Market Based Measures for the Reduction of Green House Gas Emissions from Ships: A Possible Way Forward

Temanummer: Klimakrisen – de næste skridt

The International Maritime Organization (IMO) is a specialized United Nations (UN) agency regulating maritime transport. One of the very hot topics currently on the IMO agenda is decarbonization. In that regard, the IMO decided in 2018 to achieve by 2050 a reduction of at least 50% in maritime green house gas (GHG) emissions vis-à-vis 2008 levels. The purpose of this paper is to discuss the possible role of Market Based Measures (MBMs) so as to achieve the above target. To that effect, a brief discussion of MBMs at the IMO and the EU is presented, and a possible way forward is proposed, focusing on a bunker levy.

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1. Introduction

Maritime transport carries some 90% of the world's trade and some 70% of its value (UNCTAD, 2018). The International Maritime Organization (IMO) is a specialized United Nations (UN) agency regulating maritime transport. Areas of competence include maritime safety, maritime security, marine environmental protection, legal matters, technical cooperation and others.

One of the very hot topics currently on the IMO agenda is how to decarbonize maritime transport. In that regard, perhaps no other development has been of higher significance than the decision of the 72nd session of IMO's Marine Environment Protection Committee (MEPC 72) in April 2018. It was then decided, among other things, to achieve by 2050 a reduction of at least 50% in maritime green house gas (GHG) emissions vis-à-vis 2008 levels (IMO, 2018).

How much carbon emissions are produced by maritime transport? The so-called 3rd IMO GHG study (Smith et al, 2014) estimated CO_2 emissions from international shipping for 2012 fleet data at 796 million tonnes, or 2.2% of global anthropogenic CO_2. The previous (2nd) IMO GHG study (Buhaug et al., 2009), based on 2007 fleet data, had estimated CO_2 emissions at 885 million tonnes and the equivalent percentage was 2.7%. The reduction from 2007 to 2012, both in absolute terms and in percentage, is mainly attributed to the fleet slowing down due to depressed market conditions after 2008.

It is customary to break down the spectrum of measures to reduce maritime emissions (including but not limited to GHGs) into basically three major classes.

First, *technological* measures include more efficient (energy-saving) engines, more efficient ship hulls and designs, more efficient propellers, cleaner fuels (low carbon content, Liquefied Natural Gas- LNG), alternative fuels (fuel cells, biofuels, etc), devices to trap exhaust emissions (scrubbers, etc), energy recuperation devices (exhaust heat recovery systems, etc), "cold ironing" in ports, various kites, and others.

Second, we have *logistics-based* (tactical and operational) measures, which include speed optimization, optimized weather routing, optimal fleet management and deployment, efficient supply chain management, and others that impact the logistical operation

Third, we have what we call *market-based measures* or MBMs. These include a levy on bunker fuel, Emissions Trading Systems (ETS), also known as cap and trade, and a variety of others.

We note that the separation into the above three categories is artificial in many respects. This is so because an MBM may induce the ship owner to adopt (a) logistics-based measures in the short run, and (b) technological measures in the long run. Both sets of measures would result in emissions reductions.

Fuel costs constitute a substantial part of a ship's operating costs, typically ranging from 50% to 60%, depending on many parameters that include ship type and size, engine technology, ship speed and fuel price (Wang and Teo, 2013). Reducing fuel consumption, either by technological means or by logistical means, would also reduce emissions, GHG and other, and thus might be a "win-win" proposition. However, how substantial reductions can take place while maritime trade continues to grow is a major challenge for the shipping industry.

The purpose of this paper is to briefly discuss the possible role of MBMs as tools for the decarbonization of shipping, and propose a possible way ahead. The paper draws to a large extent on prior research of the authors and their colleagues on maritime emissions circa 2008, including involvement in various IMO working and expert groups on the GHG subject. Relevant prior work includes Psaraftis (2012, 2016, 2018, 2019), Psaraftis and Kontovas (2009, 2013), and Gkonis and Psaraftis (2012), among others. However, the paper also includes some new material (mainly in Section 4), not published before.

The rest of the paper is organized as follows. Section 2 provides some background on MBMs. Section 3 comments on the bunker levy vs ETS choice. Finally Section 4 proposes a possible way ahead, focusing on the bunker levy option.

2. MBM Background

To obtain some insights into the possible role of MBMs, consider the practice of "slow steaming", widely applied in recent times mainly to reduce fuel costs and help sustain a fragile market by absorbing excess shipping capacity. From basic naval architecture, the dependency of daily fuel consumption on ship speed is at least cubic. GHG emissions being directly proportional to fuel consumed, a simple way to reduce these emissions, perhaps drastically, is for a ship to slow down. Slowing down voluntarily is called slow steaming. Since ships tend to slow down when fuel prices go up, a simple and straightforward way to reduce GHG emissions is to introduce a levy on bunker fuel.

By making a ship owner pay for his ship's CO_2 emissions, an MBM is an instrument that implements the 'polluter pays' principle. In that sense, it helps internalize the external costs of these emissions. In addition, monies raised by an MBM can be used to reduce CO_2 emissions *outside* the marine sector, for instance by purchasing what are known as 'offsets'. Such offsets could be used to invest in projects such as for instance a wind farm in Indonesia, a solar cell farm in Bangladesh, or others, and so contribute to GHG reduction outside the marine sector. These are known as 'out of sector' reductions. In the long run, an MBM can incentivize the development of energy efficient technologies and alternative fuels that are not currently viable. A ship owner would be more willing to invest in such schemes and save fuel if an MBM is imposed, rather than pay for the MBM itself.

Following the update of the 2nd IMO GHG study in 2009 (Buhaug et al, 2009), IMO activity on GHGs was largely on two parallel tracks. The first track mainly concerned EEDI, which is an individual ship index adopted in 2011 that tries to reduce CO_2 emissions per transport work, and in fact up to this day it is the only mandated measure for the reduction of GHG maritime emissions. The second track concerned MBMs.

For MBMs, an Expert Group was appointed in 2010 by the IMO's Secretary General after solicitation of member states and was tasked to evaluate as many as ten separate MBM proposals, submitted by various member states and other organizations[1]. The IMO formulated criteria for the evaluation of these proposals. These included environmental effectiveness, cost effectiveness, practical feasibility, administrative burden, compatibility with existing regulations, and others. After considerable discussion, a 300+ page report (IMO, 2010a) evaluating the MBM proposals was prepared by the MBM Expert Group and was presented and discussed. The report went at length in assessing each MBM according to the evaluation criteria, in modeling future scenarios and in assessing the impact of MBMs on trade and developing countries. However, the report contained no comparison of MBMs and no recommendation as to which MBMs should be further pursued.

1 The first author of this paper was a member of this Expert Group.

In Psaraftis (2012) an horizontal assessment of all MBM proposals according to the nine evaluation criteria was made. This is, to our knowledge, the only comparison of these MBM proposals to date. As the Expert Group report contained no recommendation on which MBM should be chosen, discussion on MBMs at the IMO level after 2010 was pretty non-productive. A proposal by Greece in 2012 (who had submitted no MBM proposal of its own) for the IMO to decide on a short-list of MBMs (levy and ETS) was rejected, apparently on the ground of not wanting to displease the MBM proposers. The same happened to a proposal by the Chairman of the MEPC in 2012 to conduct an impact assessment study, as political considerations and lack of agreement between developed and developing countries prevented a decision on the matter.

3. A bunker levy vs ETS

Much of the discussion on MBMs has centered on the comparison between a bunker levy and an ETS, which can be considered as the two main MBMs (even though a variety of other systems exist). These two systems are in a sense, mirrors of one another, as the bunker levy system sets the price on CO_2 emissions and the quantity of CO_2 emissions is determined by how the fleet reacts to the above price, whereas the ETS sets a cap on these emissions and the price is determined by the market for emissions allowances. Both systems would reduce CO_2 emissions. Some estimates of what the CO_2 emissions reductions might be exist. Devanney (2010) estimated that with a base fuel price of USD 465/tonne, a USD 50/tonne bunker levy would achieve a 6% reduction for Very Large Crude Carrier (VLCC) emissions over their life cycle and that for a USD 150/tonne levy the reduction would be 11.5%. Some estimates of CO_2 reductions for tankers and handymax bulk carriers, and for several bunker levy scenarios, were made in Gkonis and Psaraftis (2012) and in Kapetanis et al (2014) respectively. These estimates showed CO_2 reductions of more than 50% for a single VLCC if fuel price rises from 400 to 1,000 USD/tonne. However, the long term fleet-level impacts of substantial levies are as mentioned above unknown.

If an ETS system is to function ideally, one would know with certainty the total CO_2 emissions to be allowed, and no CO_2 emissions beyond a prescribed cap would be possible. However, this is only an ideal situation. In reality, things could be different, due to possible exemptions, free emissions allowances, and other factors.

The general debate on levy vs ETS (or, in economics parlance, on price vs quantity) transcends shipping and it is outside the scope of this paper to provide a full account on it. One can cite the classic paper by Weitzman (1974) who argues that a tax is a preferable instrument over a quota. In the carbon emissions context, FOE (2010) outline why carbon trading is not the solution to climate change and sets out some of the real solutions for cutting greenhouse gas emissions and delivering climate finance. On the pro-ETS side, Ellerman et al. (2010) describe experience with the EU ETS and believe that although some 'glitches' need to be fixed, the scheme is basically sound and can become a prototype for a global climate policy regime.

Currently the EU ETS only covers large stationary emission sources and as a result can reduce the emissions by between 40 and 75% of the reductions under an (equally priced) carbon levy in most countries. According to statistical results of European Commission (EC, 2019), a levy on CO_2 emissions from power generation typically achieves 80% or more of the emissions reductions under an ETS. Similarly, according to a US Congressional Budget Office study (CBO, 2008), a bunker levy is much more efficient an instrument to reduce carbon emissions than an ETS.

Energy efficiency policies, even if implemented nationwide (which would be practically challenging), are able to reduce emissions by between 25 and 40% of that under the carbon levy. Road fuel taxes are a relatively weak instrument, typically reducing emissions by less than 10% of that under the carbon levy (Parry et al., 2018). In a high-demand scenario, on the other hand, prices may surge, especially when the sector comes close to reaching the emissions cap. Among the shortcomings of an emissions-trading scheme is the relative complexity of the system that could undermine smaller companies' competitiveness. Also, an evident downside is the uncertainty of the price compared with a levy system (EC, 2019).

According to the same source (EC, 2019), emissions of GHGs from all operators covered by the EU ETS have decreased by 3.9% overall in 2018 vs 2017, as a result of 4.1% decrease of emissions from stationary installations and 3.9% increase of emissions from aviation. Under the EU ETS Directive, all commercial aircraft operators and non-commercial aircraft operators with significant emissions are accountable for their emissions from flights within the European Economic Area (EEA) in the period 2013-2023.

Existing ETS schemes have a history of weak prices due to an oversupply of emissions certificates – too many allowances were allocated free of charge out of competitiveness concerns, and demand was overestimated, given unforeseen market developments such as the financial crisis of 2008 and an unexpectedly quick adoption of low-carbon technologies. Provisions to adjust the price were not part of the scheme architecture. As a result, the price signal was not as strong as expected to provide the desired incentive to invest in low-carbon technologies.

The choice between a fixed quantity approach (ETS) and a fixed-price approach (levy) is not absolute. In emissions trading, the outcome is certain, but the price will not be known in advance. With a fixed levy, the price is known but the effect on emissions is not. An emissions-trading system could have a floor price, and a levy could be regularly reset to reflect recent market developments.

However, a carbon levy offers stable carbon prices, so energy producers and entrepreneurs can make investment decisions without fear of fluctuating regulatory costs. In addition, if emissions reductions are cheaper than expected—which might occur if, for example, an economic downturn causes emissions to fall—then a levy provides a continuing price signal whereas cap-and-trade does not encourage reductions beyond the emissions target.

As it is seen from aviation's example, sectors that are not stationary installations and have international boundaries, are difficult to be included in a regional scheme. There should be an extensive discussion and an impact assessment regarding the emissions allocation methods. Industries such as aviation and shipping should have stable and identifiable prices in order to change their behavior as whole.

By giving allowances and creating offsets the companies are continuing to be profitable and emit CO_2. Whereas in a levy scenario the "contribution" would then be carefully spent or redistributed to the companies that have invest in environmentally friendly technologies. A carbon trading scheme is not a long-term solution because there is little space left to use the collected money for research and development of new technologies that will lead to decarbonized shipping.

A carbon levy also has the advantage of collecting revenue that can be used to stimulate R&D and technology deployment. For example, an investment rebate mechanism has been applied with good results through the Norwegian NOx-fund to stimulate the uptake of abatement technology, and a similar approach could be envisaged for CO_2. However, in case of a low levy then the industries will not have enough incentives to invest in a new environmentally friendly technology. The risk of their investment will have lower return outcome than simply pay the fee. Therefore, there should be a comprehensive assessment regarding on the amount of the levy and the party that will bear the administrative role of the levy collector.

Coming back to shipping, it is also important to note that whereas the effect of a levy on slow steaming is automatic (the owner or whoever pays for the fuel responds to the increased price he faces), with an ETS things are more complicated, for it is nearly impossible to connect a carbon price paid at a certain time to purchase emissions allowances to slow steaming decisions at a later point in time (Psaraftis, 2012).

All carbon forecasting reports are full of many assumptions and caveats, and still nobody has seen a previous forecast prove accurate. In a University of Cambridge study for the IMO (IMO, 2010b), the ETS price starts at USD 177 per tonne and then skyrockets to USD 3,200 per tonne. It can go the other way too. EU ETS carbon prices have dropped precipitously as a result of the recent economic crisis and (perhaps) as a result of too many free allowances being issued.

In a review of lessons learned from CO_2 pricing in the petroleum sector, a common finding is how external factors affect emission levels. These factors include market changes, global oil prices, changes in energy systems and security of supply. Should CO_2 pricing be introduced to shipping, similar effects of external factors should be expected.

Any scheme will have to address impact on states, the critical role of international shipping in global trade, and how it can be properly enforced, collected, and deployed. It is expected that carbon pricing will provide an incentive for transitioning to low/zero carbon alternatives. Given the long asset life of vessels, a clear trajectory on carbon pricing over the long-term should positively influence investment decisions at an early stage. Hence, a carbon levy at a pre-determined level is preferable to a trading scheme where the price of carbon credits can be highly volatile, with a levy resulting in investment decisions being made under conditions of greater certainty and therefore more progress on decarbonization.

4. A possible way forward

4.1. MBMs in the IMO Initial Strategy

In May of 2013 the MEPC decided to suspend discussion on MBMs altogether, at least for the time being. This reflected a channeling of the discussion towards the subject of Monitoring, Reporting and Verification (MRV) of CO2 emissions. In November 2017, and after some negotiations between the EP and the EU Council of Ministers, it was agreed to align the EU with the IMO process, and essentially the EU refrain from taking action on ETS before seeing what the IMO intends to do on GHGs. Industry circles, concerned with the effects of an early EU ETS, welcomed this development. However, the European Commission will closely monitor the IMO process, starting from what is agreed on the initial strategy in 2018 and all the way to 2023.

Then in April 2018 the IMO/MEPC reached the landmark decision to adopt an initial strategy for GHG reductions that set (among other things) a target of GHG reductions of at least 50% by 2050, vis-à-vis 2008 levels (IMO, 2018). A list of potential measures has also been proposed, however no prioritization among measures exists yet. MBMs are included in the set of *medium-term* candidate measures stipulated in the IMO Initial Strategy. This means measures agreed to and finalized between 2023 and 2030. The wording is as follows:

- *new/innovative emission reduction mechanism(s), **possibly** including Market-based Measures (MBMs), to incentivize GHG emission reduction;*

Note the use of the word "possibly" (emphasis ours) which means that MBMs may *not* be chosen as a measure, after all.

In our opinion, and again assuming that the shipping industry is to propose something on MBMs, it should be a levy, as an ETS would be something to be avoided due to the many problems it would pose (for a discussion see Psaraftis (2012)). A levy scheme had been proposed by Denmark and other countries in 2010 in the context of the MBM discussion. The sponsors of that proposal had labeled the levy scheme as a *"GHG fund"* or a *"contribution"* for legal purposes.

If a bunker levy is to be proposed, questions to be resolved include the following:

- which ships will be subject to the levy
- the levy as a function of type of fuel used
- the level of the levy
- the timing of the levy
- who will be collecting the levy
- how and to whom the proceeds of the levy will be distributed

The following can be briefly said in that regard, with the understanding that these issues will need to be further worked on:

4.2. Which ships will be subject to the levy

In order to avoid distortions of competition and a level playing field, all ships should be subject to the levy, possibly excluding ships of very small size (eg, ships below 400 GRT). Schemes *to be avoided* include schemes that:

- exclude ships from the levy, under some criteria
- differentiate the level of the levy among certain ships,
- provide a rebate on the amount of the levy,

Criteria on the basis of which such exclusion/differentiation/rebate schemes would apply may include any or all of the following:

- ship type, size, flag, age, ownership, route, ports visited
- other criteria, such as for instance an EEDI below a certain level, a speed below a certain level, the technical characteristics of the ship including waste heat recovery devices, hybrid propulsion, exhaust cleaning devices, or others.

These exclusion/differentiation/rebate schemes would add to the burden of administering the levy and would certainly lead to distortions of competition, to carbon leakage and possibly to fraud.

4.3 The levy as a function of the type of fuel used

At the same time, and as the industry will be moving towards low carbon fuels, a differentiation of the levy with respect to the carbon footprint of the fuel used would make sense, provided that possible side-effects such as methane slip (for LNG) or others are taken into account. If this is followed, the levy could be expressed in terms of *USD per tonne of equivalent CO_2 emissions (CO_{2e})*, and then translated to USD per tonne of fuel, depending on the carbon footprint of the fuel. For instance, a levy of USD 10 per tonne of Heavy Fuel Oil (HFO) would be equivalent to a levy of about USD 3.21 per tonne of CO_2, based on a carbon coefficient of 3.11 for HFO (3.21=10/3.11).

According to this scheme, low carbon fuels, which are exactly the fuels that are desirable to reduce GHG emissions, would be levied less (on a per tonne of fuel basis) than conventional fossil fuels, because their carbon coefficient would be lower, and the levy on zero carbon fuels (should these be developed eventually) would be 0. So whenever zero carbon fuels are eventually used, there would be no levy on these fuels, and a levy would be confined only to fuels that have a carbon footprint, such as fossil fuels. The lower the carbon footprint, the lower the levy.

It should be noted that a proposal by Devanney (2011) suggested a scheme of *direct taxation*, via a device placed in a ship's stack that would directly measure CO_2 emissions. The scheme would bypass bunker fuel measurements and would report CO_2 emissions directly to the authority that would administer the collection of the levy (see section 4.6).

4.4. The level of the levy

The level of the levy should be examined after an analysis that would recommend the level that would maximize the chances of compliance with the IMO GHG reduction target. Such an analysis would examine and analyze both the short-term and long-term effects of the levy. Short-term effects include speed reduction and long-term effects include incentivizing energy saving technologies and alternative fuels.

In general one would envision the following general options on the level of the levy, together with their anticipated impacts as regards GHG emissions reduction.

Table 1: Levy levels

Levy level	Range (USD/tonne of CO_{2e})	Expected GHG reduction
Low	0.5-5	None or negligible
Medium	5-75	Moderate
High	>75	Significant

The "low" option would mainly collect monies for R&D. The "medium" option would achieve some GHG reductions, mainly in the short-term, in the form of slow steaming. How much will be reduced is currently unclear. Finally the "high" option is a full blown MBM that would have both short-term and medium term effects, the medium-term effects being the provision of incentives to develop low/zero fossil carbon fuels and ship technologies that would reduce GHGs that are not currently viable (long-term objective/effects).

4.5. The timing of the levy

If the levy is to help towards achieving the IMO GHG reduction target for 2050, it is clear that it will have to start earlier. A possible gradual phase-in schedule is as follows:

Table 2: Phase-in schedule

Year	2019-2022	2023-2024	2025-2026	2027-2028	2029-2030	2031-2050
levy	0	0.20X	0.40X	0.60X	0.80X	X

Where X is the 100% level of the levy (determined by the analysis of the previous section and subsequently agreed to by the IMO). Other schedules can also be devised.

4.6. Who will be collecting the levy

This can be again the subject of the aforementioned analysis. Options include:

- A specially designed and staffed unit of the IMO
- A scheme modelled after the International Oil Pollution Compensation (IOPC) Funds
- An industry-managed scheme
- Various specially authorized banks
- Other, certified levy collectors

4.7. How and to whom the proceeds of the levy will be distributed

This is a very difficult subject that deserves careful analysis, which is beyond the scope of this paper. The answer would really depend on the level of the levy. Situations to be avoided include the possible distortion of competition if, for instance, funds would be used in sector, or if rebate schemes are used. If monies collected are to be given to developing states for capacity building and technical cooperation, it should be avoided that these funds are given to shipping companies that can enhance their competitive position vis-à-vis other companies who do not receive such funds. Care should be exercised if funds are given as subsidies to import-competing industries, as this might distort trade. If funds are given to ports for infrastructure improvement, this may distort competition too. Uses of these funds for R&D would be legitimate, provided that appropriate co-financing schemes are devised so that private industry participation is ensured, and appropriate incentives to develop technologies and fuels are used. In all cases, strict auditing of the uses of these funds would be necessary.

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