# Global supply chain restructuring towards achieving a low-carbon procurement of mineral resources

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While mineral resources play an essential role to achieve a decarbonized society, their production processes are highly CO2 intensive. For mitigating climate change, it is important for industries worldwide to reduce CO2 emissions from productions of mineral resources which are embodied in their production activities including global supply chains (GSC). Several previous studies have revealed the current situation and the future transition of CO2 emissions from mineral resource productions; however, they did not answer the important question: How can industries improve the mineral resource procurement structure in their GSCs to reduce CO2 emissions? To address this research question, this study aims to propose an input-output (IO) analysis framework to investigate impacts of a structural change in the mineral resource procurement of GSCs induced by final demands in a specific country (i.e., GSC restructuring) on global CO2 emissions.

First, this study built a unit-hybrid multi regional IO (MRIO) table using the GLORIA database in 2019 which covers 120 sectors in 164 countries/regions and industrial material use data for mineral resources in its satellite account. Specifically, the unit-hybrid MRIO table describes elements for the specific sectors related to mineral resources in physical values (tons), and ones for the other sectors in monetary values (USD). Second, this study applied the hypothetical extraction method: HEM (Dietzenbacher et al., 2019; Maeno, 2023) to the IO table to estimate impacts of hypothetical structural change of mineral resource procurement in industrial GSCs on their global carbon footprints. The novelty of this study is to model a GSC restructuring defined by extractions/substitutions of mineral resource productions in GSCs based on "physical value" by the first attempt of applying the HEM to a unit-hybrid MRIO table, enhancing a reality and feasibility of results obtained by the proposed framework.

For a demonstration of the framework, we conduct the case study focusing on the GSC restructuring of Japanese industries targeting iron ores produced in the top five producing countries (Australia, Brazil, China, India, and Russia) which account for more than 85% of the total production of iron ores in the world. Furthermore, to reflect a more practical situation, this study defines the GSC restructuring scenario at a small scale in which basic iron sector in each country included in the GSCs of Japanese industries shifts its trading partners from the targeted countries to other substituting countries for importing 0.1 kt intermediate input of iron ores per a unit of its outputs.

The results showed the changes in the trade flows of iron ores and CO2 emissions triggered by the relevant GSC restructuring in the small scale. Specifically, we found that the GSC restructuring targeting iron ores produced in China and India contributed to net CO2 reductions by -695.9 t-CO2 and -573.2 t-CO2, respectively. On the other hand, those targeting Australia, Brazil, and Russia had the positive impacts on the net CO2 emissions by +763.1 t-CO2, +257.2 t-CO2, +34.5 t-CO2. This result implies that when Japanese industries promote a structural change of iron ore procurement in their GSCs to reduce global carbon footprints, they should target iron ores produced in China and India. Furthermore, we decomposed positive or negative contributions of substitutions in each country to the net impacts of the GSC restructuring for iron ores produced in each targeted country on CO2 emissions, indicating an effective way for Japanese industries to reduce their global carbon footprints through the relevant GSC restructuring.

Finally, we highlighted the significance of the proposed framework with a comparison to the previous

HEM model and concluded that our framework could offer valuable insights to policymakers in countries that depend on imported mineral resources as policy implications for designing effective trade strategies for industries in a relevant country to achieve a low-carbon procurement of mineral resources.