The trade-offs between carbon and critical metal footprints of Japanese households

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In recent years, the importance of measuring various environmental footprints of a product and those of a nation has been growing to realize multiple environmental managements toward sustainable consumption and production. The 17 Sustainable Development Goals (SDGs) put forward by the United Nations, for instance, need to consider multiple criteria and their synergies and trade-offs. From this point of view, it is essential to scope the trade-offs between greenhouse gas (GHG) emissions reduction and mineral resources consumption, such as â€œcritical metalsâ€• necessary for low-carbon technologies (i.e., fuel cells, electric vehicles).
For carbon footprint of a nation, some studies have demonstrated that household consumption is the greatest contributor among final demand categories. No study has examined, however, the similarities and differences between carbon footprint and material footprint associated with household consumption, despite anxiety related to increased demand for metals with the expansion of new energy technologies.

Against this background, this study simultaneously addresses the carbon and material footprints for the three critical metals (neodymium, cobalt, and platinum) in Japanese households with different income levels. In addition, the policy implications of the trade-offs between GHG mitigation and critical metals consumption are considered within the context of these differences in income.

This study employed a global link input-output model (GLIO) to analyze the household carbon footprint and material footprints for the critical metals. The GLIO is a simplified MRIO that centralized on Interindustry of Japan with global supply chains expressing the sectors of 230 countries and regions. The demand of the target metals here will be expected to increase with the further expansion of new energy technologies. We regarded five household types with different income levels (income quintiles) and estimated respective annual expenditures by disaggregating the household sector defined as a single sector in Japan input-output table (JIOT) into the five household sectors with the national household statistic. Then, they were calibrated with mathematical programming to be consisted with the annual expenditure of each commodity written in JIOT. In addition, the expenditure of each quintile was equivalized by the OECD square root scale with respect to household size, in order to improve an accuracy of comparison in the footprints among households.

As a result, the range of carbon footprints among income quintiles was quantified to be 12-17 t-CO2eq/y, while that of equivalized expenditures among quintiles was 2.53-4.65 million-JPY/y. In other words, the difference of carbon footprints between the minimum quintile and the maximum quintile is about 1.4 times, while that of consumption expenditures between them is about 1.8 times. Thus, the carbon footprint intensity of household (carbon footprints per unit household expenditure) gradually declines as household income increases. In addition, the ranges of material footprints for neodymium, cobalt, and platinum were observed to be 2.2-7.1 g/y, 32-67 g/y, and 0.073-0.16 g/y, respectively. In contrast to the carbon footprint intensity, however, these material footprint intensities rise as income increases. The difference of trends between both footprint intensities implies that the implementation of subsidies aimed reducing carbon footprints and stimulating the economy should carefully consider the unexpected increase in material footprints.

More detail results and discussions will be presented at the conference.