Bilateral Energy Trade Evolution Under Different Climate Scenarios

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Introduction

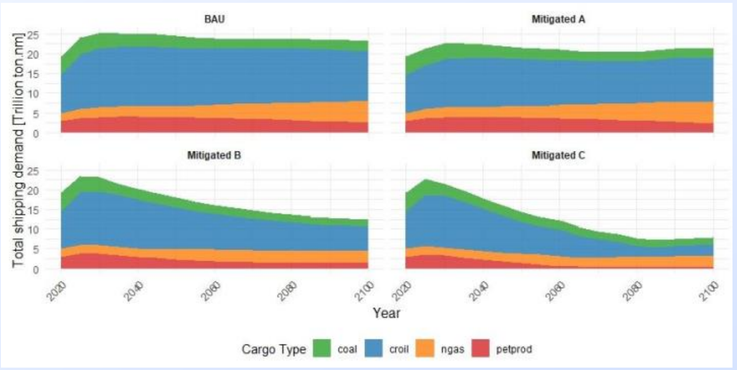
- Climate Challenge and Emissions: Our generation faces the challenge of climate change, primarily driven by greenhouse gas emissions, with the international maritime shipping sector contributing at least 3% of global CO2 emissions in 2020 (UNCTAD, 2021).
- Decarbonization Goals: The International Maritime Organization (IMO) has set a goal for full decarbonization of the shipping sector by 2050 (IMO, 2023), though the pathway to achieving this target remains uncertain and requires exploration of future scenarios.
- Interconnected Demand and Fuel Supply: Emissions depend on the fuel supply mix, which is influenced by the demand for shipping activity. Energy products like crude oil, petroleum products, coal, and gas make up nearly 40% of all international maritime transport (UNCTAD, 2022).
- Complexities of Cross-Trading: Current models often neglect the complexities of cross-trading, where a region can be both an importer and exporter of a specific product. This oversight fails to account for the physical transport involved in fuel supply and related emissions.

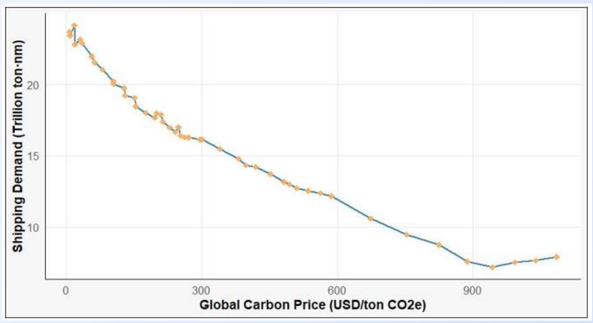
Methodology

- Gravity Model Framework: The mainstream theory behind international trade is the gravity model, based on the Armington assumption. The basic gravity equation states that trade flow between countries depends on the size of their economies and the distance between importer and exporter. This model effectively depicts bilateral trade patterns and has been utilized to estimate LNG trade flows.
- Model Modification: In this study, we modify the gravity model to specialize it for determining the bilateral trade of energy commodities such as crude oil, natural gas, coal, and petroleum products. This is achieved by adding more predictive variables and a fixed-effect component to control for unobserved heterogeneity like bilateral trade agreements.
- Data Collection and Analysis: Using data from BPstats (2014-2022), the World Bank, Clarkson Research Services, and seadistance.org (2015-2021), we organized a panel dataset, removed zero flows, and applied the RIDGE method in machine-learning multiple linear regression to address multicollinearity. After building the model, 80% of the data was used for training and 20% for testing, with k-fold validation for accuracy. Results were integrated into the WITCH IAM model to evaluate policy under four scenarios, including Business As Usual (BAU) and three increasing carbon tax scenarios, revealing shifts in bilateral trade trends under different climate policies.

Preliminary Results

The figure shows that while the BAU scenario maintains a relatively stable demand for coal, crude oil, natural gas, and petroleum products, the mitigated scenarios show a decline in the overall trade volume, particularly for coal and crude oil. This suggests that mitigation efforts might be targeting a reduction in the use of these fossil fuels.





The graph indicates an initial strong inverse correlation between carbon pricing and shipping demand for fossil fuels, signifying that as carbon prices escalate, shipping demand declines. However, past a certain carbon price threshold, this relationship appears to attenuate, with the curve flattening out. This suggests that beyond this point, the impact of rising carbon prices on shipping demand is less pronounced .

Future Work

- **Including other cargoes than only energy commodities in the model: containerized cargo, iron ore, grains, minor bulk, and hydrogen.**
- **Developing and running more interesting scenarios such as early Europe ETS on shipping.**
- **Deriving policy insights and recommendations from the results to get a clear picture of the way ahead in international shipping decarbonization.**