Measuring dependencies on critical raw materials in the supply chain

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In the European Union there is growing attention directed to securing Europeâ€™s supply of critical raw materials (CRMs), which are seen as vital in facilitating the energy transition in the scope of the European Green Deal. Consider for example the EUâ€™s Critical Raw Materials Act (2023) or the European Chips Act (2023). These measures can also be seen as a response to a surge in geopolitical competition and a desire to become more strategically autonomous and sustainable in the sourcing of vital materials. These developments lead to the question: how dependent is a country â€“ directly and indirectly, via the global supply chain â€“ on CRMs supplied by countries like China or Russia?

We quantify the import of 32 CRMs into the Netherlands, analyze their origin, and trace their use in the Dutch economy using a value chain framework. We consider both direct product-specific dependencies (via the direct import) and indirect or otherwise â€˜hiddenâ€™ dependencies. The latter involve the indirect import from third countries, i.e., via the direct import of products that embody CRMs that were traded upstream in the chain. For example, copper from Chile may be indirectly imported by the Netherlands if is first exported to China for processing and then crosses the Dutch border at a later stage embodied in a processed good (such as solar panels or wind turbines). Our approach explicitly takes that aspect into account.

A novel IO-based framework is employed that builds on the general concept introduced in Lemmers et al. (2023). To compute direct imports of CRMs, we use a â€˜national TiVAâ€™ approach by linking micro-data on international trade to national Dutch input-output tables (following Aerts et al. (2022) and Lemmers and Wong (2019)). The imports in the IOT are split at the country by industry by 8-digit product level and benchmarked to national account totals. This national TiVA approach is more timely and, crucially for our aim, has much more detail on both countries and products than a conventional IOT. For example, this allows to compute the amount of bauxite directly imported by the Dutch basic metal industry from Guyana that is ultimately processed in Dutch exports, or the import of the same product bauxite from China that may mainly go directly into Dutch re-exports.

The calculation of indirect imports involves allocating detailed trade data to all trade flows between countries and industries in the OECD Inter-Country Input-Output Table. We draw upon supply tables from the FIGARO MRIO, BACI international trade data (with HS-6 product level detail), the Dutch use table, and the BEC classification to provide this added layer of granularity. This 'global' supply-use table, which has been merged into the MRIO and is combined with detailed national data, allows to estimate the amount of production required directly and indirectly in all upstream chains (of different CRMs) to produce Dutch imports. This shows us how much nickel is indirectly imported from Russia via the direct import of stainless steel from the US.

The analysis shows that most of the direct import of CRMs in 2022 ultimately ended up abroad, either in the form of re-exports (57 percent) or in the form of imports processed by Dutch industries into exports (30 percent). Much of the rest (12 percent) went into Dutch consumption after domestic processing. Russia was the most important supplier, both directly and indirectly, of CRMs to the Netherlands in 2019, especially in the form of copper, nickel, and phosphorus. Notably, the indirect imports were in total twice as large as direct imports. This confirms the presence of significant â€˜hiddenâ€™ linkages. For example, we find sizable flows of copper and lithium from South America to China that traverse a long distance before entering the Netherlands, which underscore

potential indirect vulnerabilities.

One limitation of the method is that the extraction of raw materials that are processed into (intermediate) products within a country before crossing that same countryâ€™s border is not considered in our analysis of indirect dependencies (due to their lack of visibility in trade data). In future research we plan to address that part as well by examining the indirect import of products that are known to embody CRMs. For example, think of Chinese exports of LEDs that may embody gallium produced in China and imported indirectly via Germany in the form of electrical appliances.

Our paper thus demonstrates the potential of using detailed trade data to increase granularity in both national IOTs and in publicly available MRIOâ€™s. The combined use of the more detailed data allows for even more granular insights into the supply chain, which is especially useful where product-specific detail is necessary to address policy-relevant issues.