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The environmental effects of emission control area regulations on short sea shipping in Northern Europe: The case of container feeder vessels

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ABSTRACT

Through the adoption and development of Annex VI, the International Maritime Organization has followed a stepwise approach to sulfur content reductions in marine fuels. The Annex also implies that vessels operating in the waters of designated Emission Control Areas (ECA) need to comply with stricter limits than the global regulations, dropping as low as 0.1% from 1st January 2015. Shipping companies operating in the North Sea and the Baltic Sea have flagged their concern about short sea shipping's competitiveness as the tightened restrictions on SO_x emissions will force companies to switch to cleaner and more costly fuels, or implement other abatement measures. Hence, European transport policies aimed at transferring more cargo from road to sea might be counteracted by stricter environmental regulations. This paper presents SO_2 emission calculations of two container feeder vessels based on comprehensive shipment level data before the implementation of the ECA regulations. A comparative analysis of the environmental footprint of the short sea shipping service with a counterfactual road haulage operation is conducted in a pre- and post ECA regulation setting. This effectively illustrates how empirical data supports the necessity of stricter SO_x regulations in order for maritime operations to uphold a green image set up against competing transport modes.

1. Introduction

Close to 70% of maritime emissions are emitted within 400 km of land, consequently imposing problems with air quality in coastal areas and ports handling high volumes. SO_2 emissions can be transported over long distances from their original source and have negative effects on both the ecosystem and health related issues (Eyring et al., 2010). Roughly 5–8% of global SO_2 emissions are caused by shipping. This proportion of the emissions stemming from maritime transport is increasing, partly due to the growth in seaborne trade and partly due to the fact that regulatory measures have been more extensively implemented in other industries. In Europe, land-based sulfur emissions have been reduced since the 1980s and SO_x emissions have decreased by 54% over the first decade of the 21st century in the European Union (Viana et al., 2014). In year 2000, SO_2 emissions from ships operating in EU waters constituted 20–30% of EU land-based sulfur emissions. In 2020 maritime sulfur emissions are expected to be practically equal to those of land-based sources if not measures are undertaken (Schembari et al., 2012). The environmental regulations of maritime transport have been less ambitious than other transport modes. This may refer to the international nature of the industry, and thus, a need for these issues to be resolved at an international level, which can often be a more slow-moving regime. On the other hand, it can also refer to the fact that emissions

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to a greater extent occur at sea and therefore have less discernible and obvious impacts on the population (Cullinane and Bergqvist, 2014) (Table 1).

Annex VI *Prevention of Air Pollution from Ships* was added to MARPOL in 1997 aiming to reduce emissions to air from seaborne transport. The Annex has been up for revision, causing stricter limits in terms of SO_x pollutants with a stepwise approach in order to regulate sulfur emissions on a regional and global scale. The initial ambition level could be discussed considering that the average sulfur content of heavy fuel oil (HFO) is 2.7%, and therefore considerably below the current and already tightened global sulfur cap of 3.5% (Yang et al., 2012), while on the other hand, IMO being challenged to reconsider reducing the global sulfur content to 0.5% in 2020 in order to maintain the current climate cooling effects of shipping by continued use of HFO at high seas (Lindstad et al., 2015a; Lindstad and Eskeland, 2016). Still, challenges arise when ships enter Emission Control Areas (ECA) in which the Baltic Sea, the North Sea and the English Channel are ECAs in Northern Europe, where Annex VI regulations imply that vessels operating in these waters need to comply with stricter sulfur limits set to 0.1% from 1st January 2015. Although methanol could be used to comply with ECA regulations, Deniz and Zincir (2016) find it unsuitable as an alternative fuel for ships. Other feasible compliance alternatives involve switching to distillate fuels with low sulfur content, implementing exhaust gas cleaning systems (i.e. scrubbers) and retrofitting of ships to be able to utilize LNG. The easiest way of compliance is switching to distillate fuels since there is no need for modifications and investments upfront as opposed to the other measures, and thus carries the lowest capital costs. The drawback, however, refers to the price level of distillates which are typically 30–50% more costly than heavy fuel oil. Furthermore, in a long term perspective, future prices could stabilize at higher levels considering that production capacity is limited and demand increasing considerably with the introduction of additional ECAs in other parts of the world (Acciaro, 2014).

The maritime industry has expressed concerns about the consequences the tightened sulfur content limit may have on the competitiveness of short sea shipping, with a possible modal backshift from sea to road transport – consequently counteracting the aim of current EU policies (Notteboom, 2011; Sys et al., 2016). Concerns supported by Lindstad et al. (2015b), stating the risk of a modal backshift to be present as the increase in direct ship related transport costs, applying the most cost-efficient abatement option, is estimated to be 10–15% for smaller container feeder vessels (4000 kW engine) and 6–10% for larger container feeder vessels (12,000 kW engine). From a policy-making and implementation standpoint, the difficulties lie in balancing the environmental impacts to society and the abatement costs which arise for the shipping industry. A cost-benefit analysis of the social emission effects and the private abatement costs of sulfur reductions of a typical container vessel operating in the North Sea ECA favored low sulfur fuel as opposed to scrubbers as a compliance measure (Jiang et al., 2014). A review of 70 companies' chosen compliance strategy, comprising a fleet of some 5000 ships, also reveals that the vast majority decided upon low sulfur marine gas oil (LSMGO) as their ECA sulfur reduction measure. The LSMGO compliance option was especially preferred by tankers, bulk carriers and container vessels (Shipandbunker, 2015).

Historically, the cost of fuel has been considered relatively small in comparison to the ships' fixed costs, crewing and management. Still the proportion of total operational costs has increased over the years, indicating it could exceed 50% (Lindstad et al., 2013; Fagerholt et al., 2015), or more than 60% (Golias et al., 2009) or, with reference to a large container vessel at a price level of 500 USD per metric ton, could even constitute as much as 75% (Ronen, 2011). Since the price of LSMGO is significantly higher than that of HFO this might considerably increase vessel operating costs for shipping companies mainly operating in ECAs. Further, the general picture is that the container segment is expected to have the highest increase in costs due to the switch to low sulfur fuel (Kalli et al., 2009; Delhaye et al., 2010) considering that container vessels typically run at higher speeds in comparison with bulk carriers and tankers, and fuel consumption is a convex function of speed (Psaraftis and Kontovas, 2010).

Given that the modal backshift takes place, the ECA regulation's aim of greening maritime transport may not have the full effect as initially intended since a diversion of cargo flows from shipping may reduce the capacity utilization of ships, and thus their environmental efficiency, if the frequency of service is kept at the existing levels. If frequency is lowered to compensate for reduced load factors and/or freight rates are increased to reflect higher operating costs, the overall attractiveness of short sea shipping services may fall, which in turn could also lead to a transfer of goods from sea to road transport. This might have adverse effects on the environmental performance of maritime freight transport and the impacts of the ECA regulations should therefore be further examined.

2. Methodological approach

This paper will undertake a comparative analysis of the environmental footprint with respect to SO_2 emissions from short sea shipping services operating in Emissions Control Areas in Northern Europe. The framework of the analysis will be underpinned by SO_2 calculations based on comprehensive data sets for two container feeder vessels operating in the North Sea over a full year, prior to the implementation of the ECA regulations for sulfur oxides in 2015. The data is extracted from the shipping company's database and comprises all containers transported between ports for each roundtrip. It also includes actual sailing distances and fuel consumption of the main and auxiliary engine for each roundtrip, which altogether enables emission calculations based on origin – destination (OD) matrices. According to the author's knowledge, SO_2 emissions from container ships have not been calculated before based on this type of data, mainly due to the lack of availability and sensitive nature of the data. This brings about new empirical insight into the environmental footprint of maritime transport and the effects of stricter sulfur regulations.