# Supply Chain Performance Measurement based on the MRIO Framework: A Case Study of the Two-stage Network in the Steel Industry

Topic: Thematic IO analysis: Energy and Environment
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Performance measurement of supply chain management (SCM) is crucial for mitigating greenhouse gas emissions such as CO2 emissions through improving inefficient supply-chains of a specific decision making unit (DMU). The data envelopment analysis (DEA) is widely used for not only identifying technically-inefficient DMUs by evaluating efficiency scores but making an efficiency improvement strategy of the DMU. The novelty of this study is to extend the conventional DEA framework for the supply chain performance measurement based on the multi-regional input-output (MRIO) framework. In this study, we focused on CO2 intensive global supply chain networks between steel manufacturing industry (MANUFACTURE) and energy supplier for the steel manufacturing industry (SUPPLIER). In doing it, we used the EXIOBASE 3 and made an inventory database for energy consumption, labor force, intermediate input, and gross industrial output of MANUFACTURE and SUPPLIER in 47 countries during the study period between 1995 and 2010. A combined efficiency score calculated from efficiency scores of the MANUFACTURE and SUPPLIER of a specific country (i.e., performance of the steel supply-chain of a specific country) was estimated by the proposed DEA framework. The combined efficiency score ranges from zero to one and a higher efficiency score indicates a more efficient supply-chain. The results show that there were 7 efficient SUPPLIERs and 15 efficient MANUFACTUREs among 47 countries in 2010. Average efficiency score of the MANUFACTURE of countries has increased from 0.853 in 1995 to 0.879 in 2010, while average efficiency score of the SUPPLIER of countries has increased from 0.690 in 1995 to 0.704 in 2010. We found that the efficiency gap between SUPPLIERs was larger than that between MANUFACTUREs. We finally provide an effective policy toward the green SCM with a focus of energy and country substitutions in the inefficient steel supply-chains identified in this study.