Commodity Prices Shocks and Poverty in Chile[*]

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Abstract

This paper examines the local economic impact on poverty of large increases in metal-mining products prices in Chile. Using household data from 1998 to 2009, and exploiting differences in municipalities' exposure to changes in prices, we find evidence of a reduction in poverty rates associated with the positive terms of trade shock. The differential impact of 2% for less and more exposed municipalities is quantitatively important and almost identical to the reduction in aggregate poverty between 2003 and 2009. 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 those in metal-mining industries.

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1. Introduction

Over the last decade, several developing countries have experienced positive and large terms of trade shocks. This has been result of the strong and sustained economic growth in China and its growing appetite for commodities (Yu, 2011; Farooki and Kaplinsky, 2013). The traditional literature on Dutch Disease suggest that this phenomenon should negatively affect countries' performance by appreciating the real exchange rate and contracting the manufacturing industry (Corden, 1982; Krugman, 1987). Moreover, this should also affect economic growth adversely according to the literature on "natural resource curse" (Sachs and Warner, 2001; Sachs and Warner, 1999).

The empirical evidence on these issues is controversial, but the current consensus suggest that the negative effects of natural resources booms or windfalls would be much prevalent in economies with weak institutions (Van der Ploeg, 2011). For example, Mehlum et al. (2006) show that the negative impact of natural resources abundance is only observed in economies with inferior institutions, but not in countries with high institutional quality. Robinson et al. (2006) explains these differences about the impact of resources booms, showing that countries with institutions that promote accountability and state competence are able to ameliorate the perverse political incentives originated during resources booms[1].

The good performance of developing countries during the decade before the financial crisis – in particular for Latin American countries - challenges in part this wisdom that natural resources would be detrimental for economic performance. Indeed, resources

[1] More recent evidence by Smith (2015) and James (2015) challenges the robustness of the previous findings about a negative relationship between natural resources abundance and economic growth.

abundant countries not only experienced strong economic growth during this period, but also were less affected during the recent financial crisis compared to previous ones[2]. However, little is known on how natural resources export booms affect other dimensions of economic welfare – such as poverty or income distribution –, and how these shocks are transmitted to local communities that are potentially more exposed to these shocks. This is partly due to the belief that commodities are enclaves dominated by multinationals with few interrelated activities with the rest of the economy (Cardoso and Faletto, 1979; Prebisch, 1963)[3].

Recent literature on local markets effects explores the impact of several trade-related shocks over different economies and time periods.[4] McCaig (2011) explores how the bilateral U.S.-Vietnam trade agreement affected provincial poverty in Vietnam. Exploiting different exposure to changes in the U.S. tariffs due to differences in the structure of labor force, he finds that lower tariffs were associated with a reduction in poverty. Aragón and Rud (2013) examine the local impact of the expansion of a large gold mine in Peru, using differences in exposure originated by the distance of localities to the mine. Their results reveal positive effects on real income driven by a higher demand for local inputs. Caselli and Michaels (2013) investigate the impact of oil windfalls across Brazilian municipalities and find that the impact on households' welfare was lower than the expected by the increase in municipalities' resources. Similar approaches have been also used to evaluate the impact of

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

[3] An analysis for a particular mining region in Chile consistent with the idea of enclaves is provided by Arias et al (2013).

[4] See Aragón et al. (2014) for a review on this incipient literature on local economic impacts.

Indian trade reforms on schooling and child labor (Edmonds, et al. 2010) and poverty and consumption (Topalova, 2010)[5].

We contribute to the literature on local market effects by analyzing the impact increases in mineral prices on poverty rates across municipalities in Chile during 1998-2009. We exploit the mostly exogenous prices changes in five mineral product – mainly before the recent financial crisis - and the different exposure of municipalities to this positive shock. This within-country analysis is particularly interesting in an economy like Chile because it is highly dependent on mining exports, the change in export prices is exogenous, and the mining activity is distributed across several local markets. Moreover, as we document in the following sections, the economy has experienced an important reduction in poverty rates. We try to shed light on how positive shock to export prices may explain part of this declination in poverty rates.

In addition, we investigate the potential mechanisms through which an increase in commodity prices reduce poverty. To do that, based on the idea that this impact is mostly channeled through labor markets, we look at how increases in minerals prices increase employment and wages. We also examine the impact across industries' and workers skills.

We find evidence that municipalities more exposed to changes in mineral prices have reduced poverty rates more significantly. According to our estimations, an export price increase equivalent to the experienced between 2003 and 2009 reduced poverty rates in 2 percentage points in municipalities relatively exposed to the commodity boom –with at

[5] See also McCaig and Pavcnik (2014), Howie and Atakhanova (2014), and Marchand (2014).

least 5% of employment working in the metal-mining sector–in comparison to municipalities with no exposure to the boom.[6] Our results are robust to several checks, specifically to changes in the sample of municipalities, the period analyzed, and the inclusion of several control variables and regional shocks that might be driving our results.

In terms of mechanisms, our results indicate that reduction in poverty rates are potentially generated by the impact of price changes on labor market outcomes. In particular, we find differential effects of about 6.0 percent in nominal wages and 0.4 percentage points in the employment rate between mores and less exposed municipalities.

The paper is structured as follows. In the next section, we describe 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. In the fourth section, the main results and several robustness checks are presented. The main findings and conclusions are discussed in the fifth section.

2. Background and Data

We begin this section describing the data we use in this paper. We then provide background on the commodity boom of mid 2000s and its effect on Chilean local communities. Finally, we present preliminary evidence of the commodity price shock on local poverty and income.

[6] This number roughly corresponds to the upper decile of the metal-mining employment share unconditional distribution and to the upper quartile of the metal-mining employment share conditional on having positive employment in this sector.

2.1 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. CASEN 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. In average, CASEN includes survey information for about 65,000 households in 290 municipalities – around 1.5% of the national population (see Table A1).

In this paper, we use the five CASEN waves ranging from 1998 to 2009. CASEN is available from 1985. Nevertheless, we start our analysis in 1998, because the municipal coverage of earlier CASEN versions is significantly lower.[7] On the other end, we restrict our main sample to end in 2009, because the waves of 2011 and 2013 are non-representative at the municipal-level.[8] The fact that the commodity boom of 2004 is just halfway in between the beginning and end 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.[9]

We aggregate the original data at the municipal level –the smallest administrative unit in Chile–. In principle, the analysis could also be performed at different aggregation level

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

[8] CASEN is representative at the national and regional level for all years. At the municipal-level it is representative for a subset of all municipalities in our sample period.

[9] Specifically, we use three waves before the beginning of the commodity boom in 2004 (1998, 2000 and 2003), and two waves after the shock (2006 and 2009).

(region or provinces) an also the individual level. However, the identification of general equilibrium effects –such as spillovers to sectors not related directly to the commodity sector– may be more challenging at the individual level. We do not use data at higher aggregation levels because municipalities look more similar to the concept of local labor markets. The region consists of several provinces and municipalities, in some case covering large distances between municipalities, which indicates that it is very broad aggregation for looking at impacts on local labor markets. This is also valid for most of provinces, but not for some of them especially those where the capital of the country – Santiago - is located. In this case, the relevant labor market might be conformed for several municipalities. In addition, CASEN is only representative at the level of provinces for 2006—2009, and it usually the case that not all municipalities within provinces are surveyed every year. This implies that using the data at the level of provinces would likely result in non-representative results. Therefore, in the absence of more detailed information about commuting, we employ municipalities as our unit of study. We believe that this is conservative strategy considering that in the case that provinces were the relevant market, this would work against to find significant results at the municipality level.

The resulting dataset contains a total of 1,452 observations (335 municipalities), or 920 observations when we restrict the sample to the 184 municipalities included in all CASEN surveys from 1998 to 2009.[10]

[10] 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, we define the poverty rate σ_{ct} for each period t as:

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

Where $I(y_{ict} < \bar{y}_t)$ is an indicator function that takes the value one if individual i of municipality c in period t has an income y_{ict} below the poverty line $\bar{y}_t$, and ω_{ict} are weights given 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.[11] Note that by following the official definition of poverty, we avoid dealing with the possibility of price heterogeneity across municipalities. This may bias our results based in poverty rate downwards if prices increase relatively more in mining municipalities than in non-mining municipalities after the commodity boom.

In addition to the poverty rate, we use a series of other variables either as outcome variables or as controls. These variables are (see Appendix A for details on the construction of the variables): (i) the average wage unskilled workers (high-school or lower) and skilled workers (some post-secondary education), (ii) the average years of schooling, (iii) the share of people belonging to an ethnic group, (iv) the share of people living in urban zones, and (v) the share of metal-mining employment.[12]

[11] 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.

[12]The variable of ethnicity is only available from 2000 onwards.

We complement CASEN's data with price and production information for the main metals produced in Chile. The data on metals' prices and production are from the *Chilean Copper Commission* (COCHILCO) and the IMF's *Macroeconomic Statistics Database*.[13]

2.2 Metals' Commodity Boom

The mid-2000s 'super-cycle' has been one of the largest commodity booms of the last 100 years. 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).[14] 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.[15]

The commodity boom affected positively 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 commove with the price of Copper, its main metal. Chile it is not only the world's largest producer of copper, but it is also within

[13] Appendix A provides detailed information on the definition of each price and production variable used in this paper.
[14] Erten and Ocampo (2013) make a more general point and show evidence that suggest that all 'super-cycles' from 1865 to 2010 for non-oil commodities were essentially demand-driven.
[15] In the medium-run, commodity producing countries adjusted their production to profit from the higher prices. This response may have fed back on international prices as long as the magnitude of the supply response had been large enough. The commodity boom may also be positively feedback by increasing marginal costs. Humphreys (2010) provides evidence that a fraction of the price trajectory of mineral commodities reflected cost pressures.

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 price went from about USD 0.80 per pound in 2003 to over USD 4.00 per pound the second quarter of 2008, and Molybdenum jumped from USD 3.3 per pound to about USD 32.5 per pound over the same period –a ten-fold increase. Over the same period, tax revenues – largely dependent on Chile's main state owned mine revenues, CODELCO's – jumped significantly, and employment and economic activity flourish in mining regions (see Cochilco, 2013).

In this paper we exploit the variation in metal prices to study the effect of the mid-2000s commodity boom on poverty, income and employment of local communities. To account for the price effect of the relevant metals for the Chilean economy, we construct a metal 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.[16] We define, for each period *t* the average percentage change in metals' price $\tilde{P}_t$ as:

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

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

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

[16] 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.

Figure 2 shows the trajectory for the metals' price index over the sample period (scale on the right-axis). As it 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, while in 2006 the price index was almost three-times higher than in 2003. After a pause from 2006 to 2009, where the metals' price stabilized and had a brief collapse in 2009 following the onset of the sub-prime financial crisis, the metals' price 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.

2.3 Preliminary Evidence on Poverty, Wages and Employment

Before turning to our main empirical results, we present preliminary (and unconditional) results on the relationship between the commodity boom and poverty. We complement this evidence by looking at the behavior of employment and wages. As a first pass, in the line of difference-in-difference approach that we discuss in the next section, we compare the trajectory of poverty rate in municipalities where mining is a relatively important activity, with poverty rate in all other municipalities. 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.

A key aspect in this analysis is the definition of mining and non-mining municipalities. In principle, we could define mining municipalities in terms of their economic activity (i.e., production). However, this could lead to misleading results if workers live in different municipalities where they work.[17] Fortunately, CASEN allow us to deal with this issue: it provides information for the economic activity of each member of the household – independently on the geographical location of the job. This imply that the employment share in the mining sector of a given municipality may be relatively high even if there is no mines or mineral deposits located nearby. Thus, we opt for using mining employment to determine the degree of exposure to mining of municipalities. In particular, we define mining (non-mining) municipalities when the mining employment share is above 1% in 1998 –which roughly corresponds to the upper quartile of 1998's employment share distribution.[18]

Figure 2 shows the poverty rate, at the national level, and for mining and non-mining municipalities. As it can be seen, there is a negative trend in the national poverty rate from 1998 to 2003, common to both mining and non-mining municipalities. National poverty rate experienced an important decline, from 20.1% to 18.6%. In 2006, poverty rate experience a sharp decline from 18.7% to 13.7%.[19] Interestingly, the decline in the poverty rate is 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 2

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[17] This is a certain possibility in mining, 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.

[18] Figure 3 shows the geographical distribution of the average share of metal-mining employment for each municipality over 1998—2003. As it can be seen, relatively exposed municipalities tend to be located close to key mining deposits –such as 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, with municipalities showing positive exposure despite of the fact of being far away from the main mine deposits.

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

percentage points larger –, from 18.2% to 12.6%. After the financial crisis of 2008, poverty increased, but interestingly, the poverty gap between mining and non-mining municipalities even widened to about 2.5 percentage points.

3. Empirical Model

To analyze the impact of changes in mineral products on poverty rates, we follow a differences in differences approach and exploit changes over time in prices and differences in exposure to these changes. We estimate versions of the following equation:

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

where Y is the poverty at county c and year t, P the metal-mining prices index described in the previous section, and θ is as measure of exposure of county c to changes in P. Our baseline results are derived using the share of the metal-mining sector on each municipality overall employment. We compute the exposure variable at the beginning of our sample (year 1998), before the large increases in terms of trade experienced by the economy. The vector X includes control variables —explained in detail in the next section— that previous literature indicates as important for explaining changes in poverty regions across regions (Mc Caig, 2011).

This specification, by including county fixed-effects and year fixed-effects, allows to control for county-specific variables than might affect poverty and also for common time-varying shocks affecting to all counties. Thus, even though we are not able to identify the overall impact of increases in metal prices during the period, we are able to identify the differential effect depending on whether a county is more dependent on minerals. This exposure or dependency is measured as the mining employment share because our idea is that poverty effects of changes in terms of trade are mostly channeled through the labor market.

The expected sign for parameter θ is negative, indicating that positive terms of trade shocks should reduce poverty, and in this case, the impact should be higher in more exposed counties. In fact, minor or zero effects should be expected in counties with no mining activities. Our analysis is different from Caselli and Michaels (2013) who look at how oil windfalls across municipalities in Brazil have an impact on living standards, but the focus is on larger resources for municipalities. In the case of Chile, municipalities are not the main benefitted by windfall from mining because taxes from mining companies are collected for the central government. However, local governments may be undirected benefited from the windfall whether 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 resources booms[20].

We use a similar specification to look at some mechanisms or channels through which an increase in terms of trade might affect poverty. In those cases, the variable Y - also measured for counties over time – is some labor market outcome such as employment or wages. In fact, the most direct impact on labor markets of a positive terms of trade shock is an increase in labor demand, increasing wages and employment. However, this positive shock may also have general equilibrium effects in several other dimensions. First, consider

[20] Although this as interesting possibility, we focus on the broad impact of prices changes not distinguishing whether this was a direct effect on labor markets or indirect through increases in local government revenues.

other complementary activities associated with the mining boom such as input providers or non-tradable services. In fact, commodity booms are commonly associated with, for example, construction booms that can increase activity and wages in these sectors. Then, our empirical exercises on the mechanisms estimate the impact of prices on wages and employment by industries and workers skills.

4. Results

In this section we present our empirical results for the impact of the 2000s commodity shock on poverty. We explore different mechanisms explaining our results, and finally, we discuss robustness checks for our results.

4.1 Effect on Poverty

Before turning to our main empirical results, we make a few clarifications. First, the effective number of municipalities in all regressions is restricted to the number included in the 1998 version of CASEN, because we calculate municipalities' exposure in that year. Only 196 out of the universe of 335 municipalities are included in 1998. This results in a reduction from 1,452 to 968 observations in the effective sample size.[21] Second, we do not include observations for 2011 or 2013 in our main results. The reason for this – as explained in the data section – is related to CASEN's survey design: for these years, the survey is only representative at the regional level. Therefore, we opt to follow a conservative approach and

[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. Following this strategy enlarges our sample to 297 municipalities (1,950 observations). However, using this definition does not affect our main results.

exclude these observations from the main analysis – despite of the potential loss in identifying power that results from shortening the panel of municipalities.[22]

We first explore in Table 1 the impact of the commodity shock on poverty rates. All regressions control for municipality and year fixed-effects. Column 1 only includes fixed effects. Column 2 adds regional GDP to control for economic activity: we expect poverty rate to decrease when economic activity is higher.[23] Column 3 controls —in addition to the variables in the previous columns—for other covariates varying at the municipal-year level: municipality size (measured in terms of population), year of schooling (in logarithms), household's size (in logarithms), and the share of urban population of each municipality.[24] We expect poverty rate to be higher in municipalities with lower average schooling, larger household's size, and higher share of urban population. The sign of the municipality's size coefficient is not determined a priori: we include this variable to control for potential scale-effects (larger municipalities may attract a larger share of fiscal resources aimed at reducing poverty). Finally, column 4 repeats the estimation of column 3 for the subset of municipalities with information in all five CASEN surveys from 1998 to 2009.

Results are summarized below:

- 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

[22] In appendix B we show that, if anything, our results become indeed significantly more precise when including observations from 2011 and 2013.
[23] 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.
[24] See appendix A for data sources and definition.

the 95% confidence level. The coefficient is notably stable across specifications – it moves in the range -0.140 to -0.158.

- 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 average exposure to the commodity shock, the find a modest impact: a 100 percent increase in the metals' price index reduces poverty in about 0.3 percentage points in these municipalities (relative to municipalities with zero exposure).
- The impact of the shock, however, increases significantly as we move away from the average exposure to the upper tail of its distribution: for municipalities in the upper decile, the impact of the shock increases to 1 percentage point, and for municipalities in the upper percentile, the effect is about 4.1 percentage points – more than 10 times the average effect–.
- With the exception of regional growth, results are consistent with our expectations: poverty tends to be larger in municipalities with lower average schooling, larger household's size, and higher share of urban population. Municipalities' size is non-significant (see columns 3 and 4).
- Columns (2)-(4) shows a positive correlation between regional GDP growth. This result deserves further examination, as it goes against our expectations.

The finding that poverty rate fell by more in municipalities where the mining sector is notable: mining represents a small share of employment, yet a shock to this sector seems to have leaked to the inhabitants of local communities with employment linkages the this sector. However, these results about the impact on poverty rates does not allow to understand which were the mechanisms through which the positive shock on metal products contributed to reduction in poverty. In what follows, we examine the impact of the shock on labor markets variables: employment and wages.

4.2 Mechanisms: Impact on Employment and Wages

Employment Rate and Employment Composition

In Table 2 we estimate (1) using employment rate – defined as total employment over overall population – as dependent variable. The aim of this exercise is to understand whether in municipalities with higher exposure to the prices shock, the employment increased by more than in municipalities less exposed to this shock. Results – as expected – show a positive coefficient for our variable of interest, although it is only significant in the last specification. Then, the evidence is not too strong about that a large employment generation is behind the reduction in poverty.

Yet, it may be possible that prices shock had a heterogeneous impact on employment across industries and workers qualification. In Tables 3 and 4 we explore this possibility. Making use of the fact that OLS is a linear operator, we decompose the overall employment rate by workers skill-level and sectors.

Table 3 decomposes the effect on employment rate by sectors: mining and non-mining. The aim of this exercise is to explore whether metals' price shock affected exclusively employment on the metals' sector, or on the contrary, if it leaked to other sectors of the local economy. Results in Table 3 show a statistically significant employment increase for the metal-mining sector, but a non-significant response for rest of the economy. This is consistent with the idea that commodities are enclaves dominated by multinationals with few interrelated activities with the rest of the economy (Arias et al, 2013). The magnitude of the metals' price coefficient indicates a maximum response of 1.5 percentage points in employment rate when the metal price index increases 100 percent for municipalities in the upper percentile of the exposure distribution.

In Table 4, we decompose the impact on employment rate by skill level. Intuitively, if poverty reduction occurred through the employment margin – i.e., individuals exiting poverty after obtaining a new job –, we would expect the impact of the commodity price shock to be concentrated in individuals with low skill-level. We define unskilled workers as individuals which highest attained education is high-school or below, and skilled workers to individuals with some post-secondary education (e.g., college). Results in columns 1—3 shows a negative and non-significant coefficient for skilled employment. In contrast, the coefficient for the unskilled employment rate is positive and significant. The magnitude of the metals' price coefficient suggests that, when evaluated at the top percentile of the exposure distribution, the effect of a 100 increase in the metal price index is an increase in about 1.2 percentage points the unskilled employment rate.

In Table 5 we investigate whether the positive employment response in the metal-mining sector is concentrated in skilled or unskilled labor. Results – as in Table 3 for the overall local economy – suggest that effect is concentrated over unskilled workers. The metals' price coefficient is moderately larger than in Table 3 and 4, showing that for municipalities in the upper percentile of the exposure distribution, the employment rate response is about 2 percentage points for each 100 percent increase in the metals' price index.

Wages

In Table 6 we present estimations for the impact of the price shock on average wages. Across the different specifications, our findings reveals that price increase had – as expected – a positive impact on wages. For municipalities in the upper decile of the exposure distribution, an increase of 100% in prices augmented wages by 3 –4 percent, while for municipalities in the upper percentile of the distribution, the impact on ages was considerably larger: a 100% increase in metals prices increased wages in 12.5-14.5 percent.

In Table 7 and 8 we study the effect of the metals' price shock on skilled and unskilled wages, respectively. Table 7 shows a large and non-significant effect of metals' price variable on skilled wages.[25] Taken at face value, the magnitude of the coefficient suggests that for municipalities in the upper percentile of the exposure distribution, a 100 percent increase in the price of metals increase wages in about 2.5-6.0 percent – although imprecisely estimated.

In Table 8 we study the effect of the commodity boom on unskilled workers' wage. In contrast to the case of skilled labor, this table shows highly significant coefficients in all specifications – all of them significant at the 1% level. The magnitude of the metals' price coefficient is significantly higher too: for municipalities in the upper decile (percentile) of the exposure distribution, a 100 percent increase in the price of metals raise unskilled wages in about 5.0 (19.0) percentage points.

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[25] The difference in the number of observations with respect to Table 6 is explained by 3 municipalities with no skilled labor in a particular year.

We also study the effect of the shock in metal-mining wages and on the rest of the economy. Similar to the previous estimations for employment, the evidence (not reported, but available upon request) suggests that the impact of the commodities prices shock is mostly positive for workers in the metal-mining industry and small or non-significant for the rest of the economy..

4.3 Robustness Checks

We performed a number of robustness checks, added covariates, and considered a series of extensions. In this subsection we discuss the most important of them.

- *Alternative definition for mining exposure and longer panel.* In our baseline results we only use the 5 waves of CASEN between 1998 and 2009. Despite of the fact that CASEN 2011 and 2013 are not representative, we replicate our results for poverty in Table B2 using the complete panel between 1998 and 2013. As it can be seen, if anything our results get more precise as we consider the additional years.
- A key variable in our results if the exposure of each municipality to the commodity shock. 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 (see Table B1). As an alternative, we measure exposure as the average employment share in 1998-2000. This enlarges the universe of municipalities to 297 municipalities (1,950 observations for the full panel 1998-2013). Table B3 shows that results using this alternative definition of exposure does not change qualitatively 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 —Chile's capital city—. To check if this affect our results, we repeat our estimations for poverty, employment and wages excluding the Metropolitan Region – which includes the 'Gran Santiago' as well as other neighboring municipalities that are close enough to the city center so that people can commute to their jobs – (results available upon request). Results are largely unaffected by the exclusion of the Metropolitan region. In addition, we studied whether the exclusion of other conurbations such as Concepción-Talcahuano, Valparaíso-Viña del Mar y Coquimbo-La Serena. Results confirm our main conclusions.
- *Additional covariates*. In a number of specification we included other control variables. For instance, we included the share of population with less than high school as highest attained level of education instead of years of schooling. Results confirmed our main results. A second check we performed was to investigate whether the share of ethnic population in the municipality affected our results. Once again, our results – and in particular, the coefficients—were not affected by the inclusion of this variable.

5. Conclusions

Several developing countries, and particularly Latin American economies, have largely benefited by positive terms of trade shocks during the 2000s. Although 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 –mainly copper in the case the Chile – on poverty rates. The case of Chile is especially interesting, because it was largely favored by an increases in export prices during the 2000s, and its poverty rate showed an important decline during this period.

Following previous empirical works 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 effects of this shock. Our results indicate that an increase in mineral prices contributed to poverty reduction significantly.

In addition, to better understand how prices changes are associated with poverty reduction, we investigate the potential mechanisms of the relationship between commodity prices and poverty. We investigate whether this impact is mostly channeled through labor markets and 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 to the impact on other sectors and workers, such as those in manufacturing and non-tradable industries. This and other questions, for example related to the short -and long-run effects on employment and wages, can be an interesting are of future research. In general, more work need to be done to understand better the local effects of resources booms, especially with the recent evolution of commodities prices and the potentially negative consequences of their current and future reduction.

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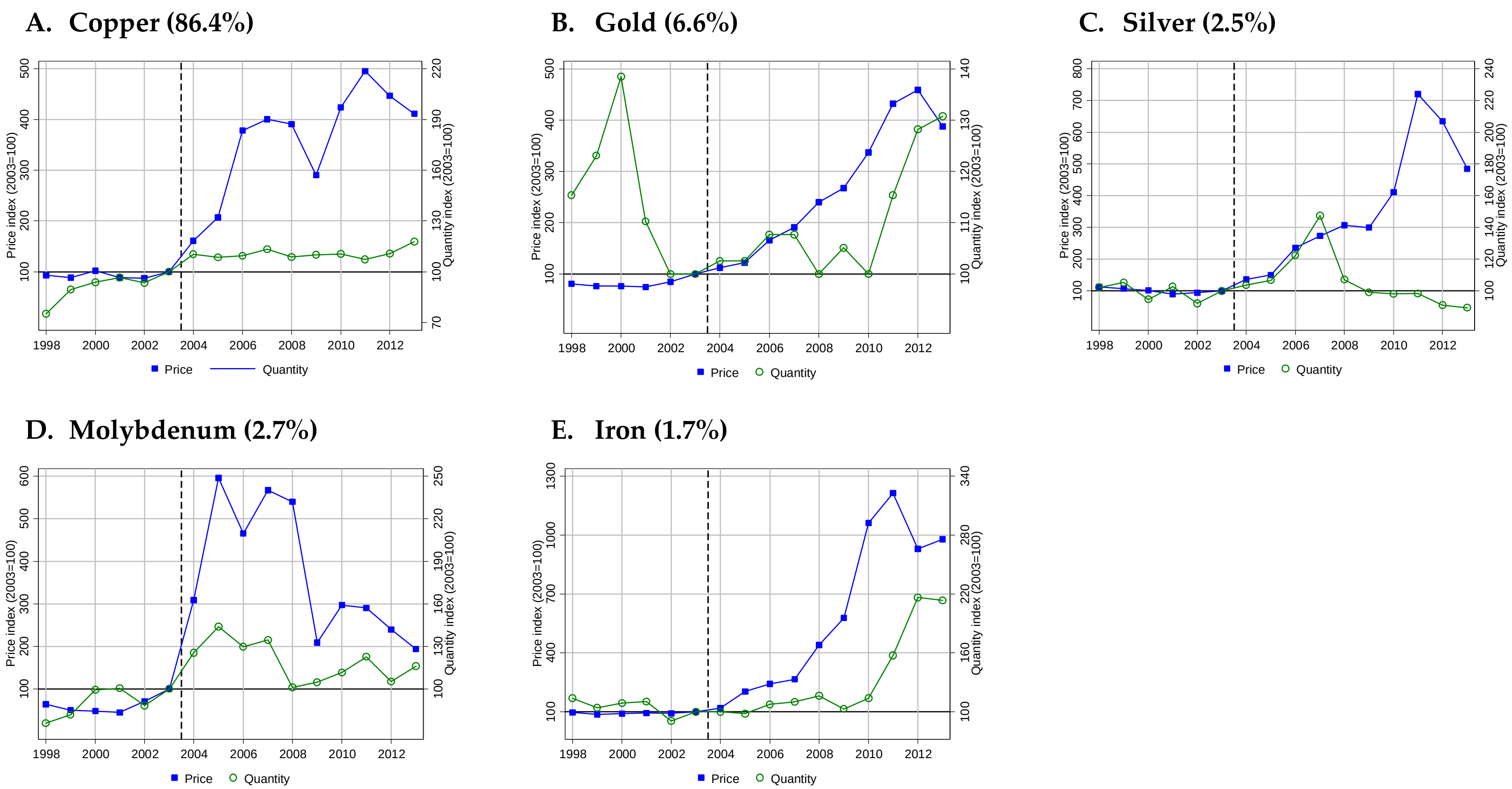
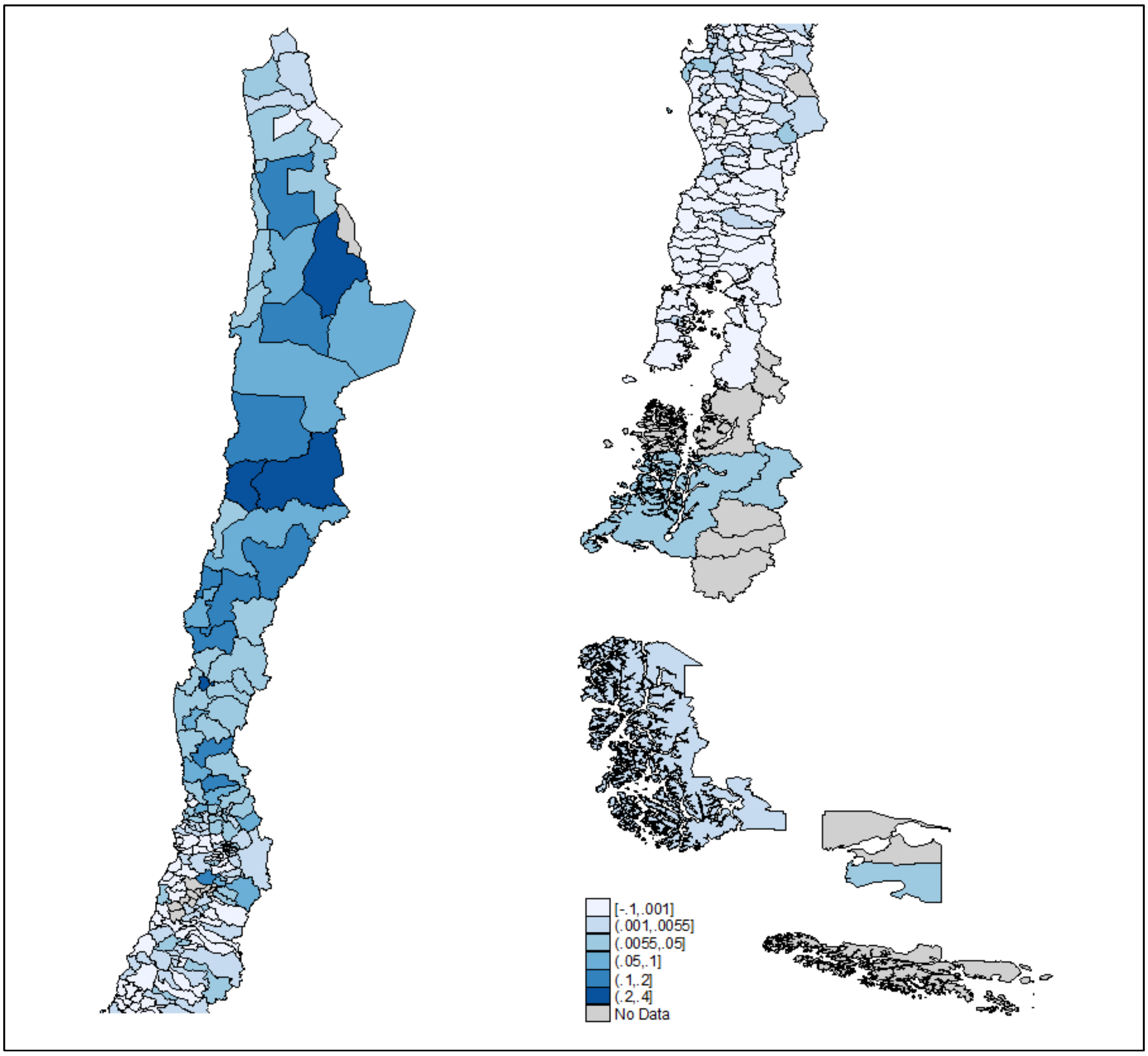
FIGURES

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



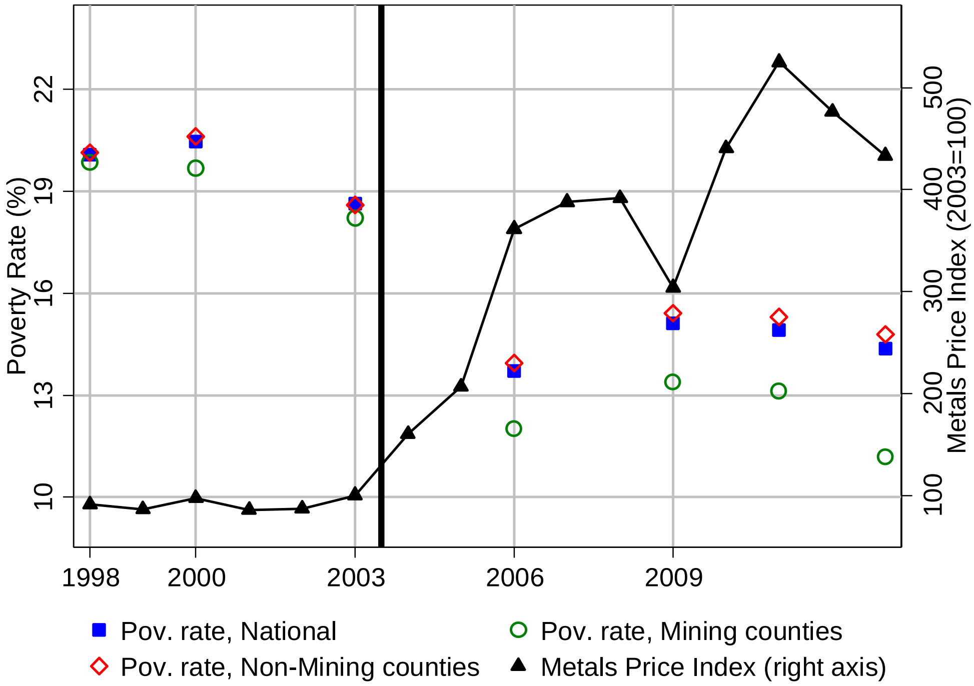
Note: The Figure shows price (left axis) and quantity (right axis) trajectories for the top-5 most important metals in Chile. These metals account for over 99% of the annual production value over the sample period. In parenthesis we show the relative importance of each metal in production value in 2003.

Figure 2: Metal-Mining Employment Share (Average 1998-2003)



Note: The figure 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.

Figure 3: Metals Price 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.

TABLES

Table 1: Observations in CASEN 1998-2009

	1998	2000	2003	2006	2009	Average
National Poverty Rate*	20.1%	20.5%	18.6%	13.7%	15.1%	--
Surveyed Households	48,107	65,036	68,153	73,720	71,460	**65,295**
Surveyed Individuals	188,360	252,748	257,077	268,873	246,924	**242,796**
Implied National Population*	13,143,833	14,361,014	15,340,042	16,115,197	16,584,521	**15,108,921**
Municiplaities	196	285	302	335	334	**290.4**

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

Table 2: Impact on Poverty Rate

	(1)	(2)	(3)	(4)
Log Pt x θc	-.158 (.067)**	-.140 (.066)**	-.141 (.068)**	-.143 (.069)**
Regional GDP growth	--	.171 (.094)*	.196 (.086)**	.179 (.087)**
Log popullation	--	--	.023 (.028)	.021 (.030)
Log Household Size	--	--	.118 (.026)***	.122 (.027)***
Log Years of Schooling	--	--	-.106 (.039)***	-.102 (.040)**
Urban Share	--	--	.092 (.047)*	.098 (.051)*
Municipality FE	✔	✔	✔	✔
Year FE	✔	✔	✔	✔
R-squared	0.44	0.44	0.46	0.47
Observations	968	968	968	920

Notes: This table shows the effect of metal prices changes on poverty rate in a panel of 169 municipalities over the period 1998-2009 (observations only for CASEN's years 1998, 2000, 2003, 2006 and 2009). 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. Key: *** significant at 1%; ** 5%; * 10%.

Table 3. Impact on Employment

	(1)	(2)	(3)	(4)
Log Pt x θc	.0270 (0.020)	.0240 (.020)	.0270 (.020)	.0330 (.020)*
Regional GDP growth	--	-.0350 (.052)	-.0430 (.049)	-.0410 (.050)
Log Household Size	--	--	-.0400 (0.019)**	-.0390 (0.020)**
Log Years of Schooling	--	--	.0200 (.019)	.0150 (.020)
Urban Share	--	--	-.0370 (.030)	-.0430 (.033)
Municipality FE	✔	✔	✔	✔
Year FE	✔	✔	✔	✔
R-squared	0.27	0.27	0.29	0.29
Observations	968	968	968	920

Notes: This table shows the effect of metal prices changes on total employment rate. Employment rate is defined as municipal-level employment over population. See Table 2 for a description of the sample. 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. Key: *** significant at 1%; ** 5%; * 10%.

Table 4. Decomposing Employment Effect on Skilled and Unskilled Employment

	Skilled			Unskilled		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Pt x θc	-.015	-.005	-.002	.042	.032	.035
	(.011)	(.012)	(.012)	(.019)**	(.017)*	(.017)**
Regional GDP growth	--	.010	.010	--	-.053	-.052
		(.027)	(.027)		(.045)	(.045)
Log Household Size	--	.002	.006	--	-.042	-.046
		(.012)	(.012)		(.016)**	(.017)***
Log Years of Schooling	--	.089	.085	--	-.069	-.070
		(.012)***	(.012)***		(.019)***	(.020)***
Urban Share	--	-.052	-.053	--	.015	.010
		(.016)***	(.016)***		(.023)	(.024)
Municipality FE	✔	✔	✔	✔	✔	✔
Year FE	✔	✔	✔	✔	✔	✔
R-squared	0.22	0.28	0.27	0.4	0.42	0.42
Observations	968	968	920	968	968	920

Notes: This table shows the effect of metal prices changes on skilled (columns 1-3) and unskilled (columns 4-6) employment rate. Skilled (unskilled) labor is computed as the count of workers with some post-secondary (at most high-school as highest attained level of education). See Table 2 for a description of the sample. θ_c corresponds to the 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 5. Decomposing Employment Effect in Metal-mining Employment and Rest

	Metal-Mining Employment			Rest		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Pt x θc	.047	.050	.050	-.020	-.023	-.018
	(0.018)***	(0.017)***	(0.017)***	(.027)	(.028)	(.028)
Regional GDP growth	--	.014	.015	--	-.058	-.056
		(.029)	(.029)		(.049)	(.050)
Log Household Size	--	-.002	-.001	--	-.038	-.038
		(.005)	(.005)		(.019)**	(.020)*
Log Years of Schooling	--	.004	.004	--	.016	.012
		(.004)	(.004)		(.020)	(.020)
Urban Share	--	-.008	-.007	--	-.029	-.036
		(.019)	(.020)		(.022)	(.024)
Municipality FE	✔	✔	✔	✔	✔	✔
Year FE	✔	✔	✔	✔	✔	✔
R-squared	0.13	0.14	0.14	0.22	0.23	0.24
Observations	968	968	920	968	968	920

Notes: This table shows the effect of metal prices changes on metal-mining (columns 1-3) and non-metal employment rate (columns 4-6). See Table 2 for a description of the sample, and section 2 for the metal-mining sector's definition. θ_c corresponds to the 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 6. Impact on skilled and unskilled metal mining employment rate.

	Skilled - Metal employment rate			Unskilled - Metal employment rate		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Pt x θc	-.004	-.003	-.003	.062	.055	.053
	(.006)	(.006)	(.006)	(.022)***	(.022)**	(.022)**
Regional GDP growth	--	.007	.007	--	.004	.004
		(.006)	(.006)		(.034)	(.034)
Log Household Size	--	.001	.001	--	-.004	-.008
		(.001)	(.001)		(.012)	(.012)
Log Years of Schooling	--	.005	.005	--	-.085	-.082
		(.002)***	(.002)***		(.012)***	(.012)***
Urban Share	--	-.004	-.004	--	.044	.046
		(.003)	(.004)		(.020)**	(.021)**
Municipality FE	✔	✔	✔	✔	✔	✔
Year FE	✔	✔	✔	✔	✔	✔
R-squared	0.03	0.04	0.05	0.22	0.27	0.27
Observations	968	968	920	968	968	920

Notes: This table shows the effect of metal prices changes on skilled workers employment rate (columns 1-3) and unskilled workers employment rate (columns 4-6) in metal mining industry. Skilled (unskilled) labor is computed as the count of workers with some post-secondary (at most high-school as highest attained level of education). See Table 2 for a description of the sample, and section 2 for the metal-mining sector's definition. θ_c corresponds to the 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 7. Impact on average wages.

	(1)	(2)	(3)	(4)
Log Pt x θc	0.499	0.499	0.428	0.444
	(.213)**	(.213)**	(.226)*	(.230)*
Regional GDP growth	--	-0.006	-0.04	0.023
		(.329)	(.311)	(.311)
Log population	--	--	-0.178	-0.171
			(.068)***	(.070)**
Log Household Size	--	--	-0.207	-0.203
			(.093)**	(.094)**
Log Years of Schooling	--	--	0.755	0.777
			(.136)***	(.140)***
Urban Share	--	--	0.044	-0.019
			(.141)	(.144)
Municipality FE	✔	✔	✔	✔
Year FE	✔	✔	✔	✔
R-squared	0.57	0.57	0.61	0.61
Observations	968	968	968	920

Notes: This table shows the effect of metal prices changes on average wages See Table 2 for a description of the sample, and section 2 for the metal-mining sector's definition. θ_c corresponds to the 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 8. Impact on Average Wages of Skilled Workers

	(1)	(2)	(3)	(4)
Log Pt x θc	.219	.207	.082	.103
	(0.342)	(.345)	(.366)	(.370)
Regional GDP growth	--	-.113	-.165	-.090
		(.540)	(.514)	(.515)
Log population	--	--	-.333	-.328
			(.114)***	(.122)***
Log Household Size	--	--	-.395	-.398
			(.143)***	(.148)***
Log Years of Schooling	--	--	.834	.884
			(.207)***	(.213)***
Urban Share	--	--	.073	-.019
			(.219)	(.213)
Municipality FE	✔	✔	✔	✔
Year FE	✔	✔	✔	✔
R-squared	0.51	0.51	0.54	0.54
Observations	965	965	965	917

Notes: This table shows the effect of metal prices changes on average wages of skilled workers. Skilled (unskilled) labor is computed as the count of workers with some post-secondary (at most high-school as highest attained level of education). See Table 2 for a description of the sample, and section 2 for the metal-mining sector's definition. θ_c corresponds to the 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 9. Impact on Average Wages of Unskilled Workers

	(1)	(2)	(3)	(4)
Log Pt x θc	.663	.676	.626	.625
	(.105)***	(.107)***	(.108)***	(.108)***
Regional GDP growth	--	.126	.106	.152
		(.273)	(.265)	(.268)
Log population	--	--	-.049	-.040
			(.056)	-0.056
Log Household Size	--	--	-0.15	(.165)
			(0.062)**	(0.060)***
Log Years of Schooling	--	--	.348	.352
			(.118)***	(.120)***
Urban Share	--	--	.150	.125
			(.085)*	(.085)
Municipality FE	✔	✔	✔	✔
Year FE	✔	✔	✔	✔
R-squared	0.72	0.72	0.73	0.74
Observations	968	968	968	920

Notes: This table shows the effect of metal prices changes on average wages of unskilled workers. Skilled (unskilled) labor is computed as the count of workers with some post-secondary (at most high-school as highest attained level of education). See Table 2 for a description of the sample, and section 2 for the metal-mining sector's definition. θ_c corresponds to the 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%.

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 - Macroeconomic Statistics	Dollars per Metric Tons of iron ore (U$/MT).
Cooper Production	COCHILCO	Thousands of Metric Tons (MT).
Molybdenum Production	COCHILCO	Metric Tons (MT) of Fine Content.
Gold Production	COCHILCO	Kilograms (Kg) of Fine Content.
Silver Production	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 Poverty Rate	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.
Municipality Size	CASEN	Number of people living in each municipality.
Average Schooling	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.
Skilled Workers	CASEN	Workers who at most ended high school.
Unskilled Workers	CASEN	Workers with more education than high school.
Average Wages - skilled workers	CASEN	Average wages (income from main occupation) of skilled workers, for each municipality.
Average Wages - unskilled workers	CASEN	Average wages (income from main occupation) of unkilled workers, for each municipality.

B. Additional Tables

Table B1. Using Full PANEL 1998-2013

	(1)	(2)	(3)	(4)
Log Pt x θc	-.164	-.164	-.162	-.155
	(.066)**	(.066)**	(.067)**	(.066)**
Regional GDP growth	--	.004	.021	.038
		(.092)	(.086)	(.084)
Log population	--	--	.027	.027
			(.022)	(.022)
Log Household Size	--	--	.058	.040
			(.025)**	(.025)
Log Years of Schooling	--	--	-.123	-.146
			(.038)***	(.039)***
Urban Share	--	--	0.063	0.08
			(.036)*	(.037)**
Municipality FE	✔	✔	✔	✔
Year FE	✔	✔	✔	✔
R-squared	0.35	0.35	0.37	0.39
Observations	1356	1356	1356	1274

Notes: This table replicates Table 2 using the full sample 1998-2013. See Table 2 for notes on the sample and definition of θ_c. Theta corresponds to the metal mining employment share in 1998. Standard errors (in parenthesis) are clustered at the municipal level. Key: *** significant at 1%; ** 5%; * 10%.

Table B1. Using Alternative Measure of Exposure

	(1)	(2)	(3)	(4)
Log Pt x χ_c	-.152	-.150	-.157	-.159
	(.065)**	(.065)**	(.066)**	(.068)**
Regional GDP growth	--	.037	.047	.032
		(.088)	(.084)	(.084)
Log population	--	--	.025	.028
			(.018)	(.022)
Log Household Size	--	--	.047	.040
			(.022)**	(.025)
Log Years of Schooling	--	--	-.087	-.146
			(.032)***	(.039)***
Urban Share	--	--	.047	.079
			(.031)	(.036)**
Municipality FE	✔	✔	✔	✔
Year FE	✔	✔	✔	✔
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 χ_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%.