Operational measures and logistical considerations for the decarbonisation of maritime transport

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Abstract

Maritime shipping is widely considered as the most fuel-efficient mode of transport. During the past decade, the relative share of CO_2 emissions of the shipping sector has seen a slight reduction that has been attributed to the depressed market conditions that led to the resurface of the slow steaming practice. The sector has seen increasing regulatory pressure to further improve its environmental performance, not only in greenhouse gas (GHG) terms, but also in other pollutant types. Important regulation has been implemented with regards to the maximum allowable content of sulphur in marine fuel from the International Maritime Organization (IMO), whereas the introduction of MRV(monitoring, reporting, verification) in Europe will also assist in the efforts to reduce the environmental impacts of shipping. The European Union has also adopted the Transport White Paper that has set ambitious targets for reductions in GHG emissions compared to 1990 for all transport modes.

At the same time, it is noteworthy that international shipping has been excluded from the COP21 climate change agreement in Paris. The discussion on possible pathways to achieve reductions in the maritime sector is currently in a stalemate. While certain Market Based Measures (MBMs) for GHGs have been contemplated at the IMO, a final decision has not been reached. In February 2017, the European Parliament voted to include shipping into the EU Emissions Trading Scheme (ETS) as of 2023, in the event that no global agreement is reached by 2021. This potential solution has been met with criticism as there are concerns that the ETS could lead to distortions in trade, and actually not be an efficient method to reduce GHG emissions. Other measures have been submitted as potential solutions to the IMO such as the introduction of an additional levy on bunker fuel, as well as hybrid proposals that also take into consideration ETS type solutions, and the EEDI (Energy Efficiency Design Index).

In this paper, the implications of these measures are examined in a quantitative context whereby the objective is to identify the potential for emissions reduction in different shipping sectors.

In addition to estimations on emissions reduction, logistical considerations are thoroughly examined in the paper. For example, an introduction of a tax levy will result in a higher bunker price and thus operating costs for ship operators, which will de facto alter the optimal sailing speed of the vessel to lower levels. This will result in lower emissions per trip, but may require the deployment of additional vessels to satisfy the total transportation demand, or lead to a modal shift towards other modes due to the shippers' requirements for a faster service. This sort of distortion has already been observed due to the stricter fuel requirements within SECAs (Sulphur Emission Control Areas), but was rather anticlimactic due to the in general very low fuel prices observed in 2015. With regards to the EEDI, it is a well established fact that while the rationale was to improve vessel and engine design, a potential alternative to comply with the limits would be to simply lower the sailing speed, leading to underpowered vessels. In the case studies examined in this paper, a variety of vessel types, sizes, and deployed routes are considered to explore the impacts of the different decarbonisation pathways.

This paper presents a new modelling framework that allows the quantitative estimation of the effectiveness of various MBMs in emissions reduction, also considering the total cost for the achieved reduction. The required tax on fuel to reduce emissions is calculated on a parametric analysis that considers desired reduction, sailing speed, carrying capacity, fuel price, and freight rates. Case studies on liner shipping, Ro-Ro shipping, and tankers are considered, with a discussion on the role of the operating area of the vessel (ocean-going vs short sea shipping, outside vs inside SECAs). Finally, using data on the world fleet and the current trade volumes, a range of the potential reduction for CO_2 emissions is performed for different values of levies on bunker fuel.

The results can be useful in the way forward to decarbonising maritime transport, while also considering the economic and environmental trade-offs due to potential modal shifts, closure of services, and required fleet renewal. The constructed modelling framework is also able of assessing the impact of various other environmental regulation that may be proposed but may have a more local character (for example speed limits near the coastlines, requirements at the port etc.).