Advancing the representation of critical minerals supply chains in the global economic models

Topic: Trade and Global Value Chains Policies (1)
Author: Maksym G. Chepeliev
Co-Authors: Ayse Nihal Yilmaz, Dominique van der Mensbrugghe

Earlier studies have estimated that achieving ambitious climate mitigation targets will require an unprecedented expansion in renewable infrastructure and technologies, such as wind turbines, solar panels, batteries for electric vehicles, etc., leading to the growing demand for critical minerals and materials, such as nickel, platinum group metals, zinc, rare earths, etc., which are essential inputs for the development of renewable energy systems. Apart from pure supply and logistical constraints, the rising demand for critical minerals and materials is also associated with national security aspects and is prone to generate geopolitical frictions, as mining and processing/refining of many important minerals are concentrated in a limited number of countries. Trade policy interventions are frequent, in particular in the form of export restrictions.

It is important to have the analytical capacity for the assessment of future energy transition scenarios, as well as trade and domestic policies, with an explicit representation of the critical minerals supply chains. The evolution of the latter is impacted by various drivers, including costs of technologies, future changes in incomes and population, the spatial distribution of the mineralsâ€™ mining and refining capacities, bilateral trade patterns, etc. At the same time, such a level of detail is missing in most global databases and integrated assessment models. In this study, we address this gap by enhancing the Global Trade Analysis Project (GTAP) Database with detailed representations of critical minerals and metals supply chains, including both upstream and downstream activities. GTAP is a global multi-region input-output (MRIO) framework, which is widely used for global and regional economic and environmental modeling.

We start from a refined version of the GTAP 11 circular economy (GTAP-CE) Data Base with the 2017 reference year, which disaggregates the mining and refining of iron, bauxite, copper and other non-ferrous metals ores from a single extraction sector, tracing production and bilateral trade across 160 countries and regions, as well as 99 sectors.

We further disaggregate around 20 additional ores and metals, including lithium, cobalt, rare earth elements, nickel, graphite, manganese, platinum group metals, gallium, silver, phosphorus, chromium, titanium and magnesium, among others. The implemented splits include mining, processing/refining and use stages (downstream sectors, such as magnets, batteries, solar panels, wind turbines, electric vehicles, etc.).

We showcase the application of the newly developed GTAP MRIO Data Base by providing a detailed analysis of the global value chains, tracing the geographical and supply-chain (i.e. across different activities) distribution of the critical minerals, as well as identifying the value-added creation stages in this process. Such estimates would allow to better understand the configuration of these complex value chains and provide important policy insights in the context of import dependency and national security dimensions as the world continues to address climate mitigation challenges.

The next steps of this project will include modeling the wide range of forward-looking climate mitigation scenarios in countries around and analyzing the evolution of critical minerals value chains under alternative policy assumptions.