DEPARTMENT OF INTERNATIONAL AND EUROPEAN ECONOMIC STUDIES

ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

Sustainable Shipping: Levers of Change

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Working Paper Series

20-25

May 2020

Chapter 10

Sustainable Shipping: Levers of Change

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Abstract

Sustainable shipping refers to the broad set of challenges, nature of governance rules and regulations, patterns of management and corporate behaviors and aims, engagement of stakeholders, and forms of industrial activity that should come to define a marine transport industry that is shaped by the broader societal goals of sustainable development. This chapter aims to provide a brief overview of the marine transport industry, its role and relevance in sustainable development and the kinds of changes that are needed for shipping to be sustainable. The focus is mostly on the environmental dimension of sustainable development. As a sector, and for reasons that have to do with the special nature of its international governance that partly falls outside the confines of national jurisdictions, shipping may have been a late comer to some of the most pressing sustainability challenges of our time. After presenting some recent economic trends of the sector and their potential implications for sustainability the chapter will present some environmental pressures that are related to shipping and will focus on two particular sustainability challenges confronted by maritime transport: the need to drastically reduce sulfur emissions and the even more demanding challenge to mitigate CO_2 emissions. Before concluding, the penultimate section will briefly present some sustainability initiatives already under way.

Key words: Sustainable shipping, maritime transport, CO2 emissions mitigation, EU ETS,

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10.1 Introduction

Two landmark agreements adopted in 2015 are the 2030 Agenda for Sustainable Development under the framework of the United Nations Sustainable Development Summit and the Paris Agreement on climate change under the auspices of the United Nations Framework on Climate Change (UNFCCC). None of the 17 sustainable development goals (SDGs) is dedicated to the thematic area of transport. In elaborating the goals the international community recognized that by integrating and mainstreaming transport considerations into a range of SDGs its cross-sectoral nature would be a critical enabler of most of them (Benamara, Hoffmann, & Youssef, 2019).[5]

Maritime transport is an economic sector in its own right. With 80% of international merchandise trade by volume and over two thirds by value in 2017 (UNCTAD, 2018), it is central to the sustainability agenda. Maritime transport links almost all countries relevant supply chains, supports international production processes, carries international trade and provides access to the global markets. In addition, many sectors and industries are intimately linked to marine transport: marine equipment manufacturing, marine auxiliary services (e.g., insurance, banking, brokering), fisheries, tourism, ship building and demolition, offshore energy (Benamara, Hoffmann, & Youssef, 2019).

Maritime transport can be seen as environmentally friendly relative to other modes of transportation when measured in tonne-miles (weight per distance travelled). In conjunction with its strategic economic and social function of supporting international trade it can be viewed as an important sustainable development enabler (Benamara, Hoffmann, & Youssef, 2019). Unsustainable transport pattens, however, are linked to numerous social costs in the form of air and marine pollution, GHG emissions, resource depletion and biodiversity loss among others.

Sustainability in maritime transport involves, inter alia, the ability to provide transportation infrastructure and services that also further the multiple dimensions of sustainable development. For instance: safety, accessibility, social inclusivity, reliability, fuel-efficiency, affordability, environment-friendly, low carbon and climate resilient. Figure 1 provides an overview of the intersection between the three pillars of sustainable development as they relate to the marine transport sector.

5. This chapter draws heavily on Benamara, Hoffmann, and Youssef (2019) and UNCTAD (2018)

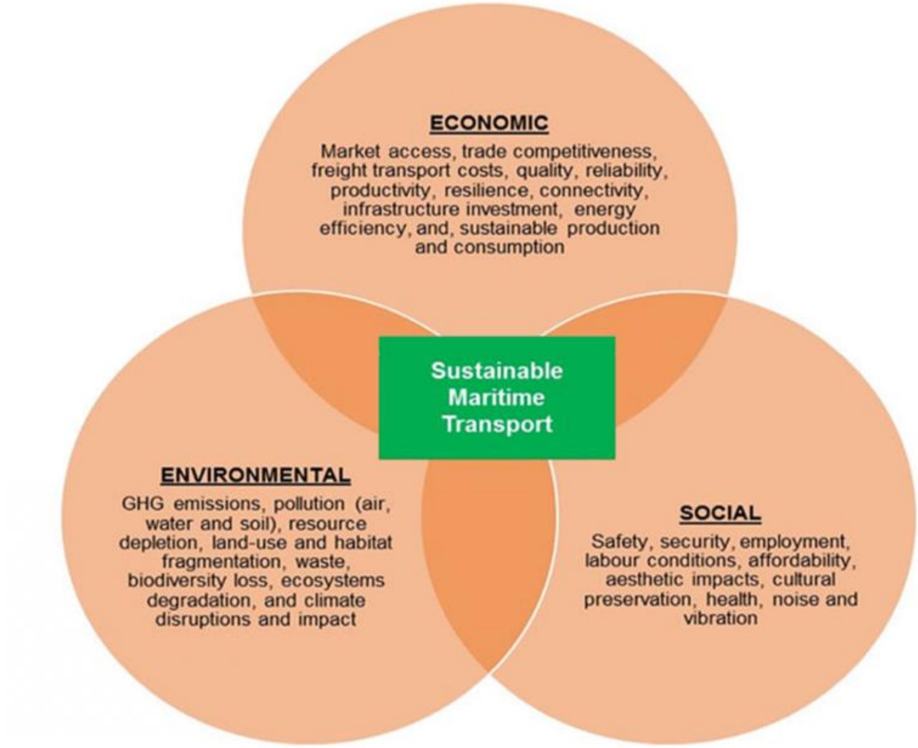

Figure 1 - Source: UNCTAD (2015)

10.2 Recent economic trends for maritime transport

Demand for maritime transport increases in tandem with gross domestic product and industrial production. OECD (2017b) projects the tripling of total freight transport demand over the 2015-2050 driven mostly by economic growth with maritime transport accounting for 75% (up from 71% in 2015). The projected increase in total freight transport is expected to translate into 120% increase in CO_2 emissions (OECD, 2017b).

The growing role of developing countries in trade and global economic growth is also reflected in marine transport with 60% of world seaborne trade volumes originating in developing countries while 63% were delivered to their territories (UNCTAD, 2018). New patterns of geographical distribution of production and consumption emerge altering cargo flows and directions with implications for shipping networks, fuel consumption, transport costs, ship emissions and climate change (Benamara, Hoffmann, & Youssef, 2019).

While there has been growth in deadweight tonnage of the commercial shipping fleet in the last two years, this has followed a 5-year period of decelerating growth. The overall weak global demand particularly affected the container shipping segment which carries 16% of world trade by volume and over half by value (UNCTAD, 2018). This period of an oversupplied market has been characterized by consolidation and rationalization to reduce costs and optimize capacity utilization as evinced in the arrival of mega ships and the formation of new and larger shipping alliances. The potential increase in market concentration, mega ships, enhanced network efficiency could lead to higher prices for shipping services, redefine supply chains and reduce the number of port calls. The economies of scale at sea brought about by large container ships do not necessarily extend to ports. The number of ports and terminals able to accommodate the larger ships will be limited and ports will have to undertake infrastructural investments and the increased intensity of activity will require enhanced port efficiency. These are some of the broad economic developments influencing the sustainability equation (Benamara, Hoffmann, & Youssef, 2019).

Climate change impacts in the form of rising water level, floods, storms, precipitation and extreme weather events are likely to have significant effects on transport networks and seaports (Asariotis, Benamara, & Mohos-Naray, 2017). Enhancing climate resilience of the maritime transport system will also be critical for sustainability.

10.3 Environmental pressures from shipping

A number of environmental pressures are associated with the marine transport industry. South and East Asia undertake a large share of ship recycling and unsustainable conditions pose serious risks to human health, environment and society including children. Hazardous and oily materials (e.g., asbestos, polychlorinated biphenyls, oils and oil sludge) contained in many of the old ships are a key problem. A number of regulations are meant to address these issues (Benamara, Hoffmann, & Youssef, 2019). Sea also Mikelis (2019) for fuller discussion.

Various types of wastes are generated by ships such as oily wastes, drainage from bilges, sewage and garbage and cargo residues. Wastes dumped in the marine environment results in negative impacts in the form of chemical pollution and non-degradable waste that affects marine life while also degrading the natural and economic value of coastal areas. The MARPOL Convention addresses many of these concerns and these obligations are mirrored in EU directives.

Harmful aquatic organisms and pathogens can be transferred between marine ecosystems through ships's ballast waters and sediments. This is a major environmental challenge that can significantly damage coastal and marine environments and ecosystems (Benamara, Hoffmann, & Youssef, 2019). In September 2017 the International Convention for the Control and Management of Ships' Ballast Waters and Sediments came into force, requiring ships to have ballast water treatment systems.

About half of global crude oil production is carried by sea making oil spills a major pollution risk. The international oil pollution regulatory framework under IMO has contributed to a substantial drop in the number oil spills from tankers. Other types of pollution, including spills of hazardous and noxious substances remain a concern.

10.4 New challenges to sustainable shipping

10.4.1 Heavy reliance on oil for propulsion

The transport sector accounts for more than 50% of oil demand today. Over half of the increase in freight transport energy projected by 2040 can be attributed to shipping (EIA, 2017). Figure 2 provides a breakdown of energy usage in the transport sector globally in 2015. International shipping increased demand for energy at an annual rate of 1.6% from 2000-2014 (IMO, 2014). Some decoupling between maritime transport activity and marine bunker fuel that has taken place in the recent past more likely reflects the upgrading of the global container fleet to larger more efficient ships, the scrapping of older ships and slow steaming rather than energy efficiency improvements or reduced dependence on oil. These trends were likely a response to the excess capacity resulting from the 2009 downturn (Benamara, Hoffmann, & Youssef, 2019).

Reducing energy consumption and the heavy reliance on oil for propulsion is a key challenge for sustainable maritime transportation. Marine bunker fuels are very polluting and have a high carbon intensity. In addition, the affordability of maritime transport service could be jeopardized by high and volatile oil prices. A future of low oil prices, however, could undermine the needed transition sustainability.

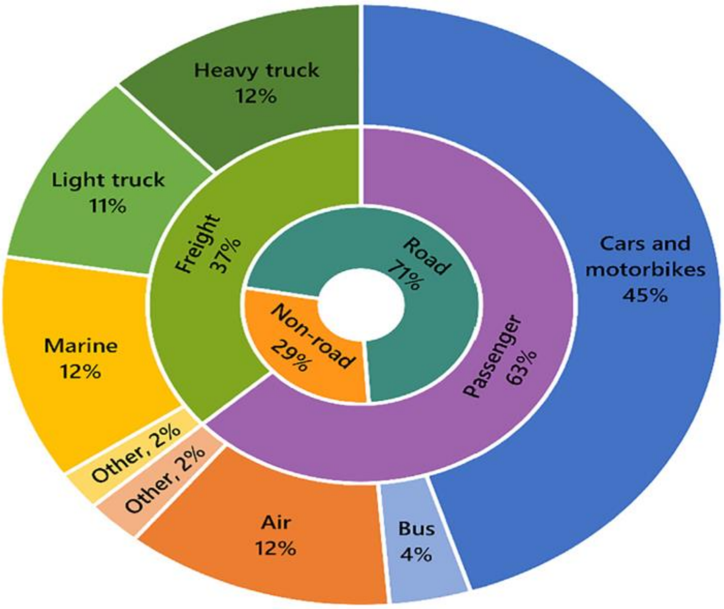

Figure 2 - Breakdown of energy usage in the transport sector globally in 2015. The outer ring gives the share of individual modes, the middle and inner rings aggregate these uses. Data source: EIA (2016). Source: Bouman et al. (2017)

10.4.2 Air pollution with a focus on the 2020 sulfur cap

Sulfur dioxide is not considered a greenhouse gas and it has been argued that SO_2 has a cooling effect. The long-recognized harmful effects of sulfuric acid deposition to land-based ecosystems has led to strict regulation on land-based sources of SO_2 (power stations and vehicle emissions) with concomitant reductions of the sulfur burden over North America and Europe. Fossil fuel combustion from power plants is the largest source of SO_2 emissions (73%). Industrial facilities are the second largest source (20%) followed by smaller sources that include burning of high sulfur containing fuels by locomotives, non-road equipment and large ships (EPA, 2013). Emissions from shipping have been poorly regulated despite evidence of enhanced acidification in coastal regions. As a result shipping is responsible for a large proportion of man-made SO_2 emissions (Endres et al., 2018). In the year 2000 SO_2 emissions from shipping was three times greater than that from all traffic and aviation combined (Eyring, K\"ohler, Van Aardenne, & Lauer, 2005). On some calculations a single container carrier emits as much SOx as 50 millions of diesel cars (International Gas Union, 2017). Shipping is thus by far one of the worlds top sources of SOx as well as a major source of NOx and GHG emissions. NOx and SOx emissions from international ships account for about 13% and 12% respectively over the 2007-2012 period (IMO, 2014). One large container ship visiting a port is estimated to produce the equivalent amount of NOx as that of 12,500 cars (McKinnon, 2016). These emissions are closely associated with heavy bunker fuels. Ships have been an important cause of premature deaths and respiratory symptoms as winds carry marine emission inland (EPA, 2016).

The International Maritime Organization (IMO) regulates air pollution from shipping through the International Convention for the Prevention of Pollution from Ships (1973) as modified by the Protocol 1978 (MARPOL). Annex VI of MARPOL specifically regulates airborne emissions from ships and entered into force in 2005. Emission control areas (ECAs) in Europe and the Americas enforce stricter limits on SOx emissions. New control areas are being established in China. Shipping will be required to meet the global sulfur cap of 0.5% by 2020. Stricter NOx ECA limits came into effect in 2016 in North America and Northern Europe will apply NOx ECA to ships built from 2021 (Benamara, Hoffmann, & Youssef, 2019).

The new IMO regulations due to take effect in January 2020 aim to drastically lower the sulfur cap for air emission from ships. The three main options available to shippers on current technology are to run on liquefied natural gas (LNG), to use HSFO and process air emissions through an exhaust gas cleaning system (EGGS) called "scrubber" fitted on board the ship along with dedicated tanks to hold and treat resulting wastewater from the process, or to switch from HSFO to a lower-sulfur fuel known as low-sulfur fuel oil (LSFO) (Halff, Younes, & Boersma, 2019). Many industry participants have yet to decide which of these three paths to take despite the imminence of the regulation and the fact that IMO first announced the cleaner-burning bunker rules as far back as 2008 (Halff et al., 2019).

Other fuel options include electricity, biodiesel, methanol, liquefied petroleum gas (LPG), Ethan dimethyl ether (DME), biogas, synthetic fuels, hydrogen and nuclear fuel (GL, 2017). The availability of fuels and their costs, uncertainty relating to alternative technologies and their level of maturation, and the investment requirements in terms of bunkering infrastructure are just some of the factors influencing the decision to adopt a particular option (GL, 2017). Scrubbers for instance will require additional expenditures and there are uncertainties about the underlying technology. Distillates are technically feasible but if demand increases for them the cost differential with conventional bunker fuels may widen. LNG use will involve important investments in bunkering facilities.

Halff et al. (2019) identify three sets of factors that discourage a prompt response to the new policies: the financial burden of premature compliance; financial risks stemming from market uncertainty (exacerbated by the IMO policy itself) and regulatory uncertainty. LNG and scrubber options both entail multimillion dollar up front capital expenditures. The attractiveness of the different options depend on the premium that low sulfur fuel has relative to HSFO. The industry's rate of adoption of various compliance options will also likely affect their competitiveness, e.g., widespread adoption of LNG could lead to an increase its price undermining its attractiveness. HSFO prices may plummet if there is large scale switching to LSFO or LNG making scrubber adopters less competitive. In this sense, early adopters may suffer from a deficit of information (on what others are planning) providing an incentive for waiting.

Potential interaction with regulations on GHGs and NOx further adds to the uncertainty. A global cap on NOx or GHG could damage the business case for scrubbers that do not filter out NOx and are relatively carbon intensive. While LNG is low in both SOx and NOx there are concerns that methane leakage could make it a source of high GHG emissions if the entire LNG lifecycle is accounted for. Similar concerns apply to LSFO or MGO being too carbon intensive if the fuel lifecycle of these fuels is considered (Halff et al., 2019). See Halff et al. (2019) for an extended discussion of these uncertainties.

10.4.3 SO2 emissions policy

IMO has chosen performance standards ("obligation of results") over technical standards ("obligation of conduct") in order to regulate SO_2 emissions. It sets the amount of sulfur dioxide that ships are allowed to release in the air but leaves it up to the shippers to find the means (conduct) to achieve that goal. From a standard theoretical economic perspective that does not take into account transaction or enforcement costs this make sense. Performance standards allows participants to find the least-cost method of reducing emissions whereas technical standards essentially "pick a winner" and can thus potentially stymie innovation and narrow the range of possible means of reducing emissions. Performance standards, however, are generally much more difficult to enforce. This is a special challenge in the case of shipping emissions as there is no single entity to carry out inspections on the high seas. Port states and flag states don't have the capacity and may not have the will to carry out inspections. New technologies, like remote sensing via satellites, may offer hope for effective enforcement (Halff et al., 2019).

10.4.4 CO_2 emissions

All transport accounted for 24% of the world CO_2 emissions from fuel combustion in 2015. Total shipping emissions reached approximately 938 million tons CO_2 emissions in 2012 with international shipping representing 85% for this total accounts for 2.2% of global total CO_2 emissions (OECD, 2017a). Depending on economic growth and global energy demand international carbon emission could increase by 50-250% by 2050 (IMO, 2014).

International shipping emissions were notably absent from the Paris Agreement. CO_2 emissions from international shipping have grown more slowly than international trade. This decoupling reflects increases in shipping efficiency (with slow steaming, increased size of ships and other operational measures playing a key role rather than technological innovations). There is presently no global mechanism to control CO_2 emissions beyond the efficiency standards for new-build ships (Traut et al., 2018). The Kyoto Protocol mandated its parties to work through the IMO for emission reductions from international shipping. For international aviation emissions it mandated the International Civil Aviation Organization (ICAO) (UNFCCC, 1997). Parts of the shipping industry have argued that shipping should have a more limited role in emission reductions because of its 'vital role' in serving developing economies (drawing on the notion of Common but Differentiated Responsibilities and Respective Capabilities) and because shipping has fewer opportunities to decarbonize relative to other sectors (ICS, 2016).

IMO adopted a mandatory data collection system for fuel consumption of ship in 2016 and in April 2018 the IMO Marine Environment Protection Committee (MEPC) adopted an initial strategy on GHG emissions reductions from ships (IMO, 2018). This strategy entails the first global climate framework for shipping and includes quantitative GHG reduction targets through 2050 as well as a list of candidate policy measures to help achieve these targets. A key target is to reduce CO_2 emissions per transport work as an average across international shipping by at least 50% by 2050 compared to 2008 while simultaneously pursuing efforts to at total phase out. Market-based measures (MBMs) are considered as potential measures. More generally the international community under the auspices of IMO/UNFCCC has seen a number of proposals in the form of incentivizing shipping companies to reduce carbon through operational changes or adoption of more carbon-efficient vessels, the introduction of a carbon tax on shipping, or emission trading mechanisms.

In the short-term CO_2 intensity of shipping can be reduced by a number of measures like changes to speed, ship size and utilization, retrofit technologies and other efficiency measures. Slow steaming, a practice of deliberately lowering he speed of a ship to reduce fuels costs is one suggested response to the sulfur cap. It proved very effective when the shipping industry was hit hard buy the oil rally of 2002-2008. Slow steaming even in a lower oil-price environment can help mop up excess capacity when the shipping markets are oversupplied. In addition to saving energy it has been argued that shipping carbon emissions are also reduced and marine transport reliability is improved by reductions in bottlenecks in terminals (Halff et al., 2019). See also Maloni, Paul, and Gligor (2013) for a cost benefit analysis of slow steaming.

Energy efficiency is also an important means of reducing air pollution. One study that considered 22 potential ship efficiency measures found that a reduction of 33% of CO_2 emissions could be achieved by 2020 (ICCT, 2011). Another study found that energy-saving could reduce CO_2 emissions by 50% by 2030 (Alvik, Eide, Endresen, Hoffmann, & Longva, 2010). Energy efficiency has been promoted in the maritime transport sector through regulatory measures in force since 2013 : IMO's Energy Efficiency Design Index (EEDI), Energy Efficiency Operational Indicator (EEOI) and Ship Energy Efficiency Management Plan (SEEMP) (IMO, 2017).

Virtually full decarbonization will be needed in the longer term that will mean fleet-wide deployment of near-zero carbon ships. This is a great challenge given the very short time frame (Traut et al., 2018). Bouman, Lindstad, Rialland, and Strømman (2017) review around 150 studies to provide a comprehensive overview of CO_2 emissions reduction potentials and measures published in the literature and find that emissions can be reduced by more than 75% based on current technologies (and through a combination of the proposed measures) by 2050. See Figure 3 as a snapshot of CO_2 emissions reduction measures and their potential impact. Also, for a marginal abatement cost (MAC) curve that presents the average marginal cost associated with alternative individual measures in CO_2 emissions reduction see Figure 4.

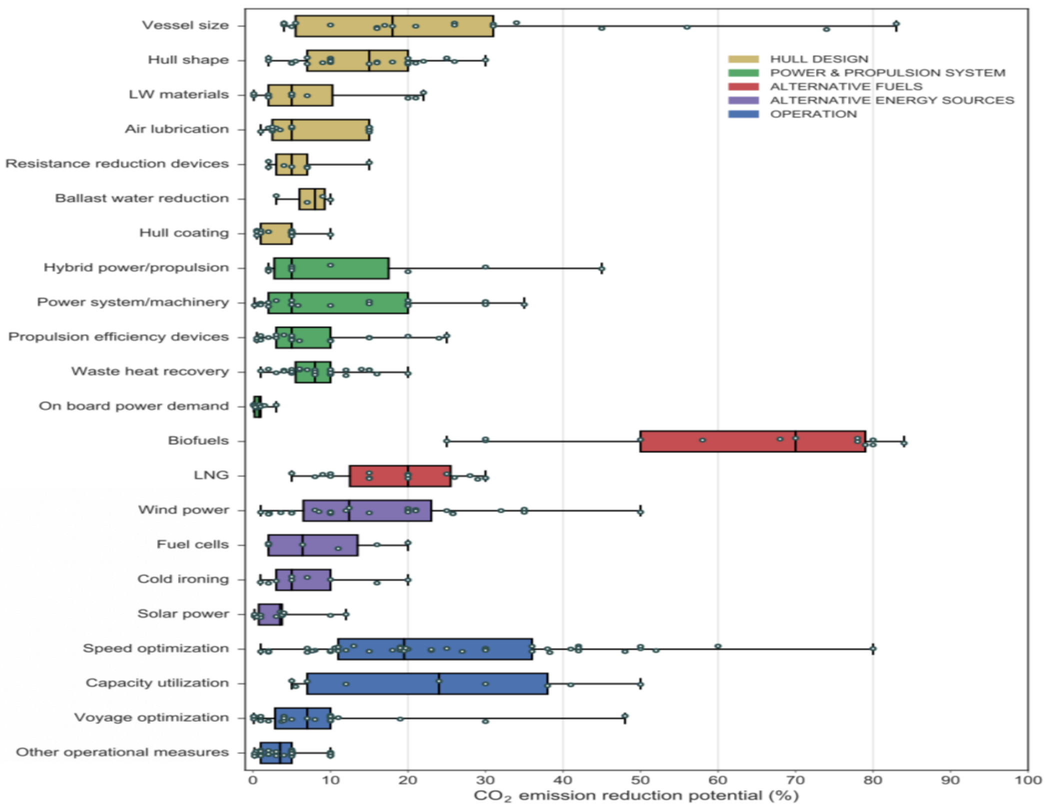

Figure 3 - CO2 emission reduction potential from individual measures, classified in 5 main categories of measures. Source: Bouman et al. (2017)

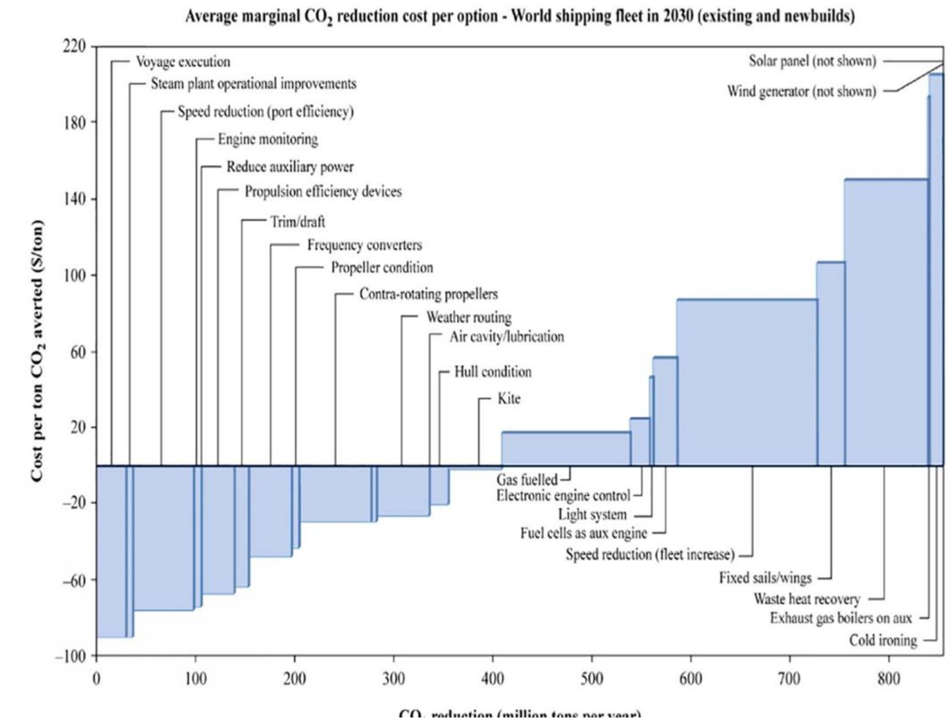

Figure 4 - Average marginal CO 2 reduction cost per option. Figure adapted from the study by Eide, Longva, Hoffmann, Endresen, and Dalsøren, B. (2011). Source: Wan, el Makhloufi, Chen, and Tang (2018)

Psaraftis and Zachariadis (2019) highlight some issue in the discussion about the use of alternative fuels for marine use for GHG reductions. Many of what are called “clean burning” fuels may be correctly labelled as such when focusing on SOx, NOx and particulate matter but not when the GHG footprint is considered. When considering the life cycle GHG footprint of nearly all proposed alternative fuels, they are worse than conventional liquid fuels (marine gas oil (MGO), marine diesel oil (MDO), or desulfurizer fuel oil). For instance, when taking into account its life cycle methane slip LNG’s global warming effect is much worse than conventional liquid fuels and possibly even worse than coal. See Psaraftis and Zachariadis (2019) for a discussion of the alternative fuels: Natural Gas (NG), Liquified Natural Gas (LNG), Liquified Petroleum Gas (LPG), Hydrogen, Methanol, Ammonia, Biofuels (Ethanol, Biodiesel, etc.) and Fuel Cells. In their view, until new technologies (batteries, synthetic fuels, synthetic biofuels, or others) that provide a “quantum leap” become economically viable current conventional liquid fuels have the smallest GHG footprint.

10.4.5 European Green Deal and European Climate law

On December 2019, European Commission (EC) announced the introduction of the European Green Deal (EGD), which aims to boost the implementation of the Agenda 2030 and of the 17 SDGs. Europe aims to become the world’s first climate-neutral continent by 2050 increasing the EU’s greenhouse gas emission reductions target for 2030 to at least 50% and towards 55% compared with 1990 levels (European Commission, 2019). The EGD aims at the reformation of four sectors of the economy, namely Energy, Buildings, Industry and Mobility. The majority (75%) of the EU’s GHG emissions are associated with the energy sector, while transport represents 25% of EU’s GHG.

In order a just and inclusive transition to be achieved, the European Commission commits to support companies transition to green and clean technologies. A 90% reduction in the transport emissions is targeted by 2050, while the supply of sustainable alternative transport fuels (e.g. biofuels and hydrogen) is boosted and promoted in shipping including other forms of transport, such as aviation and road transport. The European Community Shipowner’s Association (ECSA) support European Commission EGD and specifically it encourages the evaluation of the roll out of infrastructure for the delivery of alternative (non-fossil) fuels and the transition to no pollution in ports (ECSA, 2020).

European Green Deal was followed up with a proposal for European Climate Law on March 2020 aiming at writing into law the objective set out in the European Green Deal (e.g. Europe to become the first climate-neutral continent by 2050). This act includes cutting emissions, investing in green technologies and protecting the natural environment (European, Commission, 2020a). Despite its positive nature, the current climate law neither sets an ambitious goal for 2030, nor it refers to regulations and revisions needed for its achievement. Also, it gives significant power to European Commission without allowing it to impose sanctions on Member States, which do not comply with the respective recommendations of the European Commission to take additional measures and change policies that will correct possible deviations from the path to achieving the goals. The article on climate change adaptation is generic and not linked with the systemic documentation of the needs and financial resources required for the transition.

In addition, the EC proposal on the climate law is missing a number of critical elements. Besides core sectors (e.g. energy, transportation etc), all climate related components need to be included in the decarbonization plan aiming at climate neutrality, namely waters, underground waters, biodiversity, forestry, livestock. The decarbonization plan should also include the time factor, i.e. individual goals for each objective (short-medium-long), which should be achieved in all environmental components. In other words, climate law to be applicable in the maritime sector needs to identify key time-linked targets for ships, which if all be achieved the greater objective of climate neutrality will be reached.

Special care must be taken to create equal conditions for competition between EU companies and non-EU companies, mitigating the risk of "carbon leakage". More specifically, a clear reference is made to the obligation to formulate a relevant policy that ensures that the European Union's relations with third countries take into account their commitment and contribution to climate neutrality. This policy and tools could include, for example, the carbon end, linking aid and funding programs to complying with agreed climate change targets, technology exchange and know-how only with compliant countries. Particular care is needed to support the shipping industry to cope with the challenge of its transformation aiming at the harmonization with the climate neutrality objective.

Climate law lacks an explicit description of the financial mechanisms that will be essential for climate neutrality achievement, which is the main objective of this law. In particular, the EU's financial gap for achieving the 2030 energy and climate targets is estimated at €180 billion a year, increasing the pressure on the climate law to include a financial plan of implementation. Therefore, many initiatives are needed to create the appropriate financial framework for the extraction of the necessary funds, while taking advantage of the roadmap for sustainable financing. In addition, EU should consider imposing a carbon tax as well as strengthening the EU Emissions Trading System (EU ETS), whose prices have fallen sharply due to the COVID-19 crisis (European, Commission, 2020b).

Since November 2014, rules related to the Effort Sharing Decision are being implemented by the Union, building up binding annual GHG emission targets for Member States for the period 2013–2020. The Effort Sharing Decision concerns emissions from non-included in the EU ETS sectors, such as transport, buildings, agriculture and waste. In detail, the transport sector, as described in the Effort Sharing Decision, does not include aviation and international maritime shipping, which are large and growing sources of GHG emissions, due to their energy intensity and market share in global trade. This need is also emphasized by Directive (EU) 2018/410 of the European Parliament and of the Council, which highlights the need for EU ETS to act on shipping emissions as well as all other sectors of the economy.

10.4.6 Market-based mechanisms for GHG mitigation

Several market-based mechanism proposals have been submitted to the Maritime Environment Protection Committee (MEPC). A sector-wide cap on net emissions from international shipping and a trading system alongside this was recommended by Norway. A similar proposal was suggested by France but also included an auction design. An Emissions Trading System was proposed by the UK with an initial phase including offsets for emissions. The US Ship Efficiency and Credit Trading preferred a mandatory energy efficiency standard enforced via an efficiency credit trading programme. Importantly, in February 2017 the EU parliament voted to include shipping into the EU-ETS as of 2023 if there is an absence of action from the IMO by 2021. This cause concern among industry stakeholders that such a regional MBM would create distortions and may not lead to reduced CO_2 emissions, though the intent is to catalyze global action (Balcombe et al., 2019).

Broadly speaking market-based approaches can be divided into three categories: environmental price control approach, environmental quantity control approach, and subsidies. The environmental price approach can involve emissions charges or charges on fuels. The latter means that some opportunities for decoupling are lost, e.g., carbon capture, but may be easier to enforce. Kosmas and Acciaro (2017) consider bunker levy schemes for GHG emission reductions in the form of a unit-tax per ton of fuel and an ad-valorem tax. While recognizing that MBM's do not seem to be up for discussion in the foreseeable future Psaraftis (2019) sees the idea of a significant bunker levy at a global level worth pursuing. He points to how higher fuel prices in Europe and Japan have had a significant impact on the fuel-efficiency of their cars relative to the USA. Importantly a levy (or any charge resulting from tax or permits) should not be confined to marine transport as this could lead to a modal shift to land-based modes that are generally greater emitters of GHG.

The emission quantity control approach includes credit programs that provide operators with credits to if they undertake or support activities that reduce emissions. Benchmarking trading programs sets an average emissions level that should not be exceeded and usually allow for offsetting as opposed to elimination of emissions. A cap-and-trade program sets a total aggregated cap on emissions and allocates emission allowances that can then be traded by emitters.

Subsidies can be used to provide direct financial support for mitigation. Under the Freight Technology Incentives Program subsidies are provided by Transport Canada to encourage the employment of energy efficient technologies (Nikolakaki, 2013).

The global application of market-based measures is essential to avoid carbon leakage and competitive distortions especially given the relative ease with which ships are able to change their legal jurisdiction and register flags of convenience with more lenient carbon regulation. A maritime ETS or a carbon tax, or some hybrid system of emission trading with a price floor and/or ceiling could provide cost-efficient emission reductions allowing for the fullest range of responses by ship owners. An additional advantage of a tax or auction of permits is that the funds raised could be used to support technological innovation, cover administrative costs and be used to re-distribute funds towards developing countries and climate change funds. A key challenge for such a system are the costs of administering, monitoring and enforcing these measures. Given the myriad of options available for mitigation in the shipping industry market-based mechanisms have the advantage of not attempting to pick the technological or operational fix. On the other hand, a short-term option like LNG may require a combination of subsidies and port dues to effectively accelerate the large capital infrastructural costs involved.

10.5 Sustainability initiatives in maritime transport

Beyond regulatory measured and IMO strategies there have been a number of Government led initiatives for sustainability in transport more generally and maritime transport in particular that have emerged. The 2011 EC White Paper on Transport defines a strategy toward competitive and resource-efficient transport systems and a number of objectives and targets that relate to the logistics chains, promotion of more energy-efficient modes of transport at a larger scale, and reduction in emissions. Another example is the 2012 China Green Freight Initiative (CGFI) that seeks to improve fuel efficiency, reduce CO_2 emissions and adopt cleaner technologies in freight transport. Other states have also promoted sustainability targets and measures (Benamara, Hoffmann, & Youssef, 2019).

There are also numerous industry-led voluntary actions and initiatives. Maersk, for instance, has developed an "eco voyage" maritime software tool which can help cut fuel costs and make a voyage plan resulting in minimum fuel consumption. CMA CGM decided to equip its future giant containerships with engines using LNG meant to bring about large reductions in pollution emissions. Examples of voluntary self-regulation in maritime transport include the Clean Cargo Working Group that provides tools to help understand and manage sustainability impacts, the Sustainability Shipping Initiative that brings leading companies to promote a sustainable future, and Eco-Ships that involves investing and ordering a new generation of vessels that are eco-friendly and at the same time fuel efficient. For more examples of voluntary self-regulation in maritime transport see Benamara, Hoffmann, and Youssef (2019) and Lun, Lai, Wong, and Cheng (2015). Industry players with a role in promoting sustainability often in the form of enforcing international commitments to standards include entities as diverse as the International Chamber of Shipping (ICS), the International Association of dependent Tanker Owners (INTERTANKO), the International Association of Ports and Harbors (IAPH) (Benamara, Hoffmann, & Youssef, 2019).

With growing institutional pressures, and hopefully heightened awareness, shipping firms are likely to increasingly engage in sustainability management. This is evinced in part through numerous voluntary initiatives. Beyond government and industry led initiatives, shipping firms are responding to the rapidly evolving regulatory challenges as well as the institutional pressures from civil society and investors. The Environmental, social and governance (ESG) rating industry is putting pressure on international and domestic companies to improve their sustainability profile. ESG reports, ratings and indices are increasingly relied upon by institutional investors, asset managers and financial institutions and other stakeholders to assess and measure company sustainability performance. There are many ESG data providers like Bloomberg ESD Data Service, Sustainalytics Company ESG Reports, DowJones Sustainability Index (DJSI) to name a few. Huber and Comstock (2017), Siew (2015) and Olmedo, Torres, and Izquierdo (2010) offer an overview of the sustainability rating indices and agencies. In response to the greater demand of stakeholders for greater transparency in sustainability matters, shipping companies may undertake sustainability reporting on their own and in conjunction with third party certification agencies. For an overview of corporate sustainability reporting tools see Siew (2015). For a company to achieve good sustainability ratings or to gain certification for (dimensions of) sustainability ultimately it needs to adjust or fundamentally alter its strategic vision and management approach. There is a vast and rapidly growing literature on sustainable corporate management (Epstein & Buhovac, 2017; Modak, 2018; Brockett & Rezaee, 2012; Lambin & Thorlakson, 2018; Chrun, Dolšak, & Prakash, 2016). There is less literature focusing squarely on sustainable company management in the context of the marine transport industry, or the link between such sustainability practices, institutional pressures, and performance outcomes of companies. Lun, Lai, Wong, and Cheng (2015) raises this issue in a book focusing on green shipping management. They point to many firms that are placing importance on environmental protection when performing shipping activities such as mega carriers (e.g., Hapag-Lloyd, APL, K Line, Maersk, NKY, and OOCL) and giant shippers (e.g., IKEA, Mattel, Nike, Home Depot, and HP) that are members of the Clean Cargo Working Group looking to integrate sustainability business principles into transport management. In the very broad context Lambin and Thorlakson (2018) look at sustainability standards and how the overall interaction between private actors, civil society and governments is reshaping global environmental governance.

10.6 Conclusions

Maritime transport has a critical role in addressing the sustainability challenges of our times. It plays a key role in international trade, providing market access and linking communities. “Safe, secure, energy-efficient, affordable, reliable, low-carbon, environmentally friendly, climate-resilient and rule-based maritime transport systems contribute to achieving an economically efficient, socially equitable and environmentally sound development" (Benamara, Hoffmann, & Youssef, 2019). The new regulatory challenge posed by the sulfur cap in 2020 has generated substantial uncertainty in the shipping industry. While the shipping industry is focusing on the sulfur cap the greatest challenge it has likely ever faced is the need to find the effective means of decarbonizing in line with global commitments. The speed of the required transition along with the relative difficulty of technological options vis-a-vis other sectors of the economy make this a particularly demanding endeavor.

A number of government-led initiatives indicate a growing awareness of the shipping challenge while initiatives at the level of industry and companies suggests a new reckoning of corporate responsibility. The International Maritime Organization will have a critical role to play in determining the right approach for decarbonization policy. Market based mechanisms could potentially play an important role though they are still far from the center of the debate. They can incentivize the low carbon transition, spurring innovation across CO_2 emissions options and providing needed funding both for innovation and supporting developing economies address the heightened burdens of the transition. They are likely however to be one of many measures, regulations and initiatives needed for the task. Scaling up financial resources and investments will also be an important enabler. This is a role that can be undertaken by regional and national development banks, e.g., the European Investment Bank (EIB) and ING signed an agreement to support the European shipping market with 300 million worth of green investment. Green bonds are another potential instrument for large infrastructural investments.

Enhancing the sustainability of the maritime transport will require a multi-sector approach involving governments, transport industry, financial institutions, academia and civil society. The inherently international nature of maritime transport would seem to make it especially suited for global challenges, but it is also a potential weakness in that most governance institutions and their means of enforcing law and regulation are national in nature. Besides the ambitious goals of the European Green Deal and the European Climate Law of achieving climate neutrality by 2050 in alignment with the Agenda 2030 and IMO regulation, there is a lack of depth in the individual targets that need to be met by all Climate components. Shipping industry, as well as other sectors, needs to be specifically mentioned and targeted in the short-medium-long term in these agendas, otherwise the overarching goal of reducing GHG by 2050 will not be achieved. Furthermore, financial mechanisms that will be essential for climate neutrality achievement, need to be explicitly stated, while maritime transport emissions should be included in the EU ETS.

We have focused here primarily on some of the environmental dimensions of sustainable shipping, partly because of the particular historic junction we are at, but there are many other aspects of sustainable shipping that need to be part of our overall effort to achieve the Sustainable Development Goals. For instance, while more women have been entering the shipping industry in all roles, and efforts to advance their role have been made, the level of women's participation in the maritime industry remains low at on estimated 2% and patterns of job segregation persist (UNCTAD, 2018). Sustainability is a very broad and sometimes ambiguous concept, but it captures societal values and shapes our vision with a persistence similar to that of those other familiar concepts like democracy, justice and liberty that have driven change throughout human history.

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