Estimating the price elasticity of critical mineral supply

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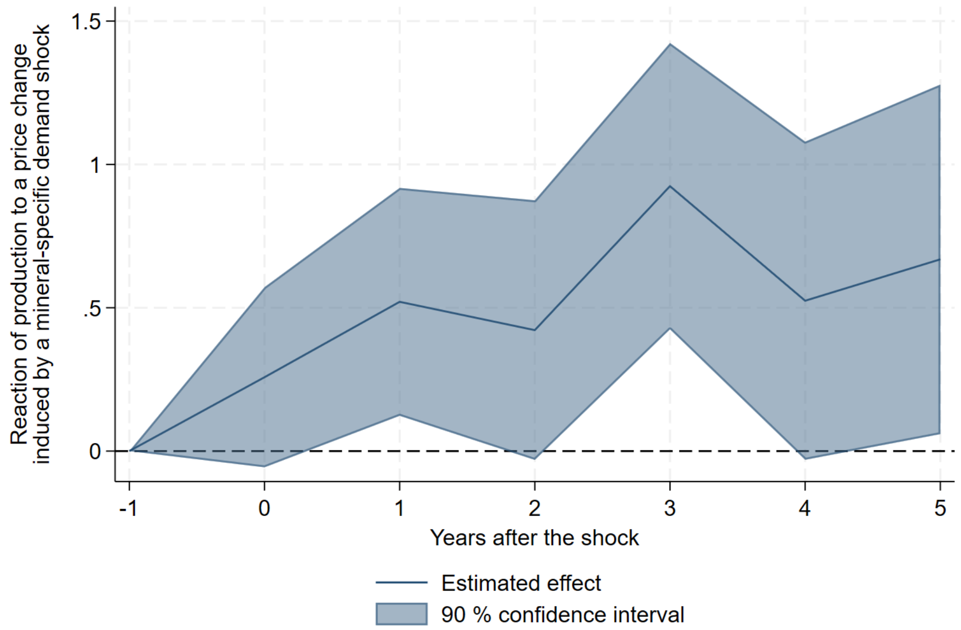
Granular mine data show that the supply of minerals critical to the energy transition reacts rapidly to price movements caused by demand shocks. The reaction depends on the characteristics of mines and of global mineral markets. It is weaker in Africa due to the higher prevalence of conflicts near mines, which makes it harder for supply to adjust.

Chart 1: Average price elasticity of the supply of eight critical minerals over a five-year horizon



Source: Jasansky et al. (2023), USGS, IMF; authors' calculations.

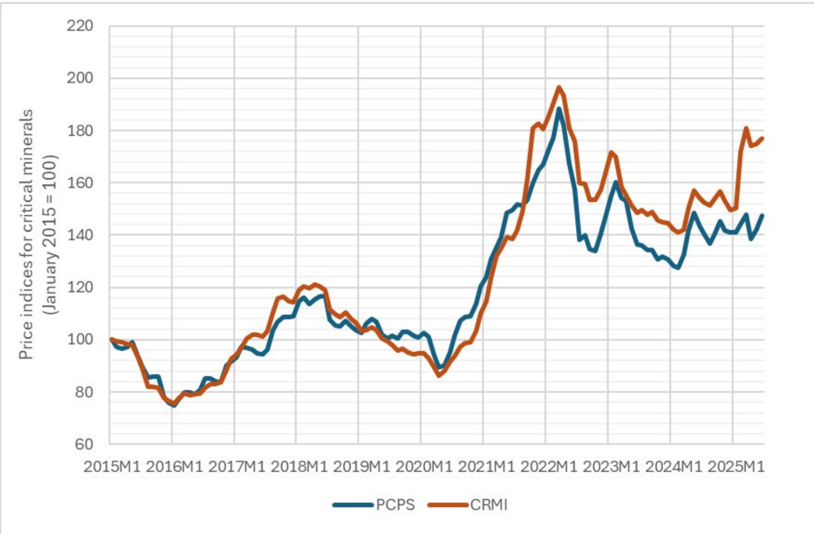
Note: The blue line shows the estimated effect, with the 95% confidence interval shaded in grey. One year after a 1% rise in the price of a given mineral, its production is 0.5% higher.

The energy transition is likely to trigger a surge in global demand for so-called "critical" minerals, which are essential for producing and storing low-carbon energy and for the expansion of AI. Between 2020 and 2040, the need to meet net zero emissions targets by 2050 is expected to push up critical mineral demand nearly sevenfold (Miller et al., 2023). It is paramount that supply is able to adjust to this demand, to keep costs under control and minimise the risk of macro-financial instability linked to price volatility. Critical materials also pose significant geopolitical challenges, including the issue of supply security, notably in the European Union.

The upward trend in demand for critical minerals should be accompanied by a rise in prices (Boer et al., 2024) – a phenomenon already observed over the past decade (Chart 2). In this context, it is crucial to understand how price movements in turn impact critical mineral supply, via the cost of each additional unit of production.

Rising prices can prompt firms to open new mines, which will boost supplies in the long run as lead times from discovery to production can reach 10 to 20 years. Higher prices can also boost supplies over the short run, through an intensification of production at existing mines. Whether supply will be able to adjust to prices depends on various factors, including mine-level characteristics (such as the size of their reserves, the number and type of minerals they extract and their shareholder structure). However, research into the price elasticity of supply (i.e. the impact of prices on output) remains scarce, and the few recent papers on the topic tend to neglect critical minerals that have experienced a surge in global demand (such as cobalt and molybdenum).

Chart 2: Price indices for minerals critical to the energy transition



Sources: Primary Commodity Price System (PCPS): IMF; Critical Raw Materials Index (CRMI): Hasse and Nobletz (2024)

Note: The PCPS comprises 16 minerals, and the CRMI includes 29 minerals. In the CRMI, the weight of each mineral depends on its share in global exports. The difference between the two curves since 2022 is explained by a rise in tin and gallium prices (absent from the PCPS but included in the CRMI).

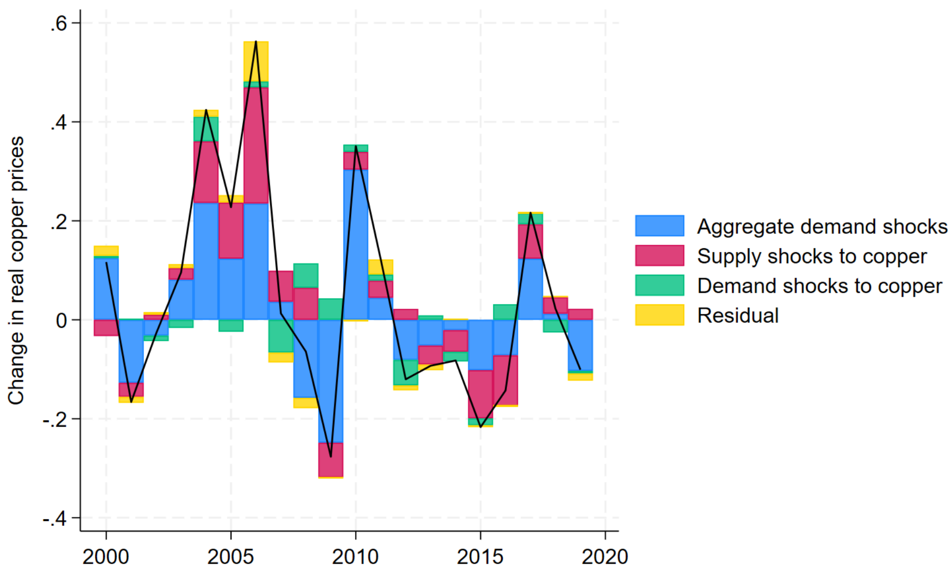
A marked reaction of supply to a price shock over five years

In a recent article (Vertier et al., 2025), we propose new estimations of the price elasticity of supply, using granular mine production data from Jasansky et al. (2023) for the 2000-19 period and covering 318 mines in 43 countries. Our analysis focuses on eight of the principal minerals critical to the energy transition: cobalt, copper, lead, molybdenum, nickel, platinum-group metals, silver and zinc. The data cover at least 20% of global production for each of these minerals and we have an average of ten years of observations for the mines studied.

The observed fluctuations in mineral prices may reflect both supply shocks and demand shocks. Therefore, to estimate the price elasticity of supply, we retain only price movements induced by demand shocks and remove all those induced by supply shocks. In addition, to isolate the effects of the energy transition (Boer et al., 2024), we focus only on mineral-specific demand shocks (e.g. caused by the introduction of a new green technology), and exclude those common to all minerals (global raw materials cycle, financial crises).

To do this, we estimate structural vector autoregression models using data on global economic activity, global mineral prices and global mineral production for the 1912-2019 period. We include three types of shocks (mineral-specific demand shock, non-specific demand shock and mineral-specific supply shock), identified by applying sign restrictions to their impact on the model variables. This allows us to break down the global price variation for each mineral (see Chart 3 for the example of copper) and isolate the component linked to the mineral-specific demand shock.

Chart 3: Breakdown of the change in the price of copper (2000-19)



Source: USGS, IMF; authors' calculations.

Note: The variable broken down is the real price of copper in US dollars, i.e. adjusted for the US consumer price index.

Using a local projection approach for a horizon of 0 to 5 years, we then examine how production of a given mineral at each mine reacts to a price rise induced by a mineral-specific demand shock. We estimate, on average, that for a 1% rise in the price of a mineral caused by a specific shock, mine-level production of that mineral will rise by around 0.5% over the following five years. The effect is relatively stable over the projection horizon, fluctuating between 0.2% and 1% (see Chart 1).

The significant reaction of mine-level production over a relatively short period contrasts with existing studies based on aggregate data, which find more moderate reactions. This may be explained by our use of more granular data, which avoids any possible aggregation bias.

Substantial heterogeneity of estimated effects, linked to local and global factors

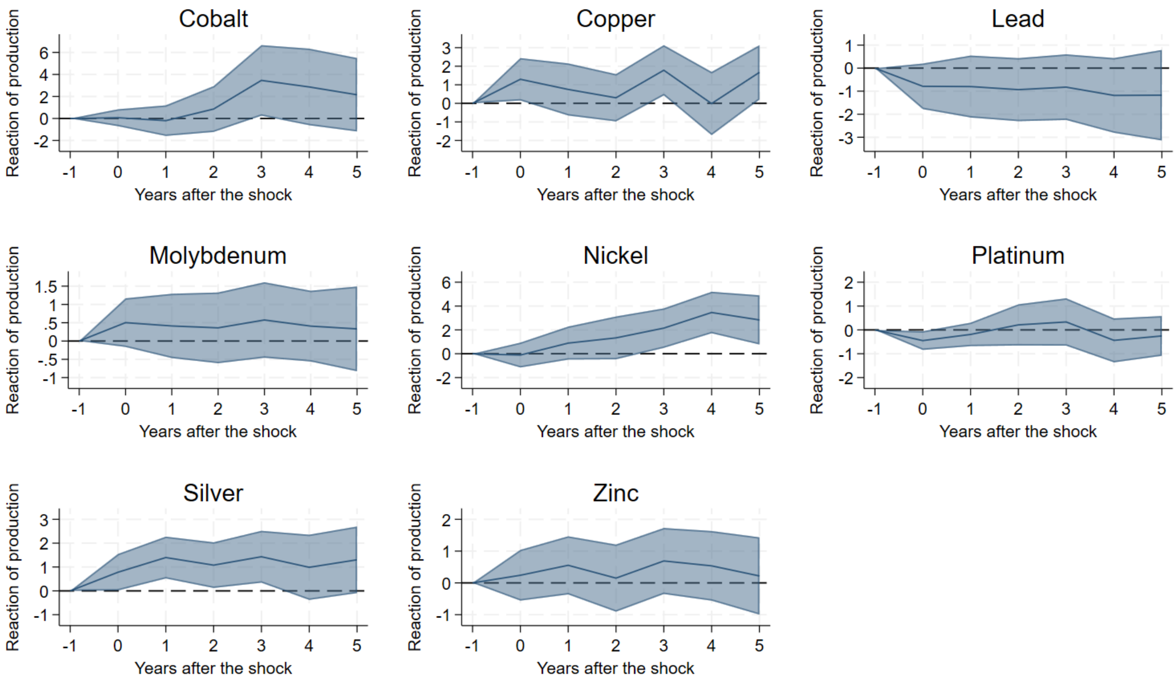
Our results suggest that, at mine level and over a relatively short time window, supply is able to adjust to price movements. However, the reaction of supply is heterogeneous. It is particularly strong for silver, copper and nickel (Chart 4) and depends on the characteristics of the mine, its location and the characteristics of the global market.

Regarding the characteristics of the mine, the reaction is smaller if the mine produces more than one mineral, suggesting possible smoothing effects on supply. However, at these mines, the reaction is stronger for “primary” minerals (i.e. those accounting for most of the economic value produced by the mine) than for “secondary” minerals. For the latter, production is more sensitive to changes in primary mineral prices than to changes in the prices of the secondary minerals themselves. The reaction of supply is also weaker when the mine is owned by more than one company (suggesting a slower decision-making process), and when mineral reserves are larger (possibly allowing for more longer-term management of resources).

As for mine location, local economic activity levels and proximity to transport infrastructure have no impact on the supply reaction. However, the reaction is weaker in mines located close to conflict zones. This partly explains the lower price elasticity of supply in Africa, where there is a higher prevalence of conflicts than in other regions. These results confirm the significant development constraints faced by the mining sector in Africa, particularly in terms of governance, logistics and transport (Clair and al., 2023).

Lastly, regarding global market characteristics, we test the sensitivity of supply elasticity to the concentration of production (reflecting economies of scale or market dominance). Price elasticity is weaker when production is concentrated among a smaller number of mines. Conversely, we find that the introduction of export restrictions has no impact on the reaction of production, at least up to 2019. However, given that the issue of critical minerals and energy independence has since become more pressing, questions remain as to the possible impact of strategic behaviour by producing and investing countries.

Chart 4: Estimated price elasticity of each mineral



Source: Jasansky et al. (2023), USGS, IMF; authors' calculations.

Note: The blue line shows the impact (in %) on the production of a given mineral of a 1% rise in its price induced by a shock to global demand, with a 90% confidence interval (grey-shaded area). For example, one year after a 1% rise in the price of silver, its production is around 1% higher.