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"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

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RELEVANCE

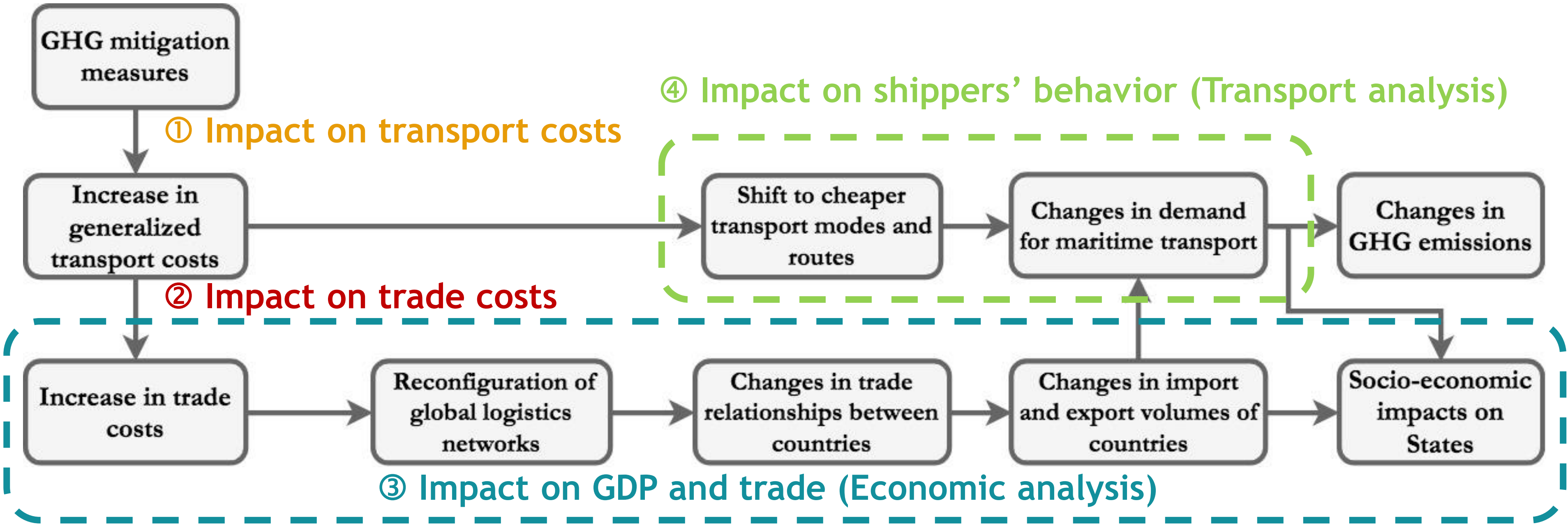
Initial strategy's objective 2

- 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



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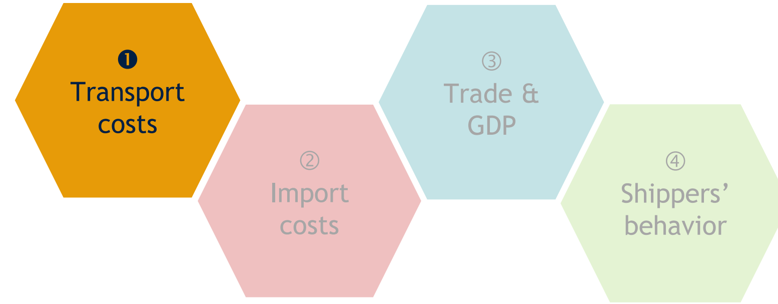
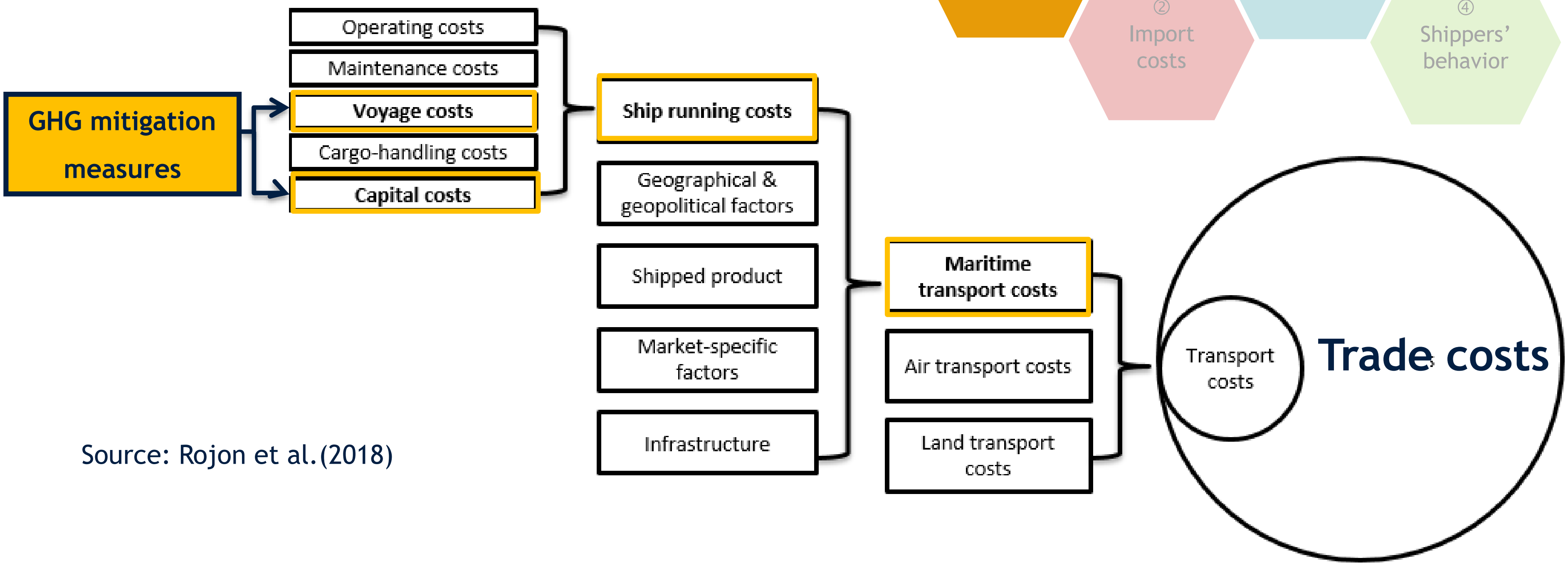
❶ TRANSPORT COSTS





Source: Rojon et al.(2018)

- **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

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❷ IMPORT COSTS

① Transport costs | ❷ Import costs | ③ Trade & GDP | ④ Shippers' behavior

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

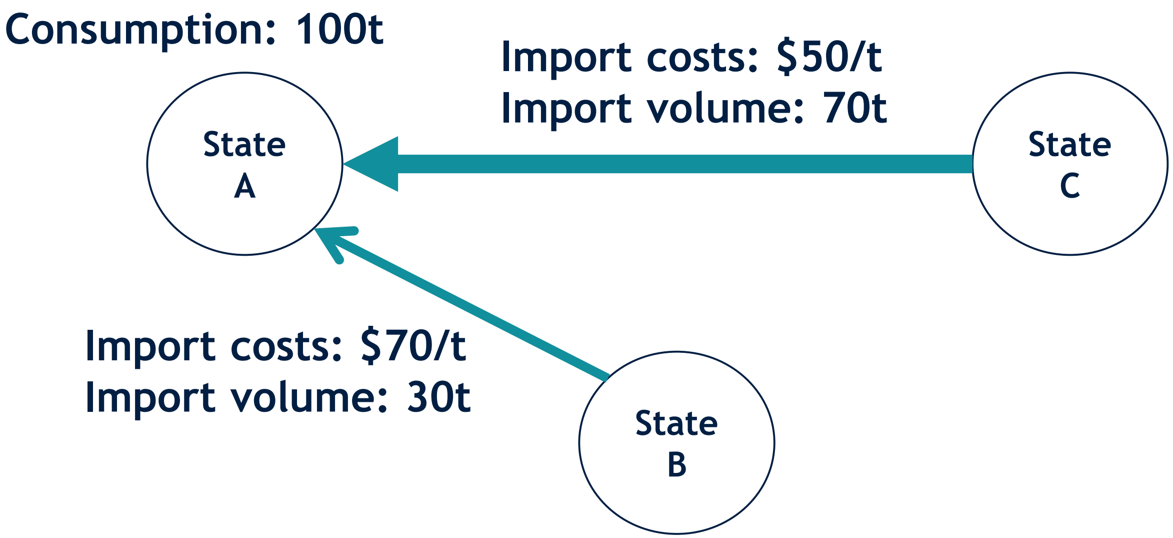
Literature	Inputs/assumptions			Findings	
	Transport segment/product studied	Fuel price assumption	Carbon price or bunker contribution/levy	Increase in freight costs	Increase in import costs
Kronbak, Yang, and Chen (2009)	Container	US$550/tonne	US$ 45/tonne CO_2	1-5%	<1.9%
Faber and Rensma (2008)		US$700/tonne	US$ 30/tonne CO_2	4-8%	<1%
		US$450/tonne		6-12%	
Faber, Markowska, Eyring, Cionni, and Selstad (2010)	handysize bulker, capesize bulker, handysize product tanker, VLCC, container and ro-ro	US$360.5/tonne	US$ 30/tonne CO_2	7-16%	0.4-3%
			US$ 15/tonne CO_2	4-8%	0.2-1.4%
IMO (2010)			10% increase of bunker fuel price		<0.2% (similar for exports)
	Iron ore			5-14%	
	Crude oil			1.2-6%	0.2-0.4%
	Grains			2.5%	0.2-0.7%
	Furniture & clothing				<0.2%
Anger et al. (2013)	all	US$738/tonne	US$ 10-50/tonne CO_2	0.4-3.4%	
Chowdhury and Dinwoodie (2011)	Coking and steam coal		10% increase in spot bunker price	6-13.6%	
Miao and Fortanier (2017)	all	US$25/barrel (~US$184/tonne)	Fuel price increase to US$75/barrel (~US$551/tonne)	1.49%	
Purvis and Grausz (2012)	all, but impacts only determined for US	US$2.40/gallon (~US$741/tonne)	US$15-30/tonne CO_2		0.1-0.28%
	Agriculture (only US)				0.14-0.29%
	Raw material (only US)				0.18-0.36%
	Crude oil (only US)				0.06-0.13%
	Manufacturing (only US)				0.1-0.2%

- 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.**

1) Rojon et al., 2018
2) Vivid Economics, 2010

❸ TRADE AND GDP

① Transport costs
② Import costs
❸ Trade & GDP
④ Shippers' behavior

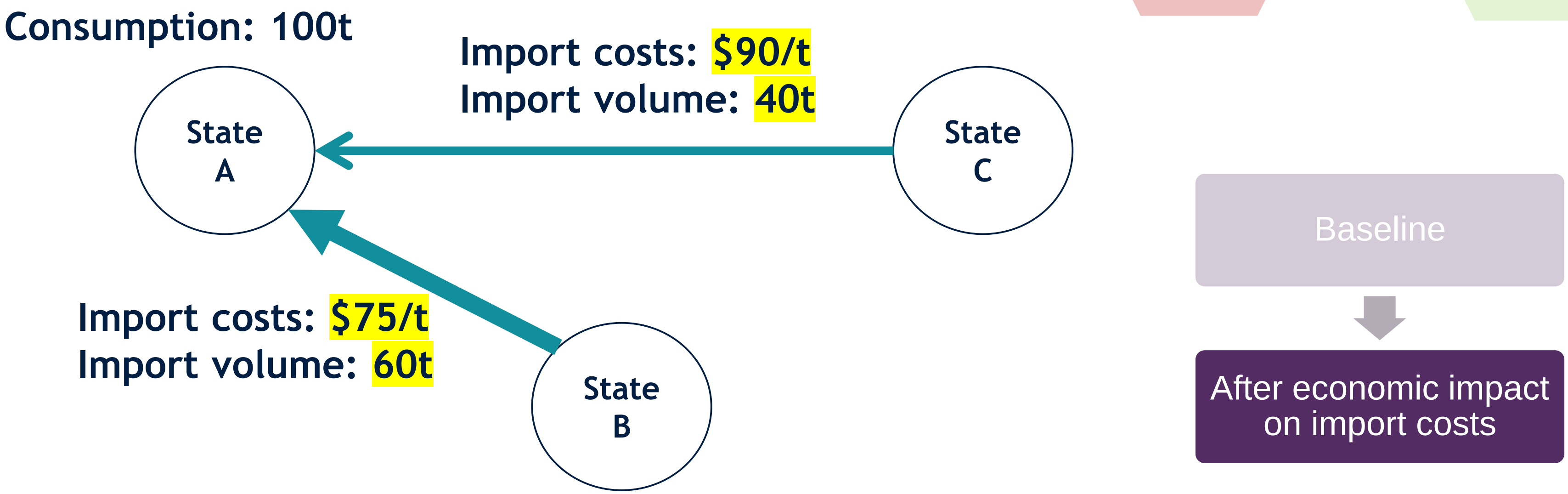


Baseline

After economic impact on import costs

- **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.

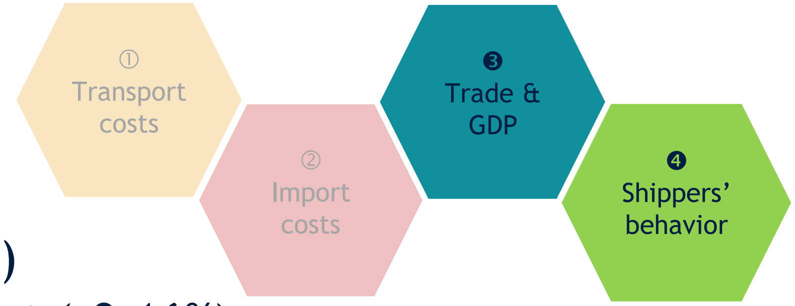
❸ TRADE AND GDP



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

❸❹: TRADE, GDP AND SHIPPERS' BEHAVIOUR



Generally, modest impact on:

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

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

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**.

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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

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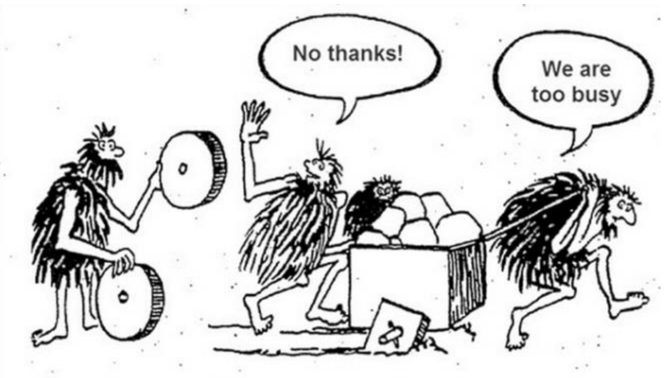
SUGGESTIONS FOR POLICY MAKERS



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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UNDERSTANDING THE ECONOMIC IMPACTS OF GHG MITIGATION POLICIES ON SHIPPING

WHAT IS THE STATE OF THE ART OF CURRENT MODELLING APPROACHES?

Understanding the economic impact of GHG mitigation policies on shipping: What is the state of the art of current modelling approaches?

Ronald Halim (World Bank, formerly OECD-ITF)

Executive Summary

What we did

Concise summary of the report and its context related to IMO's initial strategy objectives

This paper reviews the state-of-the-art methodologies for assessing the impact of GHG mitigation policies in international maritime transport on the economy of States. This is done in light of the second objective of the IMO's initial strategy to identify actions to be implemented by international shipping sector while considering their economic impacts on States due to the critical role of international shipping in supporting global trade and maritime transport services.

Research method of this report is by means of literature study

We conducted a literature study on various modeling approaches developed to analyze the economic impacts of GHG mitigation policies on maritime transport costs, import prices of goods, international trade patterns, shippers' behavioral choice in international shipping, and the wider economic indicators of States.

The objectives of this report

The contribution of this report is twofold: First, it presents different available modeling approaches that can be used to assess the economic impacts of GHG mitigation policies on States and their findings. Second, it hopes to provide a guidance on the use of modeling frameworks for assessing these impacts based on their theoretical and practical advantages and limitations and best practices found in the literature. Furthermore, the report also provides recommendations on the possible ways to apply the state-of-the-art modeling approaches to assess the impacts in terms of aspects listed in section 4.11 of IMO's initial strategy: 1) geographic remoteness of and connectivity to main markets; 2) cargo value and type; 3) transport dependency; 4) transport costs 5) food security; 6) disaster response; 7) cost-effectiveness; and 8)socio-economic progress and development.

What we found

Transport costs as key factors that can bring about changes in trade-transport systems

Among different drivers that can impact both maritime transport services and the economy of States, transport costs are the key drivers which impact could propagate through the elements of trade and transport systems, and in turn, can impact the economy of States. We present a conceptual framework which could help to understand how the changes in transport costs will propagate through the elements of the trade-transport systems and eventually impacting the economy of States.

Full research paper forthcoming,
currently being finalized and reviewed with support from

UNITED NATIONS UNCTAD · International Monetary Fund · International Energy Agency — Secure Sustainable Together

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