Carbon Tax in the Shipping Sector: Assessing Economic and Environmental Impacts

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Agenda

1. This Study

2. Data and Method

3. Results

4. Final Remarks

1. This Study

Overview of the study

- We run a **global comprehensive assessment of a carbon tax (US\$ 50/tCO$_2$)** on international shipping

- We consider **all direct and indirect effects on countries** with results on:

    - Exports (total and by country/region and sector)

    - GDP (total and by country/region)

    - Maritime emissions (in tCO2)

    - Food prices

- We find that

    - **emissions from ships are reduced**

    - **exports and real GDP are negatively** impacted

    - Food prices is expected to increase

2. Method

GTAP

- We use the **global and multi-region GTAP** version 10 database (reference year: 2014):

  - global static computable general equilibrium **model used in climate policy simulations** by institutions worldwide.

  - reports **replicable results** for several economic variables.

  - **Captures the effects of climate policies on international trade flows and GDP**, which is very important in the context of maritime shipping.

  - information of 141 countries (35 SIDs, 45 LDCs) and 65 production sectors.

  - we **keep the disaggregation of the database at its highest level** to report results for all potential affected participants under the IMO Governance

An assessment of the economic impact of a maritime carbon tax by shocking the changes in the maritime transport cost

GTAP and GTAP-E
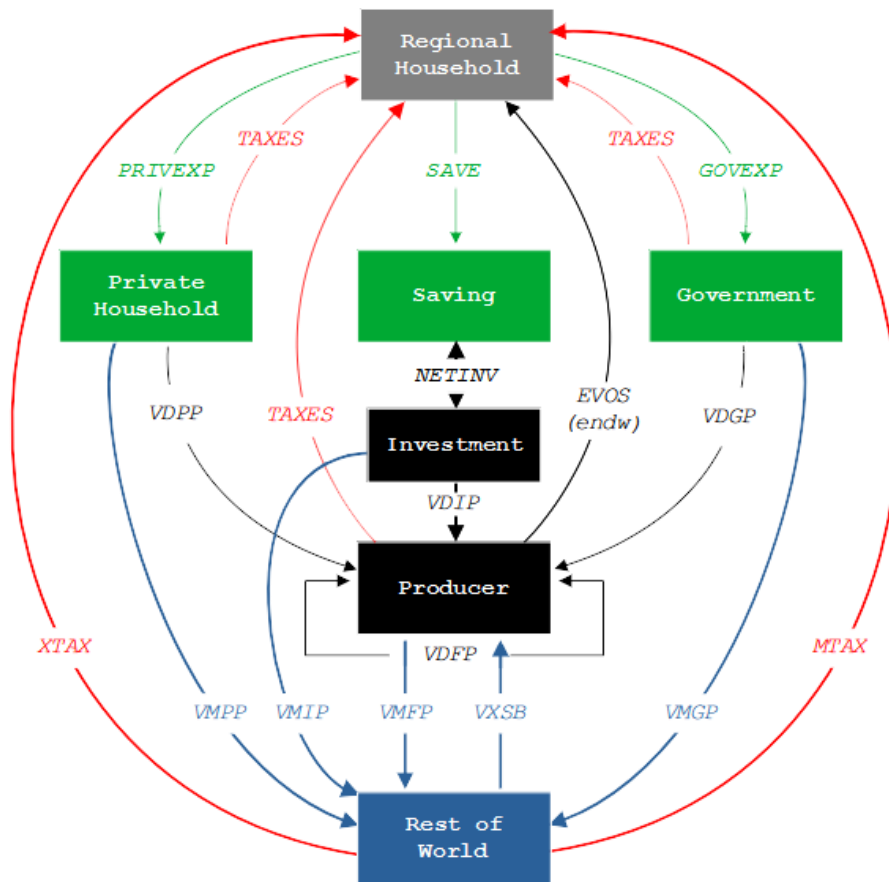
GTAP circular flows

Main characteristics:
- sets of equations from economic theory
- Competitive markets, constant returns to scale technology
- describes the domestic economy and its interactions of all agentes

Model implementation: market-clearing condition.

GTAP has 20 million equations

Data: Carbon Emissions from Ships

GTAP database: No information on carbon emissions from ships.

We **estimate carbon emissions** from intern. shipping using:

- Trade data from GTAP/UN COMTRADE (in US$ and tons).

- Sea transport share of trade updated based on Cristea et al (2013)* and Machine Learning techniques

- Associated average ship by bilateral trade flow and sector.

- Shipping distance per trade flow (Seadistances.org) and ship characteristics per bilateral trade flow and sector.

- We calculate total shipping emissions of 863,096,687 tCO_2, or 89.5% of total emissions (4th IMO GHG)

- **GTAP has data on shipping costs per transport mode** (in million US$)

*Cristea, A., Hummels, D., Puzzello, L., & Avetisyan, M. (2013). Trade and the greenhouse gas emissions from international freight transport. Journal of environmental economics and management, 65(1), 153-173.

GTAP and Carbon Tax Design

We follow Lee et al. (2013)* to calculate the shock:

$$\Delta s_{mijs} = \frac{\tau \times CO2emissions_{mijs}}{margincost_{mijs}}$$

τ is the carbon tax that affects directly costs (in US$/ton), and $CO2emissions$ are the total maritime (m) CO2 emissions from the bilateral trade flow between country i and j for commodity s.

The tax impacts the model by changing relative transport prices:

$$TransportPrices_{mijs} = margincost_{mijs}(1 + \Delta_m + \Delta_i + \Delta_j + \Delta_s + \Delta s_{mijs})$$

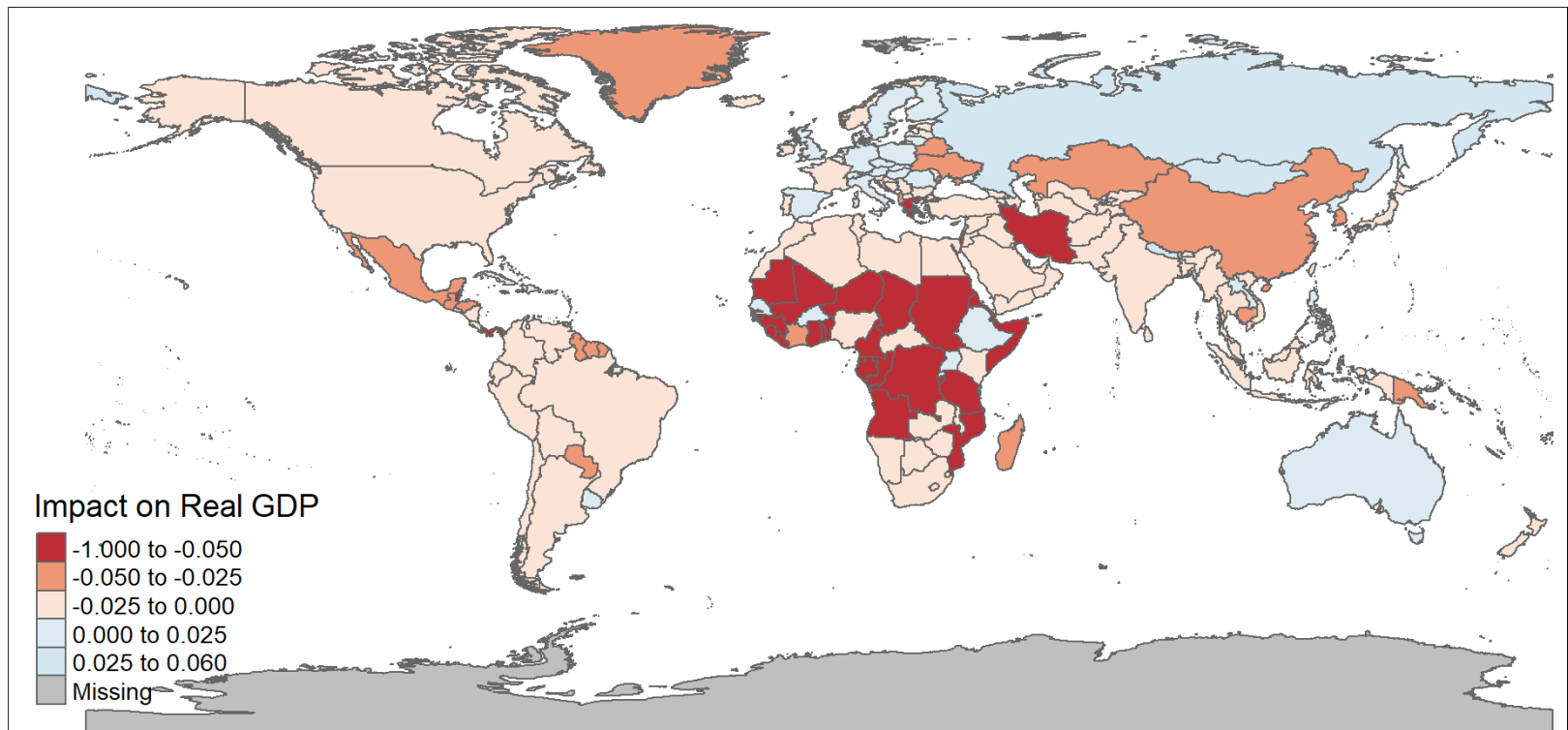m, i, j, s represent transport mode, country of origin and destination, and commodity, respectively.

* Tsung-Chen Lee, Young-Tae Chang, Paul T.W. Lee. (2013) Economy-wide impact analysis of a carbon tax on international container shipping. Transportation Research Part A 58. 87–102.

3. Results

**Impacts on world real GDP in %, by country/region
(baseline = 2014)**

Impact on Real GDP
- -1.000 to -0.050
- -0.050 to -0.025
- -0.025 to 0.000
- 0.000 to 0.025
- 0.025 to 0.060
- Missing

Results – GDP Impacts

Impacts on world real GDP in % by region (baseline = 2014)

Region	Real GDP
Oceania	-0.001%
South and Southeast Asia	**-0.017%**
North America	-0.004%
Central and South America	-0.016%
Europe	0.004%
Western Asia and Former Soviet Union	**-0.020%**
North Africa	-0.010%
Western Africa	**-0.067%**
South and South-Central Africa	**-0.049%**
Eastern Africa	**-0.087%**
Other	0.005%
Total change (all countries)	**-0.295%**

SIDs	**-0.007%**
LDCs	**-0.052%**

Results – Emissions Impacts

Impacts on the global CO$_2$e shipping emissions and other variables (baseline = 2014)

Item	Carbon Tax of US$ 50/tCO2e
Emissions	
Before carbon tax (tCO2e)	863,096,687
After carbon tax (tCO2e)	802,748,261
Change in emissions (tCO2e)	-60,348,426
(change in emissions using GTAP in 2014, %)	*-7.0%*
(change in emissions using 4th IMO GHG in 2014, %)	*-6.3%*
(change in emissions using 4th IMO GHG in 2008, %)	*-7.6%*
Other variables (% change)	
Total exports	-0.20%
Total nominal GDP	0.02%
Total real GDP	-0.30%
Global import food prices	4.17%

4. Final Remarks

Key Takeaways

1. Possible to **perform global comprehensive impact analysis** with results by country/sector: general equilibrium effects considering the dynamics of the global economy and price effects

2. Important to **rigorously calculate the carbon emissions** from ships when assessing impact of MBMs;

3. GTAP is a clear and transparent model used to simulate climate policy

4. Results for **141 countries/regions (incl. SIDs and LDCs)**

5. **Potential to analyze specific routes** in terms of trade flows and sectors

Next Steps

Further improvements:

i. **Dynamic impacts:** Estimate impacts over time.

ii. **Update carbon emissions** using:

    i. full ship distribution by bilateral trade flow and sector.

    ii. the current policies (EEDI, EEXI, CII) when assessing impact evaluation of candidate measures over time.

iii. **Update GTAP:**

    i. We are now using GTAP version 11.

    ii. Modal substitution for 20 sectors.

iv. **Impact of other MBMs and combined economic measures:** Simulate other economic measures under debate here at IMO.

v. **Compensation/offsets**: We intend to conduct impact assessment of potential compensation mechanisms (**exemptions, revenue recycling, different schedules)** to reduce regional inequalities from measures.

Thank you!

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