KEY MESSAGE

Notwithstanding significant energy efficiency improvements, CO₂ emissions from international shipping will grow between 10% to 20% by 2020, and 126% to 218% by 2050 (already clear in 2008 IMO Report).

Intensive speed reduction and use of low-carbon fuels for example offer a window of opportunity that cannot be realised unless policy change takes place.

Overall costs for the sector are limited: the issue is the ensuring level playing field and avoiding creating complex bureaucracy for operating the systems.

REDUCTIONS OF EMISSIONS ASSOCIATED WITH DIFFERENT STRATEGIES

There is clearly a gap between where the sector is and where it should be. Efficiency improvements are too low.

INSTITUTIONAL ROLES

The Kyoto Protocol (art. 2.2) mandated International Maritime Organisation together with International Civil Aviation Organisation to deliberate on Climate Change issues in the maritime and aviation industries. Paris Agreement excluded Shipping and aviation.

Other bodies (UNFCCC or WTO) have the potential of intervening.

Unilateral action from regional authorities is also possible although against international law.

Legal and political complexity

Conventions VS amendments
NECESSITY FOR FURTHER EMISSION MITIGATION ACTIONS

• Inadequacy of existing measures
• Emission Control Areas (ECAs)
• Energy Environmental Design Index (EEDI)
• Ship Energy Efficiency Management Plan (SEEMP)
• Market Based Measures
  - (Maritime) Emission Trading Scheme (METS)
  - Bunker Levy Scheme

HOW TO DEAL WITH CLIMATE CHANGE IN SHIPPING

Do nothing
Trust technology (provide incentives)
Self regulation (CSR, market pressure, sustainability as competitive advantage, risk mitigation)
Offsetting
Market based measures
  - Emission Trading Scheme
  - Speed limits
  - Levy
  - Other?

AIM OF THE RESEARCH PAPER

• Economic implications of the introduction of two different forms of a tax-levy scheme in the bulk shipping industry
  - a unit tax per ton of fuel
  - an ad valorem tax; as percentage of fuel prices
• Levy costs allocation in the shipping sector
  - who will actually pay the enforced levy costs
  - to what percent

METHODOLOGY

• Equilibrium in international shipping; interaction among the four markets
• Application of the cobweb theorem in international shipping

ANALYSIS

New order for ships at period $t$ according to Luo et al.(2009)

\[ N_t = n \times \Pi_t \]

- $n$: average proportion of profit accounting for new vessel purchase
- $\Pi_t$: profit,
- $\Pi_t = p \times W - (OC_t + F_t) \Psi_t$
- $p$: freight rates ($/$ton), $W$: tons of bulk cargo carried, $OC$: operating costs,
- $F$: fuel costs
- $F_t = \rho t f t \lambda t S^3$

- $\rho$: operating time at sea (hours), $f$: fuel price ($/$ton), $\lambda$: coefficient of ship’s energy efficiency, $S$ (knots) is average speed, $\Psi$: no. of ships required, $d$: route distance (nautical miles) and $H$ is ship’s average capacity (tons)
\[ \Delta Z_t = Z_t - N_{t-\theta} = (G_{t-\theta} - P_{t-\theta} W_{t-\theta}) \]

Based on the cobweb theorem:
\[ \Delta P_t = P_t - P_{t-1} = \delta (\Delta W_t - \phi \Delta Z_t) \]

\( \Delta W \) = change in cargo transported, \( \Delta Z \) = change in fleet capacity, \( \delta > 0 \) = freight adjustment factor on the basis of demand and supply alterations, \( \phi > 0 \) = average fleet capacity utilization rate.

**Introduction of the levy schemes**

- \( D_t = P_t - (G_t + P_t (1 + \Delta P_t) - \lambda_t) \)
- \( D_t = P_t - (G_t + P_t (1 + \Delta P_t) - \lambda_t) \)

For the unit scenario:
\[ M = \Delta S_t = \frac{\Delta S_t}{S} = \sqrt{\frac{1}{1+\frac{\delta}{\phi}}} - 1 \]

For the ad valorem scenario:
\[ M = \Delta S_t = \frac{\Delta S_t}{S} = \sqrt{\frac{1}{1+\frac{\delta}{\phi}}} - 1 \]

**ECONOMIC IMPLICATIONS**

- Profit Maximisation Problem
- Solution for ship-owners
  - decrease speed
  - decrease fuel consumption
  - increase energy efficiency of the industry

**OPTIMAL SPEED**

- For the unit tax scheme:
  \[ S_t = \frac{\Delta S_t}{\sqrt{\frac{1}{1+\frac{\delta}{\phi}}} - 1} \]
- For the ad valorem scheme:
  \[ S_t = \frac{\Delta S_t}{\sqrt{\frac{1}{1+\frac{\delta}{\phi}}} - 1} \]

**PERCENTAGE OF SPEED CHANGE**

- Dependent on:
  - Fuel Price
  - Tax Amount

- Only for the ad valorem scenario:
  - Enforced Percentage Tax

**SPEED REDUCTION WITH DIFFERENTIATED IMPOSED TAX VALUES**

**PROFIT DIFFERENTIATIONS**

Both levy schemes → Profit decrease

**LEVY COSTS ALLOCATION**

- Who bears the levy costs? To what percent?
- Role of price elasticity of supply and demand

<table>
<thead>
<tr>
<th>Market situation</th>
<th>Profit decrease (%)</th>
<th>Levy borne by the shipper</th>
<th>Levy borne by the shipper</th>
</tr>
</thead>
<tbody>
<tr>
<td>prosperous</td>
<td>High demand</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td>prosperous</td>
<td>Low demand</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Overcapacity</td>
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<tr>
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</tr>
<tr>
<td>Low demand</td>
<td>High freight rates</td>
<td>75%</td>
<td>25%</td>
</tr>
<tr>
<td>Low demand</td>
<td>Low freight rates</td>
<td>25%</td>
<td>75%</td>
</tr>
</tbody>
</table>

Higher percentage of the extra costs has to be absorbed by the ship-owners.
CONCLUSION ON LEVY

Both schemes:
- Extra costs added on fuel prices
- Profit decrease

Solutions:
- Speed decrease
- Fuel consumption decrease
- Increase energy efficiency

Levy costs allocation depends on the market situation

CONCLUSIONS

- Urgency to deal with regulation questions
- Options are on the table
- A coordinate effort is necessary to avoid market distortions
- Tax/levy as a potential option
- Importance to carry on further research