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Reference:

Sys Christa, Vanelslander Thierry, Adriaenssens Mathias, Van Rillaer Ive.- International emission regulation in sea transport : economic feasibility and impact
Transportation research: part D: transport and environment - ISSN 1361-9209 - 45(2016), p. 139-151
Full text (Publisher's DOI): <https://doi.org/10.1016/J.TRD.2015.06.009>
To cite this reference: <http://hdl.handle.net/10067/1334430151162165141>

INTERNATIONAL EMISSION REGULATION IN SEA TRANSPORT: ECONOMIC FEASIBILITY AND IMPACT

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ABSTRACT

Emissions from shipping due to the burning of the sulphur content of marine fuels conduce to air pollution in the form of sulphur dioxide and particulate matter. Various international organizations and institutions impose environmental standards on their member states to limit the emission of greenhouse gases. This paper examines both the potential effects of the emerging international maritime emission regulations on the competition between seaports and the potential underlying economic motivations fostering the discussion of introducing Emission Control Areas. It focuses on deepsea shipping. Another novelty is that the environmental issues are addressed from a policy, an economic and a legislative viewpoint. For the policy-related part, it is found that the political theory of public choice suggests that not the green lobby but rather the petrochemical lobby is the major driving factor behind the very strict emission caps. A potential port shift from Northern Europe to Mediterranean ports seems unlikely due to logistics disadvantages and service problems in Southern European ports. Finally, no convincing proof was found that the main liner companies would be unprepared for this legislation and should be persuaded to change their routes in favour of Mediterranean ports solely on account of the various emission regulations. The legal analysis, however, showed that the current enforcement regime of MARPOL Annex VI should be improved in order to rule out the possibility of a low degree of compliance and to protect the competitiveness of complying ships.

Keywords: Emission Control Areas, Port competition, Port shift, Sustainable shipping, Mediterranean Sea, North Sea

1 INTRODUCTION

By developing an extensive legislative playing field, the International Maritime Organisation (IMO) and national governments¹ have accelerated their environmental efforts in international shipping. The strong correlation between the sulphur degree of maritime exhausts and acid rain on the one hand, and public health on the other, is undoubtedly one of the driving forces behind this. In 2008, the IMO directed the first revision of the International Convention for the Prevention of Pollution From Ships (MARPOL Annex VI) which resulted in substantial measures for a gradual worldwide reduction in SO_x and NO_x (IMO, 2008). After the revision of MARPOL Annex VI, the focus moved to the issue of CO₂ reduction and the optimization of shipping efficiency (see e.g. Aronietis et al., 2014; Stevens et al., 2014). The requirements of SO_x and NO_x reduction also triggered the development of other guidelines such as the code for gas-fuelled ships, the International Code for Ships

¹ European Commission (2013) for instance states that “*The Commission's 2011 White Paper on transport suggests that the EU's CO₂ emissions from maritime transport should be cut by at least 40% of 2005 levels by 2050, and if feasible by 50%. However, international shipping is not covered by the EU's current emissions reduction target*”.

Using Gases or Other Low-Flashpoint Fuels or IGF code and guidelines for scrubbers. The entire package requires the shipping industry to look at new business models and aims at providing environmental benefit and health gains. Each measure involves costs as well as benefits, with potential negative effects for the maritime economy. The bunker fuels presently used by international maritime transport will have to be replaced by alternative, less polluting fuel. Alternatively, the combustion process used will have to be adjusted by new techniques to reduce their hazardous emissions, called vessel retrofitting (Aronietis, et al., 2014; Brynolf, et al., 2014; Cullinane and Bergqvist, 2014; Fathom Shipping, 2014; Stevens, et al., 2014; Frouws, et al., 2012; Wärtsilä, 2012; Endresen, et al., 2005). It is presumed that this implies extra costs: the petrochemical process of refining is prolonged while more intensive and new investments on the ship have to be made (Seaat, 2011).

A substantial amount of research exists on the link between emission legislation and maritime economics, mainly focusing on shortsea shipping. An overview of some of this research is provided by Entec Consulting Ltd. (2010). The main conclusions relate to three topics: which method is best suited to achieve this transition successfully (Miola et al., 2010), what are the additional costs faced by sailing to/from an Emission Control Area (hereafter ECA) zone, and what is the possibility of a so-called reverse modal shift (i.e. road transport winning again from a competitive and cost perspective compared to maritime transport, mainly shortsea shipping) (Jiang, et al., 2014; Aronietis, et al., 2014; Johansson et al., 2013; Odgaard et al., 2013; Entec Consulting Ltd., 2010; Turku, 2009). The latter studies expect a reverse modal shift from sea-based transportation to currently more competitive land-based transportation, ranging from 3% to 50% on some trade lanes. () Such a substantial shift could eradicate the environmental gains through rising congestion and pollution caused by transportation of this cargo by land. Nevertheless, such a shift is possible since shortsea shipping, which will have to be completely sulphur-free due to its geographical location within the sECA-zones of the Baltic and North Sea, has always been in stiff competition with land-based transportation on relatively short distances. In contrast, Holmgren et al. (2014) concludes that a modal backshift to road transport is unlikely to occur for the shipments of relatively high-valued containerised goods from Lithuania to the British Midlands.

Clearly, focusing on the impact upon deepsea shipping from an transversal viewpoint fills a gap in the literature. Concentrating on deepsea means taking into account that the vessel passes different zones with several different emission legislations (for instance, US coast guard). This could provoke shifts in routes: certain zones with very severe emission caps could become less attractive for maritime transport in comparison to less strict, alternative regions. An example of this dichotomy can be found in Europe, which features two ECA's: the Baltic sulphur-ECA and the North Sea sulphur-ECA. In contrast, the Mediterranean area currently remains free from such legislation, and is only required to follow European legislation and IMO's global rules (Maarsen, 2010). As a result, the Mediterranean ports could use their advantageous position to raise their market shares and attract new trades (Garcia-Milà, 2010).

This paper examines both the potential effects of the emerging international maritime emission regulations on the competition between seaports and the potential underlying motivations fostering the discussion of introducing ECA's (Emission Control Areas) and their efficiency. The scope of the paper is limited to the main container liners and the Northern

European and Mediterranean ports of call. The main question of the present paper is whether enhanced sulphur emission legislation provides the Mediterranean ports with a competitive advantage, and provokes a potential port shift and growing hinterland due to changed cost balances. The research question will be addressed from a policy, an economic and a legislative viewpoint. This transversal approach is rather unique. The policy part to the answer addresses the current state and the likely future of ECA regulation regimes, which will determine the need for and likelihood of a potential port shift. The economic part to the answer gives quantitative and qualitative insights in operator impacts and strategies. The legislative part to the answer finally contributes by showing the side-conditions for making the ECA implementation successful and therefore showing the real potential of a port shift.

The paper is structured as follows. Firstly, the scope and the methodology is described in detail. Then, the paper continues with a policy, an economic and a legal analysis. The policy part, in section 3, consists of a brief overview of IMO and EU legislation and an analysis of interviews conducted with[...]. Given that port competition can also contribute to reducing emissions, the economic part in section 4 focuses on the ports, port competition and hinterland. This is clearly the core part of the analysis. Finally, in order to provide some legal insights in the discussion about ECAs, in section 5 the attention will be turned to those legal and regulatory aspects that can affect a potential port shift. Major findings and conclusions will be found in section 6.

2 SCOPE AND METHODOLOGY

The international span of deepsea shipping is different from the more regional character of shortsea carriers, given that vessels navigate through different zones or regulations. Shippers might take this into account while opting for these routes. This paper concentrates on the European situation, with a focus on four ports out of the sECA adjacent to the Hamburg-Le Havre range (including the ports of Le Havre, Antwerp, Rotterdam and Hamburg) compared to 8 ports located at the coastline of the non-sECA Mediterranean Sea². These ports include Valencia, Barcelona, Marseille and Genova on the western side, Piraeus on the northern side, Mersin and Port Said on the eastern side; and finally Tanger on the southern side of the Mediterranean coastline. Here, the port selection is based on the spread over the Mediterranean and the regional importance. Both groups are mainly composed of European ports, which leads to certain conditions (e.g. European regulation) remaining the same. Additionally, the focus is on the biggest container shipping operators, providing us with a clear example of a very competitive market. More specifically, the analysis is limited to the five biggest global players because of their extensive routing, shipped volumes and leadership roles in the market. Last, the object of the analysis is the Westbound Asia-Europe trade, being the largest maritime trade flow of the world, but least often dealt with as far as

² European Union (2009, p. 4) points out that “the geographical dimension of container liner shipping services consists of single trades, defined by the range of ports which are served at both ends of the service”. Relevant trades are those from and to Northern European areas and from the Mediterranean to other non-European areas and back. Note: Big feeder hubs like Marsaxlokk or Gioia Tauro will be left out of this comparison, since those ports mainly handle transshipment traffic (75 %) with hardly any effect on the continental European hinterland.

sECA research is concerned³. (Adriaenssens, 2011; Van Rillaer, 2013). Both the policy (section 3) and the economic (section 4) part will investigate influencing factors and analyse the possible relationship between the factors. It should be stressed that doing so for all factors might be difficult, as not all the emission regulations are formal and/or definitive, and some are subject to periodic review and/or adjustment.

The research is based on a qualitative and quantitative research design in order to capture changing preferences and discussions. For the policy part (section 3), the public choice theory of Buchanan and Tullock (1984) is applied to explain how public decisions are made. In the public choice theory, the actors are individuals (politicians, lobbyists, etc.) (Reksulak, et al., 2013). Hence, to identify the underlying factors and preferences, desk research was combined with traditional face-to-face interviews with business representatives. The interviewees were selected according to a maximum functional and geographical spread and their role as key decision makers. They were mainly officials of the legislative bodies (i.e. IMO and EU representatives) and interest groups (representatives from respective seaport, shipowner and shippers associations among others) (see Annex 1). A public choice analysis of international organisations allows explaining which lobby groups have the greatest influence. Most interviews were held with the associations because they determine the economic playing field. The interviews were either held at their offices or via email and all followed an open interview structure in order to maximize input (see Annex 2). The validity of the factors was strengthened by questioning their characteristics independently and multiple times (Dye & others, 2000). To explain why some interest groups are able to have a larger impact on government policy than others, Olson's Logic of Collective Action is used. It considers the internal organisational structures of lobbying groups. Olson (1965) states that lobbying groups can act effectively if they can counteract the free-riding behavior of their members. In pressure groups where the benefits of collective action are more diffuse in nature (because of the variety of actors and the share of their particular interests), this is particularly difficult. (Olson, 1965)

The policy and economic part are not independent from each other; on the contrary, the legislative framework determines the economic playfield. If the legislation changed, the dichotomy of sECA versus non-sECA could alter or even disappear.

Throughout sections 3 and 4, the same methodology is used. They start with a theoretical framework, an analysis of the theory and a test of the hypotheses with the insights gathered from literature and interviews; this approach is complemented with modelled quantification of cost impacts. In section 4, the analysis is complemented with a quantified supply chain cost analysis, so as to compare total transport costs for Northern and Southern European ports.

Ultimately, in section 5 the paper also provides some legal insights in the discussion about sECAs. Specific attention is given to those legal aspects that may impact on the potential port shift. The issue is analysed from a legal and economic point of view, based on a review of relevant literature and interviews with actors in the field. Furthermore, an efficiency analysis of the enforcement regime is conducted. This analysis is based on Becker's (1968) theoretical framework.

³ North and Baltic sea: see Holmgren, et al., 2014; the Mediterranean Sea (cases Thessaloniki, Greece and the industrial hubs of Northern Germany): see Panagakos, et al., 2014.

3 THE POLICY PERSPECTIVE ON ECA'S

The International Maritime Organisation has made 'clean seas and sustainable shipping' one of its top priorities. In 1973, it strengthened this priority by the creation of the MARPOL Treaty. It broadens the scope of maritime pollution beyond oil spills and affects all floating objects treated in this paper (Somers, 2010). In general, only ships with 400 gross tonnage or above carrying the flag of one of the member states fall within the field of application. Here, the focus is on the specific Annex VI legislation with respect to sulphur emissions. The MARPOL Annex VI is the most recent annex and came into force in May 2005 after the required number of at least 15 ratifications was reached. Annex VI falls apart in two sections. The first part contains the sECA's. These zones can be proposed by one or more member states with a clear fencing of the targeted sea and a clear environmental and health gain. The designation of a sECA is largely based on the particular sensitivity of the proposed area to sulphur emissions. This is often the case in densely populated areas located near a large concentration of industrial and commercial activity. Until now, there have been sECA's in the Baltic sea (with the rising option to make it also apply to NO_x-emissions), the North Sea, the Northern American Coasts and the United States - Caribbean sea (NO_x-emissions from 2016) (IMO, 2014b). The Japanese seas, Australia and New Zealand, Singapore and the Mediterranean are also often subject to discussion, but no official designation has been noted until today. Figure 1 depicts the actual (orange-marked) and potential (pink-colored) ECA zones.

Figure 1 - Actual and potential ECA zones (Source: Wärtsilä, 2012)

The maximum sulphur emission cap allowed in these sECA zones is 1.0% as of July 2010, dropping to 0.1% in 2015. The second part of the sulphur legislation in Annex VI installs a

global sulphur emission cap of 3.5% in 2012 with the initial aim of bringing it to 0.5% in 2020 (see Figure 2) (IMO, 2013 and 2014b)⁴.

Figure 2 – Timing of sulphur regulation (Source: Clean North SeaShipping, 2009)

The European Union is a firm supporter of these IMO regulations. Some European countries stated in the first half of 2012 that they will develop a complementary legislation to the IMO policies (Opinion of the Committee of Transport & Tourism, 2012), not fearing a modal shift due to the 'more efficient use of fuels'. It is nevertheless important to know that the EU is not a full-fledged member of IMO and still has to confront its member states in a part of this policy. The EU also introduced some legislation outside its IMO-minded policies, mostly provoked by its own environmental agenda and the inertness felt due to its informal status at the IMO. The most important legislative action is the so-called 'sulphur decree' (decree 2005/32/EC). This decree installs emission caps for ships in the ECA zones (1.5%) and at berth in European harbours (also 1.5%). A brief overview of the IMO and EU sulphur legislation can be found in Table 1. The decree also encouraged Member States to substantially raise port state control on these issues. Other decrees, such as 2009/123/EC, strengthened this evolution by bringing environmental crimes in European criminal law (DG Environment, 2011). At that moment, the European Commission expressed its resolution to lower these caps in order to harmonize them with the IMO standards. That took several years.

⁴ Hong Kong will implement an ECA-area with a 0.5 percent limit on sulphur emission as of July 2015.

Table 1 – Overview of judiciary regime

Juridiciary Regime	Region	In effect from	Emission Cap	Review?
IMO MarPol	sECA Baltic Sea	2006	1.00%	0.1% (sure, 2015)
	sECA North Sea	2007	1.00%	0.1% (sure, 2015)
	sECA & nECA North America	2011	1.00%	0.1% (sure, 2015)
	sECA & nECA United States Caribbean Sea America	2014	1.00%	0.1% (sure, 2015)
	Worldwide	2006	4.50%	
		2012	3.50%	0.5% (possible 2020)
EU Sulphur decree	ECA-zones	2005	1.50%	1.50%
	Transit EU-ports	2005	1.50%	1.50%
	In EU-ports	2005	0.10%	0.10%

Source: own compilation based on IMO, 2013 and 2014b

On September 14th, 2012, the European Parliament endorsed the compromise regarding directive 2012/33/EU amending directive 1999/32/EC concerning the sulphur content of marine fuels. This compromise aligns the EU legislation with the stricter standards for sulphur content in marine fuels; as a result, the EU is now in line with Annex VI of the MARPOL Convention. Under the directive, the limits for the sulphur content of maritime fuels used in designated SO₂ Emission Control Areas (SECAs) such as the Baltic Sea, the North Sea and the English Channel are set to 1% until 31 December 2014 and fall from the previously agreed level of 1.5% to 0.1% as of 1 January 2015. However, the IMO standard of 0.5% for sulphur limits outside sECAs will be mandatory in EU waters by 2020. That implies an even more considerable cut, from 4.5% down to 0.5% by 1 January 2020. The possibility of postponing the reduction until 2025, foreseen by MARPOL, will not apply in Europe. It is clear that the agreement recognizes that the costs of new requirements for reducing sulphur emissions could have negative effects on the competitiveness of the industry and could produce a reverse modal shift from sea to land (EU, 2012). Therefore, Member States may provide aid for investment costs. Furthermore, the Commission should make full use of financial instruments that are already in place and promote the development and testing of alternative technologies for reducing emissions from ships (see for instance projects like Retrofit-project.eu).

In line with the US initiative, the EU foresees a gradual approach of the inclusion of maritime GHG emissions in its commitments. In June 2013, the European Commission set out a strategy (COM (2013) 479) for the progressive integration of maritime emissions into the EU's policy on the reduction of its domestic greenhouse gas emissions. The strategy consists of three consecutive steps: (1) monitoring, reporting and verifying CO₂ emissions from large ships using EU ports; (2) defining greenhouse gas reduction targets for the maritime transport sector; and (3) applying further measures, including market based measures (MBMs), in the medium to long term. (European Commission, 2013)

A relevant policy-related question then is *why the Mediterranean Sea is not a sECA*. A first argument is that 'a proposal for an ECA zone implies a perseverance, conviction and will of

the Member States' (Mortensen, 2010). Furthermore, the recent political turmoil within the Southern border of the Mediterranean Sea is likely to result in unstable and perhaps unreliable partners. An IMO official also indicated that there are still Treaty conflicts within the Mediterranean Sea, especially on the definitive conclusion of certain Territorial Seas or Exclusive Economic Zones. Some respondents also indicated that certain political sensitivities, such as the Greek-Turkish border or Cyprus, complicate these discussions considerably. Other respondents stated that environmental concerns are "not high on certain Mediterranean agendas" and mentioned a "negative spill-over from the discussion up in the North" (Mille, 2010; Norroy, 2011). An actor active in the Cruise Industry even mentioned that there is a lack of "convincing proof of the necessity" (Adriaenssens, 2011).

The interviews confirm that it is not inconceivable that the sulphur regime is expanded to the Mediterranean. Most respondents keep this in mind, but no one could put a timing on it. An ECSA actor illustrated this by saying that his organization "acted as if the MED could become an ECA soon" (Adriaenssens, 2011). The firm conviction held by the Commission on sustainable shipping is furthermore illustrated by its unilateral actions taken in the field of CO₂ reduction.

The IMO also indicated that most governments of the countries surrounding the Mediterranean Sea are proponents of a sECA in this area, but that initiatives to start a designation are currently being blocked by the shipping industry, which has a strong influence in the southern European countries (Hughes, 2013).

Another policy-related question is *where the 0.1 % standard for sECA's comes from*. The 3.5% standard that would apply from 2012 for global shipping was not seen as a problem for the maritime sector, as most of the fuels used today contain around 2.5% sulphur. The 0.1% cap, however, is viewed as much more problematic.

The "Public Choice" theory, and in particular its "rent seeking" theory, may offer a good explanation for why the 0.1% standard was chosen. Public Choice offers an economic and game-theoretic approach to decision-making, whereby public sector policy makers and other actors function as rational economic actors and their behaviour is analysed on the basis of the outcomes they achieve (Buchanan & Tullock, 1984). Public Choice theory sees the interrelationship between actors as a game, with winners and losers at the end. It is useful to explain the behavior of actors, and determine the role that lobby groups for instance are playing. Which groups will benefit from this legislation? In order to get a notion of the payoff matrix, let us consider a 2x2-game, given in Table 2.

Table 2 – Payoff matrix

0.1% sulphur cap		Carriers	
		Do not adjust	Adjust
Pressure groups	Do not adjust	(0,0)	(0,1)
	Adjust	(1,-1)	(1,1)

From Table 2 and the interviews, it appears that the carriers (and the shippers) most certainly do not benefit (1,-1) as they are faced with rising cost⁵ in order to comply with the law. Two potential ‘winners’ are the environmentalists (who see one of their goals achieved) and the producers of the alternative propulsion methods or fuels (who see their demand rise). The former group seems a strong candidate since the Clean Shipping Coalition even obtained an observer status at the IMO, putting it at the same level as the EU. However, some elements of the Public Choice theory call against them. Indeed, the potential modal backshift would not eradicate emissions, but rather just shift them inland, while the production of alternative fuels is a major polluter itself (Brett, 2011). Furthermore, the real power of these environmental interest groups could be overestimated. Using Olson’s (1965) logic of collective action, the impact of interest groups can be explained if the environmental collective could overcome diffuse member interests. Here, it appears that the members of Clean Ocean Shipping have a rather diverse profile (from fishery to emissions technology) making successful cooperation rather unrealistic. In line with Olson’s theoretical framework, a green lobby can only succeed in achieving its goal in case the cost/benefit ratio of the common goal is smaller than the same ratio for the individual goal. Conversely, a group that is very much united in its goals and member profiles is the petrochemical lobby, strengthened by its vast resources. Norroy (2011) confirmed the hypothesis that the petrochemical sector could even be better off with the strict emission standards. Its shore-based activities are under threat from environmentalist policies and the growing importance of alternative energy. In order to compensate for a falling demand here, they could shift their (already shore-based sulphur-free) production and supply to a newly created, booming maritime demand.

In addition to the analysis of Public Choice, there are some other possible explanations that are worth mentioning, which also arose from the interviews. A first alternative explanation is geopolitical in nature as policy-makers are trying to become less dependent on oil. A second explanation is political; the greening of policies and public opinion throughout the Western world becomes apparent in certain eco-minded defenders of the strict ECA rules, such as the Scandinavian states. The pressure exercised by these actors on the IMO is not to be underestimated. The last reason may seem trivial but it is not. Chance and a lack of caution at certain times may have played a part. Some respondents clearly indicated that recklessness and the long process of negotiations may have caused negotiators/policy-makers to leave their guard down at a certain time (Adriaenssens, 2011).

4 ECONOMIC ANALYSIS: PORTS AND PORT COMPETITION

This section answers this paper’s research question from an economic viewpoint: to what extent is a shift in port calls from Northern to Southern Europe likely as a consequence of introducing the North Sea ECA? During the last two decades, the Mediterranean ports have achieved a better position in comparison to the northern ports in the Hamburg-Le Havre range. This is largely linked to emerging feeder functions, but new investment plans also

⁵ Sidenote: liner carriers charge the extra costs to their customers (in the base freight rate or via fuel surcharges and/or low sulphur surcharge).

suggest a future growth in deepsea container activity in Southern Europe. Combining these investment plans with the possibility that the ECA zones might be enlarged, the question arises what the economic impact will be on the Northern European ports.

An overview of the evolution of operated TEU/port can be found in Figure 3. A first observation is the dichotomy between the major Northern European ports and the ports in the Mediterranean. The container volume handled by the Northern European ports fluctuates between 6 Mio TEU/year and 12 Mio TEU/year, while the ports in the Mediterranean (except for the port of Valencia as of 2010) did not exceed 4 Mio TEU/year over the 2004-2014 period. A second observation is linked to the economic crisis. In the Northern European ports, the impact of the crisis was more pronounced. In 2014, the majority of the ports showed a level of activity comparable to that before the crisis.

Figure 3 - TEU/year for selected ports (Source: websites of selected ports)

An analysis of future environmental policies and/or plans of the selected ports shows that the Northern European ports are further developed and more successful in the environmental field than their Mediterranean counterparts. Acciaro et al. (2014) illustrate the number of green port initiatives taken and the success achieved and it appears clearly that Northern European ports are more successful in achieving the environmental goals they set themselves.

Next, all of the selected Northern European ports are actively investing as well. For instance, Maasvlakte II in Rotterdam and Quai du Havre in Le Havre are the largest projects in the market with respect to capacity extension, aimed at strengthening their leading positions and preparing these ports for the growing scale of shipping (see Sys et al., 2012). Their environmental co-operation is illustrated by initiatives such as their research and preparatory work in the EU Interreg IVB project Clean North Sea Shipping, or their drive towards the Environmental Shipping Index, a tool for ports to promote clean shipping.

The Mediterranean ports, on the other hand, are trying to valorise their crucial position on the Asia-Europe trades by attracting more trade flows to their ports of call. Some of these ports, however, are not too successful in this strategy. Some of the infrastructure projects in the Port of Barcelona had to be restarted, while social unrest paralysed the port of Marseille more than once. The INTERMED-initiative between the ports of Barcelona, Marseille and Genoa, aiming at enlarging the ports' market share through capacity enlargement and logistics developments, did not move on as quickly as planned. The project intends to counter the rail connectivity problems between France and Spain or the exclusion of Marseille's connectivity in the latest TEN-T schemes - which could also be facing liquidity problems and postponement in the wake of the current financial crisis. This might change in the future. Improved rail connectivity (e.g. BarceLyon Express) and a development of new transport chains at the operational level are high on the agenda of the Southern European ports. The role of the selected Southern European ports in sustainable and more efficient logistics is fourfold: (1) a reduction of navigation days and CO₂ and NO_x emissions (e.g. a reduction of emissions of up to about 15% in the Far East-Europe route); (2) a reduction of congestion in Northern European infrastructures; (3) taking advantage of the Mediterranean and North-African economic potential, and (4) a reduction of logistics costs (Ruá, 2012).

Currently, the Southern European ports account for 25% of the European trade with Asia, while the Northern European ports receive and process 75% of the Asian trade goods. This is a strange distribution in itself, given that many of these goods find their way back to the South and that this route accounts for an extra three days (Garcia-Milà, 2010; Terrier, 2013).

Ultimately, to quantify the cost increase associated with sailing through a sECA and to assess the possibility of a port shift from Northern-European ports to the Mediterranean the Port Shift Assessment Method (PSAM) has been used. The PSAM considers the total logistics cost in port selection decisions (Van Rillaer, 2013). First of all, the result of this PSAM model indicates that on the Shanghai-Antwerp trajectory, the cost increase is within a range of 2.15% and 2.66%, depending on the sailing speed and fuel price scenario. Furthermore, the results suggest that the sailing speed has a higher impact than the fuel price. The percentage of the cost increase is lower than in most studies. An explanation can be found in the fact that those studies are mainly focused on shortsea shipping, where commercial speed is very important and a far greater percentage of the sailing distance needs to be covered with low sulphur fuel than in this deepsea shipping case. Secondly, the possibility of a port shift is assessed by comparing the total logistics cost of a number of trajectory options (Brussels, Madrid and Zürich). The results suggest that from a cost perspective the port of Antwerp is the port of call to be chosen. Here, the higher maritime trajectory cost is compensated for by the lower road transport cost. In only one case, namely shipping a container to Madrid, is it more appropriate to choose the port of Tangier. The ports of Mersin and Port Said are unlikely to be called at in all cases for hinterland traffic.

The results are in line with the quantification of chain cost impacts obtained in van Hassel et al. (2015). In addition to the sailing distance, the distance in ECA area and the fuel price ratio, table 3 shows that for an existing container shipping loop, fuel cost increases through the North Sea ECA introduction range between 3.1% for the weakest case (Southampton) and 16.9% (Le Havre). The reason for the different level of cost impacts is linked to the position of specific ports in the call pattern. As fuel is only one element in the total chain cost,

the impact gets much softened, to levels similar to those obtained with the above-mentioned PSAM model.

Table 3 – Fuel cost increase from North Sea ECA introduction

	Sailing distance	Distance ECA	MDO/HFO	Increase in fuel costs
Ports in ECA	(1)	(2)	(3)	(4)
Southampton	10,464	220	1.476	3.1%
Hamburg	10,931	687	1.476	9.3%
Bremerhafen	10,970	726	1.476	9.8%
Zeebrugge	11,246	1,002	1.476	13.2%
Rotterdam	11,333	1,089	1.476	14.2%
Le Havre	11,571	1,327	1.476	16.9%

Source: van Hassel et al. (2015)

Figure 4 shows the impact of introducing the North Sea ECA on the most interesting port of call from a hinterland region point of view and based on total chain costs. As well as the ports from table 3 therefore, Marseille and Koper feature as the two Southern European ports in the loop. In this figure, horizontal lines represent the hinterland regions where the Northern European ports (H-LH range) in the loop are the most interesting ones, while vertical lines represent areas served by the port of Koper and diagonal lines represent areas served by the port of Marseille. Areas where different types of lines interact can be attributed to different ports. As it can be seen, there is only a minor shift from a few areas which were previously purely in the sphere of the Northern European ports (see outlined areas in figure 4). Hence, Northern European ports hardly concede hinterland regions to Southern European ports as a consequence of the North Sea ECA. .

Figure 4 – Division of hinterland without/with (outlined) North Sea ECA zone

The PSAM results are also in line with the viewpoints of the interviewees. Given the geographical location of the respective ports, the competitive strength and success of ports in the Hamburg-Le Havre range is mainly related to their proximity to the large concentrations of purchasing power in Western Europe (Hiratsuka, 2013, Aronietis et al., 2011). Also, the organizational and administrative cost of a port shift and the politically unstable climate in Northern Africa lower the probability of a port shift. However, this does not mean that Turkish and Northern African ports do not have the potential to grow and attract more traffic. For destinations in the South and the East of Europe, it could be interesting to use ports in Turkey or Northern Africa. Moreover, the own hinterland of these ports might grow when the purchasing power in the region concerned gains strength. (Van Rillaer, 2013)

To further answer the port shift question, both port ranges are compared on criteria such as transportation costs, transit times, quality and frequency. Table 4 summarizes the outcomes of interviews with sector representatives from the perspective of Southern European ports.

Table 4 – Opportunities/chances versus weaknesses/pitfalls of Southern-European ports

Opportunities and Chances	Weaknesses and Pitfalls
Closer to Asia	Geography (mountains, locations etc.)
Liberalisation creates dynamism	Social tensions and strong unions
Not as congested as the North	Few barge connections
Northern-African hinterland and market	North-African competition
Rising capacity	Old infrastructure and less capacity
New initiatives	Lack of cooperation and perseverance
Wants to develop logistics chains	Few green strategies
Potential grower	Stays number two in Europe
Does not border a sECA-zone	

Source: Own composition based on interviews with sector representatives.

The importance of hinterland connectivity needs to be added, as a result of the growing importance of trade flows and the avoidance of bottlenecks by logistic operators. Furthermore, the Northern European ports benefit from their geographic location, which puts them in the logistics and industrial centre of Europe. The consolidation strategy put in place by most container liners in the wake of the 2008 crisis also strengthened their position as they continued to act as main ports of call and hubs while smaller ports were cancelled. Furthermore, the Northern European ports are presently also the best suited in welcoming the new generation of massive container vessels. At the same time and as mentioned before, they lead the way in environmental strategy and cooperation. The latter neutralizes competition to a certain degree. Such neutralization is not possible in the Mediterranean, where the Arabic and Northern African ports remain competitors in the backyard of Mediterranean co-operation. None of the Northern European port directors even mentioned the sECA zones as a potential threat. This does not mean, however, that they are not aware of the dichotomy and that they remain passive in this discussion. The port of Rotterdam called for the 0.1% cap also to be applicable to the Mediterranean, while recent votes in the German Bundestag also make this position a growing point of interest in Europe's largest economies.

The Mediterranean ports, on the other hand, face a more complicated geographical situation (rocky coasts and large tourist zones) and a history of public ports (resulting in low efficiency and frequent social unrest). Beddow (2010) also mentioned that their older infrastructure and smaller capacity resulted in considerably higher storage and restowing costs than for their northern competitors. The hinterland connectivity of these ports is also less effective than up north. Barge transport is scarcely developed and rail connectivity is facing issues as well. The Northern African competition produces a growing hinterland but also strong competitors (with lower labour costs, for example) in the immediate vicinity (Capellini, 2011). The development of LNG or low-sulphur fuels in these ports is somewhat lagging behind. Finally, none of the interviewed port representatives named the existence of sECA zones a strong competitive advantage for the southern ports. On the contrary, the Port of Marseille official noted that *'local pollution is so high that we fear that strong regulation may be introduced immediately in the Mediterranean Sea'*. Nevertheless, the Mediterranean ports have their own strengths, as illustrated in table 3. In line with this, the European Union (2004, p. 4) concluded that *"As regards substitution between Northern European and Mediterranean ports, the possibility of inland transport and transshipment between Northern Europe and the*

Mediterranean does not seem to lead to substitution to a considerable extent.” Hence, the European Union (2008) identifies both ranges as separate markets.

All in all, it can be concluded that an activity shift to Southern European ports is not likely, and that the answer to the main research question is therefore negative.

5 LEGAL ANALYSIS: ENFORCEMENT AND EFFECTIVENESS OF REGULATION

This section addresses the enforcement of the regulations concerning sulphur emissions in the shipping industry. The question arises whether the current enforcement regime is efficient or not. Some legal literature has drawn attention to the fact that an enforcement regime such as the one governing MARPOL Annex VI could lead to compliance problems and threaten the competitiveness of complying shipping companies. The industry also suggests that some shipping lines may ignore the new regulation, particularly when penalties in certain countries are estimated to be lower than the increased cost of using the more expensive fuel. The industry points out that in contrast to the Northern American ECA enforcement, the enforcement of the Northern-European ECA requirements⁶ is fairly weak. In combination with a substantial cost burden increase in 2015, it might lead to increased non-compliance (Brett, 2014). Based on Becker’s theoretical framework (1968), which can be used to explain why people decide to violate or not to violate a certain regulation, a conclusion can be drawn and recommendations can be made. (Van Rillaer, 2013; Khee Jintan, 2006; Knapp and Francis, 2006; Özkayir, 2004; Cameron et al., 1996)

According to one of the fundamentals of international law, state parties of an international convention must ensure the implementation of the provision of the concerned convention in their own national legal system. However, the MARPOL convention does not provide guidelines for this implementation. Consequently, this might lead to a number of different enforcement regimes, each with its own sanctions and control measures. Important flag states which hardly ever see their ships in their territorial water might lack an incentive to effectively enforce regulations that are aimed at preventing environmental damage to other countries (Khee Jin Tan, 2006). Hence, the potentially large differences between countries will leave ship operators with a great amount of uncertainty.

Article 11 of MARPOL Annex VI states that member states are obliged to co-operate in the detection and sanctioning of violations. Therefore, state parties have been given the power to subject any ship carrying the flag of one of the member states to inspection. If a violation occurs, the state that conducted the inspection has to send a report to the flag state which is then obliged to impose a suitable sanction. The coastal state has a means of enforcement in Regulation 10 of MARPOL Annex VI, which gives the coastal state the possibility to detain a ship that is not meeting the requirements of the convention. Due to the high economic cost of this means of enforcement, it appears very effective. However, detainments based on non-compliance can easily be undone by changing the fuel in the tanks.

⁶ Note: EU -states will begin a concentrated inspection campaign, with sulphur compliance being a part of all port inspections (Eason, 2014).

The main problem is that, in practice, ship inspections are limited to a verification of the documents that the ship needs to have on board. More specifically, the sulphur content is mostly inspected by the bunker delivery notes. An actual inspection by making an analysis of fuel samples is theoretically possible when the controlling state has clear grounds to doubt the sulphur content but hardly happens in practice.

If the current enforcement regime does not lead to a good degree of compliance, a port shift is less probable. Based on Becker's theoretical approach (1968), a shipping company will violate the regulations when the associated benefits exceed the costs and when utility is maximized. Since, in the context of sulphur emission restrictions, ship detainments can easily be undone, there are no major penalties for offenders. Therefore, the absence of inspections and penalties, and the differences in various national legislations should be considered an important weakness of the current enforcement regime of MARPOL Annex VI. Hence, the answer to the legislative part of the research question is negative in that the current regulation framework does not seem effective.

6 CONCLUSION

This paper analysed the field of sulphur emissions legislation and its relationship with deepsea container liner shipping. To do this, the research first focused on the policy and its future. Subsequently, the main research question whether liner carriers would be likely to re-route their ports of call to avoid the more costly Emission Control Areas, assuming that both port areas can receive these ships and serve the same hinterland, was answered with a combination of a qualitative and quantitative economic analysis. The research question was finally also addressed from a legislative viewpoint. This transversal approach contributes to well-founded conclusions and ensures a more holistic approach to the topic.

The policy part first of all shows that the reasons for the temporary absence of an ECA zone in the Mediterranean are diverse: a politically unstable climate, legal disputes and negative tendencies spilling over from the North are but a few. Furthermore, not everyone is convinced of the environmental necessity of stricter emissions rules for the Mediterranean. This dichotomy in law does not correspond to the consensus approach of the IMO and the idea of a single European market. As a final international factor it was mentioned that bringing down the global emissions standard to 0.5% in 2020 (or in 2025 at the latest) will reduce the difference in ECA cap substantially, and would therefore erode the exceptional status of the ECA's.

The policy section also focused on the origin of the 0.1% emission threshold, fiercely contested by some, in the ECAs from 2015 on. The political theory of public choice suggests that not the green lobby but rather the petrochemical lobby is the major driving factor behind the very strict emission caps. An alternative explanation could be traced to international energy policies and the 'greening' of politics.

With respect to economic impact, two important conclusions can be drawn about the competition between the Northern European ports and their Mediterranean counterparts. The Northern European ports are more mature and successful in their (environmental) projects than the Southern European ports. Furthermore, the latter fail to offer optimal hinterland

transport connections. In the light of the entire supply chain (and the port as only one part of the chain), this is far from insignificant. Their geographical location and obstacles, combined with an infrastructure backlog, exacerbates these tendencies. The port shift literature confirms, moreover, that costs are not the only factor relevant to whether or not a port is successful: quality, speed of treatment and frequency are equally important. In that respect, the Northern European ports are currently favoured. This does not mean that the Southern European ports cannot be potential growers. Their location and ambitious strategic view for the future are strong assets. These ports are able to serve Central Europe and the emerging market of Eastern Europe in a faster way than the Hamburg-Le Havre Range ports. Simultaneously, they reckon with stronger competition with the emerging Black Sea ports. As a result, it cannot be affirmed that sECA's are a determining factor in a port shift context. The Mediterranean ports have without a doubt certain strongpoints but face various challenges that outweigh other factors when comparing their competitive position with their Northern European counterparts.

Finally, in order to improve the current enforcement regime, more legal clarity and a better organised system of inspections to protect the competitiveness of the complying shipping companies are recommended.

Of course, this research does not provide a final answer to the discussion. The emission discussion is thoroughly complex and seems to change rather frequently, which makes research challenging and subject to volatile evolution. The whole regulatory package is forcing the shipping industry to look at new and innovative business models. The propulsion equipment of the ship is becoming more important as its performance will increasingly determine success in the market. Not only the size of the ship, but also the performance of its propulsion with respect to air emissions and efficiency will become a dominant parameter in the shipping game.

Further research could elaborate more on NO_x and SO_x emissions and the requirements that they impose. Furthermore, the framework of this paper could be used for further quantifying positions and power relationships of the various actors involved in ECA decision making.

ACKNOWLEDGMENT

The authors gratefully acknowledge the suggestions of the anonymous reviewers of the journal. Furthermore, the authors wish to thank Edwin van Hassel and Jeroen Cant for the assistance in mapping the shift in the hinterland.

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Annex 1 – List of interviewees

ASHDOWN, Robert	Director on technique, safety and the environment at European Cruise Council
CARSAUW, Kenneth	Evergreen Belgium
CORBETT, James	Engineering University of Delaware
DEVEZE, Magali	Grand Port Marseille-Fos
LAFFINEUR, Ludovic	Environmental Advisor at Royal Belgian Shipowners' Association
LOICQ, Benoit	Adviser on marine safety and environmental ECSA (European Community Shipowners Association)
MICHAEL, Antonis	Advisor on sustainable development and marine environmental affairs ESPO (European Seaports Organisation)
MILLE, Walter	FPS Mobility, Belgium
MORTENSEN, Niels Bjørn	Director, Regulatory Affairs at Maersk Maritime Technology
NORROY, Patrick	DG Mobility and Transport
VAN ASCH, Joost	Manager operations APL Rotterdam
VAN DER JAGT, Nicolette	European Shippers Council
VAN OPSTAL, Fernanda	Intermodal & operations execution manager at Maersk Benelux BV
VAN MEEL, Guido	Advisor at Antwerp Port Authority
VERELST, Patrick	Operations & Security Manager CMA CGM Belgium

Annex 2 – Questionnaire “The effects of MARPOL Annex VI on deepsea shipping”⁷

- 1) Could you describe your stance towards the approaching emission regulations (IMO, 2015, 2012)?
 - a) Grimaldi Group: “The divide ECA/non-ECA is discriminatory! This will provoke economic slaughter in the maritime sector!”
- 2) Which are the most important consequences of these policies for your sector or company?
- 3) How will you cope with this?
- 4) Why do you think that IMO, on a relatively rapid pace, is pursuing such a dramatic cutback of emissions?
 - a) Do you think certain interests or opinions have been followed too harshly?
 - b) How do you perceive the reaction of ‘maritime Europe’?
- 5) Do you think that the MARPOL-policy is a fair one? Or a certain sectors or regions dis- or advantaged?
 - a) Why do you think the Mediterranean Sea is not an ECA zone? Or will this become inevitable?
 - b) ESPO statement: ‘To promote free and fair competition in the port sector’
- 6) What do you make of the EU-policy? Is this better or worse than the IMO policy? Will the two continue to exist separately or will they harmonize (towards the strict IMO rules or more relax EU rules?)
 - a) EU-official: ‘It would do nothing for our credibility to make a U-turn now and start renegotiation this complex and hard-won agreement’; we shall align EU legislation with the IMO decision in 2011’
- 7) Do you think the international shipping will try to evade ECA zones, to save on fuel-expenses (ECA zone = more expensive fuel – certainly in the short run)?
- 8) Do you believe ECA-ports will witness a competitive disadvantage in the face of non ECA ports?
 - a) Rising investments in Southern Ports?
- 9) What should ports do, confronted with these problems?
 - a) Landside electricity, LNG-availability, scrubber-receivers, selling ‘green image’
 - b) Quid hinterland: is the South ready for this?
- 10) Do you think that more ECA zones will arise in the future?
- 11) Will ship-owners be prepared to make the necessary investments to keep on sailing in the ECA zones or will they rather look for alternative(s)/alternative routes?
 - a) Do you to some extent support the ‘scrubber’-idea of the full switch to LNG? Why?
 - b) Will there be enough low-sulphur oil or LNG to meet the markets demand?

⁷ Thoughts/quotes to strengthen the question are in italics.