

Understanding the Economic Impacts of Greenhouse Gas Mitigation Policies on Shipping

What Is the State of the Art of Current Modeling Approaches?

Executive Summary for Policy-Makers in International Maritime Transport



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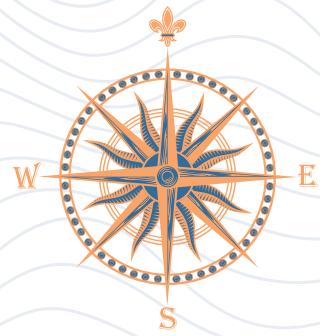
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Furthermore, the paper has benefitted from the expert discussions taking place at the following events:

1. **OECD-ITF & CPLC Shipping Expert Workshop** on Carbon Pricing in International Maritime Transport, 8–9 January 2018, OECD, Paris
1. **4th Session of the International Maritime Organization's (IMO) Intersessional Working Group on the Reduction of GHG Emission**, 17–18 October 2018, IMO, London
2. **International Transport and Energy Modelling 4 Workshop**, 29–31 October 2018, International Institute for Applied Systems Analysis, Vienna
3. **UNCTAD & CPLC Shipping Expert Workshop** on GHG policy induced economic impacts on States and related mitigation options, 19–20 November 2018, UNCTAD, Geneva.

CONTEXT

The initial International Maritime Organization (IMO) strategy on reduction of greenhouse gas (GHG) emissions from ships ("Strategy") stipulates that any GHG reduction measure should be considered in the light of its impacts on States. This means that these impacts should be assessed and taken into account as appropriate before adoption of the measure. The Strategy further notes that the impact assessment procedure should be specified and agreed on as a matter of urgency as part of the follow-up actions and that disproportionately negative impacts should be assessed and addressed as appropriate.

APPROACH

This paper aims to contribute to this discussion by reviewing state-of-the-art research on the economic impacts of GHG mitigation measures on States using model-based analysis. Specifically, this report:

1. Identifies areas of economic impact from GHG mitigation measures and the mechanisms by which these impacts could propagate through transport and trade systems and the economies of States.
2. Compiles the latest findings on the order of magnitude of the economic impacts of GHG mitigation measures in the specified economic impact areas.
3. Presents different modeling approaches to assess economic impacts of GHG mitigation measures, along with best practices on selecting and applying these models for efficient and effective impact assessments.

While this study takes economic impacts as its primary focus, it acknowledges that the Strategy lists eight types of impacts: i) Geographic remoteness of and connectivity to main markets; ii) Cargo type and value; iii) Transport dependency; iv) Transport cost; v) Food security; vi) Disaster response; vii) Cost-effectiveness and viii) Socio-economic progress and development. Most of these impacts, with the exception of disaster response, can be estimated using models and data similar to those discussed here.

FINDINGS AND SPECIFIC RECOMMENDATIONS

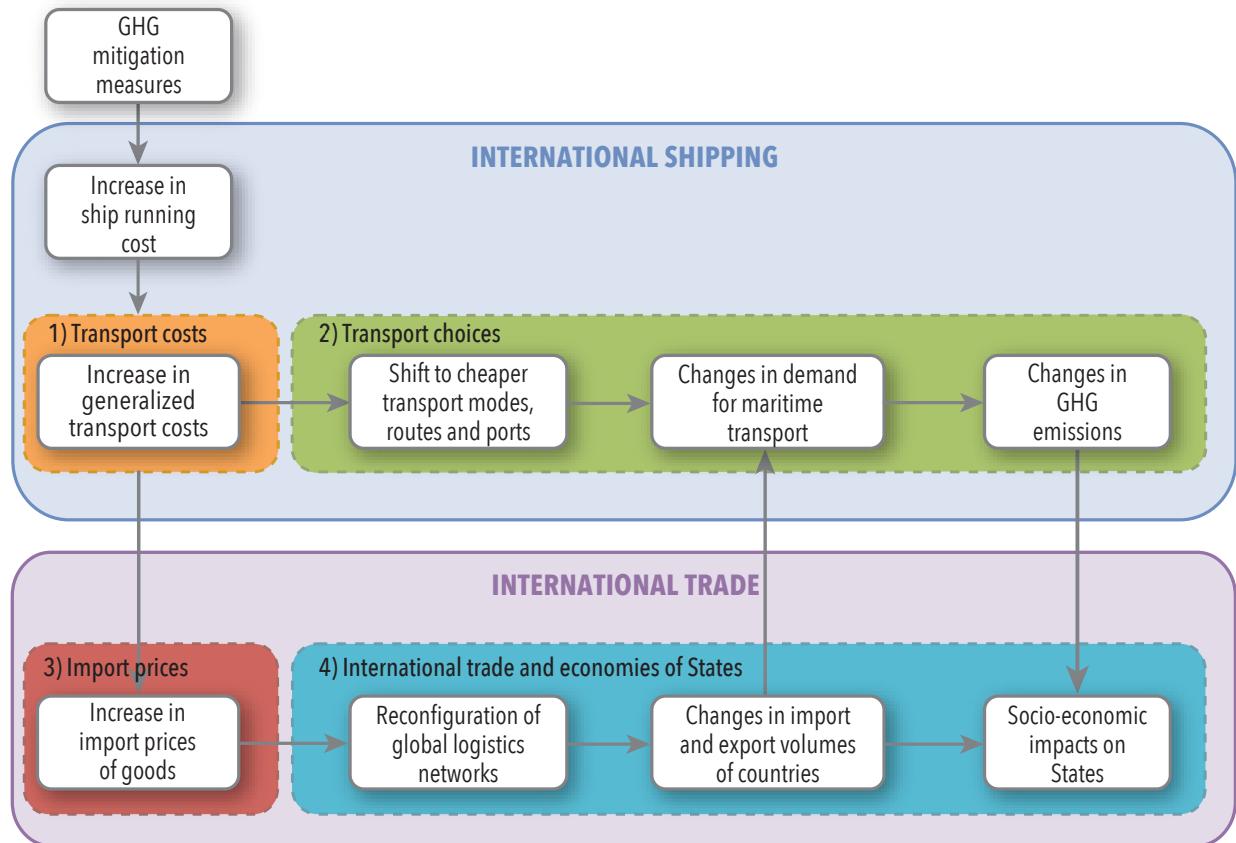
Four economic impact areas

The paper breaks the economic impacts down into the following areas: i) Transport costs; ii) Transport choices; iii) Import prices of goods; and iv) International trade and economies of States.

The application of a GHG mitigation measure may impact transport systems. These effects might propagate to trade systems, which, in turn, impact the economies of States. In this paper, the term "transport costs" has been defined from the perspective of the shipper, or the user of the transport services. It is the price the shipper pays for the transport of the traded goods.

GHG mitigation measures affect State economies through a chain of causalities:

- First, the GHG mitigation measure increases costs of running a ship, be it through higher fuel prices (due to a levy or other market mechanism) or higher capital costs as carriers invest in new technologies and vessels or other emissions-reduction solutions. These higher costs lead to higher freight rates, or "transport costs," for clients. These may not be incurred immediately depending on market structures, trade balances, or possible cross-subsidies, but it can safely be assumed that higher transport costs will eventually lead to higher prices.
- Second, higher transport costs may cause shippers in international freight transport networks to shift to cheaper alternative modes and routes of transport, which can impact State economies.
- Third, increases in transport costs may inflate import prices of goods and reduce the volume of commodities traded worldwide.
- Fourth, in the long term, increases in import prices may cause firms to relocate their manufacturing facilities or consumers to substitute local or cheaper products for the import. On a global scale, this could lead to changes in States' export and import volumes, which eventually impact States' gross domestic products (GDP) and other socio-economic performances.



Specific recommendation: Impact studies may use this framing of four main areas of economic impact as a guiding principle for systematic analysis.

1) Impact on maritime transport costs

GHG mitigation measures, such as energy efficiency standards, carbon pricing, or a bunker levy are likely to increase the operational and/or capital costs of ships. Existing literature estimates that a carbon price on bunker fuels — often also used as a proxy for the impact of any GHG mitigation measure — in the range of 10–50 USD/ton CO₂, would increase maritime transport costs by 0.4–16%. While some commodity types such as grains might see an increase in the lower bound of the range (2.5%), the upper range might apply for bulk products (11%), and containerized products (16%). These differences come from the different shares of transport costs in the overall costs of these respective goods: the higher the share, the larger the increase. This implies that impact assessments should focus on flows of low-value bulky goods and containerized products.

Specific recommendation: In general, GHG mitigation measures are expected to increase maritime transport costs only by a small to moderate percentage. Moreover, transport costs usually represent only a small to moderate share of overall consumer prices of goods. Hence, the overall impact of increased transport costs on the industry is expected to be, at most, moderate. Further study on how the increase in transport costs will be passed on to stakeholders such as carriers and shippers will allow better estimation of the impacts.

2) Impact on transport choices

Existing studies have investigated the potential impact, at a global level, of GHG mitigation measures on transport choices among shippers. One study analyzed the impact of a 100% increase in maritime transport cost (due to a carbon tax) combined with a 25–65% reduction in ship speed on the modal choice of shippers. Results indicated that the share of sea transport could decrease globally very slightly, by 0.16%. This slight decrease would be equivalent to approximately 34 megatons (Mton) of freight volume, or equivalent to the total amount of crude

oil imported by sea to Africa. Most of the modal shift is expected to happen from sea to road (13 MTon) and rail (18 MTon). Another study found that the application of a carbon price on bunker fuel reaching 49 USD/ton CO₂ by 2040 could lead, on average, to a 0.5% decrease in the annual container throughput of ports worldwide. With the potential exception of specific geographic locations (e.g. coastal areas) where there is strong competition from alternative modes of transport, it is likely that impacts on transport choices do not need to be too diligently taken into account, at least for initial estimates of overall impacts.

Specific recommendation: Studies suggest that increases in maritime transport costs induced by GHG mitigation measures will only have a limited impact on the modal shift from maritime transport to other modes globally. Consequently, this economic impact area might not need to be the primary concern for initial impact assessments, except for regions with large coastal areas or with strongly competing transport modes.

3) Impact on import prices of goods

In line with the finding that maritime transport costs account for a limited share of overall trade costs and of the value of many traded goods, the increase in import prices of goods is found to be marginal (<1%) at a carbon price ranging from 10–50 USD/ton CO₂. It is important, however, to understand how the increase in import prices may pass between the relevant actors (shippers, carriers, and consumers). Furthermore, it was also found that the total weight of certain commodities on certain routes, such as electronics, metal products, fishing products, and manufacturing and transport equipment, might be negatively affected by an increase in the import prices of goods. This means that an increase in transport costs might lead to a reduced trade volume of these commodities.

Specific recommendation: The overall impact on import prices of goods can be considered negligible in many cases (e.g. often <1%). Analysis should focus on the few goods where maritime transport cost might account for a significant share of the overall value of the good, e.g. industrial raw materials.

4) Impacts on international trade and economies of States

In terms of wider economic impacts, such as GDP, several existing studies examined the impact of GHG mitigation measures like carbon pricing on the real GDP of States. These studies, which considered carbon prices ranging from 10–90 USD/ton CO₂, found only modest impacts: The highest losses in GDP were estimated to be within the range of -0.002% (estimated for a large developing country at a carbon price of 90 USD/ton CO₂) to -1% (estimated for a small island developing state, at a carbon price of 30 USD/ton CO₂), with some countries potentially even seeing a slightly positive change in their GDP. Even among least-developed and developing countries included in those studies with high geographical detail, the majority of these countries were estimated to lose less than 0.2% of their real GDP. In terms of global trade flows, a study concluded that a carbon price of up to 49 USD/ton CO₂ could reduce the volume of global trade by -0.9% by 2040 with the agriculture sector potentially experiencing the strongest reduction (-4.2%) due to consumers' substitution of foreign with domestic products.

Specific recommendation: Similar to prior findings, impacts on GDP are estimated to be very low globally and limited to specific countries. Analogous to impacts on import prices, GDP impact assessments should therefore put the most focus on flows of low-value bulky goods and low-value consumer goods. It is important to note that, for this type of overall economic impact, negative impacts from increases in prices of imported goods can be partially offset by positive economic impacts from increased domestic production. Thus, both need to be included when estimating the full range of impacts.

Three main models

In general, three different models can be used to assess the effects of GHG mitigation measures on States: economic trade models, transport models, and combined transport and trade models.

ECONOMIC TRADE MODELS

describe the responses of an economic system, which may include international trade flow values (e.g. financial flows, such as investments), wider economic indicators of States (e.g. GDP), or both. While economic trade models can implicitly include features of transport systems, physical responses of the transport system (e.g. value-to-weight conversion of commodities, modal or route choice) are often not captured.

Examples of economic trade models include regression, input/output, and computable general equilibrium (CGE) models. Regression models are best used when data are limited, and the scope of analysis is focused on the short- and medium-term impacts on a single economic indicator or one particular sector. CGE models are best suited to estimate the long-term redistribution of trade flows and economic indicators of States at the global level due to the application of strong/disruptive GHG mitigation measures where significant economic consequences are foreseen.

TRANSPORT MODELS

describe the responses of a transport system, which may include the redistribution effect of trade flows due to changes in transport costs, conversion of trade values to weights, or mode and route choice of shippers. While these models can estimate the economic impacts on States due to changes in their international (export and import) volumes, they are not suited to estimate impacts on wider economic indicators, such as GDP and welfare.

Transport models are best used when GHG mitigation measures are expected to induce changes in shippers' transport choices, such as mode, route and port choice, next to changes in the patterns of international trade.

COMBINED TRADE-TRANSPORT MODELS

can provide detailed impact assessments of the major indicators for both transport and economic systems. This integration means that the impacts of GHG mitigation measures both on transport and trade systems can be examined comprehensively. That is, the propagation of effects due to changes in trade relationships between States can be reflected in international shipping; and the changes in international shipping, such as changes in mode and route choice or development of new infrastructure, can be taken into account in estimating trade activities.

Combined models are best used when the scope of impact assessments include detailed transport and economic system responses at the global level. Specifically, combined models can provide valuable insights when: i) the impact of disruptive/strong GHG mitigation measures may lead to significant increases in transport costs; ii) redistribution of international trade is expected and the wider economic indicators of States, such as GDP, welfare, and the production/consumption of different sectors, are of interest; and iii) changes in shippers' behavior (both choice of modes and routes) could affect the economies of States, especially those that are driven by the port and shipping industry.

Specific recommendation: A range of modeling approaches with distinct strengths and limitations are available. Choosing the right model for impact assessment should be based on an informed decision in the light of the specific modeling purpose.

Data availability and needs

There are several data sets available that can help modeling exercises for impact assessments. However, many of them are incomplete. These data sets need to be updated with newly available or estimated data to allow thorough analysis, especially for countries where data are scarce.

OVERALL RECOMMENDATIONS

Beyond the more specific recommendations, several general recommendations that apply to future impact assessments of GHG mitigation measures in shipping emerged during the development of this paper.

1) No need to reinvent the wheel

Much groundwork research exists that can be leveraged to better understand economic impacts, both globally and on specific States. Much existing groundwork that can be leveraged to better understand economic impacts, both globally and on specific States. There is no significant need for the development of new models or additional analytical tools.

2) "Kaizen¹" — continuously improve and innovate

As modeling expertise, computing technology, and data availability continue to improve, the quality of information on economic impacts will continue to improve. Policy makers are encouraged to work closely with academic and business experts to effectively advance the relevant policy discussions.

3) Prioritization

This paper has reviewed different modeling approaches and shown that these can be applied in different contexts depending on the geographical scope of the study and the impacts that are anticipated to be of greatest importance. In other words, there is not a single model that can solely deliver on all possible impact assessment objectives. Prioritization is key, and these priorities must be reflected in the choice of the model.

¹ Kaizen is the Japanese term for continuous improvement.

4) Do not let perfect be the enemy of the good

While a combined transport-trade model might be desirable to assess the comprehensive economic impacts of GHG mitigation measures, the use of such models might be more valuable when detailed and thorough country-specific insights are needed. The studies reviewed in this paper have shown that the use of simpler models with fewer data requirements can still provide very valuable insights on specific economic impact areas and can still make important contributions to the time-critical policy discussion.

5) Seeing the forest for the trees

Given there are numerous GHG mitigation measures that can be implemented, it is useful to consider certain principles that can increase the efficiency of the assessment process. For instance, impact assessments should be proportionate to the likely impacts of a measure. If initial studies in the literature suggest insignificant impacts (see previous section on "Four economic impact areas"), a full impact assessment for a GHG mitigation measure might not be needed and scarce research resources can be allocated to more significant economic impact areas and geographic locations.



