

The Effects of Optimal Production Resource Reallocation on Carbon Footprint of Nations

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Climate change is a crucial problem for our society and all the countries need to effectively reduce the greenhouse gas emissions such as CO₂ emissions by improving their production technologies. An important question is how production technology in a specific country is environmentally and economically efficient in the sense that desirable outputs are maximized, whereas undesirable outputs (i.e., CO₂ emissions) are minimized, referring to the production technologies of other countries.

The Data Envelopment Analysis (DEA) has widely used in addressing this problem. A recent important study by Fujii and Managi (2015) used the World Input-Output Tables during 1995 to 2009 and estimated the effects of reallocating production resources on the emissions reduction. They also found that basic material industry have a great potential to reduce the emissions. However, Fujii and Managi (2015) did not estimate the emissions embodied in final demand of countries (i.e., consumption-based emissions) under the world optimal production structure found in the DEA framework and they did not evaluate how consumption-based emissions under the optimal world production structure differ from ones under the actual world production structure.

Firstly, this study identified the set of efficient production technologies (i.e., production frontier) of 10 manufacturing sectors using the DEA framework considering domestic output as a desirable output, CO₂ as an undesirable output and intermediate inputs. Data of World Input-Output Tables of 40 countries during 1995 to 2009 is applied. Then we estimated consumption-based emissions (i.e., carbon footprint of nations) using the actual World Input-Output Tables and ones using the modified World Input-Output Tables that include optimal sectoral outputs and the emissions estimated by the DEA. From the results, we found that chemical and steel sectors are inefficient in some countries like China in the sense that those technologies can increase outputs and simultaneously reduce CO₂ by shifting their inefficient production activities to the production frontier.

We finally conclude that consumption-based emissions can reduce considerably by reallocating production resources referring to the production frontiers of 10 manufacturing sectors estimated by this study.