Visualizing spatial effects of regional emissions in China: A combination of multi-regional input-output analysis and complex network analysis

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This paper proposes an environmental extended multi-regional input-output model (EEMRIO) together with the complex network analysis to uncover the regional CO2 emission structure at national, regional, and sectoral level, and then the spatial decomposition analysis is used to evaluate the determinants of emission flows. In contrast with studies investigating the CO2 emission structure based on traditional EEMRIO, network analysis and central degree analysis are important tools to show the correlation and relationship between regions and sectors. Following EMRIO tables, we calculate the complete CO2 emission matrix representing by a n * n matrix to show a network with regard to regional CO2 emissions. By using the elements of the network, we can define self effect and sectoral spillover effects. Self effect are the elements on the main diagonal including the feedback effects, while spillover effects are the non-diagonal elements of matrix. Complex network analysis is used to analyze the production-related emission network at the national, regional, and sectoral levels, in which regional industries of the MRIOTs are treated as nodes and the values of the emission matrix are treated as links. In the network analysis based on EMRIOTs, regional and sectoral heterogeneous are considered. Spatial structural decomposition analysis is used to illustrate the determinant of regional emission flows and emission structural changes. In this paper, Chinese multi-regional input-output tables for 2007,2010, and 2012 are used. We observe that at national level, small clusters have been found, implying the regional in the same cluster are highly connected through regional emission flow, while at regional level, electric power generation and heavy industries play the role on emission transfer. For the spatial structural decomposition, changes in final demand scale will have positive spatial effects for most region, while final demand structure, such as consumption and export, may reduce emission in other regional. Investment in one region, may have different spatial effects. Based on the analysis of spatial effects, overall planning for industrial transfers and environmental protection throughout the entire country, cooperative development within adjacent provinces will remarkably promote emission mitigation. Meanwhile, to keep the promise of reducing CO2 emissions, increase energy efficiency will be the effective way for China.