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Abstract

This paper examines the local economic impact of large increases in metal-mining product prices on poverty in Chile. Using household data from 1998 to 2013 and exploiting differences in municipalities' exposure to price changes, we provide evidence of a reduction in poverty rates following the positive terms of trade shock of 2003. According to our estimations, the increase in mineral prices experienced between 2003 and 2009 reduced poverty by more than 2 percentage points in municipalities relatively exposed to the commodity boom – with at least 7% of employment in the metal-mining sector – in comparison to municipalities with no exposure to the boom. In addition, we explore some of the mechanisms explaining the reduction in poverty. We find significant effect of higher products prices on wages and employment, especially for unskilled workers and for workers employed in metal-mining industries.

Keywords: Commodity boom, poverty, local economic development

JEL Classification: I32, R23, O13

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1. Introduction

Over the last decade, several commodity-producing countries experienced large, positive, and persistent terms-of-trade shocks. The existing literature (e.g., "Dutch Disease" and natural resource "curse" literature) suggests that this phenomenon should have a negative effect over medium-term economic activity (e.g. Corden, 1982; Krugman, 1987). However, the good economic performance of developing countries during the last commodity boom – in particular Latin America countries – challenges this view.[1] A large literature studies the impact of terms of trade shocks on economic growth (see for example Edwards and Levi-Yeyati, 2005; Collier and Goderis, 2012). However, much less is known on whether natural resource export booms may have a positive effect over other dimensions of economic welfare – such as poverty – and if so, how these shocks are transmitted to local communities.[2]

In this paper, we study the local effect of commodity shocks on poverty. To this end, we exploit the exogenous price shock associated with the last commodity "super cycle" (starting circa 2003), and use municipal-level data from Chile – a country which economy is highly dependent on minerals – to analyze the effect on local level poverty. Existing evidence suggests that the recent boom in commodities was most likely caused by China and its insatiable appetite for commodities (Yu, 2011, and Farooki and Kaplinsky, 2013). The fact that the shock was demand rather than supply driven allows us to use the change in commodity prices as a quasi-experiment for studying poverty changes.[3]

Our identification strategy relies on the use of differences in municipalities' exposure – the smallest administrative division in Chile – to the positive minerals' shock. As in Topalova (2007, 2010), we define exposure in terms of the initial employment share of the mining sector. By comparing the change in poverty rates across municipalities with different degrees of exposure to the shock, we obtain an estimate of the differential effect of the commodity boom on poverty.

Our main result suggests that municipalities that are relatively more exposed to mining sector fluctuations experienced larger reductions in poverty. We find that the increase in the price of minerals between 2003 and 2009 – about 100 percent – reduced poverty by around 2.4 percentage points in municipalities relatively more exposed to the commodity boom, i.e. with at least 7% of

[1] See De Gregorio (2014) and De Gregorio and Labbé (2014) for the case of Latin American countries recent growth performance, and Chile in particular.

[2] The work by Goderis and Malone (2011) provides aggregate cross-country evidence on the impact of natural resource booms on income inequality. They find that inequality falls during a boom and then increases over time until this effect disappears.

[3] The mining industry is subject to capacity constraints: production is limited by the number of mines under exploitation. Therefore, in the short run the supply response to any demand shock is most likely limited.

employment working in the metal-mining sector, in comparison to non-exposed municipalities.[4] Our results hold to several robustness checks and falsification exercises.

The case of Chile is particularly interesting for several reasons. First, the Chilean economy is highly dependent on mining exports: mineral production represented about 13 % of GDP over the last decade. Second, despite that Chile is the world's main producer of copper and molybdenum, the change in export prices was mostly exogenous and associated with Chinese demand. Third, mining activity is unevenly distributed across several local markets, providing enough heterogeneity to identify the impact of price shock using the ex-ante exposure to this boom. Finally, Chile experienced an important reduction in the national poverty rate of 6.4 percentage point during the period under analysis, 1998-2013. Our results shed light on the importance of the positive shock to export prices in explaining the decline in national poverty.

This paper is related to recent empirical literature on local effect of macroeconomic shocks on income and poverty. In a series of influential papers, Topalova (2007, 2010) exploits differences in the initial employment composition of India's districts to assess the impact of import competition, finding a negative effect on local poverty and income. A similar strategy is followed by Costa, et al. (2014), to analyze the effect of Chinese competition on Brazil's local manufacturing wages and income inequality, McCaig (2011) to study how the bilateral U.S.-Vietnam trade agreement affected provincial poverty in Vietnam, and Kovak (2013) and Dix-Carneiro and Kovak (2015) to study the effect of Brazil's trade liberalization on wages, and the skill-premium respectively. The general conclusion in these studies suggests that stronger import competition negatively affects local wages and poverty, while trade liberalization – by improving access to export markets –positively affects local income and reduces poverty.[5]

Our paper is also related to the literature studying the effect of resource abundance on local economic outcomes. Aragón and Rud (2013) examine the local impact of the expansion of a large gold mine in Peru and find positive effects on real income, which are driven by a higher demand for local inputs. Michaels (2011) studies the long-term effects of oil abundance on local economic development in the U.S. south and finds a positive impact on the local educational level and income. Allcot and Keniston (2015) study the effect of oil and gas busts and booms on local economic growth with a particular emphasis on the manufacturing sector. Their findings suggest a high sensitivity of

[4] This number roughly corresponds to the upper-decile of the metal-mining employment share unconditional distribution, or equivalently to the upper quartile of the metal-mining employment share distribution of municipalities with positive employment in this sector.

[5] Similar approaches have also been used to evaluate the impact of Indian trade reforms on schooling and child labor (Edmonds, et al. 2010), the spread of the sub-prime crisis over U.S counties (Stumpner, 2015), and the impact of U.S. anti-dumping duties applied to exports of Vietnamese catfish products on rural households' income in Vietnam (Brambilla, Porto and Tarozzi, 2012).

local economic growth to natural resources cycles, but they do not find any evidence of a resource curse.

Finally, in concurrent work to ours, Pellandra (2015) studies the effect of commodity boom on the wages and employment of skilled and unskilled workers in Chile between 2003 and 2011. Although closely related, his focus is on the skill-premium and employment by skill levels, while ours lies on understanding the effect of the commodity boom on poverty. In addition, he uses the change in employment-weighted producer price index (PPI) between 2003 and 2011 as a price variation, which may capture forces different than the commodity price shock. In contrast, our paper measures the price shock directly using the mineral prices.

Relative to the existing literature, we make several contributions. First, we provide evidence that suggests that countries that are highly dependent on natural resources – such as Chile – benefited from the last commodity boom, helping them to significantly reduce poverty in regions highly economically dependent on the natural resource sector. Second, our paper contributes to the discussion on the "natural resource curse" by providing local market level evidence on the economic effects of natural resources booms. The current consensus in this literature is that natural resources booms or windfalls would be negative for economies with weak institutions (Van der Ploeg, 2011).[6] We contribute to this literature by showing that in a country with relatively strong institutions, the impact of natural resources boom is positive (as in Mehlum et al., 2006). Finally, the evidence we present complements previous results on the effect of trade reforms on local poverty and income, showing that commodity shocks are amidst trade reforms –that improves access to foreign markets– in terms of its effect on local poverty and income.

The paper is structured as follows. The next section describes the data and the main stylized facts on the relationship between prices and poverty rates. The third section presents the empirical approach and discusses the identification strategy. The fourth section, presents the main results and several robustness checks. The fifth section explores the labor markets mechanisms – employment and wages - behind our results. The main findings and conclusions are discussed in the sixth section.

2. Background and Data

We begin this section providing background on the commodity boom of the mid-2000s and its effect on Chilean local communities. We then describe the data we use in this paper. Finally, we

[6] Robinson et al. (2006) explain these differences about the impact of resources booms, showing that countries with institutions that promote accountability and state competence can ameliorate the perverse political incentives originating during resources booms.

present preliminary evidence of the relationship between the commodity price shock and poverty, looking at differences in poverty reduction between exposed and not-exposed local communities.

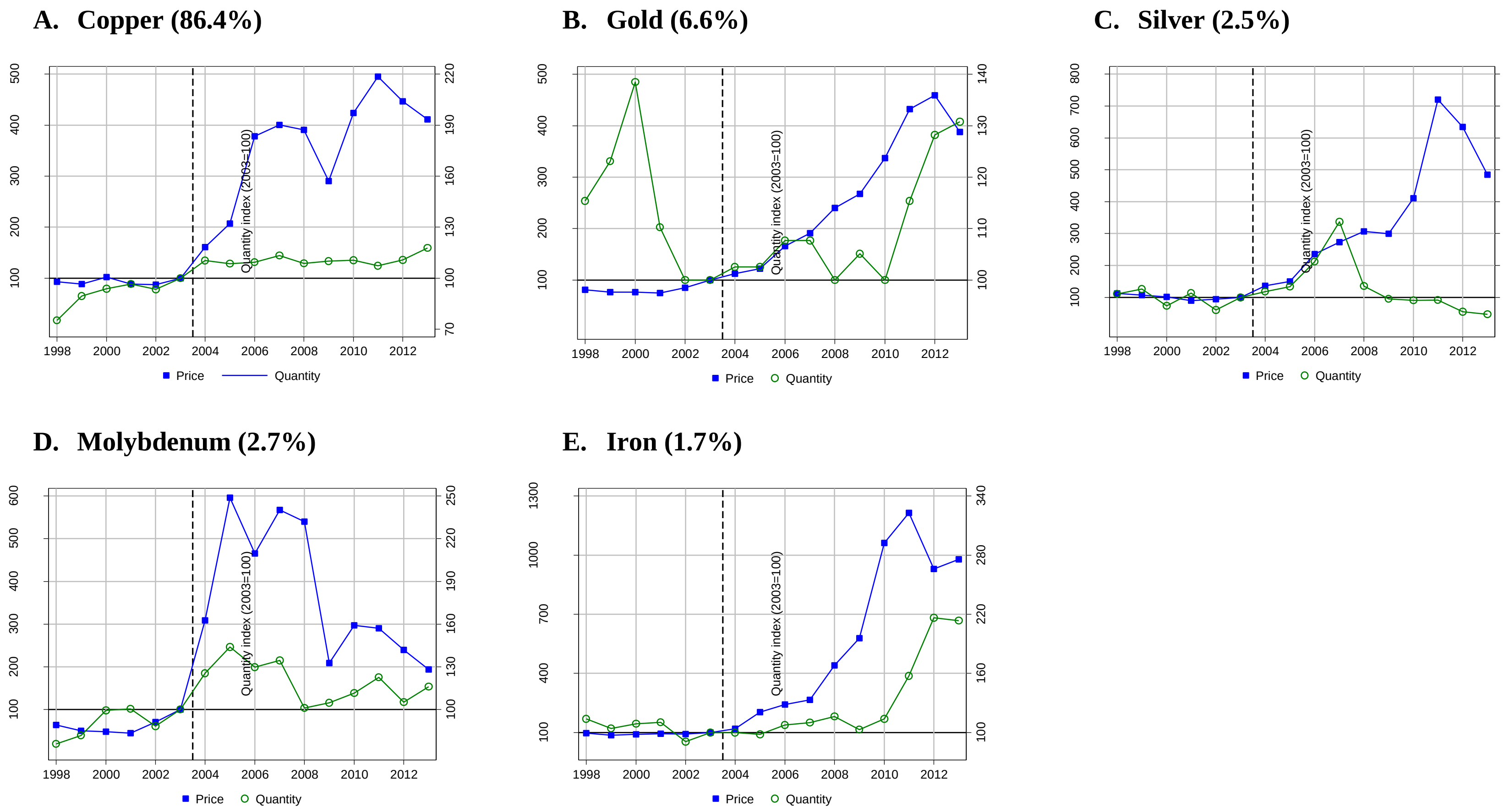
2.1 Metals' Commodity Boom

The mid-2000s "super-cycle" has been one of the largest commodity booms of the last century. Between 2003 and 2008, oil and metal prices tripled, and food and precious metal prices doubled (Baffes and Haniotis, 2010). Almost a decade after the beginning of the boom, there is consensus among scholars and market analysts that the boom was mostly caused by demand pressures from emerging economies – in particular China – rather than from general increases in the marginal production cost (as it was the case of the 1975-1980 boom).[7] This is important for our study, because it implies that most of the initial shock to international prices was largely exogenous for a commodity-producing country such as Chile.[8]

The commodity boom positively affected activity in most commodity producing countries. The case of Chile is a particularly attractive for study, because it is a large-scale producer of metals and its economic activity strongly commoves with the price of copper. Chile is not only the world's largest producer of copper, but it is also within the top-three largest producers of molybdenum (U.S. Geological Service). The price of these two metals experienced substantial rises during the commodity boom: copper went from about USD 0.80 per pound in 2003 to over USD 4.00 per pound in the second quarter of 2008, and molybdenum jumped from USD 3.30 per pound to about USD 32.50 per pound over the same period, a ten-fold increase (see Figure 1). Over the same period, tax revenues – largely dependent on Chile's main state owned mine, CODELCO's revenues – jumped significantly, and employment and economic activity flourished in mining regions (see Cochilco, 2013).

[7] Erten and Ocampo (2013) show that, actually, all 'super-cycles' from 1865 to 2010 for non-oil commodities were essentially demand-driven.
[8] In the medium-run, commodity producing countries adjusted their production to profit from the higher prices. This response may fed back to international prices lessening the magnitude of the initial shock, as long as the magnitude of the supply response is large enough. On the contrary, the commodity boom may also feedback positively if marginal costs increase as production adjust to demand (see Humphreys , 2010).

Figure 1: World Price and Chilean Extraction of Selected Metals (2003=100)



Note: The Figure shows price (left axis) and quantity (right axis) trajectories for the top-5 most important metals in Chile. These metals account for over 99% of the annual production value over the sample period. In parenthesis we show the relative importance of each metal in production value in 2003.

2.2 Data

The main dataset we use in this paper is the Chilean National Socioeconomic Characterization (CASEN) Survey. CASEN is a household survey applied by the Chilean Social Development Ministry (MIDEPLAN) every two or three years. This survey is the main source for Chile's socioeconomic statistics, such as the official poverty rate, and its information is periodically used to assess the impact of social policies and programs. On average, CASEN includes survey information for about 65,000 households in 300 municipalities, around 1.5% of the national population (see Table 1).

Table 1: Observations in CASEN 1998-2013

Survey Year	Poverty Rate*	Surveyed Households	Surveyed Population	Population*	Municipalities
1998	20,1%	48,107	188,360	13,143,833	196
2000	20,5%	65,036	252,748	14,361,014	285
2003	18,6%	68,153	257,077	15,340,042	302
2006	15,1%	73,720	268,873	16,115,197	335
2009	14,9%	71,460	246,924	16,584,521	334
2011	14,4%	59,084	200,302	16,902,542	324
2013	13,7%	66,725	218,491	17,218,400	324
MEAN	**16,8%**	**64,612**	**233,254**	**15,666,507**	**300**

Note: * indicates that the variable is computed with municipal expansion factors provided in CASEN

In this paper, we use the seven CASEN waves ranging from 1998 to 2013. Although CASEN is available from 1985, we start our analysis in 1998, because the municipal coverage of earlier CASEN versions is significantly lower.[9] Nevertheless, the fact that the commodity boom of 2003 falls in the middle of our sample is important for our study because it allows us to control for pre-shock trends in the poverty rate and to study medium-term effects of the commodity boom on poverty, wages, and employment. Specifically, we use three waves before the beginning of the commodity boom in 2004 (1998, 2000 and 2003), and four waves after the shock (2006, 2009, 2011 and 2013).

[9] For instance, CASEN surveyed only household from 126 municipalities in 1996 –about 40% of the average number of municipalities covered in 1998-2013 and two-thirds of the municipalities surveyed in 1998.

We aggregate CASEN's household data at the municipal level – the smallest administrative unit in Chile – because municipalities are closest to the concept of local labor markets.[10] In principle, the data could have been used at a higher aggregation level (e.g., provinces or regions). However, these alternative divisions are too broad for studying local labor markets. Regions – the most aggregated administrative unit –, and some provinces extend as much as 400 kilometers (250 miles) from north to south.

Note that our decision of working with municipalities constitutes a conservative strategy for assessing our research question. If larger administrative units were a better approximation to local labor markets, then we would be less likely to find significant effects at the municipality level because the relevant exposure variable, mining employment share, should ideally be measured at a higher level of aggregation. Thus, the bias caused by using municipalities rather than provinces works against our results. Nevertheless, we show in the robustness checks section that our main results are not significantly affected when using province-level data.[11]

The resulting dataset is an unbalanced panel for seven waves of the survey, with a coverage ranging from 196 municipalities in 1998 to 335 municipalities in 2006. As it can be seen in Table 1, there is a significant positive trend in the number of households surveyed. For example, in 1998 the survey was applied to 48,107 households from 196 municipalities, while in 2013 it was applied to 66,725 households in 324 municipalities.

The main variable we use in this study is the poverty rate. For each municipality c and period t, we define the poverty rate σ_{ct} as:

$$\sigma_{ct} = \frac{\sum_i^I \omega_{ict} I(y_{ict} < \bar{y}_t)}{\sum_i^I \omega_{ict}} \tag{1}$$

Where $I(y_{ict} < \bar{y}_t)$ is an indicator function that takes a value of one if household i has income y_{ict} below the poverty line $\bar{y}_t$, and ω_{ict} are weights defined by the municipal expansion factor provided by CASEN. To define poverty, we use the Chilean official poverty line, defined in terms of the cost of a minimum bundle of products necessary to satisfy dietary requirements.[12] When constructing the poverty line, we assume the same prices for all municipalities. Although it would be desirable to compute the poverty line at the level of local markets, the absence of geographically

[10] A municipality or commune may contain several cities and towns, and it is similar to the concept of county. Each municipality is governed by a directly elected mayor (*alcalde*) and group of councilors (*concejales*), for a period of four years.
[11] On the other end, we avoid working with household level data because in this case it may be more challenging to capture general equilibrium effects such as spillovers to sectors not related directly to the commodity sector.
[12] The composition of the bundle is determined by the *Economic Commission for Latin America and the Caribbean* (ECLAC), based on the minimum caloric requirements advised by the *World Health Organization* and the *Food and Agriculture Organization*.

disaggregated prices renders this task impossible. This may bias our results based on the poverty rate downwards if prices increase relatively more in mining municipalities than in non-mining municipalities after the commodity boom, which may be especially relevant for the case of non-tradable goods. However, available evidence suggests that this bias is most likely of limited magnitude in our sample.[13]

To account for the price effect of the relevant metals for the Chilean economy, we construct a price index for all metals representing more than 1% of the overall production value in 2003. Five metals fall under this criterion: copper, silver, gold, molybdenum, and iron ore.[14] We define, for each period *t* the average percentage change in metals' price $\tilde{P}_t$ as:

$$\tilde{P}_t = \sum_{i=1}^{5} \theta_i^{98} \cdot \frac{\Delta P_{i,t}}{P_{i,t}}$$

where the subscript *i* represents each of the five metals defined in the previous paragraphs, θ_i^{98} is the production value share of each metal *i* in 1998 (scaled by the production value of the five metals, so that they add up to one, $\sum_{i=1}^{5} \theta_i^{98} = 1$), and $P_{i,t}$ is the nominal price of each metal. Then, we compute the *metals' price index*τ_t as

$$\tau_t = \left(1 + \tilde{P}_t\right) \cdot \tau_{t-1}, \quad \text{with } \tau_{2003}\text{=100}$$

In addition to our main variables, we use a series of other variables either as outcome variables or as controls. These variables are:[15] (i) average wage for unskilled (high-school or lower) and skilled workers (some post-secondary education), (ii) average years of schooling, (iii) share of people living in urban zones, (iv) average household size, and (v) share of metal-mining employment.

We complement CASEN's data with price and production information for the main metals produced in Chile. The data on metal prices and production are from the Chilean Copper Commission (COCHILCO) and the IMF's Macroeconomic Statistics Database. Finally, to control for economic local economic activity, we use regional real GDP growth information from the Central Bank of Chile.[16]

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[13] In a complementary exercise (available upon request), we analyze the dynamics of housing rents – as a proxy for non-tradable goods – before and after the commodity shock. Although we find that rent grew relatively more in mining regions, the growth rate was lower than the change in local wages. Therefore, we believe that our results would still hold under the hypothetical case that we were able to correct our results by local prices.

[14] These metals represent over 99.5% of the production value in 1998-2013. Out of these metals, copper is the most important by far: it account for over 85% of the total production value each year. Figure 1 shows the international price and Chilean production (normalized in 2003) of these five metals for the sample period.

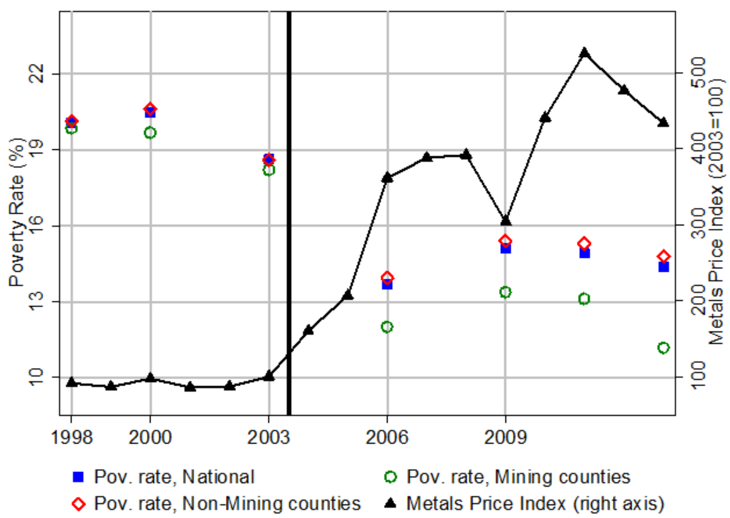
[15] See Appendix A for details on the construction of the variables.

[16] Appendix A provides detailed information on the definition of each price and production variable used in this paper.

2.3 Mining Exposure and Poverty Reduction

Before turning to our main empirical results, we present preliminary (and unconditional) results on the relationship between the commodity boom and poverty reduction depending on the degree of exposure to the metal price shocks. As a first pass, we compare the trajectory of the poverty rate in mining and non-mining intensive municipalities, before and after the commodity shock that started by 2003. We define as more exposed municipalities as those with mining employment share above the upper quartile of the employment share distribution in 1998 (about 1%). If the commodity boom affected poverty, we would expect these trajectories to diverge after the beginning of the commodity boom in 2004, with poverty declining in mining relative to non-mining municipalities.

Figure 2: Metals' Prices and Poverty rate in Chile



Note: The figure shows the national poverty rate, and the poverty rate in municipalities with high and low mining intensity for the period 1998-2013. Poverty rates are computed based on CASEN information for the period. Municipalities with high (low) mining intensity are those with metal-mining employment share above (below) the median; employment shares are computed in 2003.

Figure 2 shows the trajectories for poverty rate at the national level, and for mining and non-mining municipalities (left axis), and for the metals' price index (right axis).[17] As can be seen, from 1998 to 2003 the price index remained relatively stable. From 2004 on, the price index shows an increasing trajectory. In 2004, the price index jumped about 70% with respect to the previous year,

[17] All poverty rates are computed as the share of population with income below the poverty line. This is equivalent to calculating the population-weighted average poverty rate for the municipalities under each definition.

while in 2006 the price index was almost three-times higher than in 2003. After a pause from 2006 to 2009, where the metals' prices stabilized and then had a brief collapse in 2009 following the onset of the sub-prime financial crisis, the metals' prices resumed its growing trajectory until 2011, when it peaked at a value equal to 500 – almost 4 times the value of the index in 2003.

Regarding poverty, the figure reveals a negative trend in the national poverty rate from 1998 to 2013, which is common to both mining and non-mining municipalities. The national poverty rate experienced an important decline over the period, from 20.1% in 1998 to 13.7% in 2013. In 2006, poverty rate experienced the sharpest decline during the period, going from 18.6% in 2003 to 15.1% in 2006.[18] Note that the decline in the poverty rate was significantly larger in mining municipalities. While in non-mining municipalities, poverty fell from 18.7% to 14.7%, the decline in mining municipalities was much larger – about 6 percentage points – from 18.2% to 12.6%. After the financial crisis of 2008-2009, poverty increased, but the poverty gap between mining and non-mining municipalities widened.

In Table 2 we summarize the evidence comparing average poverty rates between both groups of municipalities before and after the commodity boom. The reduction in poverty rate is 2.5 percentage points higher in relatively exposed municipalities. These results support the hypothesis that the commodity boom helped to reduce poverty in municipalities relatively exposed to the commodity boom. In the next sections, we complement this descriptive analysis with regression-based results and study whether other factors could be driving these findings.

Table 2: Poverty Rate by Municipalities (Simple average per-period)

	Before: 1998-2003	**After: 2006-2013**	**Difference**
Non-exposed	0.233	0.162	-0.071
St. dev.	0.008	0.006	0.004
Exposed	0.244	0.147	-0,096
St. dev.	0,012	0.009	0.009
Difference	0.011	-0.014	-0,025
St. dev.	0.015	0.011	0.010

Non-exposed municipalities are those with mining labor share lower than 1% (percentile 75%) and exposed municipalities are those with mining labor share higher than or equal to 1%.

[18] The difference between these numbers and the official poverty rates are due to the use of municipal expansion factors.

3. Empirical Model

The commodity boom of mid-2000s was externally originated and abrupt, providing a quasi-natural experiment for studying the effect of commodity price changes on poverty. The fact that municipalities are differentially exposed to the shock allows us to perform a difference-in-difference (DID) approach to establish whether certain municipalities benefited relatively more from the commodity boom in terms of poverty reduction. We estimate versions of the following equation:

$$Y_{ct} = \alpha_c + \alpha_t + \gamma X_{ct} + \beta LogP_t \times \theta_c + e_{ct} \quad (1)$$

where Y is the poverty rate of municipality c at time t, α_c and α_t municipal and year fixed-effects that account for all municipality-specific variables than might affect poverty and also for common time-varying shocks affecting to all counties, X is a vector that accounts for other variables that previous literature indicates as important for explaining changes in poverty across regions (McCaig, 2011, see next section for details), P is the metal-mining prices index described in the previous section, and θ□is as measure of exposure of municipality c to changes in P.

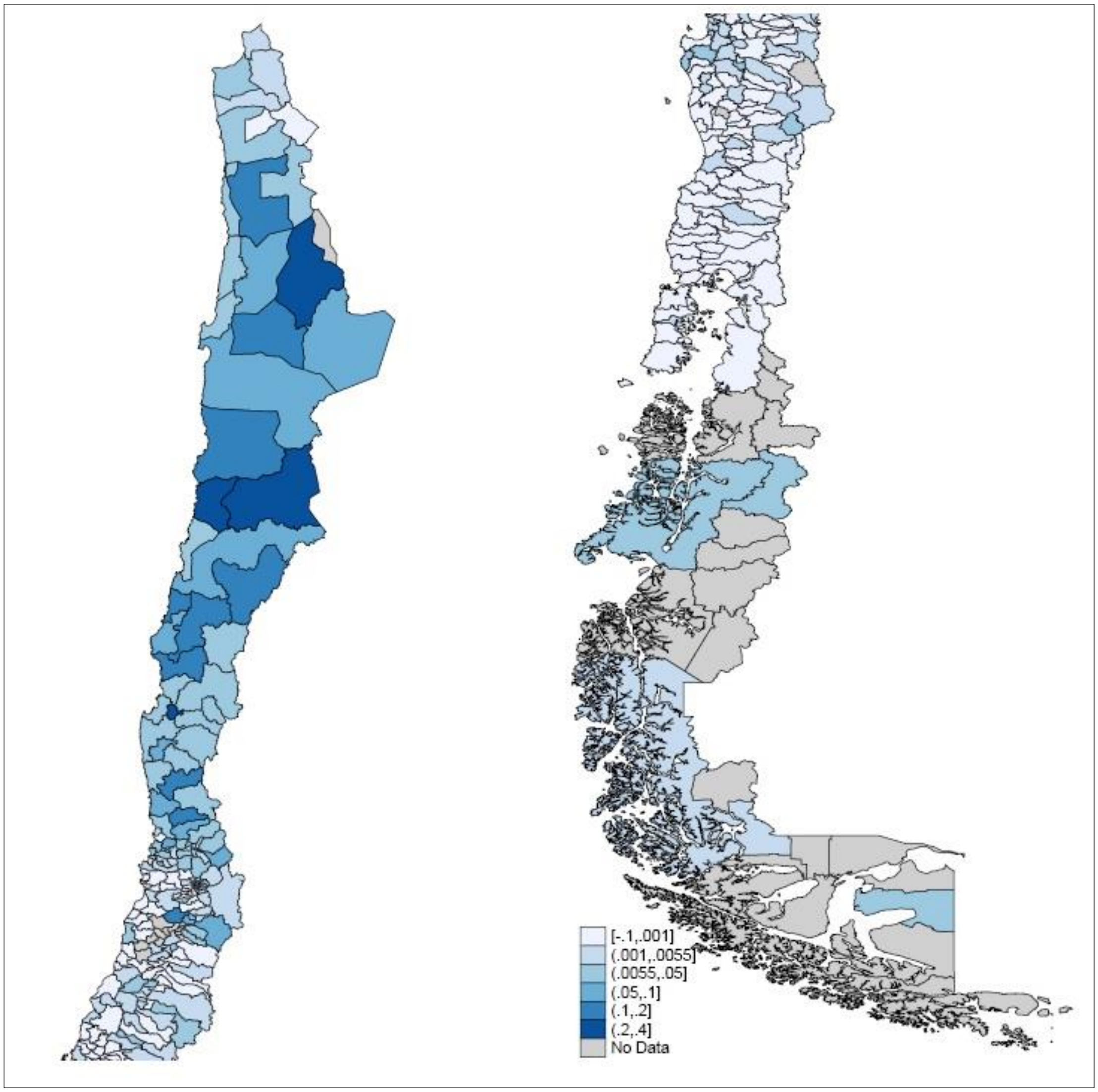
The parameter of interest in equation (1) is β, and it measures the differential impact of the metals' price index on municipalities' poverty. We expect β to be negative, indicating that positive shocks reduce poverty. Because θ is continuous, the shock's impact in a given municipality with metal-mining exposure θ_c will be β□× θ_c and the magnitude will be higher – in absolute terms – for municipalities with higher exposure.

Note that equation (1) does not identify the channel through which the commodity shock affects income and poverty. One possibility would be that municipalities benefit from the shock because of greater resources for municipalities, as in Caselli and Michaels (2013) for the case of oil shocks in Brazil. However in Chile municipalities do not directly benefit from windfalls in the mining sector, because taxes from mining companies are collected by the central government. Local governments may indirectly benefit from the windfall if the central government transfers more resources to mining municipalities or through the increase of local revenues coming from the growing economic activity originated by the resource booms. Although this as interesting possibility, we focus on the broad impact of price changes not distinguishing whether this was a direct effect on labor markets or indirect through increases in local government revenues.

A key variable in equation (1) is the metal-mining exposure θ□□ We proxy this variable in term of metal-mining employment share, defined as the ratio of employment in the metal-mining sector over total municipal employment. In our baseline results we compute this variable using information for 1998 – the first year of our sample – but we obtain similar results when using years 2000 or 2003.

The advantage of using employment-based measures over other proxies of municipal exposure such as measures based on economic activity or production is that it allows us to consider cases of municipalities with minor or no mineral deposits, but with a significant fraction of its population working in the metal-mining sector.[19]

Figure 3: Metal-Mining Employment Share



Note: The figure shows the average municipal employment share for the period 1998-2003. Employment share is computed as the ratio of metal-mining employment over total municipal employment. Employment information is from CASEN.

[19] We believe this is a certain possibility in the mining sector, where workers tend to work in non-standard shifts, such as 7x7 (7 days working in the mine and 7 seven days resting) or 4x3.

Figure 3 shows the show the geographical distribution of the exposure variable θ.[20] Relatively exposed municipalities tend to be located close to mining deposits, e.g., *Chuquicamata* in the North of Chile or *El Teniente* in the Central zone. However, the figure also reveals an important heterogeneity in the exposure distribution. This lends support to our strategy of using ex-ante employment based exposure to the commodity boom.

4. Results

4.1 Effect of the Commodity Boom on Poverty

Before turning to our main empirical results, we note that the effective sample used in the regression analysis is smaller than the sample of municipalities in CASEN. Specifically we have to restrict the sample to municipalities included in the 1998 version of CASEN, because we can only compute the exposure variable for municipalities included in that year. Out of the maximum of 335 municipalities, only 196 are included in 1998 (see Table 1), i.e. a reduction in sample size from 2,345 to 1,356 observations.[21]

Table 3 presents our baseline estimates for the commodity shock's impact on poverty. All regressions control for municipality and year fixed-effects. Columns 1-3 show results for the full sample 1998-2013; column 4 restricts the sample for the balanced sample of municipalities with information for all years between 1998-2013, which reduces the number of municipalities from 196 to 182. In terms of covariates, column 1 includes only fixed effects. Column 2 includes two household-based variables to control for differences in the composition of the average household across municipalities: the average number of years of schooling and the average household size (both in logarithms). Column 3 adds regional GDP growth – to control for economic activity – and other covariates varying at the municipal/year level: municipality size (measured in terms of population) and the share of urban population of each municipality.[22] Finally, column 4 repeats the estimation of column 3 for the subset of municipalities with information from all five CASEN surveys from 1998 to 2013. [23]

[20] For expositional purposes, in this figure we plot the simple average over 1998–2003.
[21] An alternative to avoid this drastic reduction in sample size is to use the average share in metal-mining employment over 1998-2000 to compute the exposure variable θ. This strategy increases our sample to 297 municipalities (1,950 observations). However, using this definition does not affect our main results (see Table B2 in the appendix).
[22] Note that economic activity is defined here at a broader level of aggregation — regions instead of municipalities — thus the coefficient for this variable is not collinear with year fixed-effects
[23] See appendix A for data sources and definition.

We expect poverty rate to be higher in municipalities with lower average schooling, larger household size, and higher share of urban population. The sign of the municipality size coefficient is not determined a priori; we include this variable to control for potential scale-effects, for example that larger municipalities may attract a larger share of fiscal resources aimed at reducing poverty or that workers have more employment opportunities in larger municipalities.

Table 3: Impact on Poverty Rate

	(1)	(2)	(3)	(4)
Log P_t x θ_c	-0.164**	-0.163**	-0.162**	-0.156**
	(0.066)	(0.068)	(0.067)	(0.066)
Schooling	---	-0.116***	-0.123***	-0.146***
		(0.038)	(0.038)	(0.039)
Households Size	---	0.058**	0.058**	0.039
		(0.025)	(0.025)	(0.025)
Urban Share	---	---	0.073**	0.084**
			(0.036)	(0.037)
GDP growth (Region)	---	---	0.021	0.038
			(0.086)	(0.084)
Municipality Size	---	---	0.027	0.027
			(0.022)	(0.022)
Constant	0.261***	0.439***	0.120	0.195
	(0.008)	(0.100)	(0.231)	(0.245)
Observations	1,356	1,356	1,356	1,274
Sample	All	All	All	Balanced
Year Fixed-Effects	Yes	Yes	Yes	Yes
Muncipality Fixed-Effects	Yes	Yes	Yes	Yes
R-squared	0.353	0.366	0.370	0.393
Number of Municipalities	196	196	196	182

Notes: This table shows the effect of metal prices changes on poverty rate in a panel of municipalities over the period 1998-2013).θ_c corresponds to the metal mining employment share of municipality c in 1998. All regressions controls for municipality and year fixed effects. Standard errors (in parenthesis) are clustered at the municipal level. *** significant at 1%; ** 5%; * 10%.

We find consistent and robust evidence that increases in metal prices were associated with higher poverty reductions in more exposed municipalities. In all regressions, the sign of the interaction between the log of the metals' price index and the index of municipal exposure is negative and statistically significant at the 95% confidence level. The coefficient is notably stable across specifications; it moves in the range -0.156 to -0.164.

Note that because this coefficient is identified both by the cross-sectional exposure and the temporal variation of the price index, to gauge the economic significance of the commodity boom we need to evaluate this coefficient for municipalities with different levels of exposure. When we evaluate the effect for municipalities with the median exposure to the commodity shock, we find a modest impact: a 100% increase in the metals' price index reduces poverty by about 0.06 percentage points in these municipalities. The impact of the shock, however, increases significantly as we move away from the median exposure to the upper tail of its distribution. For municipalities in the 75th percentile the impact of the shock increases to 0.32 percentage points, and for municipalities in the 90th percentile, the effect is about 2.4 percentage points, more than 30 times the median effect.

Relative to other control variables – schooling, household size and urban share – results are consistent with our expectations: poverty tends to be higher in municipalities with lower average schooling, larger household size, and higher share of urban population. The municipality size coefficient is non-significant (see columns 3 and 4), while regional real GDP growth is positive, although non-significant. Finally, we obtain similar results for the commodity shock and control variables when we restrict ourselves to the balanced sample of municipalities (column 4).

4.2 Confounding Factors

In Table 4 we verify whether several potential confounding factors could challenge our identification strategy and results. First, when we restrict the estimation sample to the pre-boom period (1998-2003), we find a non-significant relationship between poverty and metal prices (column 1). This suggests that metal prices had a limited influence on poverty reduction before the commodity boom, providing support to our DID strategy. Second, we show that during this pre-boom period both exposed and not-exposed municipalities experienced similar reductions in poverty rates (column 2), which is consistent with the parallel trends pre-requisite for the application of this DID methodology.[24] In fact, the F-test cannot reject the null hypothesis of similar pre-trends in exposed and non-exposed municipalities (p-value of 0.280) before the commodity boom. Finally, in column

[24] In this case and in the rest of the estimations, municipalities are defined as "exposed" when their initial mining employment share is above the upper quartile of the employment share distribution in 1998 (about 1%).

3, we show that when controlling for parallel trends, the price variable is non-significant when again restricting the sample to the pre-boom period.

Table 4. Potential Confounding Factors: Parallel Trends and Poverty Convergence

Sample	98-03	98-03	98-03	98-13	98-13	98-13
	(1)	(2)	(3)	(4)	(5)	(6)
Log P_t x θ_c	-0.026	---	0.231	-0.139*	-0.156***	-0.125***
	(0.992)		(1.136)	(0.071)	(0.045)	(0.047)
Trend(Mining,98-03)	---	-0.017***	-0.017***	-0.013***	---	-0.011***
		(0.004)	(0.005)	(0.004)		(0.004)
Trend(Rest,98-03)	---	-0.014***	-0.014***	-0.011***	---	-0.010**
		(0.005)	(0.005)	(0.004)		(0.004)
Trend(Mining,06-13)	---	---	---	-0.010***	---	0.000
				(0.002)		(0.002)
Trend(Rest,06-13)	---	---	---	-0.008***	---	0.003
				(0.002)		(0.002)
Log P_t x τ_{98}	---	---	---	---	-0.208***	-0.209***
					(0.017)	(0.017)
F-test: Trend (Mining,Pre) = Trend (Rest,Pre)	---	0.280	0.287	0.134	---	0.0825
F-test: Trend (Mining,Post) = Trend (Rest,Post)	---	---	---	0.817	---	1.575
F-test: Trend (Mining,Pre) = Trend (Mining,Post)	---	---	---	1.099	---	17.29***
F-test: Trend (Rest,Pre) = Trend (Rest,Post)	---	---	---	1.703	---	20.16***
Observations	576	576	576	1,356	1,356	1,356
Year & Municipality Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of Municipalities	196	196	196	196	196	196

Notes: Mining municipalities are municipalities with mining employment share above 1% in 1998. Columns 1-3 restricts the sample to the pre-shock period to assess the existence of pre-shock parallel trends. Columns 4-6 uses the full sample from 1998-2013. θ_c corresponds to the metal mining employment share of municipality c in 1998. τ_{98} corresponds to the poverty rate in 1998. All regressions controls for municipality and year fixed effects. Standard errors (in parenthesis) are clustered at the municipal level. *** significant at 1%; ** 5%; * 10%.

Our previous analysis confirms a minor role for pre-shock trends, which is also consistent with Figure 3, where mining and non-mining trajectories are indistinguishable before 2003. Nevertheless, to rule out the possibility that other factors other than the commodity price are driving our results, we include linear trends for both groups of municipalities in our estimation, before and after the commodity boom (column 4 in Table 4). Our main results remain unchanged. The coefficient for the interaction between mineral prices and exposure is negative and significant, although the parameter is lower than previous estimations (in absolute value).

Finally, we evaluate whether our exposure variable is simply capturing the effect of a different starting point in the presence of a poverty convergence phenomenon. In fact, if mineral-resource-abundant municipalities are poorer than scarce ones, and poverty is falling everywhere, then we should expect a higher poverty reduction in (poorer) mineral abundant communities. To analyze this possibility, we interact the poverty rate in 1998 with the logarithm of the price index. The results are presented in columns 5 (no trends) and 6 (with linear trends) of Table 4. As expected, poverty declined more in poorer municipalities, but the interaction between the price index and exposure remains negative and significant.

4.3 Placebo

We also study whether the effect of the shock can be falsified. For this purpose, we re-estimate the baseline equation (1), but using forward rather than actual prices interacted with exposure. If there were reasons other than current commodity prices driving expected growth in more mineral abundant municipalities, and they were correlated with increases in commodity prices, then expected prices should also reduce poverty.

To test this potential effect, we interact the price index variable in t+s (with s=3 and 5) with our measures of municipal exposure. The results are shown in Table 5. We find no supporting evidence for the placebo commodity shock, either when using 5-year (columns 1 and 2) or 3-year (columns 3 and 4) forward prices. In all specifications (with and without linear trends), the coefficient for the interaction term is non-significant

4.4 Further Robustness Checks

We performed several robustness checks and extensions. In this subsection, we discuss the most important of them. The results are presented in appendix B.

- *Municipalities sample*. In our baseline results we use the 7 waves of CASEN from 1998 and 2013, but the recent versions of this survey are not representative at municipality level. We replicate our results for poverty using a shorter panel during the period 1998-2009 and our main result holds unchanged (see Table B1 in the Appendix).

Table 5: Placebo Experiment on Poverty Rate

Placebo	5-years forward		3-years forward	
	(1)	(2)	(3)	(4)
Commodity Shock Placebo	-0.028	0.003	0.035	0.111
	(0.125)	(0.126)	(0.064)	(0.070)
Trend_(Mining,98-03)	---	0.033***	---	0.032***
		(0.007)		(0.007)
Trend_(Rest,98-03)	---	0.038***	---	0.039***
		(0.007)		(0.007)
Poverty98*Pindex	---	-4.375***	---	-4.398***
		(0.509)		(0.509)
F-test: Trend (Mining,Pre) = Trend (Rest,Pre)	---	0.992	---	1.713
Observations	576	576	576	576
Year Fixed-Effects	Yes	Yes	Yes	Yes
Muncipality Fixed-Effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
R-squared	0.107	0.280	0.107	0.282
Number of Municipalities	196	196	196	196

Notes: This table study whether a placebo variable is correlated with poverty reduction. The placebo variable interacts mining exposure θ_c with future metals' prices. Columns 1-2 uses 5-year (realized) forward prices, while columns 3-4 uses 3-year (realized) forward prices. Mining municipalities have mining employment share above 1% in 1998. All regressions restricts the sample to the period 1998-2003. All regressions controls for municipality and year fixed effects. Standard errors (in parenthesis) are clustered at the municipal level. *** significant at 1%; ** 5%; * 10%.

- *Measurement of exposure to mining.* In our baseline results we computed this variable using the employment share in 1998. This choice may be problematic, because only 196 municipalities were included in the 1998 CASEN survey. As an alternative, we measure exposure as the average employment share in 1998-2000. This increases our sample to 297 municipalities (1,950 observations for the full panel 1998-2013). Table B2 shows that using this alternative definition of exposure does not qualitatively change our main results.
- *Local labor markets.* It may be argued that our unit of observation — municipalities — is inconsistent with the idea of local labor markets. This may be especially true for large conurbations, such as Santiago, the capital. To check if this affects our results, we repeat our estimations for poverty excluding the Metropolitan Region, which includes the Santiago as well

as other neighboring municipalities that are close enough to the city center so that people can commute to employment in the city. Results are largely unaffected by the exclusion of the Metropolitan region (see Table B3).

- *Other commodity shocks*. Similar to the metals' price index, we compute alternative price indexes for non-mining commodities, and compute municipal exposure in terms of the employment share of those products. [25] As in the previous estimations, our results hold to the inclusion of this additional interaction term (see Table B4).

Table 6: Impact on Poverty Rate, Province-Level Data

	(1)	(2)	(3)
Log P_t x θ_c	-0.207***	-0.218***	-0.277***
	(0.049)	(0.049)	(0.050)
Schooling	---	-0.068	-0.086
		(0.076)	(0.056)
Households Size	---	0.072	0.060
		(0.077)	(0.064)
Urban Share	---	---	0.021
			(0.059)
GDP growth (Region)	---	---	-0.084
			(0.143)
Municipality Size	---	---	-0.057***
			(0.018)
Constant	0.265***	0.316	1.040***
	(0.009)	(0.212)	(0.211)
Observations	276	276	276
Sample	All	All	All
Year Fixed-Effects	Yes	Yes	Yes
Muncipality Fixed-Effects	Yes	Yes	Yes
R-squared	0.543	0.551	0.593
Number of Provinces	46	46	46

Notes: This table replicates Table 3, but with the data aggregated at the level of provinces. One province is composed of several municipalities. θ_c corresponds to the metal mining employment share of municipality c in 1998. All regressions controls for municipality and year fixed effects. Standard errors (in parenthesis) are clustered at the municipal level. *** significant at 1%; ** 5%; * 10%.

[25] The products included are some fruits, pulp, wine, and fish meal, among others.

- Finally, we check whether our results hold when we change the aggregation level. A wider definition of local labor market allows us to remove potential concerns related to the fact that people may live in one municipality, but work in another municipality within in the same province. Thus, we also estimate the model using province-level data. Results in Table 6 are in line with those using municipality-level data. The interaction term between the price index and the exposure variable measured at the province level is negative and significant, indicating that higher metal prices reduce poverty more in provinces with larger initial employment share in mining industry. Then, we conclude that our results are robust to defining our variables at a higher level of aggregation.[26]

For our finding that the poverty rate fell more in relatively exposed municipalities to be convincing, it needs to be supported by some additional evidence on the mechanism because mining in general represents a small share of employment. In what follows, we examine the impact of the price shock on two labor market variables: employment and wages. Moreover, given that mining production intensively uses unskilled labor, we estimate the impact of commodity prices for both skilled and unskilled workers.

5. Labor Market Mechanisms

In this section, we study whether the labor market response could explain why poverty fell relatively more in municipalities exposed to the commodity shock. In practice, we use the average wage and employment rate (employment over population) as dependent variables to look at how the commodity boom impacted labor markets outcomes. We estimate the model for unskilled and skilled workers. A worker is defined as unskilled when he has only secondary education or less.

In Table 7 we show the estimation results. The aim of this exercise is to understand whether, in municipalities with higher exposure to the price shock, the employment and wages increased by more than in municipalities that are less exposed. Results in Panel A of Table 7 show – as expected – a positive and significant coefficient for our variable of interest (Column 1). Thus our evidence is suggestive that one channel for poverty reduction was an increase in employment. Moreover, this poverty reduction is associated with employment gains for unskilled workers, whose wages are closer to the poverty line than those of skilled workers. We present evidence consistent with this idea in columns 2 and 3 of Table 7. Dividing the sample between skilled and unskilled workers, our results indicate that positive price shocks were associated with mild increases in employment rate for

[26] The results for provinces are also robust to the battery of robustness checks that we present in appendix B for municipalities.

unskilled workers, but not for skilled ones. Doubling the price index, as roughly happened between 2003 and 2013, leads to increases in the unskilled employment rate of about 0.1 and 0.8 percentage points in the 75th and 90th percentiles of mining labor share distribution respectively.[27] Looking at the potential impact of metal prices shocks on unskilled employment across other industries, we find that the positive effect is only observed in the minerals industry.[28] This is consistent with previous findings by Arias et al (2013) showing that commodities are not very interrelated with other industries of the local economy in the case of Chile.

Table 7: Impact on Employment and Wages

Sample	All	Skilled	Unskilled
	(1)	(2)	(3)
Panel A: Employment Share			
Commodity Shock	0.071***	0.018	0.052**
	(0.024)	(0.017)	(0.026)
R-Squared	0.326	0.304	0.351
Observations	1,356	1,356	1,356
Municipalities	196	196	196
Panel B: Log(Wages)			
Commodity Shock	0.466**	0.151	0.515***
	(0.188)	(0.270)	(0.081)
R-Squared	0.617	0.583	0.835
Observations	1,328	1,328	1,328
Municipalities	196	196	196
For all regressions:			
Year Fixed-Effects	Yes	Yes	Yes
Municipality Fixed-Effects	Yes	Yes	Yes
Pre/post Trends	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Notes: This Table shows the effect of metal prices changes on total employment rate. Employment rate is defined as municipal-level employment over population. Skilled (Unskilled) are workers with schooling higher (lower) than secondary. All regressions controls for municipality and year fixed effects. Standard errors (in parenthesis) are clustered at the municipal level. *** Significant at 1%; ** 5%; * 10%.

[27] For comparison, note that unskilled employment participation is 30%.
[28] These results are available upon request.

In Panel B of Table 7 we present estimations for the impact of the price shock on average wages. Our findings reveal that price increase had – as expected – a positive impact on wages. Like our previous findings, our results indicate that the impact is positive and significant only for unskilled workers. For municipalities in the 75th and 90th percentiles of the exposure distribution, doubling metal prices would have increased unskilled wages by 1% and 8% respectively.

6. Conclusions

Several developing countries, particularly Latin American economies, have largely benefited from trade shocks during the 2000s. Although the traditional literature has explored the aggregate effects of these booms on economic performance, little is known on the local effects on poverty and income distribution. In this paper, we use disaggregated Chilean municipality-level information to shed light on the impact of changes in mineral prices on poverty rates. The case of Chile is especially interesting because it was largely favored by increased export prices during the 2000s, and its poverty rate showed an important decline during this period.

Following previous empirical work on local effects of trade shocks, we apply a difference in difference approach by exploiting exogenous prices changes in five mineral products and the different exposure of municipalities to this positive shock. We focus mainly on the poverty effect. Our results indicate that the increase in mineral prices contributed significantly to poverty reduction.

In addition, to better understand how these price changes are associated with poverty reduction, we investigate the potential mechanisms of the relationship between commodity prices and poverty, specifically whether this impact is mostly channeled through labor markets. We look at how increases in minerals prices increase employment and wages. Our findings indicate that commodity price shocks had a positive impact on employment and wages, but particularly for unskilled workers in mining industries.

In sum, our results are more in line with the idea of direct effects on labor demand for unskilled workers rather than potential indirect effects on other industries and workers through backward linkages. However, with the data at hand, it could be possible to look more specifically at the impact on other sectors and workers such as those in manufacturing and non-tradable industries. This and other questions related to the short -and long-run effects on employment and wages, are an interesting focus of future research. In general, more work needs to be done to better understand the local effects of resource booms, especially with the recent evolution of commodities prices and the potentially negative consequences of their current and future reduction.

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A. DATA APPENDIX

Variable	Source	Definition
Cooper Price	COCHILCO	Dollars per pound of refined cooper (U$/lb) - London Metal Exchange: Copper Grade A Settlement.
Molybdenum Price	COCHILCO	Dollars per pound of molybdenum (U$/lb) - US Dealers.
Gold Price	COCHILCO	Dollars per ounce of gold (U$/oz) - HANDY & HARMAN.
Silver Price	COCHILCO	Dollars per ounce of silver (U$/oz) - HANDY & HARMAN.
Iron Ore Price	FMI - MacroeconomicStatistics	Dollars per Metric Tons of iron ore (U$/MT).
Cooper Production	COCHILCO	Thousands of Metric Tons (MT).
MolybdenumProduction	COCHILCO	Metric Tons (MT) of Fine Content.
Gold Production	COCHILCO	Kilograms (Kg) of Fine Content.
SilverProduction	COCHILCO	Kilograms (Kg) of Fine Content.
Iron Ore Production	COCHILCO	Thousands of Metric Tons (MT).
Price Index weighted by production	COCHILCO	Index of metal prices, weighted by production of each metal over total production of five metals.
Price Index weighted by value of production	COCHILCO	Index of metal prices, weighted by value of production over total value of production of five metals.
Metal Mining Share	CASEN	Ratio of workers employed metal mining (ISIC Rev.3 1310 and 1320) over total municipal employment.
Municipal PovertyRate	CASEN	Ratio of poor people, over total municipal popullation. An individual is defined as "poor" if their income (or income per-capita of the household) doesn't covers the cost of a Basic Food Basket, and a Basic Non-Food Basket. So, the poverty thresholds is the total value of both baskets.
MunicipalitySize	CASEN	Number of people living in each municipality.
AverageSchooling	CASEN	Average years of schooling for older than 15 years.
Avg. Number of persons in households	CASEN	Average number of persons per household, for each monucipality.
Ethnic Share	CASEN	Ratio of people who belong to an ethnic, over total municipal popullation.
Urban Share	CASEN	Ratio of people living in urban area, over total municipal popullation.
SkilledWorkers	CASEN	Workers who at most ended high school.
UnskilledWorkers	CASEN	Workers with more education than high school.
AverageWages - skilledworkers	CASEN	Average wages (income from main occupation) of skilled workers, for each municipality.
AverageWages - unskilledworkers	CASEN	Average wages (income from main occupation) of unkilled workers, for each municipality.

B. Additional Tables

Table B1. Using Restricted PANEL 1998-2013

	(1)	(2)	(3)	(4)
Log Pt xθ_c	-0.155**	-0.140**	-0.101*	-0.108*
	(0.066)	(0.068)	(0.054)	(0.056)
Trends (Metal-mining)			-0.001	-0.001
			(0.002)	(0.002)
Trends (Non Metal-mining)			0.003	0.003
			(0.002)	(0.002)
Poverty98*Pindex			-0.240***	-0.237***
			(0.022)	(0.023)
Controls	No	Yes	Yes	Yes
Observations	968	968	959	911
Year Fixed-Effects	Yes	Yes	Yes	Yes
Muncipality Fixed-Effects	Yes	Yes	Yes	Yes
R-squared	0.436	0.462	0.531	0.532
Number of Municipalities	196	196	195	183

Notes: This table shows the effect of metal prices changes on poverty rate, computing exposure θc as the average metal mining employment share of municipality c in 1998. Standard errors (in parenthesis) are clustered at the municipal level. Key: *** significant at 1%; ** 5%; * 10%.

Table B2. Using Alternative Measure of Exposure

	(1)	(2)	(3)	(4)
Log Pt xθ_c	-0.152	-0.150	-0.157	-0.159
	(0.065)**	(0.065)**	(0.066)**	(0.068)**
Regional GDP growth	--	0.037	0.047	0.032
		(0.088)	(0.084)	(0.084)
Log population	--	--	0.025	0.028
			(0.018)	(0.022)
Log Household Size	--	--	0.047	0.040
			(0.022)**	(0.025)
Log Years of Schooling	--	--	-0.087	-0.146
			(0.032)***	(0.039)***
Urban Share	--	--	0.047	0.079
			(0.031)	(0.036)**
Municipality FE	yes	yes	yes	yes
Year FE	yes	yes	yes	yes
R-squared	0.33	0.33	0.34	0.39
Observations	1950	1950	1950	1274

Notes: This table shows the effect of metal prices changes on poverty rate, computing exposure θ_c as the average metal mining employment share of municipality c in 1998-2000. Standard errors (in parenthesis) are clustered at the municipal level. Key: *** significant at 1%; ** 5%; * 10%.

Table B3. Excluding Metropolitan Region

	(1)	(2)	(3)	(4)
Log Pt xθ_c	-0.123*	-0.114*	-0.109**	-0.108**
	(0.066)	(0.066)	(0.048)	(0.048)
Trends (Metal-mining)	-	-	0.002	0.002
			(0.002)	(0.002)
Trends (Non Metal-mining)	-	-	0.008***	0.008***
			(0.002)	(0.002)
Poverty98*Pindex	-	-	-0.199***	-0.207***
			(0.022)	(0.023)
Controls	No	Yes	Yes	Yes
Observations	995	995	991	927
Year Fixed-Effects	yes	yes	yes	yes
Muncipality Fixed-Effects	yes	yes	yes	yes
R-squared	0.395	0.419	0.463	0.492
Number of Municipalities	144	144	144	133

Notes: This table shows the effect of metal prices changes on poverty rate, computing exposure θc as the average metal mining employment share of municipality c in 1998. Standard errors (in parenthesis) are clustered at the municipal level. Key: *** significant at 1%; ** 5%; * 10%.

Table B4. Including Other Commodities Prices

	(1)	(2)
Log Pt xθ_c	-0.174***	-0.112**
	(0.066)	(0.045)
Log Pot xϕ_c	-0.077*	0.046
	(0.043)	(0.038)
Trends (Metal-mining)	-	0.002
		(0.002)
Trends (Non Metal-mining)	-	0.005***
		(0.002)
Poverty98*Pindex	-	-0.219***
		(0.017)
Controls	y	y
Observations	1356	1356
Year Fixed-Effects	y	y
Municipality Fixed-Effects	y	y
R-squared	0.372	0.434
Number of Municipalities	196	196

Notes: This table shows the effect of metal prices changes on poverty rate, computing exposure θ_c (ϕ_c) as the average metal mining (other commodities) employment share of municipality c in 1998. Standard errors (in parenthesis) are clustered at the municipal level. Key: *** significant at 1%; ** 5%; * 10%.