“Sustainable freight transport in support of the 2030 Agenda for Sustainable Development”

Understanding the Economic Impacts of GHG Mitigation Policies on Shipping
What is the State of the Art of Current Modelling Approaches?

By
CPLC, UCL, OECD, World Bank
UNDERSTANDING THE ECONOMIC IMPACTS OF GHG MITIGATION POLICIES ON SHIPPING
WHAT IS THE STATE OF THE ART OF CURRENT MODELLING APPROACHES?
OUTLINE

1. Relevance
2. Links between GHG measures and economic impacts
3. Economic impacts on:
   ① Transport costs
   ② Import costs
   ③ Trade and GDP
   ④ Shippers’ behavior
4. Three type of models
5. Modeling approaches
6. Suggestions for policy makers
RELEVANCE

Initial strategy’s objective 2
• Identifying actions to be implemented by the international shipping sector, while addressing impacts on States...

Guiding principles 3 and 4
• The need to consider the impacts of measures on developing countries, Least Developed Countries (LDCs) and Small Island Developing States (SIDS).
• The need for evidence-based decision-making balanced with the precautionary approach (MEPC.67(37))
LINKS BETWEEN GHG MITIGATION POLICIES AND ECONOMIC IMPACTS

1. Impact on transport costs
   - Increase in generalized transport costs

2. Impact on trade costs
   - Increase in trade costs
   - Reconfiguration of global logistics networks

3. Impact on GDP and trade (Economic analysis)
   - Changes in trade relationships between countries
   - Changes in import and export volumes of countries

4. Impact on shippers’ behavior (Transport analysis)
   - Shift to cheaper transport modes and routes
   - Changes in demand for maritime transport
   - Changes in GHG emissions

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GHG mitigation measures

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CARBON PRICING LEADERSHIP COALITION
International Transport Forum
OECD
WORLD BANK GROUP
• Diverse share of maritime transport costs in product values e.g. 5% (manufactory) vs. 11% (agriculture) vs. 24% (raw materials industry)

• No direct proportionality between potential carbon price and increase in maritime transport costs

• Wide range of transport costs across products and countries of origin and destination

• Asymmetric impacts on transport costs due to mitigation measures
## Import Costs

- **Basic assumption:** carbon price of $10-50/tCO2

<table>
<thead>
<tr>
<th>Literature</th>
<th>Inputs/assumptions</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transport segment/product studied</td>
<td>Carbon price or bunker contribution/ levy</td>
</tr>
<tr>
<td>Kronbak, Yang, and Chen (2009)</td>
<td>Container</td>
<td>US$45/tonne CO₂</td>
</tr>
<tr>
<td>Faber and Rensma (2008)</td>
<td>US$700/tonne, US$450/tonne</td>
<td>US$ 30/tonne CO₂</td>
</tr>
<tr>
<td>Faber, Markowska, Eyring, Cionni, and Selstad (2010)</td>
<td>handysize bulker, capesize bulker, handysize product tanker, VLCC, container and ro-ro</td>
<td>US$360.5/tonne, US$ 15/tonne CO₂</td>
</tr>
<tr>
<td>IMO (2010)</td>
<td>Iron ore, Crude oil, Grains, Furniture &amp; clothing</td>
<td>10% increase of bunker fuel price</td>
</tr>
<tr>
<td>Anger et al. (2013)</td>
<td>all</td>
<td>US$738/tonne, US$ 10-50/tonne CO₂</td>
</tr>
<tr>
<td>Chowdhury and Dinwoodie (2011)</td>
<td>Coking and steam coal</td>
<td>10% increase in spot bunker price</td>
</tr>
<tr>
<td>Purvis and Grausz (2012)</td>
<td>all, but impacts only determined for US</td>
<td>US$2.40/gallon (~US$741/tonne)</td>
</tr>
</tbody>
</table>

- Estimated increase in maritime transport costs is 4%-16%\(^1\).
- Increase in import costs is marginal (<1%).
- Heavy, low-value commodities have relatively higher increases in import prices.
- Freight rate elasticity with respect to bunker price varies across commodities and routes.

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1) Rojon et al., 2018
2) Vivid Economics, 2010
**TRADE AND GDP**

Consumption: 100t

<table>
<thead>
<tr>
<th>State</th>
<th>Import costs: $50/t</th>
<th>Import volume: 70t</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Import costs: $70/t</td>
<td>Import volume: 30t</td>
</tr>
<tr>
<td>C</td>
<td></td>
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</tbody>
</table>

- **Consumers will substitute products** from different producers depending on the changes in import prices according to the elasticity of substitution for the commodities imported (Armington assumption).
- **States with higher import costs** might not be favorable over states with lower import costs anymore causing *shift of volume of demand* to States with lower import costs.

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[Image of carbon pricing leadership coalition and other organizations logos]

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Potential asymmetric increase in import costs due to GHG mitigation measures could lead to:

- Decline of export in State C which could lead to decline in GDP
- Increase of export in State B could lead to increase in GDP
Generally, modest impact on:

- GDP of individual countries (-0.02% to -1%)
- Mode shift from sea to land based transport (-0.16%)

<table>
<thead>
<tr>
<th>Literature</th>
<th>GHG mitigation measures</th>
<th>Economic Indicators</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee et al. (2013)</td>
<td>Carbon price 30, 60, 90 USD/ton CO2 for the year 2007</td>
<td>Real GDP</td>
<td>-0.002% to +0.004%, Global average: -0.0003%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volume of container flows</td>
<td>Reduction of 925 KTEU (Twenty-Foot Equivalent Units) globally</td>
</tr>
<tr>
<td>Sheng et al. (2018)</td>
<td>Carbon price 40 USD/ton CO2 by 2030</td>
<td>Real GDP</td>
<td>-0.06% to +0.001%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GDP growth</td>
<td>-0.17% to +0.01%</td>
</tr>
<tr>
<td>L.A. Tavasszy et al. (2014)</td>
<td>Carbon price 49 euros/ton CO2 by 2040</td>
<td>Global trade flows</td>
<td>-0.9% in total trade flows</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Commodity trade flows</td>
<td>-0.2% (food) to- 4.2% (agriculture)</td>
</tr>
<tr>
<td>Anger et al. (2013)</td>
<td>Carbon price 10,30,50 euros/ton CO2 by 2025</td>
<td>Real GDP</td>
<td>&lt;-0.01% in global GDP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>real GDP changes for developing countries</td>
<td>-1% GDP for one country</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;-0.2% for majority</td>
</tr>
<tr>
<td>Halim et al. (2018)</td>
<td>Slow steaming (25-65% speed reduction), and carbon price on maritime transport with 100% increase in maritime transport by 2030</td>
<td>Volume of international maritime transport</td>
<td>-34 Mtonnes in demand for maritime transport</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shift to freight rail mode (e.g. Eurasian railways)</td>
<td>-0.16% in modal share of maritime transport</td>
</tr>
</tbody>
</table>
THREE TYPES OF MODELS

1. Economic models
Describe the responses of the economic system e.g. GDP, trade flows, welfare, prices, economic growth.

(+) Suited to estimate economic indicators and their drivers.
(-) Often does not capture the response of transport system.

2. Transport models
Describe the responses of the transport system: redistribution of trade flows, mode and route choice of shippers, weights of goods traded.

(+) Valuable to investigate substantial mode and route shifts.
(-) Not suited to capture wider economic impacts such as GDP, welfare.

3. Integrated trade & transport models
Describe detailed impact assessments of the major indicators for both transport and economy systems.

(+) Address the limitations of transport and economic models
(-) More complex and requires more data.
## MODELLING APPROACHES

| Types            | Modelling Approaches                              | Advantages                                                                 | Disadvantages                                                                                                                                  | Best practice                                                                 |}
|------------------|---------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|}
| Economic Model   | **Linear Regression**                             | Easy to explain, less data hungry                                           | Difficult to account long-term effects in prediction, focused only on one indicator per model                                             | Short term prediction for an economic indicator.                              |}
|                  | **Elasticity-based**                              | Simple, less data hungry                                                   | Elasticity is not transferrable for different sectors                                                                                       | Short term prediction for a specific indicator when data is limited           |}
|                  | **Computable General Equilibrium (CGE)**         | Simulates the whole economy taking into account dynamics in each market and how they interact with one another | Requires extensive estimation process, extensive data, harder to trace causal relationships                                                 | Used to assess the long term redistribution effect on global trade and wider economic indicators |}
| Transport Model  | **Four step freight transport model**             | Able to simulate redistribution of trade flows and shippers behaviour (e.g. Mode and route choice) | Analysis is limited to trade and transport flows for commodities                                                                        | Used when substantial mode and route shift are expected, especially for economies driven by ports |}
| Integrated model | **CGE + four step freight transport model**       | Able to simulate trade and transport system responses                       | Requires extensive data for both models, complex and costly to build and maintain                                                            | Used when the scope of impact assessments cover both trade and transport systems |}

**Carbon Pricing Leadership Coalition**

**UCL**

**OECD**

**World Bank Group**

**Climate Change**
SUGGESTIONS FOR POLICY MAKERS

1. No need to reinvent the wheel
Take full advantage of and leverage the existing knowledge base (studies, models, techniques).

2. “Kaizen”
Models and data are constantly improving. Stay tuned for today’s challenging approaches to become easy tomorrow.

3. No one size fits all
Different models should be applied in different contexts according to the scope of the study, and individual strengths/weaknesses of the models.

4. Perfect not as enemy of the good
While an integrated transport-trade model might be desirable, tradeoffs need to be made in light of scope, complexity, and costs.

5. Seeing the forest for the trees
Impact assessments should be proportionate to the likely impacts of a measure. If literature suggests insignificant impacts, a full impact assessment might not be needed.
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REFERENCES (1)

REFERENCES (2)


REFERENCES (3)


