CO2 Mitigation Potentials through Sub-global Policies in International Shipping Sector

Topic: YSI and Development Programme IV (Discussant: R. Duarte and S. Miroudot)
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CO2 emissions from international shipping represented approximately 2% of global energy-related CO2 emissions in 2018. Shipping emissions are projected to increase from about 90% of 2008 emissions in 2018 to 90-130% of 2008 emissions by 2050 due to a continuous increase of global maritime trade. Given that shipping is the most energy-efficient means of transporting cargo in terms of energy use per tonne-kilometre, it is irreplaceable in the international trade process. Consequently, there is an urgent need to reduce CO2 emissions from international shipping.

Current mitigation policies for the international shipping sector are primarily global mitigation policies. However, it has been pointed out that the effectiveness of global mitigation policies is limited recently. Supplementary approaches such as sub-global policies are necessary. Particularly, national policy interventions, including a) the amount of freight imported and exported, and b) the source and destination of freight imported and exported, have significant potential to influence shipping system.

To quantitively examine the environmental impact of a) amount of freight imported and exported, this study utilizes microdata for movements of container ships and focuses on the environmental efficiency of international shipping network, suggesting possible sub-global mitigation policies to port authorities. To examine the environmental impact of b) source and destination of freight imported and exported, this study quantifies CO2 emissions induced by Japanâ€™s sea container cargo commodity import. Through the scenario where Japan changes its import destination from China to the USA, by assessing both the environmental efficiency of container shipping and direct and indirect carbon intensity of the manufacturing industry in each country through global supply chain, this study provides the Japanese government with a comprehensive perspective for restructuring the global supply chain (GSC).

We first estimated the combined annual CO2 emissions from container ships owned by top 10 container ship operator companies, accounting for 84% of the world fleet of container ships. The combined annual CO2 emissions from container ships owned by top 10 container ship operator companies through worldâ€™s ports were 161.8 Mt in 2018 and 9.7 Mt through Japanâ€™s ports. Furthermore, we identified environmentally important ports based on the responsibility for offshore carbon emissions allocated to ports. If container ship operators with environmental efficiencies worse than the average environmental efficiencies of the top 10 companies transported freight with the average environmental efficiency, the potential for CO2 reduction was estimated at 4.3 Mt-CO2. Therefore, we suggest that, for port authorities, it is important to leverage portsâ€™ role in the international shipping network to impose restrictions on the environmental efficiencies of container ships to/from ports.

In addition, we quantified the CO2 emissions reduction potential of Japanâ€™s sea container cargo commodity imports by considering the environmental efficiencies (i.e., CO2 emissions from international shipping per import value in t-CO2/million USD) of imports from China and the USA to Japan. If Japan changes its trading partner for commodities from China to the USA, there would be an increase of 120 t-CO2 emissions per million USD in the sea transport process.

Next, we utilized the embodied CO2 emissions intensities of sectors and countries from the World

Input-Output (WIOD) database and quantified the CO_2 emissions reduction potential of substituting a specific product made in the U.S.A for one made in China. The â€˜perfectâ€™ substitution of machinery products from China by products from the USA could reduce CO_2 emissions by 909 tons per million USD in the production process, far exceeding the increase in CO_2 emissions during the sea transport process. However, for crop and animal products, CO_2 emissions reduction in the production process is only 88 tons per million USD, which cannot offset the increase in CO_2 emissions in the sea transport process. The results indicate that the decision to change trading partners depends on both the environmental efficiencies of international shipping from the import destination and the environmental efficiencies in the production process of the specific product.

In conclusion, sub-global policies in international shipping sector have significant potentials to mitigate CO_2 emissions from international shipping, and the cooperation between stakeholders, such as the IMO, state governments and port authorities, is essential. Additionally, for national governments, both the carbon footprint through GSC at the production process and the environmental efficiencies of international shipping should be considered when deciding import and export destinations.