Pervasive Dependency on Energy Transition Minerals

Topic: Input-Output Analysis: Trade and Global Value Chains policies (3)
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Anthropogenic-induced climate change presents states around the world with an increasingly pressing need to undertake a comprehensive â€˜energy transitionâ€™ to sustainable modes of energy generation. Simultaneously, the growing 'systemic competitionâ€™ in geopolitics between democracies and autocracies has pushed the former to reconsider their dependencies on the latter â€“ generally but also specifically regarding energy and critical minerals required for the energy transition (hereafter referred to as energy transition minerals or ETMs). New trade dependencies for ETMs appear unavoidable given disparities in the locations of demand (North America and Europe) and supply (China, Africa, South America and Australia) (Seong, 2024).

Policy makers are therefore working to mitigate the impacts of trade dependencies on countries supplying ETMs (International Energy Agency, 2025). However, a threshold question that has not been adequately addressed is whether ETM trade dependencies will be similar to, or different from, dependencies which exist for the supply of fossil fuels. Further investigation is therefore required to evaluate if ETM trade dependency offers the same potential for exploitation, via economic coercion, as historic dependencies for fossil fuels (Panwang and Hu, 2025).

To do this, this project has, for the first time, quantified the â€˜pervasive dependencyâ€™ of democracies on the suppliers of the ETMs cobalt, copper and nickel. We define pervasive dependency, per Wiedmann et al. (2016), as the extent to which a particular economy â€˜consumesâ€™ embodied ETMs which are used anywhere in the entire supply chain, not just those physically exported to the consuming location. This approach differs from that used in current minerals criticality assessments which focus on physical flows of minerals in relatively basic or semi-refined forms.

Pervasive dependency was calculated from consumption-based accounts for the three ETMs using an ETM-trade-enhanced version of the GLORIA multi-region input output table (Lenzen et al., 2022). New sectors were added for cobalt ores and concentrates, cobalt chemicals and basic cobalt metal based on physical production and material flows of cobalt. In addition to the ubiquitous challenge of converting physical to financial flows, construction of cobalt sectors in GLORIA was also affected by; the relatively small financial magnitude of ETM sectors, the production of cobalt as a by-product of copper and nickel mining, the myriad chemical forms into which cobalt is refined, traded in or prepared into as a battery precursor, and the particularly opaque nature of cobalt trading and intermediate sections of its supply chain.

The pervasive dependency for an economy i.e., final consumption, split by sector, was presented along with the region of origin of the ETMs. Changes in pervasive dependency for the three ETMs over time, as well as the extent of dependency by regime-type was shown. This included a comprehensive sensitivity analysis of the input-output model to price-mass relationships, trading relationships and exported forms of ETM.

The completed work provides the foundation for subsequent analysis which will compare future pervasive dependency for ETMs, under a range of different trade configurations and energy transition scenarios, with historic pervasive dependencies for fossil fuels. This study provides decision-makers with a quantitative evaluation of how dominant paradigms regarding strategic risks are affected by future ETM-trade dependency.

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