

Analyzing Structural Changes in the CO₂ Emission Clusters within Global Supply Chain Networks

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Global CO₂ emissions continue to increase and the improvement of environmental efficiency at industry level is needed in many developed and developing countries (Kagawa et al., 2015). The CO₂ emissions embedded in international trade have rapidly increased in countries with lax environmental regulations (Peters et al., 2011).

With this background, Kagawa et al. (2015) used World Input-Output Table (WIOT) of 2008 and identified 4756 significant CO₂ clusters from global supply-chain networks associated with final demand of countries. In addition, they found that U.S. transport equipment and construction demand generated relatively-large CO₂ clusters in China, accounting for 17% and 10%, respectively, of the U.S. CO₂ footprint. However, the previous study did not focus on the structural changes in the CO₂ clusters over time and it was limited to analyzing CO₂ clusters for only 2008. As a result, Kagawa et al. (2015) did not address the following questions: how the global CO₂ clusters have formed over time and which supply chain partners (i.e., stakeholders 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) to the adjacency matrices based on the environmentally-extended World Input-Output Tables during 1995 to 2009 (Dietzenbacher et al., 2013) and found key sectors by applying betweenness centrality method (Freeman, 1979) to the same matrices. The results based on the clustering analysis and centrality analysis show that (1) CO₂ clusters in China generated by the U.S. construction demand have rapidly expanded during 1995 to 2009 and (2) Chinese steel industry was a major hub sector in expanding the Chinese CO₂ clusters induced by foreign final demand. We suggest climate policy of reducing CO₂ emissions in the clusters through decreasing emission intensities of the hub sectors identified in this study.