



Modeling the Impact of Critical Mineral Price Volatility on Vehicle Demand

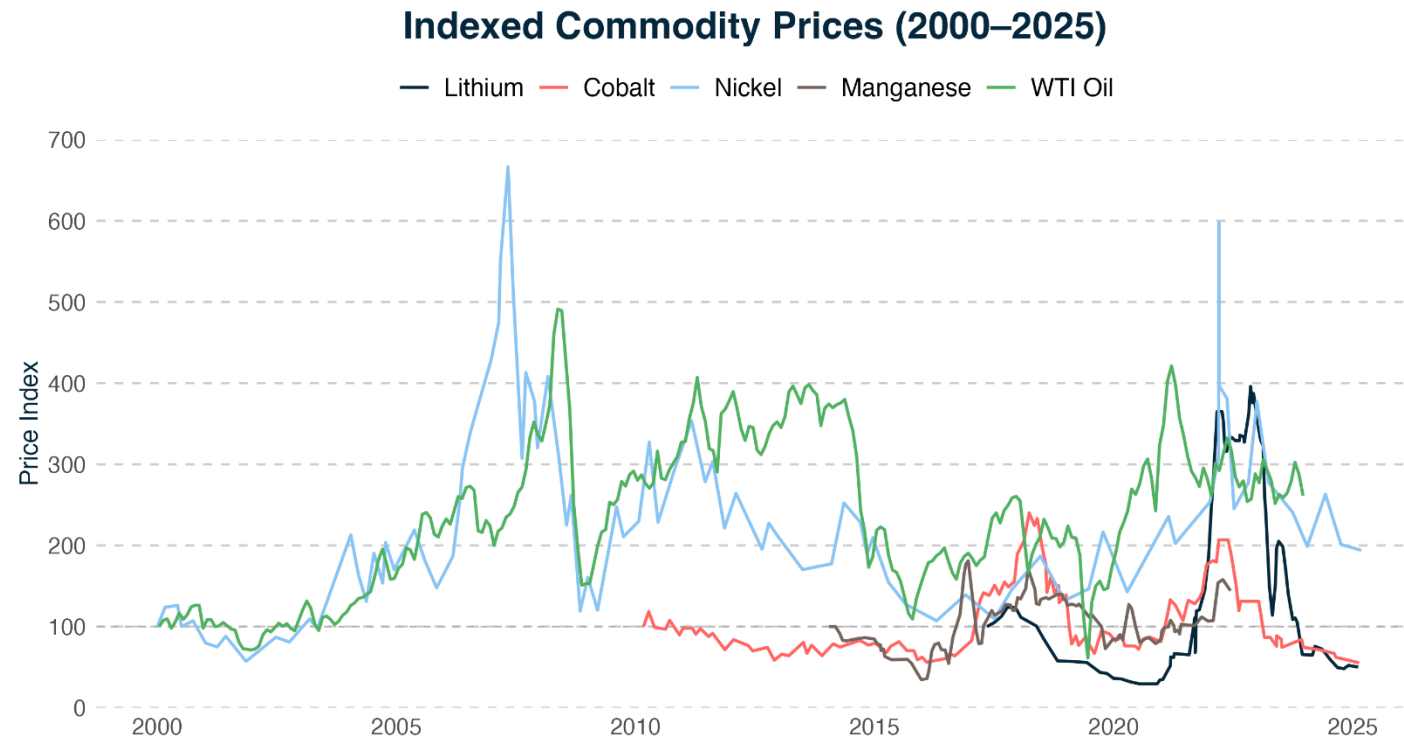
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Electric vehicle adoption demands different mineral extraction

- Like the status quo with oil, decarbonized transportation will entail dependence on mineral resources characterized by volatile markets (IEA 2021)

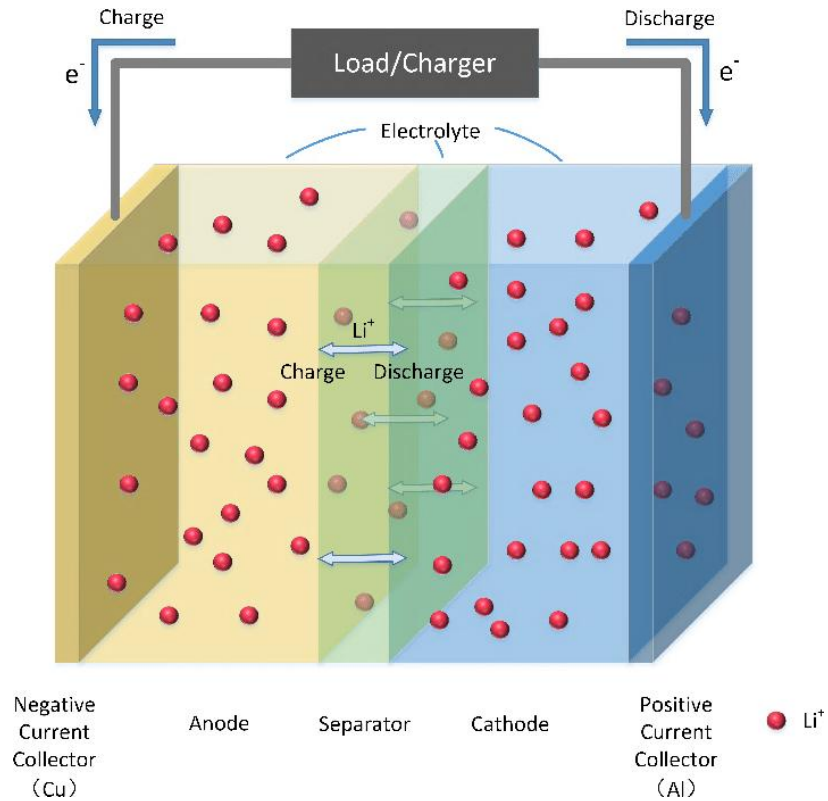


Though automakers may be protected from mineral price shocks on spot markets

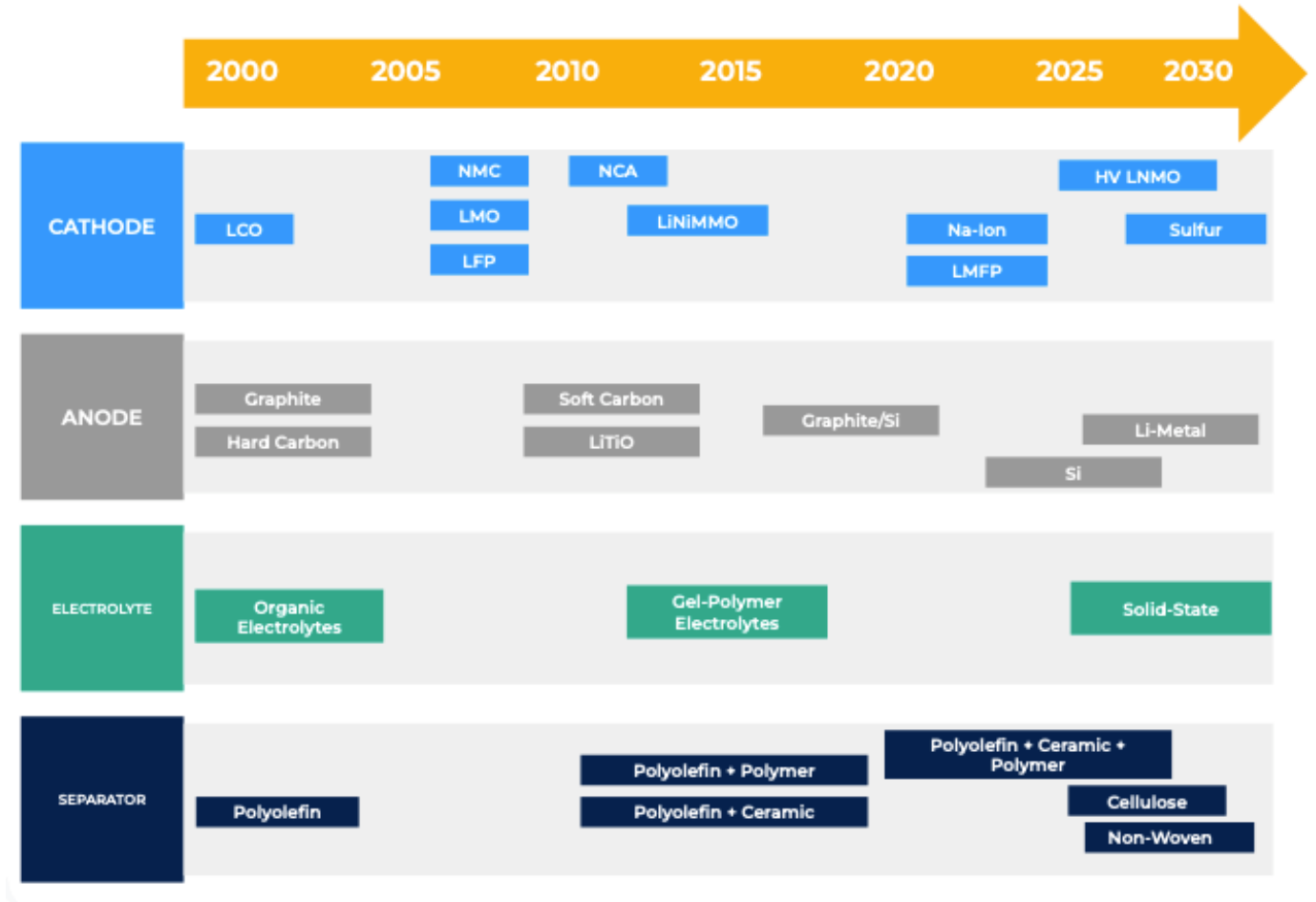
- Because certain electric vehicles (EVs) use different battery chemistries, exposure to mineral price shocks varies greatly by vehicle (Li et al. 2024)
- Certain EV batteries use little or no quantities whatsoever of an element that is essential for another battery to function (Shen et al. 2024)
- Additionally, battery manufacturers may be protected from short-term feedstock price shocks because of long-term supply contracts and offtake agreements (Jones et al. 2023)



EV Battery Primer



Source: Zhang et al. 2018



Source: Volta Foundation, 2024 Battery Report



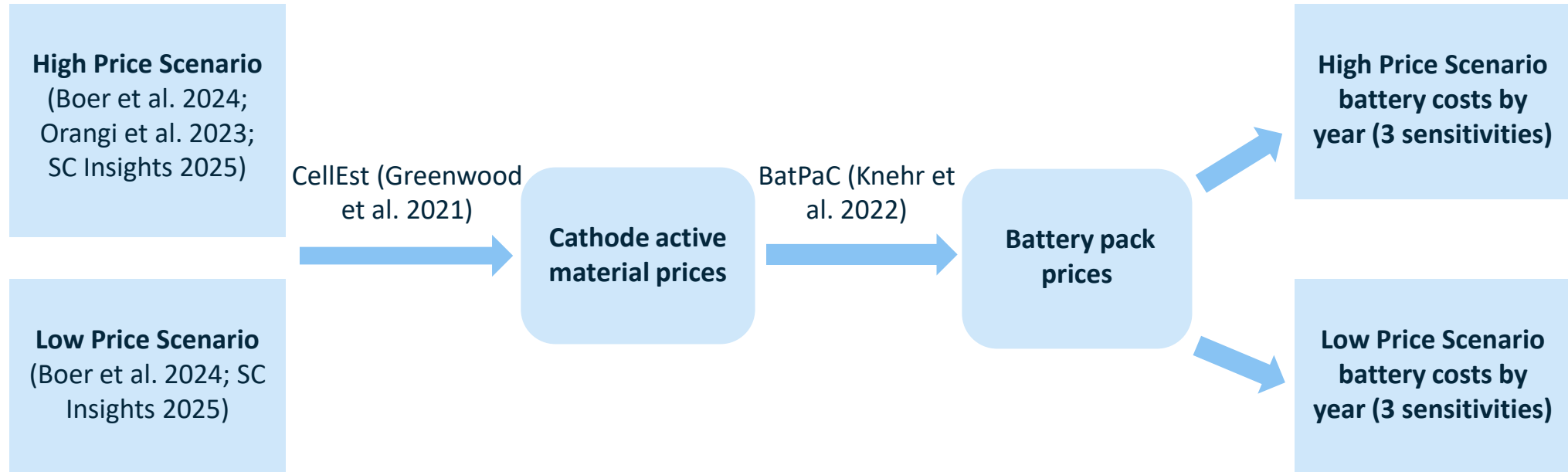
Motivation and approach

- Starting from mineral price forecasts, we use engineering models to calculate EV battery pack costs and then feed those costs into a structural economic model of the vehicle market
- We use engineering and economic models to understand how mineral price shocks may affect the electric vehicle market outcomes and consider how EV policies interact with these outcomes
- EV policies could be further motivated by insulating consumers from mineral price shocks



Battery cost forecasting with BatPaC and CellEst

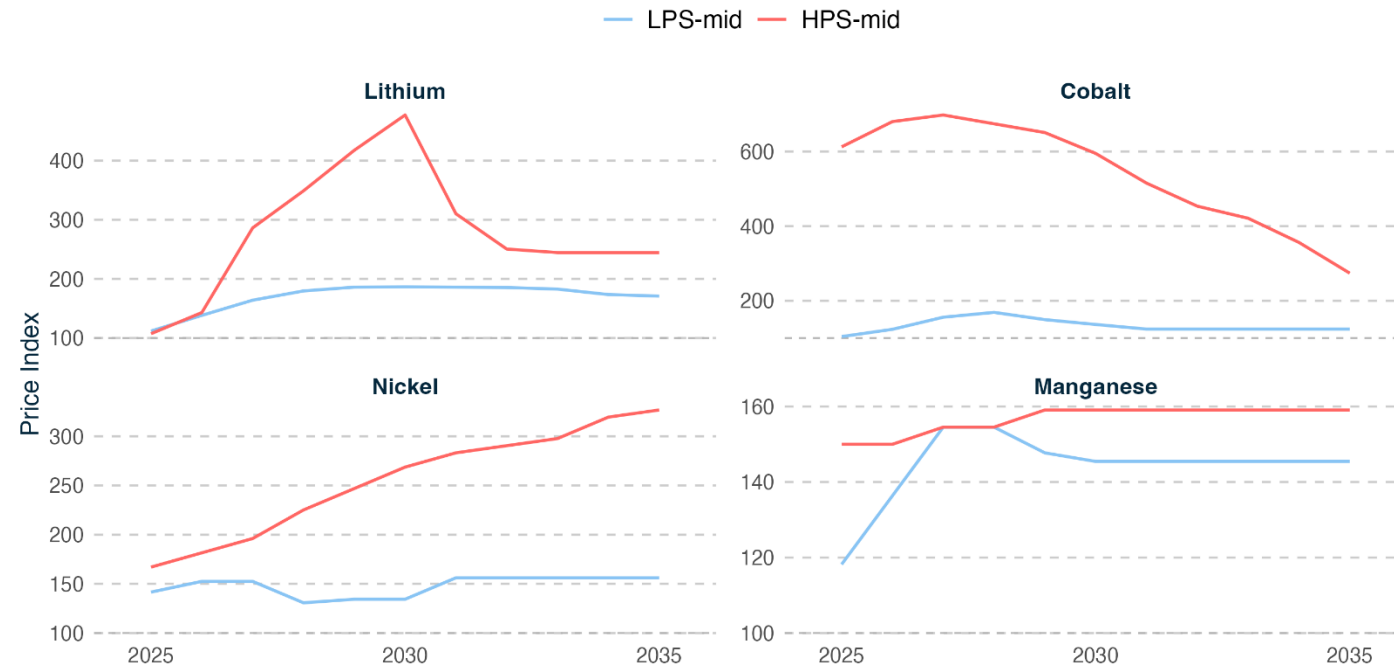
Mineral price forecasts



Mineral Price Scenarios and Vehicle Market Context

- EV policies are gone, dealing a blow to the domestic market
- Future global mineral demand is highly uncertain, as are price forecasts in the industry and literature

Price Scenarios: LPS-mid vs HPS-mid (2025–2035)



Vehicle market model

- Integrated model of vehicle supply, vehicle demand, and driving decisions
 - Supply: manufacturers choose vehicle prices and attributes and EV entry given consumer demand and policies
 - Demand: vehicle and driving preferences vary by demographics and regions
- Key parameters estimated from data on vehicle choices and attributes and driving
 - Household vehicle choices, 2010-2020
 - Vehicle attributes, 2010-2024
 - Driving, ownership, and scrappage, 2017-2022



Results

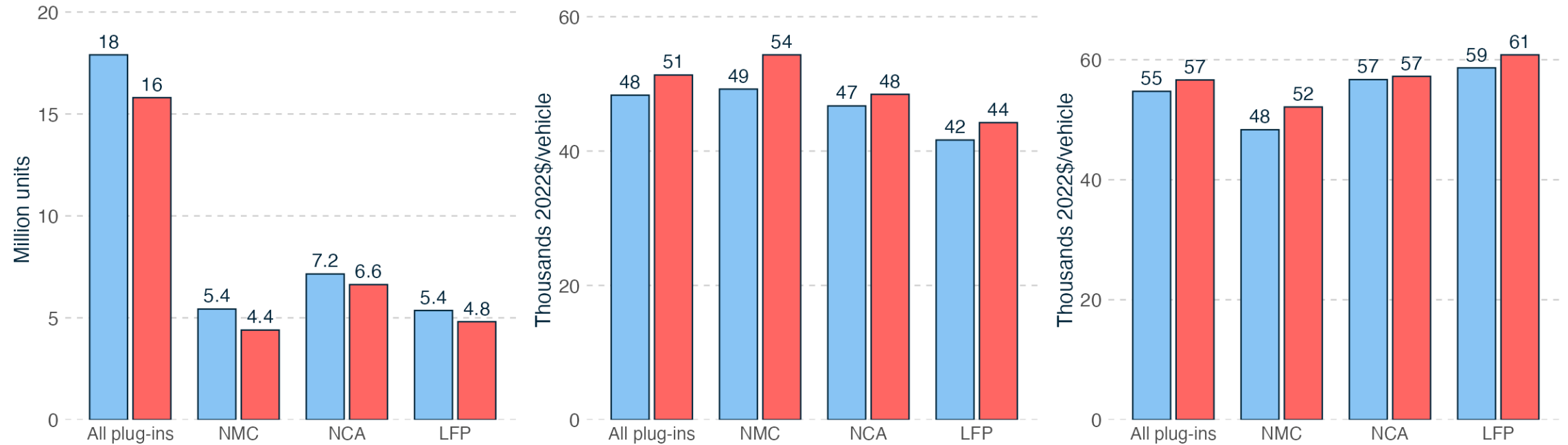
Vehicle Simulation Results by Battery and Vehicle Type (2026-2035)

Sales

Marginal costs

Transaction price

Baseline High battery prices



Why Don't Automakers Just Change the Batteries?

- Original Equipment Manufactures (OEMs) are often “locked in” to battery chemistries, because to change the battery chemistry is to change the entire battery in the vehicle. The specific battery is very important to the electric vehicle
- When OEMs change an EV battery, they typically must also make modifications to the entire vehicle platform as well as its thermal management system (Knehr et al. 2022). If vertically integrated, firms must reconfigure major battery production facilities (Degen and Krätzig 2024)
- Indeed, McKinsey found recently that OEMs have moved towards vertical integration and predominantly assemble the battery pack themselves, just purchasing the cells from battery suppliers (Breiter et al. 2020)



Next steps

- Consider the form of the cobalt high price scenario. Persistent high prices may be less feasible than a shock lasting a few years due to natural disaster or geopolitical conflict
- Refine battery price assumptions and cost model
- Now that the general approach is figured out, we can refine research questions and outcomes



References

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Thank you!

