

Finding a Global Energy and Resource Network in a Product Supply Chain using a Global Link Input–Output Model

Topic: Supply chains

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Decoupling greenhouse gas (GHG) emissions from economic growth is an important global challenge. The Japanese economy is no exception. For such a decoupling, it is inevitable that new low-carbon technologies and products be rapidly developed and widely introduced into the Japanese economy. Increased material consumption is sometimes necessary to spread new technologies such as electric vehicles, fuel cells, and solar panels. However, because Japan lacks domestic natural resources, the Japanese economy is founded upon consumption of large amounts of imported natural resources. Especially, dependence on imported mineral and energy resources is extremely high. Recently, not only have imports of natural resources increased; imports of manufactured products have increased as well. Considering this reality, the materials needed for new technologies also are expected to be dependent on supplies from foreign countries.

To achieve decoupling in Japan with dependence on foreign natural resources, the structural relation between GHG emissions and natural resource consumption in the world and Japanese product supply chain must be understood. A world input–output model including multiple nations composed of multiple economic sectors, with an accounting framework resembling that of a conventional multiregional input–output model, presents a powerful framework to achieve that purpose. However, because of the detailed accounting framework of the world input–output model, such a model often presents difficulty of data compilation, particularly in terms of the making of consistent input–output tables for all nations defined in the model. In actual applications, the world input–output model must be a structure with limited nations and at most 100 sectors for each nation, with aggregation of many products into larger categories. This is unsuitable to characterize global GHG emissions and the natural resource consumption of individual products.

This study detected a global network linking nations and individual products, with mutual connections defined by energy and resource consumption through a supply chain of products using a global link input–output (GLIO) model centering on Japan (Nansai et al., 2009). The GLIO accounting framework enables the definition of about 800 intermediate sectors of the Japanese economy to be examined in this study, with the inclusion of more than 200 nations and regions. Results show that a global energy and resource network with regard to a Japanese product is visually identifiable. The key global network of the product was also found by analyzing the structural characteristics of the network.