Analyzing the CO2 Clusters in the Global Supply Chain Network

Topic: (8.2) Methodological Aspects of Input-Output Analysis (3)
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The CO2 emissions embedded in international trade have rapidly increased in countries with lax environmental regulations with expansion of trade and the international fragmentation of productions (Peters et al., 2011). With this background, the Paris Agreement at the 21st Conference of the Parties of the UNFCCC imposes the emission regulation on also developing countries. In addition, with the importance of the improvement of environmental efficiency at industry level of a specific country, it is important to corporate within well-specified industrial clusters through supply chain engagement over developing and developed countries (e.g., Kagawa et al., 2015). Kagawa et al. (2015) used the World Input-Output Database (WIOD) and identified 4756 significant CO2 clusters from global supply-chain networks associated with final demand of countries. However, they focused on only 40 countries and regions covered in the WIOD, thereby many other countries in Asia and Africa are not considered in their supply chain analysis. To the best of our knowledge, previous studies did not address the following question: how the CO2 clusters have formed at globe over time and which supply chain partners (i.e., stakeholder countries and sectors in this study) have played an important role in changing the relatively-significant CO2 clusters over time? This study identified CO2 clusters by applying the nonnegative matrix factorization method (Kagawa et al., 2013; 2015, Nuss et al., 2016; Tokito et al., 2016) to the EORA database (Lenzen et al., 2012, 2013) covering 189 regions and found key sectors by applying betweenness centrality method (Freeman, 1979, Liang et al., 2016) and block modeling method (Borgatti and Everett, 1992) to the database. As a case study, we analyzed global supply chain networks associated with final demand of transport equipment sector in its higher demand countries of China, United States, Germany, Japan and France by using the Unit Structure Model (Kagawa et al., 2013). As a result, we identified 118 industry clusters and key sectors in their clusters. The results show that (1) â€œMining and Quarrying (China)â€•, â€œPetroleum, Chemical and Non-Metallic Mineral (China)â€•, â€œMetal Products (China)â€•, â€œElectricity, Gas and Water (China)â€• and â€œMining and Quarrying (Russia)â€• belong to each of the larger clusters induced by final demand of transport equipment sector in the demand countries, (2) the role of the large blocks distinguished by spectral clustering are not equally, for example, although the Japanese largest cluster is mostly demand side, the U.S largest cluster trade mutually (3) Chinese industries mostly did not transfer CO2 emission to foreign countries and constructed isolated large clusters in the global supply chains, and (4) sectors with relatively higher centrality belong to the larger clusters. Thus, it is important to take some measures in the largest emission clusters in China for reduction of CO2 emission associated with auto demand of developed countries. Especially, technological improvement in the sectors with higher centrality is important.