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Research Brief

A Country-Level Study of Exposure to Battery Price Fluctuations through Trade Networks

Andrea Bastianin, Ilenia Gaia Romani, Luca Rossini, and Marco Zoso

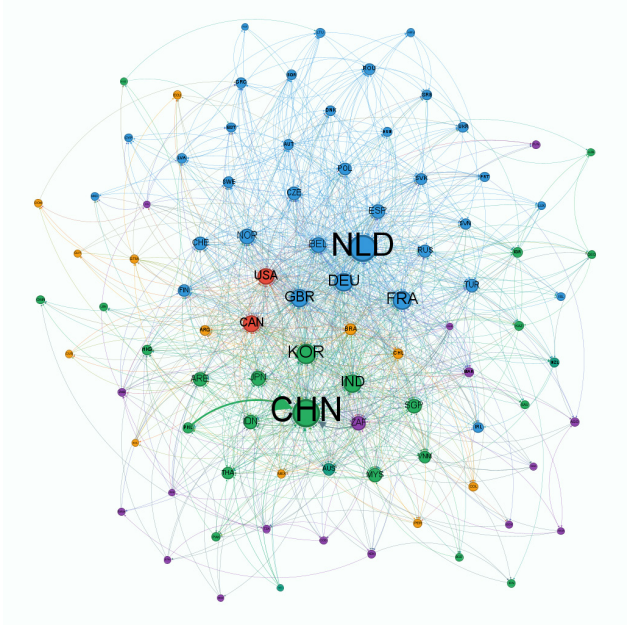
This study examines the impact of critical raw materials (CRMs) and their processed derivatives on countries' exposure to lithium-ion battery price fluctuations. Specifically, we investigate how a country's position within the global trade network of CRMs, processed materials, and batteries influences the stability of the price they pay for lithium-ion batteries.

The global transition to clean energy depends heavily on lithium-ion batteries, which power electric vehicles, renewable energy storage, and consumer electronics. Stable battery prices are therefore crucial for making clean technologies competitive with fossil fuels. If battery prices swing unpredictably, the costs of electric vehicles, renewable energy storage, and other green technologies may rise, slowing adoption.

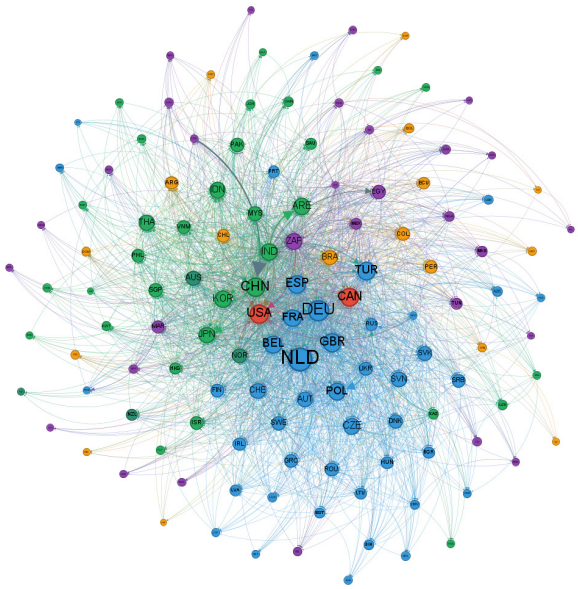
One of the main drivers of instability in lithium-ion battery prices is the complex structure of their supply chain. In particular, the raw materials needed for their production are mined in only a few countries. For example, the Democratic Republic of Congo produces over three-quarters of the world's cobalt, Indonesia dominates nickel production, and China refines the majority of processed battery materials. This concentration means that disruptions — from geopolitical tensions, trade restrictions, or even local unrest — can spread quickly through the supply chain and impact global battery markets.

Our research explores an often-overlooked issue: how a country's position in the global trade network of critical raw materials (such as cobalt, lithium, nickel, and manganese), their processed derivatives, and finished batteries affects its vulnerability to supply chain–driven price swings. By combining trade and price data with advanced network analysis, we shed light on why the risks from battery price volatility are not the same for all countries; instead, they depend on trade network characteristics.

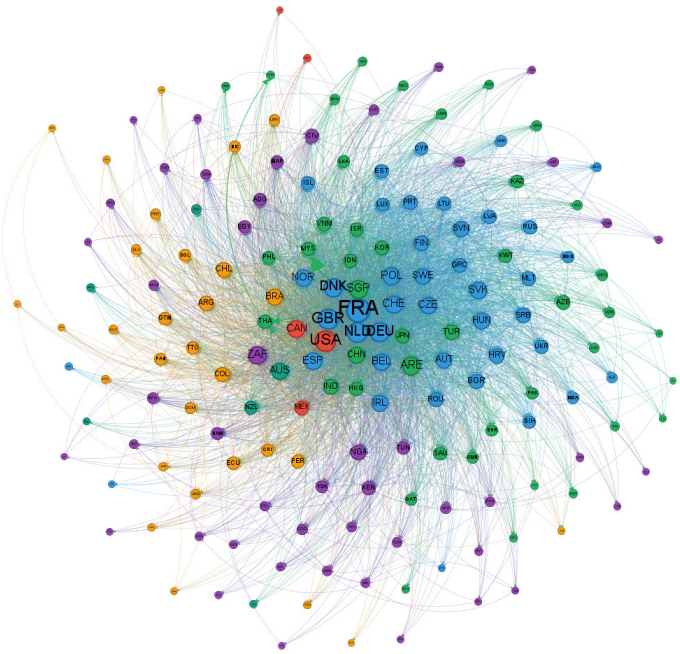
Specifically, we map the supply chain into three layers: raw minerals, processed materials, and finished lithium-ion batteries. Figure 1 shows a graphical representation of these networks for 2022, highlighting the main actors at each stage.



(a) Raw materials



(b) Processed materials



(c) Li-on batteries

Figure 1. Trade networks of raw (a), processed materials (b), and batteries (c), in 2022. Each node represents a country, with node size proportional to the number of importing partners and node color indicating geographical region.

We then regress indicators of these networks on a newly constructed country-level index of exposure to battery price fluctuations.

In theory, it is not clear whether being more connected in these trade networks makes countries safer or more vulnerable. On the one hand, greater connectivity might provide stability, since a country with many partners and a central position could spread risk and benefit from its influence. On the other hand, those same links might amplify exposure, leaving countries more vulnerable to shocks that spread quickly across the network.

We employ statistical models that account for differences across countries and over time to examine how trade network positions affect exposure to battery price swings. Our analysis shows that being central in the trade network or exporting to many partners does not seem to have an impact on vulnerability. Instead, what matters most is imports. Countries that rely on a larger number of import partners for processed materials and finished batteries are actually more vulnerable to price volatility, not less. In other words, the second hypothesis prevails — greater connectivity through imports tends to amplify, rather than mitigate, exposure to battery price shocks.

These findings have important policy implications. First, reducing vulnerability requires strategic import concentration rather than simple diversification. Mineral-dependent countries may reduce their exposure to battery price volatility by lowering the number of origin countries from which they import processed materials and batteries. This runs counter to the conventional diversification logic that more trading partners reduce risk, highlighting instead the asymmetry between exporting and importing positions in the trade network. For mineral-importing economies, resilience lies in building more stable, possibly long-term contractual relationships with fewer suppliers, or in developing domestic midstream and downstream capacities. In addition, fostering research, innovation, and industrial policies that encourage the substitution of scarce or complementary critical minerals with more abundant alternatives could further mitigate vulnerability by reducing the risk of joint supply disruptions. Taken together, such strategies can help ensure that battery prices remain stable enough to support the rapid adoption of clean energy technologies worldwide.

References

Link to the full working paper discussed in this brief:

Bastianin, A., Romani, I.G., Rossini, L., Zoso, M. (2025), "A Country-Level Study of Exposure to Battery Price Fluctuations through Trade Networks," MIT CEEPR Working Paper 2025-18, September 2025.

About the Authors

Andrea Bastianin is Associate Professor of Economic Policy at the University of Milan, Department of Economics, Management and Quantitative Methods, where he teaches econometrics and macroeconomics. He is the Director of the RAMET research program (Raw Materials for the Energy Transition) at Fondazione Eni Enrico Mattei (FEEM). Previously, he was a Fixed-Term Researcher (RTD-a) in Econometrics at the University of Milan-Bicocca. His research interests include time series econometrics and energy economics.

Ilenia Gaia Romani is a Postdoctoral Associate at the MIT Materials Research Laboratory and an Associate at MIT CEEPR, where she works on projects in mineral economics and techno-economic analyses of critical raw materials and their dependent technologies, such as electric vehicles. She is also a researcher in the Raw Materials for the Energy Transition (RAMET) program at Fondazione Eni Enrico Mattei (FEEM) in Milan. She earned her PhD in Analytics for Economics and Management (AEM) at the University of Brescia, with an empirical thesis on key minerals for the energy transition. More about her profile and projects can be found here: https://linktr.ee/ileniagaiaromani

Luca Rossini is an Associate Professor of Statistics at the University of Milan and a Senior Researcher at Fondazione Eni Enrico Mattei. His research focuses on Bayesian methods related to time series; novel forecasting techniques related to commodity and electricity prices and on novel methodologies related to multivariate time series. Before joining Milan, he held a tenure-track assistant professorship at Queen Mary University of London and a Marie-Curie Fellowship at Vrije Universiteit Amsterdam. Prof. Rossini received a Ph.D. in Economics at Ca' Foscari University of Venice, including a research state at University of Kent.

Marco Zoso is a Ph.D. Candidate at the University of Milano-Bicocca and a researcher at the Fondazione Eni Enrico Mattei (FEEM) in the "RAw Materials for the Energy Transition" (RAMET) research programme. His main research interests are: time series econometrics, Bayesian econometrics, and energy and environmental economics.

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