Resources Policy 82 (2023) 103489

Contents lists available at ScienceDirect

Resources Policy

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

Commodity price and fatalities in mining – Evidence from copper regions in Chile

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ARTICLE INFO

Keywords:
Mining boom
Price volatility
Economic bonanza
Copper
Mining safety
Chile

ABSTRACT

On October 13th, 2010, the world was glued to the TV screen to watch the rescue of the 33 miners that spent 69 days trapped 700 m underground in a Chilean copper mine. While the 33 miners were rescued alive, 43 copper miners died in Chile the same year due to accidents in mining operations – the most significant number of mining fatalities in more than 20 years. The same year, copper reached its highest average annual price in history. Does this mean that high commodity prices induce a higher number of fatal accidents in mining operations? This paper addresses this question using 21 years of accident data in copper mines in Chile. We find that when the international price of copper surpasses approx. $5200/tonne, there is a strong positive correlation with the number of fatalities in copper mining. Scrutinizing such findings, we observe that the relationship mainly occurs with companies' direct employees, while the number of deaths within contractors does not vary along with the copper price. Our results suggest that in the wave of high commodity prices, mining operations intensify their production processes, including rushing to bring back medium-sized operation sites that have previously been in care and maintenance, and which negatively affects the safety of operations.

1. Introduction

In the solid economic recovery from the 2007-08 global financial crisis (GFC), in 2010, the average annual price of copper reached its highest value in history.[1] The same year, Chile was in the spotlight of news broadcasters worldwide with the rescue of the 33 miners trapped in the underground copper mine of 'San Jose', located in the northern region of 'Atacama'. Unfortunately, while the 33 miners were rescued alive and with no significant injuries, 43 miners died from accidents in the copper mining regions of Chile during the same year.

Does a higher commodity price induce a higher number of fatalities in mining operations? Would this association be reinforced due to a higher number of external contractors working in the mining industry who might not be subject to the same occupational and health training as permanent direct employees? To shed light on such questions is paramount for the mining industry, as safety protocols can be enhanced in periods that could show a higher likelihood of fatal accidents occurrence. Given this critical point, this paper explores the exogenous variation in the international price of copper and mining fatalities in Chile –the largest copper producer in the world. More formally, the paper analyses work-related fatalities in mines located in copper regions of Chile over the period 2000–2020 as a function of international copper price variations. Based on such evidence, the study also explores if an increasing proportion of contractors versus direct company employees working in mining operations explain the results. We also examine if fatalities are more likely in small mine sites versus large mines.

We use 21 years of mining fatalities data and scrutinize whether and to what extent copper prices affect the number of mining operation fatalities in copper regions in Chile. We explore the association using different visual and econometric analyses of the data. We find that the relationship between the international copper price and the incidence of mining fatalities in the country is best explained by a quadratic function, which shows that once copper value surpassed the threshold of $5200 per tonne, the association is markedly positive –the higher the value, the more fatalities are reported in the country.

Our finding suggests that in the wave of higher commodity prices, mining operations seem to prioritize their production processes, which could significantly increase safety issues across operations. An impetus to boost operations would make it more challenging to ensure that the safety standards of operations are fulfilled, resulting in a higher number

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[1] To the time of writing, 2021 seems likely to break this record, with an average price higher than 2010 in the initial 8 months of the year.

https://doi.org/10.1016/j.resourpol.2023.103489
Received 7 June 2022; Received in revised form 3 February 2023; Accepted 13 March 2023
Available online 28 March 2023
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of fatalities. We also explore if this finding holds for the type of miner employment: contractors versus direct company employees. We find that fatality trends in contractors are more or less stable over time, showing no variation aligned to the copper price, while fatalities reported from direct employees have a tendency that seems to be affected by the cost of copper.

The remainder of the paper is structured as follows. Section 2 discusses the limited literature available and highlights our contribution to expanding it. Section 3 explains our methods, and Section 4 presents the results. Finally, Section 5 concludes by briefly discussing the results and the implications of our findings.

2. Literature review

The academic literature on industry safety highlights the significant risks in the mining industry, as stated by the International Labour Organisation (ILO, 2015). Different studies have investigated factors contributing to accidents in the industry, such as the age of workers, long working hours, outsourced companies, and small to medium-sized enterprises. For example, Groves et al. (2007) found that younger employees have a higher risk of injury, while workers older than 55 face a higher fatality risk. In addition, long working hours are associated with mining injuries and fatalities (Friedman et al., 2019). Outsourced companies and small to medium-sized enterprises are also vulnerable to fatal accidents (Candia et al., 2009; Friedman et al., 2019). Stemn et al. (2021) study focuses on Artisanal and small-scale mining (ASM) in Ghana, finding that mortality rates are higher in artisanal mining than in commercial operations, pointing to different social problems this carry for communities.

Within the Chilean context, Bachelet (2018) conducted a descriptive study of industry cross-sectional analysis of fatal work accidents, using 815 cases between 2014 and 2015. The author found that the mining sector ranked second in fatalities in both years. Interestingly, the author found that 72% of the total fatalities occurred in small and medium-sized enterprises, and 50% occurred in workers who had been employed for less than a year in their company.

Other studies fall within the spectrum of the resource curse literature (van der Ploeg, 2011; Fleming et al., 2015), where some authors have studied the link between resources boom and criminality and fatalities in regional economies (e.g., Ruddell and Ortiz, 2014; Komarek, 2018). Specific to mortality aspects, Boslett and Hill (2022) examine the effects of the resource boom, using mortality data for counties with coal mining and shale development. The authors find that counties that have more than ten coal mines in a production decrease phase, an increase in total all-cause mortality, non-drug mortality, and opioid overdose mortality (Boslett and Hill, 2022).

To the best of our knowledge, previous research exploring in particular the relationship between commodity prices and accidents/fatalities in the mining sector is scarce. Few exceptions are Cademartori (2002), Huang et al. (2016), and Knights and Scanlan (2019). Cademartori (2002) shows that in Chile, the rate of accidents is higher among contractor employees than among direct company employees because contractors tend to work longer hours than direct company employees. In addition, the working environments of contracted employees are generally worse than that of permanent employees. Although much has changed since 2002, with the mining industry considerably improving its standards in the country, we believe it is still valid to analyze if different patterns of fatalities occur in contractors versus direct employees and their association with the copper price.

Huang et al. (2016), and Knights and Scanlan (2019) base their research on coal mining. Huang et al. (2016) investigate the correlation between Coal Mining Accidental Deaths (CMAD) and China's Coal Price Index (CCPI). The study examines the correlation between CMAD and CCPI over different time intervals. Their analysis is inconclusive, although they claim that the minimum lag between a decline in commodity price and an increase in fatalities is only two months. While Knights and Scanlan (2019) postulate that when thermal coal prices drop, coal mining companies react by downsizing direct employees and relying more on contractors, who, if not carefully managed, can result in loss of knowledge around safety systems and reduced effectiveness of safety supervision. In other words, the authors claim that as commodity prices drop, to reduce costs, mining companies tend to replace some direct workers with contractors, and an increase in contractor numbers contributes to an increased risk of accidents involving multiple fatalities occurring. We expand and provide more empirical nuances on the findings from Knights and Scanlan (2019) by exploring mining fatalities in contractors and direct mining workers, something that the data used by Knights and Scanlan (2019) do not allow them to answer.

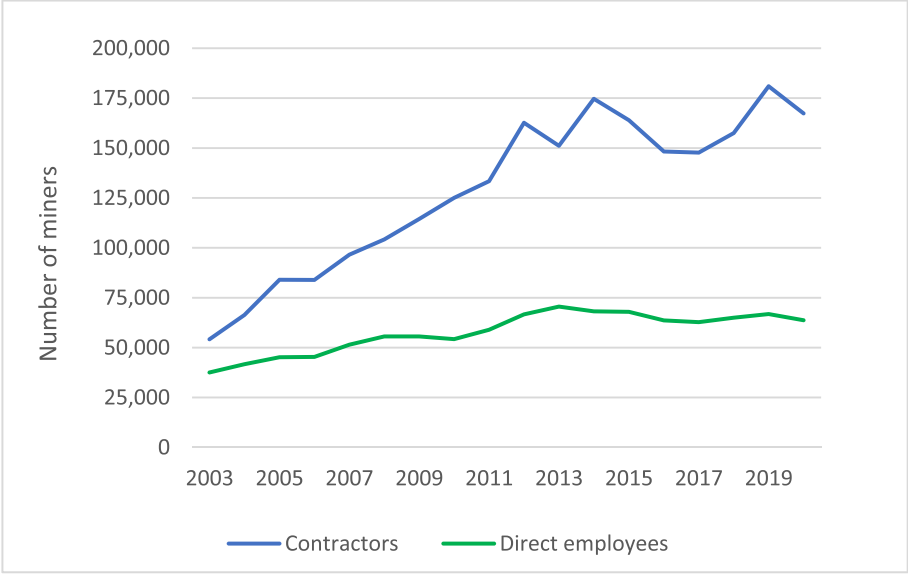

Fig. 1. The number of people employed in mining in copper regions in Chile by type: Contractors vs. direct employees.
Source: Authors with data from SERNAGEOMIN (2021a, 2021b).

Fig. 2. The number of total mining fatalities in copper regions in Chile by type: Contractors vs. direct employees.
Source: Authors with data from SERNAGEOMIN (2021a, 2021b).

3. Methodology

The number of mining employees (direct and contractor employees) and fatal accidents per year and region were obtained from the Geology and Mining Service of the Chilean Government (SERNAGEOMIN, 2021a). This dataset is publicly available in an Excel format and contains observations for the ten years 2010–2019. In addition, we expand these data with information available in past editions of the '*Anuario de la Mineria*' (annual mining report) published by the same institution (SERNAGEOMIN, 2021b). These 'SERNAGEOMIN annual reports' are only available in online PDF reports, so we extracted its data using either ADOBE Pro or manually. Data from the annual reports are available for 2003–2009 and 2020 (SERNAGEOMIN, 2021b). Contractor and direct employee fatality data before 2003 are not available online. However, total fatalities for 2000–2002 are available from SERNAGEOMIN (2015).

Figs. 1 and 2 plot the national-level observations for employees and fatalities in copper regions in Chile, respectively. As seen, the number of contractors has notably increased in Chile in the last 20 years. While in 2003, the ratio of contractors/direct employees was about 1.36, in 2019, the ratio reached 2.66.

Data on the international price of copper is retrieved from S&P Global, 2021. Average annual price values in nominal dollars were retrieved. Although data are available from 1971 to the present (as shown in Fig. 3), for our analysis, we only used average annual values for the period 2003–2020, so to match these values to mining fatalities in Chile.

As seen in Fig. 3, since 1971, the international copper price had its highest value in 2010, which was the market response to the economic rebound after the great financial crisis of 2008–09 that produced a through in the trend. Since the peak in 2010, the minimum average annual price occurred in 2015 due to a reduction in China's economic growth (Monagham, 2016).

We apply different trend analyses and econometric specifications to explore the relationship between copper price and mining fatalities. This last includes time series analysis employing ordinary least square and negative binomial regression models. More details of each model are described in the respective results subsection.

Our objective is to understand the impacts of copper price on mining fatalities, we restrict the national values of employees and deaths to those related to copper mining. Unfortunately, for several years the data do not show from what type of commodity mines the observations come from. In other words, we do not know how many fatalities work in copper mines in contrast to other mines. Therefore, to identify copper mining activity, we restrict our data to observations from Chile's copper mining regions, which encompass the northern seven regions. We assume that the majority of deaths occurring in these regions relate to workers in copper mines. These regions present no coal mines and just a handful of small mines of other resources such as gold, silver, iron ore and lithium. In Appendix, we test this assumption and provide statistics to discuss its implications. However, it can be argued that given the very high importance and dominance of copper mining in these regions, changes in its international price will affect all mining operations in these areas, as copper mines will tend to intensify the use of mining inputs and labour, affecting the competitivity of other mines to retain skilled workers (a crowding-out effect), which can jeopardize their safety standards as they would need to increasingly hire less-qualified employees.

Table 1 provides the summary statistics of the key variables we use. As mentioned, fatalities show numbers reported in all mining operations coming from mining regions in Chile.

As seen in Table 1, the number of people employed in mining in the copper regions of Chile reached 231 thousand employees in 2020. Of these, only 28% were employers directly employed by mining companies, while the rest (72%) corresponded to contractor employees. In the 18 years 2003–2020, the average annual employment of mining in northern Chile reached 219 thousand, where 29% were direct employees. In terms of fatalities, direct employees show more significant numbers than contractor employees, even though they were only a third of the workforce in 2020. This suggests that direct employees are much

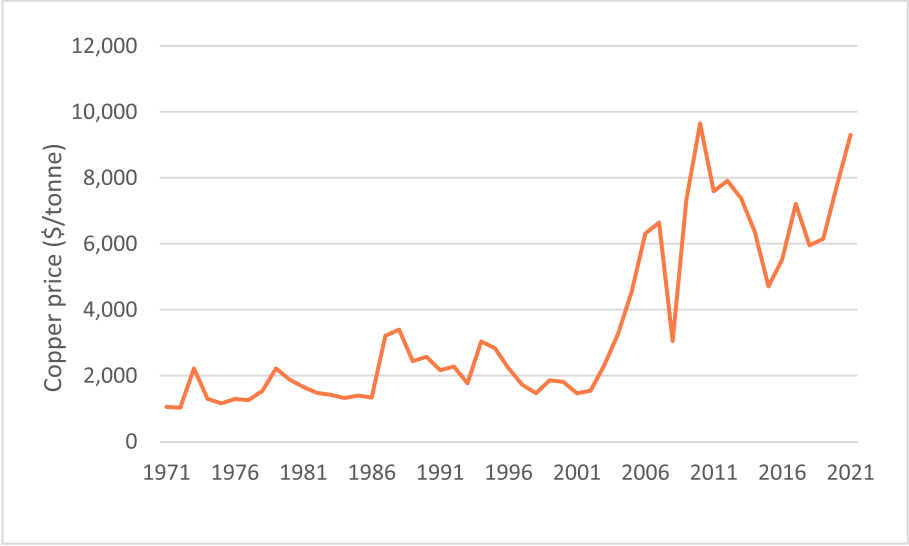

Fig. 3. Annual average copper price, 1971–2020 (nominal US$). *Note*: The international copper price is generally discussed using dollars per pound in many news outlets. For comparison, the highest annual average observed in the period, US$9650 per tonne in 2010, equals aprox. US$4.19 per pound. *Source*: Authors with data from S&P Global, 2021.

Table 1
Descriptive statistics.

	2003	2010	2020	Total(2003–2020)	Mean(2003–2020)	S.D.(2003–2020)
Total miners	91,807	179,340	231,160		219,023.0	21,335.5
- Direct	37,590	54,297	63,758		64,496.6	4844.0
- Contractor	54,217	125,043	167,402		154,526.4	17,265.2
Total deaths	23	43	12	430	21	9.3
- Direct	16	28	9	280	13.1	7.2
- Contractor	7	15	3	150	7.9	3.9
Copper price (US$/tonne)	2318.0	9650.0	7749.0		6842.5	1406.4

Source: Authors with data from SERNAGEOMIN (2021a, 2021b) and S&P Global, 2021.

more in charge of risky/hazardous operations than contractor employees – many take care of safer activities such as food and cleaning services. In the 18 years, 430 miners died in mining activity across the copper mining regions of Chile, of which 65% (280) were direct employees.

Unfortunately, disaggregated data on employment and fatalities by the size of operations (artisanal, small, medium, and large mines) are not consistently available for all years. However, scrutinizing the data in small vs. large companies is important for our analysis, so we attempt to do so with the available data in Section 4.3.

4. Results

4.1. Mining fatalities in copper regions versus copper price

Fig. 4 shows the changes in copper prices (US$/tonne) and the number of fatalities experienced between 2000 and 2020 in Chilean copper regions. There is an intriguing correlation between the movements of the international copper price and the number of fatal accidents in Chilean copper mining. The most synchronized change happened in 2010 when a sharp rise in the copper price (reflecting the commodity prices rebound following the Global Financial Crisis—GFC) was accompanied by a spike in fatalities in copper mining.

Although the copper price remained relatively high after 2010, Fig. 4 shows a sharp drop in fatalities in 2011. This observation can be explained by the increasing regulation in safety protocols enforced across mining operations in Chile after the accident that trapped the 33 miners in 2010 (BCN n.d.). This internationally recognized accident caused Chilean authorities to reinforce and intensify safety measures in mining, which outcomes reflect the drop in fatalities observed since then. Although outside the scope of our paper, it can be suggested that the accidents of the '33' have saved approximately 173 lives since its occurrence.[2]

Even after accounting for the drop in fatalities as a consequence of the '33' event, the number of deaths still positively correlates with the copper price, with the most remarkable exception being 2008. This year shows a significant drop in the copper price as a product of the GFC, but the number of fatalities did not follow such drop. This could be explained because the GFC exploited later in the year (mid-September), so high copper prices in earlier months might have still induced a large number of fatalities.

Fig. 5 plots the average annual copper price against the number of fatalities in the respective year to further explore the relationship between copper price and mining fatalities.

[2] Our back-of-the-envelope calculation to claim such number comes from a simple extrapolation in the difference of fatalities pre and post the accident event. The average number fatalities in the five years before the accident of the '33' (including the same 2010) was 35.2, while the average annual fatalities number in the period 2011–2020 was only 17.9. Accounting for this difference in the trend gives a total difference for 173 less fatalities in the last ten years ([35.2–17.9]*10 = 173).

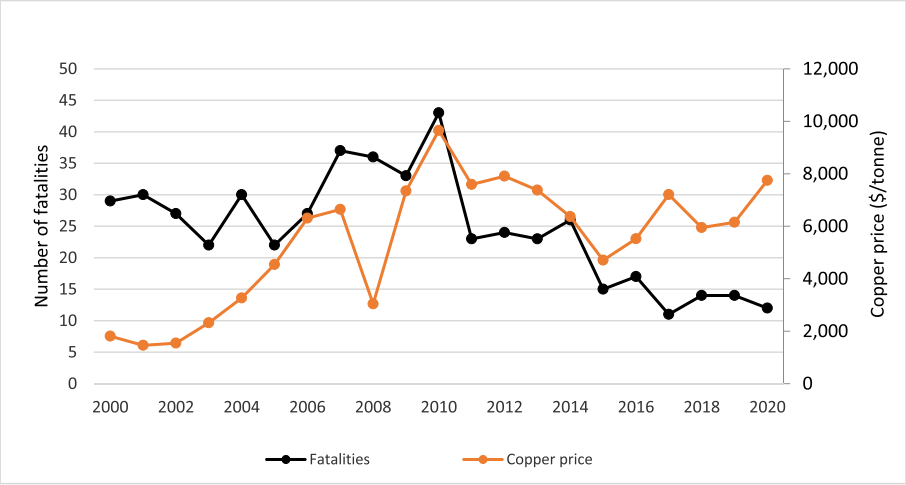

Fig. 4. Copper price and mining fatalities in Chilean copper regions, trend 2000–2020.

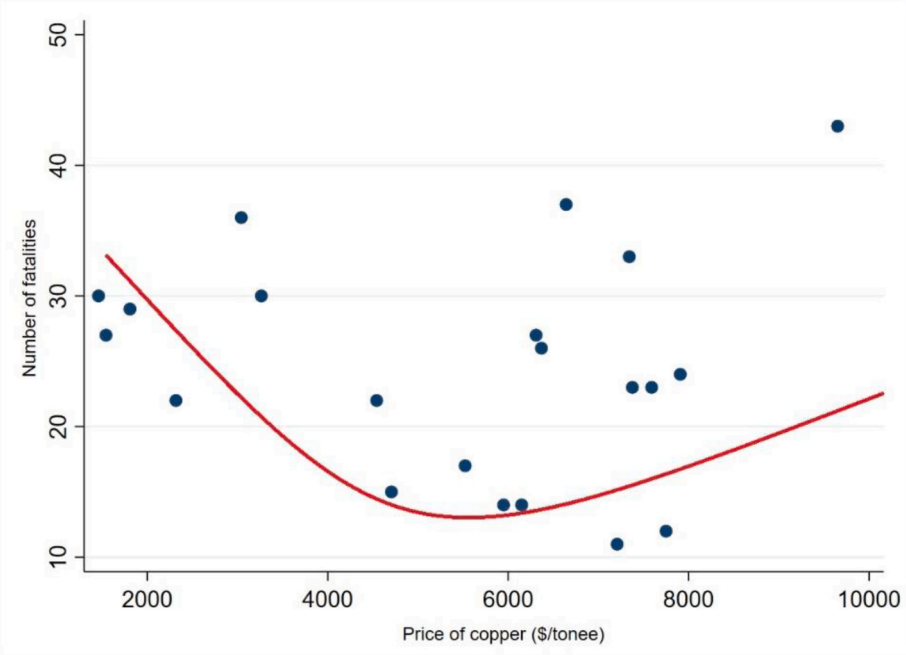

Fig. 5. The copper price – mining fatalities relationship.

As shown in Fig. 5, the relationship fits well with a quadratic function. Testing such function in a regression model (scaling prices to US $/Kg to reduce decimal points in the beta coefficients) gives us,

$$Number\ of\ fatalities = \mathbf{42.52}^{***} - \mathbf{8.67}^{***}\ Price + \mathbf{0.00083}^{***}\ Price^2$$

The obtained coefficient translates into an inflection point at 5200 US$ per tonne. In other words, the quadratic function establishes that fatalities decreased as the price of copper increased till reaching $5200 per tonne, but after this value is surpassed, fatalities in copper mining have shown a positive relationship with price, on average. Both coefficients in our regression were statistically significant at 1%, which we denote with three asterisks (using robust standard errors, R-squared = 0.26). We also tried using a Negative Binomial (NB) model to analyze the relationship, where we also found statistically significant coefficients at the 1% level. The turning point in the NB model was at $5300 US$ per tonne of copper.

4.2. Mining fatalities in contractors and direct company employees

Having shown the relationship between copper price and overall fatalities in copper mining in Chile, here we disaggregate the analysis into contractors and direct company employees. As shown in Fig. 1, the number of direct employees has slightly increased in the last 20 years, while contractors have more than tripled over the previous 20 years. Fig. 2, in contrast, shows how fatalities among indirect employees have systematically decreased since 2010, except for a jump in numbers in 2020, while contractors' fatalities have remained relatively stable over time, with 4–15 deaths per year –except again for 2020 that only reported three deaths among contractors. Such trends suggest that the Chilean government has effectively reduced risks at mine sites, especially since the accident of the '33' in 2010, which has resulted in a steady decline in the rate of fatalities per total number of workers in both

contractors and direct employees.[3]

However, is there a different link between copper price and fatalities indirect employees to those observed among contractors? To explore this, we run separate regressions for each type of employment. To do so, however, we rely only on 18 observations as disaggregated data on fatalities by type of worker is not available for 2000–2002. Findings give us the relationship:

$$\textit{Number of fatalities in direct employees} = \mathbf{42.34–10.76}^{**}\ \textit{Price} + \mathbf{0.00096}^{***}\ \textit{Price}^2$$

$$\textit{Number of fatalities in contractors} = 12.85–2.01\ \textit{Price} + 0.00019\ \textit{Price}^2$$

As shown by the asterisks, only the coefficients for the direct employees' fatalities equation are statistically significant, implying that the copper price has had no effect on the incidence of fatal accidents for contractors in the Chilean mining industry. This is, to some extent, surprising (and good to see) as the increasing number of contractors employed in mining over time has not translated to more fatalities as a consequence of high copper prices. However, with copper prices above $5632 dollars per tonne (the turning point of the quadratic function), the relationship between the number of fatalities within direct employees and price becomes significantly positively correlated. An NB model produces similar results: No statistically significant evidence for contractors and a strong statistical significance for direct employees with a turning point at $5695.

Fig. 6 plots the price trends and direct employees' fatalities since 2003. As seen, especially since 2009, the trends move in the same direction, with a few minor exceptions, such as 2016–17.

4.3. Mining fatalities by the size of operations

To explore whether our findings differ by the size of mining operations, we analyzed data based on the size of the mining companies. SERNAGEOMIN annual reports details fatalities data on large, medium, and small companies and artisanal mining. Unfortunately, mining fatalities per company size are not provided by regions for the years 2003–2013, so observations for those years are filled with the fatalities reported in copper mining.[4]

Results of fatalities trends, per company size and artisanal mining, are reported in Fig. 7. As can be seen, in most years, artisanal mining leads the number of fatalities, signalling the precarious safety conditions that these labourers face compared to formal mining. However, in 2016, large operations have shown more fatalities than other companies, including artisanal ones.

To evaluate the effect of the international copper price on the tendencies shown in Fig. 7, we tested similar econometric models as done in the previous section. Among all the types of mining, we found that only fatality trends in large mining corporations have a statistically valid (at the 10% level) positive correlation with the international copper price. A quadratic function provided no statistically valid results for any mining category. It is important to note that during high commodity prices, medium-sized mining companies often rush to resume operations previously put in care and maintenance due to being unprofitable with low commodity prices. Unfortunately, these medium-sized operations frequently resume production with safety standards similar to those in place when they went into care and maintenance.[5]

5. Discussion and concluding remarks

Contributing to the scarce literature on the topic, in this paper, we provide evidence of the link between commodity prices and fatal accidents in mining using the Chilean case. Our evidence points to an opposite inference to that claimed by Knights and Scanlan (2019). These authors argued that when commodity price drops, mining companies downsize employment and pay less attention to hazard procedures in challenging economic times, triggering a higher number of fatal accidents. We only found evidence supporting this argument in the early 2000s in Chile, when the copper price had a statistically significant negative correlation with mining fatalities. However, our most interesting finding is that around 2005, the supercycles of historically high levels of copper price have turned this relationship into more fatalities across mines in copper regions in Chile. This effect is most likely due to increased production pressure and increased inexperienced workers. Thus, to obtain a gain of the period bonanza provided by the commodity price super-cycle, companies could tend to shuffle resources from safety to production and increase the proportion of staff with low experience in hazardous environments.

Although we find a clear relationship between copper price and fatalities, this differs by type of employment. In particular, we find that within contractors, even though a growing proportion of mining employment in Chile in recent years, the number of fatalities in mining operations are not correlated to the fluctuations in the copper price. This can be explained by the role that such employees perform, which could face fewer risks than direct employees. Thus, differently from contractors' fatality trends, annual fatalities indirect employees show a statistically significant correlation with copper price fluctuations. At lower values in early 2000, the relationship was negative. Still, starting in around 2005–2006, the higher levels of copper price changes positively affected the incidence of mining fatalities of direct employees in copper regions.

We also tested if the copper price/fatalities vary by type of company (large/medium/small) and artisanal mining. On average, we only found statistical evidence of a positive correlation between copper price and fatalities in large mining companies. Medium, small and artisanal mining did not present statistically significant evidence of positive correlation. This result is undoubtedly influenced by the fact that large companies employ more people; however, it is still relevant because it shows that production pressures can negatively affect employees even in large companies.

Even though our findings are based on official data from SERNAGEOMIN, one caveat of this paper is that fatalities data are not consistently disaggregated by region, type of mining, or company size for the whole period. We complement different data records to remedy this issue, as discussed throughout the paper. Still, the robustness of results

[3] A chart showing fatalities rates over time, for total employees and for contractors vs direct employees, is show in the appendix. As mentioned here, the rate 'fatalities/number of employees' in mining has decreased over the last years, as also emphasised across most SERNAGEOMIN annuaries.

[4] Data on fatalities in copper mining are only available from SERNAGEOMIN for this period, 2003–2013.

[5] https://www.bbc.com/news/world-latin-america-11467279 (retrieved Mar. 2023).

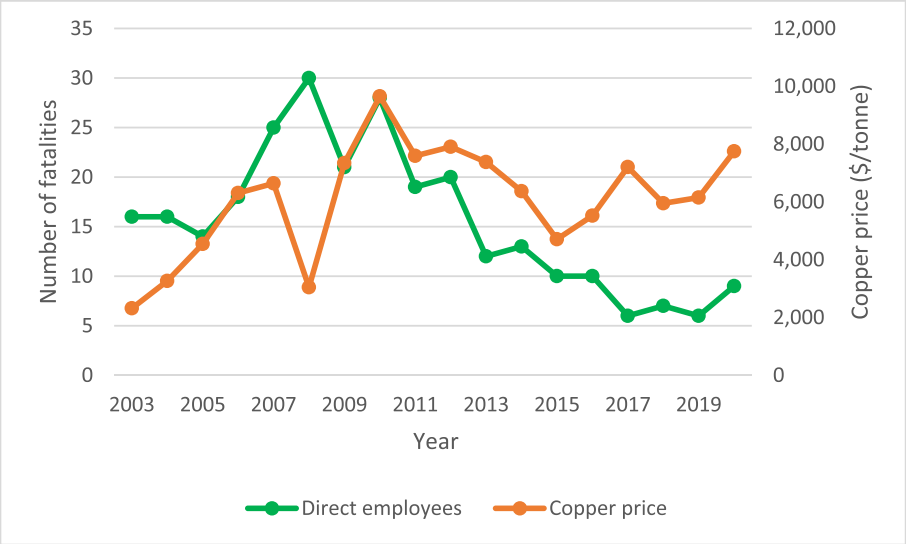

Fig. 6. Copper price and copper fatalities by contractor and direct company employees in Chile, trend 2003–2020.

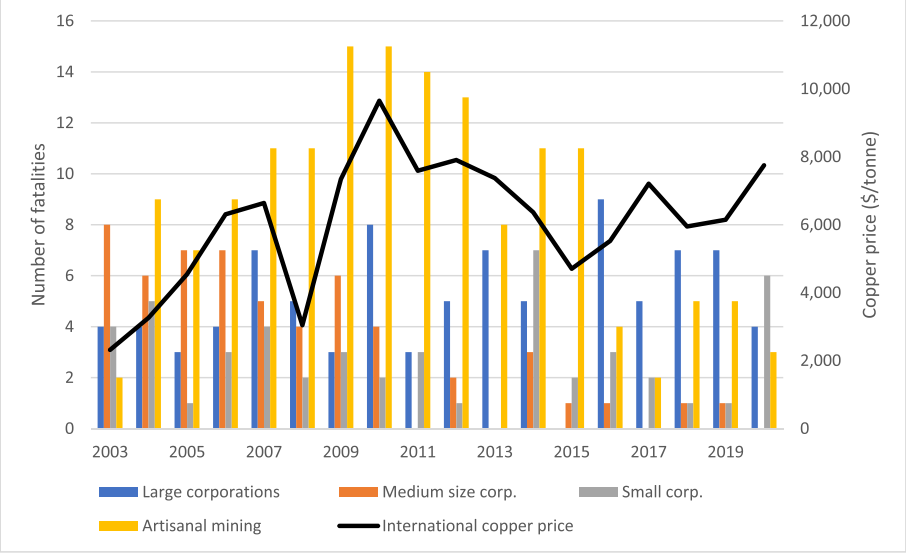

Fig. 7. Copper price and mining fatalities by company size and artisanal mining.

would be inevitably affected; therefore, what we present here needs to be taken with caution considering this. In addition, our time series analysis can suffer from bias given the small sample and the non-stationary nature of the trends. However, we argue that the models we apply to check the relationship between copper price/fatalities are still appropriate for our level of analysis. We do not claim a causational effect in this paper, but rather that the relationship exists, and extra caution needs to be taken in mining operations as a commodity price super-cycle could affect workers' safety across operations.

Despite our findings, it is important to highlight the merit of a lower rate of fatalities in the country over the recent years. In fact, we did test in our analysis (using a Wald structural test) whether there is any 'breaks' in the time series trends. The structural break test results showed that our data do present a structural change in year 2016. As seen in Fig. 4, from this year the trends show that mining fatalities have decreased and remained low in Chile, while the international copper prices have re-emerged. Although we only have five years of observations (2016–2020) to claim that this is an effect as consequence of a new policy (such as a new safety regulation), or similar, such break suggests that Chile has achieved better mining labour security in recent years. A positive outcome that hopefully will persist in years to come.[6]

Additional research could expand our analysis by looking at fatalities and accidents occurring to miners beyond operational sites. On this, the spatial distribution of Chile's mining industry could also affect fatalities frequency as many miners get involved in what is known as Long Distance Commuting (LDC) or Fly-in/Fly-Out (FIFO) (Paredes et al., 2018) systems.[7] This labour dynamic shows a growing trend when copper

[6] Although mining safety concerns are still a pressing issue in Chile–https://www.reuters.com/world/americas/workers-chiles-escondida-copper-mine-threaten-strike-2022-09-07/(retreived Sep. 2022).

[7] Like many mining countries, Chile displays mining towns located in remote areas, generally near expensive cities with large amenities such as pollution and other negative externalities (Oyarzo and Paredes, 2021). This combination of factors motivates mining workers to locate hours away from mining towns in cheaper cities. Higher mining wages and low local prices are enough to compensate for the travel cost (Paredes et al., 2018).

prices increase, mainly motivated by demand pressure to hire mining workers with direct wages. After some experience, mining workers learn to optimize the travel times, reducing the timing between travel time and the beginning of labour shift. In an extreme situation, this behaviour could also affect mining workers' proper performance and caution, resulting in fatal accidents, especially if we add the emotional components behind this dynamic.

Finally, the policy implications of our study are clear. We find that with average copper prices over $5200 $/tonne, there is a likelihood that the number of fatalities, especially among direct employees, would increase in a year showing growing copper prices. Considering that copper prices in recent years have been higher than this threshold, regulation and safety policies are increasingly crucial in operations, mainly focused on those employees that could lack the experience to perform in hazardous environments.

Author contributions

The authors declare that both authors have equally contributed to the paper, and authorship order is provided in alphabetical order.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

Acknowledgements

We thank David Fleming-Muñoz and Peter Knights for their comments in earlier versions of this manuscript. We also thank Alicia Chavez for her support with data collection. This work was supported by FONDECYT 1220566.

Appendix. Additional Analyses

Here we present charts showing three-years moving averages for our variables of interest – mining fatalities and the average annual copper price. As seen, trends are more or less similar to the charts presented above.

We also ran OLS and NB models using the three-year moving average data for the different samples (total employees, contractors, and direct employees) and found structurally similar results to the ones provided above; however, coefficients (in both OLS and NB models) were barely not statistically significant at the 10% level: The p-values of all coefficients ranged between 0.10 and 0.18. The turning points across models were around $5200 per tonne of copper on average.

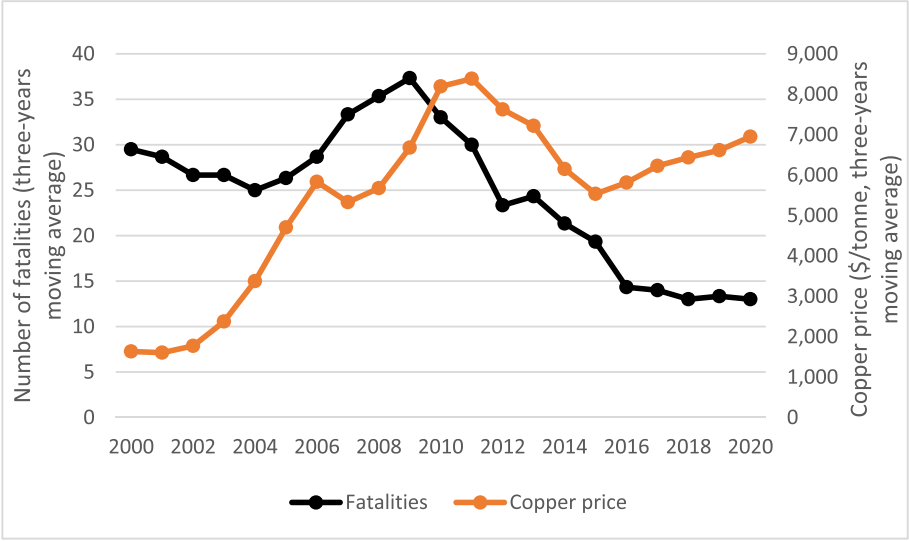

Fig. A.1. Copper price and total fatalities in the copper mining industry in Chile using a 3-years moving average, trend 2000–2020.

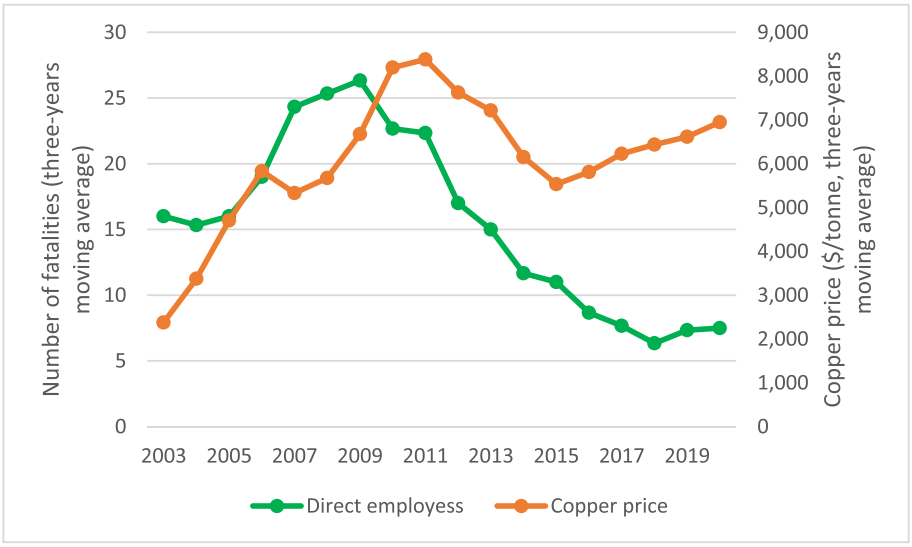

Fig. A.2. Copper price and direct company employees' fatalities in the copper mining industry in Chile using a 3-years moving average, trend 2003–2020.

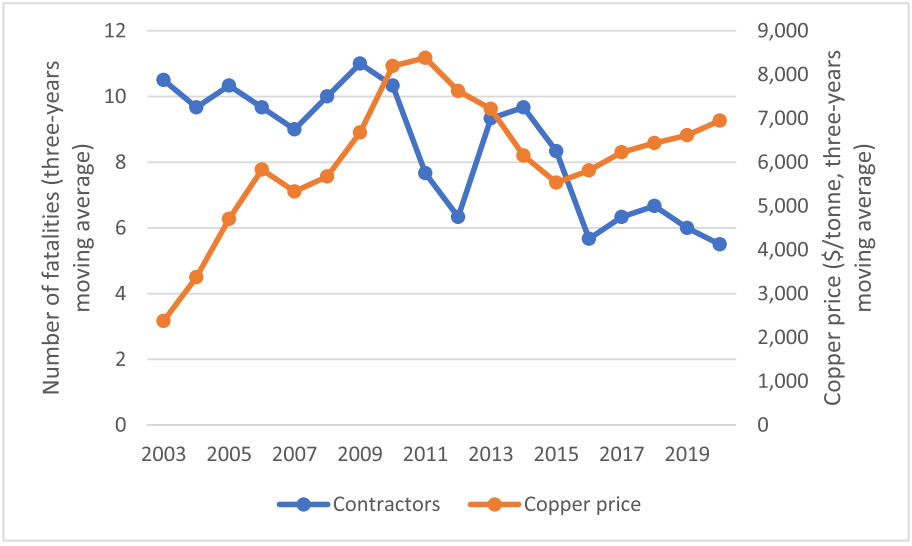

Fig. A.3. Copper price and contractor employees' fatalities in the copper mining industry in Chile using a 3-years moving average, trend 2003–2020.

Finally, to complement our analysis, we present the rate of fatalities, per 100 total employees, in Chilean copper mine regions.

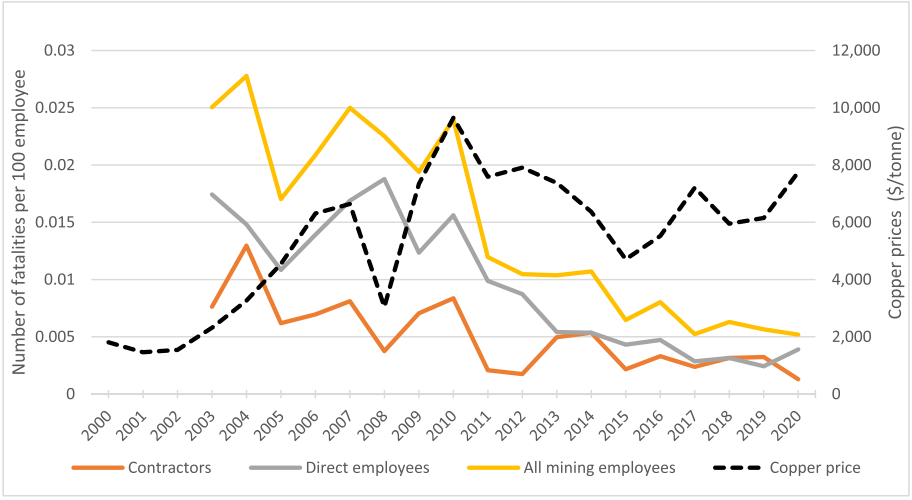

Fig. A.4. Annual mining fatalities rates in Chilean copper regions per 100 total mining employees.

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