol. 45, N° 131, pp. 129-143.

Rosenthal, S. y Strange, W. (2004). Evidence on the nature and sources of agglomeration economies. Handbook of Regional and Urban Economics, vol. 4, chapter 49.

Ross, M. (2008). Mineral Wealth, conflict and equitable development. In “Institutional pathways to equity. Addressing inequality traps”. Banco Mundial; Washington. Chapter 7, 193-216.

Sachs, J. y Warner, A. (2001). “Natural resources and economic development: the curse of natural resources”. *European Economic Review*, 45, 827-838.

Shrimpton, M. y Storey, K. (2001). The Effects of Offshore Employment in the Petroleum Industry: a Cross-National Perspective. U.S. Department of the Interior Minerals Management Service Environmental Studies Program, Herndon, Virginia

Spies, M. (2009). Oil extraction in extreme remoteness. The organisation of work and long distance commuting in Russia’s northern resource peripheries. Dissertation. Human Geography and Geography, Faculty of Social Sciences and Regional Studies. University of Joensuu. Finlandia.

Stijns, J. P. (2005). “Natural resource abundance and economic growth revisited”. *Resources Policy*, 30, 107-130

Storey, K. (2001). “Fly-in, fly-out and fly-over: mining and regional development in Western Australia”. *Australian Geographer*, 32, 2, 133-148.

SUBDERE (2009). Informe de Ejecución Fonda Nacional de Desarrollo Regional. Período 2006 – Septiembre de 2009. Documentos SUBDERE, Santiago, Chile.

Van der Ploeg, R. (2007). Challenges and opportunities for resource rich economies. Oxford Centre for the Analysis of Resource Rich Economies. OxCarre Research Paper 2008-05. University of Oxford.