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Review

How to recognize and measure the economic impacts of environmental regulation: The Sulphur Emission Control Area case

Anu Lähteenmäki-Uutela [a], Sari Repka [b, *], Teemu Haukioja [a], Tuomas Pohjola [a]

[a] University of Turku, Turku School of Economics, Pori Unit, Finland
[b] University of Turku, Brahea Center, Centre for Maritime Studies, Finland

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ABSTRACT

How does environmental regulation impact the performance of economies? Scientific literature on impact assessments on environmental regulation are analysed in this article, focusing on the ex-ante studies on the Sulphur Emission Control Area (SECA) in the Baltic Sea and North Sea. The SECA regulations on shipping exhaust gases are an example that may appear to be straightforward, but on closer inspection, this is a multifaceted issue that has several aspects that are difficult to measure and balance against each other. As such, it offers a good case example to categorize and conceptualize the questions of impact assessment. The SECA regulations are aimed at creating environmental and health benefits, and presumed to incur compliance costs. Other benefits and costs have not received much attention. Macro-economic effects and the issues of international distribution of costs and benefits are often neglected. The relevant impact categories for the SECA regulations are identified and discussed systematically. We propose a comprehensive *regulation impact framework for socio-economic effects* that can be extended to other environmental regulation to support the needs of consistent and reliable evidence-based maritime policy.

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* Corresponding author.
E-mail address: sari.repka@utu.fi (S. Repka).

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1. Introduction

Regulatory impact assessment is widely considered necessary and the European Commission has created Better Regulation guidelines and a Better Regulation "toolbox" for performing regulatory impact assessment ex-ante. Cost-benefit analysis (CBA) is an important tool for planning and evaluating the impacts of environmental regulations (Arrow et al., 1996). It provides an overview of the effects, risks and uncertainties of a regulatory measure. There is an ongoing debate on whether economics can be used to describe the value of nature (e.g. Spash, 2015; Hwang, 2016). However, economics provides a language we can use to describe the value of nature to stakeholders and can help in allocating limited resources for the greatest impact (Scharks and Masuda, 2016). Costs and benefits should be analysed as to how they impact society as a whole (Ferraro and Hanauer, 2014). By quantifying the advantages and disadvantages and assigning values to them in monetary terms, CBA provides insights into the social-welfare effects of the measure (Scharks and Masuda, 2016). Any rule will have economic impacts if it changes the behaviour of economic agents (Millimet et al., 2009). In order to comply with environmental regulations, targets are required for the implementation of new measures that will protect the environment and improve people's health. There are direct and indirect benefits and costs that together form the economic impacts of a regulation. We are moving from strictly science-based marine governance towards including stakeholders more closely to the process (Hassler et al., 2013) and economics can to our mind give a suitable language to discuss the impacts of regulation. Environmental law focuses on the future. Costs and benefits of a policy sometimes occur at different times (Hwang, 2016). Discounting has been proposed as a method to overcome this but has its flaws (Ackerman and Heinzerling, 2002; Hwang, 2016).

When measuring the impacts of a regulation, the results achieved must be compared to an alternative scenario where the regulation would not exist. The 'no policy change' scenario can be used as a baseline (European Commission, 2009, 24). European Commission guidelines focus on the baseline scenario in the situation of ex-ante impact assessment; however, the baseline scenario is also needed when performing ex-post impact assessment. Isolating regulatory impact from other causal chains is a major issue. For this purpose, trend data can be used to identify a structural break caused by the regulation, and impacts of regulation can be compared to a control group that is not subject to regulation. (Staschen et al., 2012).

Here, we scrutinize how the economic impacts of environmental regulations are to be measured. As a case example, our task is to define how the impacts of the Sulphur Emission Control Area (SECA) regulations of the Baltic Sea, North Sea and English Channel passed by the International Maritime Organization[1] and the European Commission[2] can be recognized and made quantifiable. The new sulphur rules came into force in the beginning of 2015, targeting the maritime industry operating in the SE Control Area. According to the new rules, the sulphur content of the ship fuel used cannot exceed 0.1%. Previous rules allowed ship fuels containing max 1.0% sulphur. Alternatively to changing fuel, ship exhaust gases can be purified to make the emissions correspond to use of 0.1% sulphur fuel.

Impacts can be assessed ex ante (impacts of potential regulations) or ex post (impacts of existing or past regulations). Findings of ex post impact assessment should be used as guidance in other countries planning similar regulation, and as a basis for future revision of the studied regulation itself (Staschen et al., 2012). Ex-post analysis on the impacts of the SECA regulations can now be performed. Ex-post analysis a) describes the impacts and b) compares the impacts to set criteria. The performance of the SECA rules can be compared to ex-ante evaluations (summarized by EMSA 2010) and the political claims made. In the case of the SECA rules, nine impact assessments were completed between 2009 and 2012 (summarized in EMSA 2010). It is notable that SECA was decided upon in October 2008. Some of the studies were rather simple calculations based on the price differences between the different fuel oils. A possible modal shift was also analysed. One of the impact assessments was a cost benefit analysis to support the impact assessment accompanying the revision of Directive 1999/32/EC on the Sulphur Content of Certain Liquid Fuels (AEA, 2009). According to this study, the benefits in all the scenarios considered were much higher than the costs, even though only benefits related to human health were included. Even though the results of the AEA (2009) study are clear, it would have been a good idea to study the impacts before the regulation was decided upon, which would also have eased public acceptance of the regulation. It could also have been noted that a regulation of 0.5% sulphur content would have been very cost-efficient (Kalli et al., 2015). Antturi et al. (2016) conclude that the existing Baltic Sea SECA regulations are not cost-effective and that the distributions of costs and benefits are asymmetric.

Ex-post impact assessments of environmental regulations have been performed at international and national levels. For example in Finland, ex-post impact assessments on five major environmental regulations were performed between 2010 and 2014. A meta-analysis by Ervasti (2015) showed that many studies used legal and societal analysis and a part of the studies used environmental data, but economic impacts received relatively little attention (Ervasti, 2015). There are no internationally standardized categories on different types of regulatory costs (Määttä and Tala, 2015). The same is true for regulatory benefits. We believe that the ex-ante impact assessments of the SECA regulations disregarded some of the relevant impact categories. For example, some studies assessed the health improvements by using emission scenarios, but none tried to evaluate the environmental benefits. The economic efficiency of alternative policy tools was ignored ex-ante. Ex-post SECA studies continue to ignore some impact categories altogether.

Combining previous literature on impact assessment with the specific features of the SECA rules and their aims, we seek to:

1) propose relevant categories of the economic impacts of SECA regulations, and

[1] Amendments to the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI "Prevention of Air Pollution from Ships" in 2011.

[2] The European Union (EU) Directive 2012/33/EU of 21 November 2012 regulating the sulphur content of marine fuels and the designation of the Baltic and North Sea, as well as the English Channel to Sulphur Emission Control Areas (SECAs).

2) discuss relevant methodological approaches for measuring them.

We propose that the main impact categories be the following:

i) environmental impacts (section 3.1.),
ii) health impacts (section 3.2.),
iii) business impacts (micro-economy, section 3.3.),
iv) administrative impacts (section 3.4.),
v) macro-economic impacts on the performance of the whole economy or the group of co-operative countries (section 3.5.).

Even though the impact categories intertwine, we believe this categorization is useful for grasping both the impact as a whole and its most important parts. We claim humans are distinct from the rest of the species, that micro-economic and sectoral activity is different from the whole of the economic system, and that the mechanisms and justifications for financing private market activities differ from the principles underlying public administrative duties. In the EC impact assessment guidelines (2009), administrative impacts are added on top of the basic sustainability framework separating between economic, social and environmental impacts (pages 36–41). Here, we highlight that the environment as such, the ecosystem services, human health, human welfare, jobs, the administrative system, and reputational and symbolic meanings, at least in theory, have economic value and can be expressed in economic terms. In the following sections we will discuss each category of impacts and the methods for measurement.

2. Methods

All the impact ex-ante assessments on Baltic Sea Sulphur Area Control Area (SECA) have been reviewed. For the more general context of this review article we searched the Proquest databases with phrases “cost-benefit analyses environmental regulation” and “impact assessment environmental regulation” and “regulatory impact assessment”. From these, we selected the most important, and rather recent, articles for this review based on title and abstract, and emphasizing marine environment and economic view. In addition, separate searches were made for specific health and environmental impacts related to exhaust gases and their modes of action. Separate, non-exhaustive searches were also made for the economic impacts such as branding, with search phrases combining “country/nation brand and sustainability and regulation”. In contrast to impact analysis, searches and references of these latter mentioned research fields were not meant to be exhaustive reviews. As the subject matter of this article is rather multidisciplinary we would have ended up with too many references. These selected articles were read and qualitative content analysis was performed on how to make a comprehensive impact assessment. The five impact categories were reviewed by one expert review, and her comments were taken into account in the analysis.

3. Results

3.1. Impacts on the natural and cultural environment

In terms of SECA regulations, the direct environmental impacts are mainly related to decreasing acidification and ground ozone levels. An ex-ante study by the AEA anticipated a reduction in acidification of 25% in SECA areas (EMSA 2010, 12), which will have positive effects on the environment. However, evaluating the significance of these benefits is not easy, and includes a lot of uncertainty. Nevertheless, it needs to be done for comprehensive evaluation, and has rarely been attempted. Monetarization of environmental impacts comprises two parts: a) monetarizing the value of nature as such and b) measuring the impacts of changes in natural or cultivated environment on human businesses.

Acidification has different impacts on the natural environment in soils (van Breemen et al., 1982), freshwater (Krzyzanowski and Innes, 2010), oceans, and brackish water. In particular, calcifying species in the sea are under threat (Azevedo et al., 2015). However, ocean acidification is mostly linked to rising CO_2 levels, and oceans are generally well buffered against sulphur acidification (Leduc et al., 2013). Historically, the problem of acidification has mostly been associated with freshwater ecosystems affected by acid rain precipitation but this also applies to sensitive soils. Decades of this phenomenon have reduced the acid-neutralizing capacity in many impacted areas, leading to persisting vulnerability to future changes. The non-linear dynamics in marine ecosystems call for precaution in management (Scharin et al., 2016).

Acidification can decrease biodiversity, which has value for humans in many ways. The Rio Convention on Biodiversity acknowledges “the intrinsic value of biological diversity and … the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components” (Convention on Biological Diversity 78/1994, Rio de Janeiro, preamble). Losing biodiversity diminishes the ecosystem services provided by Nature, which can be important for instance for the tourism industry. From a management point of view, a safe strategy seems to be requiring a minimum level of biodiversity for any ecosystem to be sustained (Arrow et al., 1996). The central question in valuing biodiversity has been whether we should value all elements of biodiversity (e.g. the existence of a species, the resilience of communities, etc.) in monetary terms or should they possess an intrinsic value regardless of human benefit (Nunes and van den Bergh, 2001). The monetary valuation of biodiversity has been done by several methods as reviewed in Laurila-Pant et al. (2015), of which the contingent valuation approach is the one most commonly used. The TEEB project (TEEB, 2009) has published a database for the valuation of biodiversity.

Biodiversity also increases the resilience of nature to disturbances. The total global ecosystem services in 2011 were estimated to carry the economic value of $125 trillion/year (Costanza et al., 2014). Cleaner environment provides more income to farmers, forest owners, and even for gatherers of non-wood forest products. Also tourism benefits from cleaner environment as it improves destination quality. This section discusses the value of clean nature for individual citizens, outside and regardless of the industries that are using natural resources or ecosystem services for business purposes. Asking humans to set a value on Nature is human-centered. This cannot be avoided, as only humans can set a value on Nature for the purpose of regulating it. Humans can still have values that are neither human-centered nor instrumental. Humans can and do see intrinsic value in other species and Nature (Kumpula, 2002, 47–50).

The European Commission (2009) guidelines on impact assessment do not discuss the non-monetary and monetary valuation of the environmental impacts. For several environmental impacts, including the economic impact of the SECA rules, differentiated methodological approaches are necessary. Many of the most commonly used methods are based on asking people about how much they value clean Nature. The *stated preference* (SP) method using a contingent valuation approach measures the *willingness to pay* (WTP) for an environmental good. People might also value the option to use the good in the future (*option value*). Contingent valuation can be used when there is no market price for a good (Carson, 2012). In addition to or instead of the use value, it

can measure the option value and *existence value* of an environmental good (Carson, 2012). In economic terms,

existence value = total economic value - use value - option value (Pearce & Turner, 1990, 131).

Challenges with the stated preference and contingent valuation methods are related to the survey design, the level of information given to respondents, and involving hypothetical expenditure only. The stated preference approach is only useful for the valuation of individual key values such as the value of a human life. In order to estimate the costs for a long-term environmental problem (e.g. acidification), it is necessary to consider different risk scenarios. These scenarios should contain information on the amount of costs to decrease and repair environmental damage, and on the costs of damage which cannot be repaired. As human valuations are systematically biased (see Kahneman et al., 1991 on status quo bias, loss aversion and steep discounting), adhering to public opinion can lead to the unsustainable use of natural resources.

Additionally, indirect methods like the *revealed preferences* method are viable (Adamowicz et al., 1994). Preferences are presumably revealed by the actual behaviour of people: for establishing the value of nature, one can study how much people are willing to pay to spend time there for example (the travel cost method). However, studying behaviour does not reveal option values or existence values. Preferences revealed by outdoor activities can change rather rapidly based on fashion and trends. For example, stand-up paddling (SUP) seems popular at the moment. Based on behaviour, the relative use value of marine and coastal environments not suitable for this activity has diminished.

According to Maibach et al. (2008), a major recommended approach for calculating the environmental impacts of transport is the *impact pathway approach,* which follows the dose-response function and considers several impact patterns on human health and Nature. This approach allows a fuller understanding of the impacts of human decision-making. Sometimes the lack of certain information on the dose-response function makes it necessary to combine this approach with the *standard price approach*, as an alternative for the model estimation of the damage level. In this case, as a second-best approach, the *avoidance cost approach* (cost to avoid a certain level of pollution) can be used (Maibach et al., 2008).

Generally, there are two ways of estimating the concentrations and deposition of exhaust gas emissions, i.e. the bottom-up and top-down approaches. The bottom-up approach starts at the micro-level, where basic elements are first specified in detail and then linked together to form a complete system (Friedrich and Bickel, 2001; Bickel et al., 2006; Jalkanen et al., 2009). However, due to its complexity and completeness, the bottom-up approach may be costly and difficult to implement. Jalkanen et al. (2009) use the bottom-up approach where the basic elements are the exhaust gases of individual ships. This provides relatively straightforward information on pollutants and, combined with regional model calculations such as the EMEP air pollution model, the effects of ship emissions in different geographical areas can be calculated (e.g. Jonson et al., 2015).

In addition to impacts on biological ecosystems, sulphur dioxide damages buildings and cultural heritage. Monetarizing such impacts has been done for sulphur oxides (SOx). An ex-ante SECA study made in the UK estimated that savings in the form of less damage to buildings, including monuments and buildings of special interest, and materials would amount to £6.32 million per year in the UK alone (EMSA 2010, 13). Chay and Greenstone (2005) found modest evidence that the marginal housing value benefit of air pollution reduction is lower in communities with relatively high pollution levels (air quality improvements raise the value of houses more in low polluted communities).

3.2. Impacts on human health

Impacts on public health are often a reason for enacting environmental regulations. Health is a desired social goal reflected in the value given to the life quality of individuals. There are also economic benefits in improving the health of people, which are estimated to be considerable in the case of SECA (IMO, 2014), due to the decreased mortality, sickness days, and public healthcare costs caused by decreasing particle pollution (e.g. Pope et al., 2002). The monetary value of human health-related issues such as deaths, sickness days and hospital costs are set by calculating large datasets and related to health-threatening factors. The economic value of human health is the main reason why the SECA regulations passed the ex-ante cost-benefit analyses (EMSA 2010). A study by the AEA (2009) estimated the net health benefits of the SECA rules to be 10 to 23 billion euros by 2020. Corbett et al. (2007) have estimated that 60,000 premature deaths globally can be contributed to shipping. In Europe, it was estimated that 49,500 deaths in 2000 were related to shipping exhaust emissions, and the number of deaths was estimated to rise to 53,400 in 2020 (Brandt et al., 2011). Both the short-term and long-term impacts of air emissions such as SOx and particulate matter (PM) on individual health risk and population health risk have been modelled.

Studies have associated particulates with various health problems, such as respiratory or cardiovascular diseases (Brunekreef and Holgate, 2002; Pope and Dockery, 2006). The caveat of the SECA regulation is that it does not actually regulate the most harmful component, i.e. particulates, but rather the sulphur content, the concentration of which is closely linked to that of particulates. Sulphur itself accounts for a considerable portion of the particulate material from exhaust gases. PM emissions are highly dependent on the fuel quality and the engine load (Buhaug et al., 2009; Agrawal et al., 2008). There is variability related to measuring particles from exhaust gases due to the substantial variability of experimentally determined emission factors and the differences in sampling methods (e.g. Jalkanen et al., 2013). The measurement methods for particulates should thus be further developed and standardized. Analysis of particulates should be applied to different abatement methods in order to obtain the real results on their effectiveness in removing the component that is the most harmful to human health.

Impact analysis must acknowledge that there may be specific effects on particular risk groups (determined by age, gender, disability, social group, mobility, region, etc.). Ex-ante health impact assessments anticipated regional differences in different health impacts (Jonson et al., 2015). For instance, in Denmark, the effects are clearer than in Finland (Fig.3, Jonson et al., 2015). Antturi & al. (2016) focused on the SECA health effects due to reductions in PM 2.5, and found that the Central European countries receive the greatest health benefits. According to the Danish Environmental Protection Agency, Denmark was very active in promoting the stricter rules (EPA website). Children, the elderly and people with respiratory disease, cardiovascular disease or diabetes were expected to benefit more than the average adult population (Brunekreef and Holgate, 2002).

As with analysing other types of regulatory impacts, there is no single agreed method for undertaking health impact assessment. For assessing direct and indirect health impacts, monetary and non-monetary methodologies can be used. Of the non-monetary ones, *quality adjusted life years* (QALY) measures health gains. It uses available information on objective improvements in health or quality of life and combines it with the duration of that improvement. The longer the life expectancy, the higher the QALY gain. A QALY gain would be highest for interventions aimed at children. *Healthy life years* (HLY) indicates the number of years a person of a

certain age can expect to live without disability. HLY is less sensitive to health impacts than QALY. (European Commission impact assessment guidelines, Tool # 27: Health impacts).

The monetary methods for health impact analysis study individuals' stated or revealed preferences with respect to small changes in low-probability health risks. These can be measured by using the concepts of *willingness to pay* (WTP) for an improvement or *willingness to accept* (WTA) compensation for a deterioration. These are the same concepts that are used in connection with putting a monetary value on the environment. Ways to make use of these methodologies for determining the value of health impacts include the *value of a statistical life* (VOSL) and the *value of a statistical life year* (VOLY). The VOSL is derived by investigating individuals' WTP for a lower risk of mortality, divided by that risk reduction. The VOLY measures more generally the WTP for an increase of one additional year of life expectancy. However, neither VOSL nor VOLY provides a measure of the quality of life. There are also 'accounting style' approaches that the Commission believes should be treated with caution. These include the *cost of illness method* and the *human capital method.* The *cost of illness* method means simply calculating the medical expenses related to the incidence of an illness, and the human capital refers to the loss of future earnings in case of disability or premature death. This lost productivity does not account for people who are outside the workforce. (The European Commission impact assessment guidelines, Tool # 27: Health impacts).

From a rights-based perspective, an individual could be considered to have the right to live in a healthy environment. A safe environment could be regarded as a human right, and national governments could be held responsible if they failed to act for the protection of their citizens in a case of foreseeable risk to life. For example, the Finnish Constitution (Article 14) states that government must *aim* to guarantee everyone the right to a healthy environment. Air quality that is constantly worse than recommended standards could be considered a violation against a human's right to life (International Convention on Civil and Political Rights, 1966 by the United Nations, Article 6, and European Convention on Human Rights, 1950, Article 2) (Kumpula, 2002, 15–166). So far, this issue has not been brought to trial. A clearer understanding of how environmental regulation impacts health will offer possibilities for rights-based approaches to environmental law.

3.3. Impacts on businesses: micro-economic perspective

3.3.1. Categories of business impacts

During 2009, 2010, at least eight studies assessed the foreseen economic impacts and transport pattern impacts of the SECA rules. An EMSA report summarized these studies in 2010. Many studies focused on the economic costs, and only some tried to quantify the anticipated environmental and health benefits. The most obvious short-term effect of the requirement to lower the permitted sulphur level in marine fuels to 0.1% in 2015 was an increased fuel price. Low-sulphur fuel is generally more expensive (some 70–80%) than heavy fuel oil, because it is a distillate product and the desulphurization process involves costs. The increased demand was anticipated to raise the price of low-sulphur oil even more. In the longer run, a decrease in the relative price may result, due to economies of scale. (EMSA 2010, 5). The total effect on fuel price remains uncertain. Some studies forecasted that the increased fuel price would be passed on in freight charges, while others believed it to be difficult because of the competitive situation within the freight-forwarding industry. If the ship operators absorbed the increase in fuel price, it could weaken their margins and capacities for innovation (EMSA 2010, 8.), but on the other hand economic incentives to discover efficiency innovations would increase. The market prices for oil are relatively volatile and almost impossible to forecast. Because current oil prices have fallen, the most drastic fears of some exporting industries have not been realized. In particular, Finnish export industries were especially concerned about the expected increase in operating and investment costs due to the SECA regulations. (Busk and Härmälä, 2016, 38–41). Of course, price increases of oil would worsen the current situation.

An environmental regulation such as the SECA rules will impact businesses differently. Certain countries, regions or sectors may be impacted more than others. Some will benefit and some will lose. Some might lose in the short run but benefit in the long run. In order to analyze the impacts on different business sectors, we first need to recognize the direct behaviour changes required from the addressees of the regulatory obligation, and then recognize the second-order impacts. The European Commission (2009) impact assessment guidelines (Tool #16: identification/screening of impacts) list many possible impacts on business. When businesses are required to act, it typically incurs *compliance costs*. The *cost or availability of essential inputs* (raw materials, machinery, labour, energy, etc.) may change. There may be an impact on *investment cycles*. Certain products or services may be *withdrawn* from the market, and businesses may *close down*. On the other hand, new businesses may *emerge*. There may also be *administrative costs on business*, related for example to the type of data required and the complexity of the submission processes. (European Commission impact assessment guidelines, Tool #16: identification/screening of impacts).

Another type of economic impact is related to *trade and investment*: how exports, imports and investment flows are affected. Impacts on *competitiveness* are seen as having three parts: impacts on the cost of doing business, impacts on the capacity to innovate (i.e. to produce higher quality products and services), and impacts on market share and comparative advantages in an international context. In particular, costs and burdens on the operation and competitiveness of SMEs and micro-SMEs need to be considered. Impacts on *competition* may also be relevant. Regulation may lead to a situation with higher prices due to less competition, or form barriers preventing new suppliers and service providers from entering the market. Ryan (2012) highlights the need for a dynamic model where the welfare consequences of market structure changes are included. If entry barriers increase, competition may decrease (Ryan, 2012, 1059). *Consumer prices and consumer choice* may be impacted. As regards the impacts on *innovation and research*, it should be assessed whether research and development is stimulated or hindered, and whether the introduction and dissemination of new production methods, technologies and products is facilitated. (European Commission impact assessment guidelines: Tool #16: Identification/screening of impacts).

In order to comply, an actor needs to learn about the rules, to negotiate internally and externally on how to react to the rules, and then implement the decision (OECD, 2014, 62–53). According to Littrell and Thompson, firms typically understate their regulatory costs (almost by half), where the most significant omission involves the *transaction costs* associated with regulatory compliance (Littrell and Thompson, 1997, 24). The psychological costs of stressing over the regulation and possible penalties can be included in compliance costs, but established methods for measuring such costs are lacking (Määttä and Tala, 2015). In addition to regulation targets, other affected companies similarly need to evaluate the consequences of the regulation from their perspective.

3.3.2. Impacts on the maritime industry and ports

Environmental regulations typically entail abatement costs for the companies that need to comply with them. The costs of fuel and abatement technologies are immediately borne by the maritime

industry. Some of the costs are immediate (such as investing in a scrubber), others are continuous (such as the use and maintenance of a scrubber). Bloor et al. (2013) identified a taken-for-granted culture of compliance as the main reason for compliance with the SECA regulations. Companies do not really consider the option of not complying. In the case of SECA regulations, the main alternatives for compliance are:

- to change ship fuel (to low-sulphur distillate fuel or LNG), or
- to implement/introduce exhaust gas scrubbers (Brynolf et al., 2014).

According to the ex-ante impact studies, the transport costs were forecast to rise by 20–40%, based on the price difference between heavy fuel oil and marine diesel. A significant modal shift to trucks and rail was also expected to happen. Now, in the real world situation, as low oil prices have reduced the effects of SECA on transport prices, the modal shift is also expected to be minimal (Hämäläinen, 2015; Katila et al., 2015). The refining industry has also made an innovation and developed a novel product: low-sulphur heavy fuel oil (Exxon Mobil, 2015). When oil prices rise again, the cost effects of SECA may reappear. On the other hand, the current situation will give the maritime industry more time to adapt.

The maritime industry can try to channel their costs backward or forward in the value chain. They can, for example, try to pay less for ships, pay their employees less, pay less tax, or charge customers higher prices. Ultimately, all costs for businesses are borne by people as owners, investors or employees, etc. (Määttä & Tala, 2015). Case studies are needed to find out which stakeholders end up paying the majority of the compliance costs, and if some go out of business altogether. Typically, impacts on small, medium and large businesses may differ. For example, small and medium-sized ports may lose traffic if bigger ports are more attractive targets for investments (Gritsenko and Yliskylä-Peuralahti, 2013).

According to the European Commission (2009) guidelines, "quantification of impacts on sectoral competitiveness may require descriptive statistics, input-output analysis using national or sectoral accounts, applied general equilibrium modelling or other econometric exercises". "For policy proposals that affect a diverse set of sectors, models such as computable general equilibrium (CGE) and macro-econometric input-output models can be used to quantify overall impacts". (European Commission (2009) impact assessment guidelines, Tool #16: identification/screening of impacts).

It might be difficult to determine the *opportunity costs* for businesses. Opportunity costs are costs incurred due to the need to divert expenditures to regulatory compliance and away from more preferred uses. By investing in compliance with the SECA rules, the maritime industry foregoes the opportunity to use the same effort in another manner. This other manner could give a higher return to the company, and possibly more value for society. For example, a company may not be able to invest in new ships because it has to install emission abatement technology to its old ships. The opportunity cost is the difference between the return to the business (if any) from its regulatory compliance and the best available alternative (i.e. that with the highest return). Opportunity costs thus depend on the return on capital for the business (OECD, 2014, 15).

3.3.3. Impacts on industries that transport goods

It has been suggested that the compliance costs of SECA are ultimately borne by the most peripheral northern industries that ship their goods, such as the paper industry or the metal industry. The increased cost of transport may make these industries less competitive, which has been the main concern of the opponents of the SECA rules. Shipowners will in general try to pass on the fuel price increase in the transport price, and thus it is their customers that will pay. The customers belonging to industries with tight markets and low prices such as the paper and metal industry may suffer the most (Kalli et al., 2013). In theory, the cost incidence of new regulation, i.e. who ultimately pays the increased costs, depends on the price elasticities of supply and demand of transport services. Short sea shipping (SSS) is considered to be very competitive as compared to road transportation. It means that SSS is a relatively inelastic mode of transportation and its total demand may remain quite stable despite economic or political shocks (European Commission, 2015, 53).

Freight forwarders might partly shift to other modes of transport if the cost is lower. Such a modal shift would impact these fields of the transportation business. The possible modal shift and its consequences need to be included in measuring the overall impact of the SECA rules in the Baltic Sea Region. Especially, the amount of the increase in road traffic due to the regulation needs to be evaluated. By modal shift we also mean the shortening of the sea leg of the whole transport chain. Regarding methods, statistical analysis of transport flows and freight patterns as well as interviews can be used. The modal shift will also again increase the external costs, i.e. harm human health, increase congestion and accidents. However, the studies done so far on the effects of SECA on modal shift have indicated that it they have been negligible (Hämäläinen, 2015; Katila et al., 2015).

To counteract strict environmental regulations, industries may even decide to relocate their production facilities, changing the transportation routes needed. Globally, environmental regulations are inefficient if businesses avoid them by moving to countries with lower environmental standards. Case study research combined with statistical inspection of foreign direct investments can provide information on such decisions.

3.3.4. Impacts on industries based on ecological goods and services

Decreased pollution will directly benefit industries based on fish and other aquaculture, farmed crops, and forests, all of which have economic value. Acidification decreases the growth of crops and forests on soils that do not have enough buffering capacity by hampering nutrient uptake. Ozone will directly influence plant stomata by hindering gas exchange. Seas in general have more buffering capacity for SOx pollution than lakes, but as the Baltic Sea is brackish water and generally vulnerable to environmental disturbances, its biodiversity may be compromised due to the sensitivity of some species. The acidic wash water from exhaust gas scrubbers may also have local effects on sensitive underwater vegetation or fish nursery sites.

On the basis of air quality modelling, it is possible to get accurate data on pollutants and their spatial distribution (Jonson et al., 2015). According to the previous literature, it is possible to evaluate the effects of the quantified sulphur oxide emissions on fish, crops and forests. Spatial information on the current acidification and buffering capacity of the soils can be used as background information. Monetarization of such commodities is possible as they have market value.

Fishing, diving and trekking are examples of tourism based on ecosystem services. Water quality is connected to the possibilities for marine and coastal tourism. Tourists search for *cleanliness*: Capacci et al. (2014) showed that tourist flows moved towards the Italian coastal destinations that met the Blue Flag standard for clean beaches. *Biodiversity* has value for some tourists (Bhandari and Heshmati, 2010; Vaughan, 2000) and therefore provides opportunities for ecotourism operators.

3.3.5. Impacts on the clean-tech industries

When referring to 'clean-tech', we mean industries that provide solutions for the compliance and control of the SECA rules. These include suppliers of fuels, abatement technologies and monitoring technologies. Through new technological demands, environmental regulation presumably has an innovation-inducement impact. The development and marketing of exhaust gas scrubbers are an example of this type of impact (Makkonen and Repka, 2016). Innovation is connected to *dynamic efficiency*. Regulation can slow down innovation if it forces the use of a particular technology. Innovation can also be slowed down if the regulatory situation is unclear. Dynamic efficiency is thus best realized if the target is clear but the methods of achieving the target are left for the markets to decide. The larger the expected net benefit for businesses, the larger the incentive to innovate (Määttä, 2009, 100). It is somewhat uncertain if there are *early-mover advantages* for countries that regulate first (for example, set stricter environmental rules on companies than other countries do). According to Määttä, the frontrunner advantage will depend on the level of costs inflicted on businesses (whether the costs will cause the exit of some businesses), and whether and when other countries will follow the frontrunner regulator (Määttä, 2009, 101).

So far, the most visible product innovations related to SECA compliance include scrubbers (Makkonen and Repka, 2016), LNG technology in ships, biofuels and low-sulphur heavy fuel oil. LNG as a ship fuel is a multifaceted phenomenon that will influence ship design and engine development. It will also transform the energy supply of many regions and may have several types of regional impacts (Alhosalo and Karppinen, 2013). The same is true for biofuels and methanol, which are emerging as ship fuels. Compliance control technologies are another emerging topic. Airborne and satellite imaging technologies are being developed by several research groups (e.g. Beecken et al., 2014). They will probably be a lucrative business in the future, as countries are legally required to control ship exhaust gases.

3.4. Public administrative costs and benefits

In addition to the impacts related to compliance, administrative costs are also relevant in determining the overall societal impacts of regulation. If a system or regulatory instrument is based on overt bureaucracy, its overall impact may be negative. Administrative costs are borne both by private and public actors (Määttä, 2009). Regulation does not automatically increase administrative costs: it can also lower them. Smart regulation can also have administrative benefits: it may for example result in enhanced expertise or enhanced international cooperation networks of the administrative staff.

Cost efficiency in public administration means that the given policy objective should be achieved at the lowest costs of administration and compliance. It is important to notice that the public objective should not be to minimize the costs of the public agency (cost pool), but the total costs of bureaucracy in the whole economy. A socially desirable regulatory system should include at least the following principles: 1) economic efficiency (not distortionary), 2) administrative simplicity, 3) flexibility (easy adaptation and allowing alternatives), 4) political responsibility and transparency, and 5) fairness (similar treatment of similar agents in similar circumstances). Direct administrative costs consist of running the public operations, and indirect costs, i.e. compliance costs, are borne by the agents who are regulated. Such costs include the costs of time spent completing administrative forms, costs of record keeping and reporting, and the costs of auxiliary business and judicial service. Indirect costs can be several times larger than direct costs (See Stiglitz and Rosengard, 2015, 512 and 518).

According to the European Commission guidelines, impact assessment should include the budgetary consequences for *public authorities* at different levels of government (EU, national, regional, local), both immediately and in the long run. A regulation may even require the creation of new public authorities or the restructuring of old ones. (European Commission (2009) impact assessment guidelines: Tool #16: Identification/screening of impacts).

Määttä and Tala (2015) note that there are administrative costs even before the regulation exists, and there will be administrative costs throughout the lifetime of the regulation. All administrative costs include:

a) the costs of rule-making (preparing the regulation, hearing stakeholders and experts, lobbying, decision-making), and
b) b) the costs of implementation, monitoring and control of the rule.

Direct administrative costs can be calculated by counting the working hours used and multiplying by the cost of an hour's work. In the case of SECA, public administrative costs are mainly borne by the traffic security agencies or similar public authorities of the port states. Ship fuels are inspected based on ship risk profiles, and also airborne monitoring is performed (Trafi, 2014). According to Gritsenko and Yliskylä-Peuralahti (2013), no single actor has the full authority and capability to implement SECA. Monitoring, certification, control and penalization rely on multiple actors with different and conflicting agendas: the shipping governance arena is polycentric. Gritsenko and Yliskylä-Peuralahti see ports as good candidates for an important role in SECA monitoring and control due to their physical properties and their environmental stewardship. Ports can coordinate and cooperate for the infrastructure harmonization that is needed. Port adaptation will relieve the administrative burden of public actors, but will set new demands on port strategies. As regards penalization, non-compliance with the EU sulphur emission directive 2012/33/EU is to be penalized by the national authorities of the EU member states. (Gritsenko and Yliskylä-Peuralahti, 2013).

Coherence of regulations with respect to other regulations and regulatory build-up also need to be considered (Coffey et al., 2016). The OECD (2009) sees regulatory impact assessment foremost as an instrument to promote coherence in regulatory policy. It should also be taken into account that a change in regulation may require another change in regulation. In particular, the use of exhaust gas scrubbers has created the need to regulate the treatment of the wash water of these scrubbers (EMSA 2010).

3.5. Macro-economic perspective on environmental regulation and economic performance

3.5.1. The pursuit of blue growth: setting policy targets and choosing policy tools

For economic growth, it is not a matter of indifference, how regulation is implemented in practice. For example, Djankov et al. (2006) make an empirical finding that countries with better regulations grow faster. On the other hand, Bovenberg and Smulders (1995) show theoretically that the environmental quality and economic growth are feasible objectives at the same time, but with certain conditions. The purpose of this section is to go beyond sectoral inspection and to comprehensively scrutinize the effects of

multinational environmental regulation on macroeconomic performance from the perspective of the so-called blue economy, or interchangeably, blue growth. Without a dominant definition, it can be described to present something where *socio-economic activity is in balance with the long-term ecological sustainability of the natural environment*[3]. The basic idea is the same as in the concept of sustainable development: it is not an unavoidable necessity that we have to choose between economic growth and environmental sustainability. With careful strategic planning it is possible, at least in theory, to achieve a balanced co-evolutionary development path with ecological and socio-economic sustainability (EIU, 2015, 11, Hettich, 2000).

It is useful to recognize that setting national or international policy targets is a complex process where various factors affect the compromise. Objectives of regulation and pollution targets should be clearly stated if we want effective, and smart, regulation that reaches its objectives with a viable ecology and economy without wasting economic resources. In practice, environmental policy targets are seldom constructed on the grounds of economic efficiency or sustainable development. Rather, they are based on health risks, acceptable public opinion, lobbying, pressure groups, sectional interests or other political or business coalitions. The economic approach to a sustainable environmental policy is:

a) to set a policy objective (such as environmental targets and health targets), and
b) to choose the best policy instruments that help to maximize social welfare in the long run.

The specific way in which pollution is controlled also has its specific socio-economic impacts: the regulatory tool used will modify the constituents of the cost-benefit calculation. In theory, in each situation, there exists one appropriate policy implementation that maximizes social net benefits. Other implementations cause less total net benefits, possibly excessive or too restrictive regulation, and efficiency losses. While tracking the socio-economic impacts of regulation throughout an economy, one has to identify both the static effects and the dynamic effects, i.e. the impacts in the short run and the long run. There also may be conflicts of interest between specific interest groups and total welfare. The impacts of the SECA rules should be compared to the scenario of using an incentive-based approach instead of administrative rules.

The SECA regulation is a typical case of command-and-control policy where common standards are set for all market actors. However, there exist theoretically sound alternatives to strict standards or technical regulation. Almost without exception, environmental policy is practised by setting standards (e.g. SECA), requiring special technologies (energy-efficient light bulbs), or controlling inputs (SECA) or outputs (energy consumption). This is the one salient difference between the theory of environmental regulation and policy practice. According to economic theory, the most general case of an efficient solution is to control the polluting activity directly, not the inputs or outputs. That is, if the problem is some harmful emission, one should not control the input, output, technology or practice, but the emissions, discharges or effluents whenever it is possible (Cropper and Oates, 1992, 680). In the case of SECA, there could be considerable possibilities to increase efficiency and economic performance without environmental compromise if SOx emissions were controlled directly by unit taxes, marketable permits or some combination of them (Cropper and Oates, 1992, 683). Economic incentives (emission trade, taxes, port charges, etc.) could have been more effective for reaching the environmental and health goals. By responding to incentives, individual market participants would make their own decisions about optimal technology, fuels, processes, procedures, scrubbers or whatever they might innovate to meet the environmental requirements most efficiently in their current state of business.

Incentive-based regulations may induce firms to be more innovative than is the case with command-and-control regulation. The so-called 'double dividend' hypothesis and 'no regret' policy, together with technological progress, may enable such an opportunity. Induced technological change may eliminate technical and economic inefficiencies, which may create both socio-economic and environmental benefits. The double dividend hypothesis says that, through 'green' tax reform, it is possible to simultaneously achieve a healthier environment and increased economic efficiency. Economic theory shows that taxes on labour, income and capital are distortionary, i.e. they give negative incentives to work and invest, which generates inefficiency losses. On the other hand, the so-called Pigouvian taxes that discourage harmful externalities, like pollution emissions, generate efficiency gains. In a revenue-neutral environmental tax reform, pollution is reduced and productive efficiency gains can be made (Pearman et al., 2003, 175–176).

With emission trading, we can set the limit for emissions, we do not know what it will cost, but expect cost to be minimized through market forces. With taxes, we set the cost but do not know the amount of emissions that will follow. Uncertainty and irrationality in behaviour is caused by transaction costs and decision-making biases (Gunningham and Sinclair, 1999). Command-and-control regulation is typically not cost-effective when the cost structures differ between regulated actors (Stavins, 2011). Market-based approaches, i.e. effluent fees (Pigouvian taxes) and emission trading, are often found to be more efficient and effective than administrative regulation. (Cropper and Oates, 1992; Stavins, 2011). In the case of sulphur dioxide emissions, the classic case is provided by the United States Clean Air Act of 1990. The objective was to reduce acid deposition generated by coal-burning power plants. Instead of giving uncompromising standards or technological requirements, an emission trading system was implemented. This scheme led to significant reductions in sulphur dioxide with lesser total costs to industries and society as compared to command-and-control regulation (Scharks and Masuda, 2016). Such a result is possible because market actors have more freedom of choice and more incentives to innovate – different choices have different costs, and the differing cost structures of firms imply different choices – in optimizing their behaviour within more stringent environmental requirements.

Winnes et al. (2016) analyze the options available to meet NOx targets in the Baltic Sea, the North Sea and the English Channel. They propose a couple of policy instruments that are based on different combinations of levying NOx emissions, funding and slow steaming. According to their study, by using economic instruments in blue environmental policy, substantial reductions in pollution can be made as compared to conventional SECA/NECA types of regulation. Next, we will briefly consider the impacts of environmental regulation on innovation and competitiveness, employment, international cooperation and country brands in the blue growth framework.

3.5.2. Competitiveness of economies

As a general remark, the growth effects of environmental policies and regulation are ambiguous, and no general conclusions can be made without context-specific factors. It is a common

[3] EUI (2015, 7) gives the following working definition for the blue economy (oceans): "A sustainable ocean economy emerges when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy."

understanding in economics that stringent environmental policy has detrimental effects on economic activity in the short term, but the long-term effects can be either negative or positive (Kozluk and Zipperer, 2015). Jaffe et al. (1995) find only minor empirical evidence to the claim that environmental regulations have large adverse effects on the competitiveness of U.S manufacturing. On the other hand, environmental compliance expenditures can have a statistically significant positive effect on innovation activity (Jaffe and Palmer, 1997). Environmental regulation can spur innovation and competitiveness. Of the separate impact categories, the OECD (2009) puts special focus on the impacts on competition. Restricting competition is seen as a common side effect of regulation. By competition, the OECD refers to market competition free from monopolies and cartels, which is a different issue from the competitiveness of the industry or the competitiveness of nations. According to the Porter hypothesis, strict environmental regulation can spur domestic innovations, which may, in the long run, lead to improvements that more or less offset the compliance costs, and increase international competitiveness, thanks to early-mover advantages. Naturally, some firms cannot survive in competition, but others may benefit. The Porter hypothesis is a dynamic one, which means that the effects are opposite to a static view where stricter regulations always cause cost disadvantage to domestic producers in comparison to their global rivals. Thus, strict environmental regulation may ultimately give competitive advantage to domestic producers, but regulations must be properly designed (Porter and van der Linde, 1995).

Environmental regulations could enhance competitiveness though various mechanisms. Porter and van der Linde (1995) explain how properly crafted regulations may lead to enhanced competitiveness. Regulation signals to companies about likely resource inefficiencies and potential technological improvements, reduces uncertainty of the value of environmental investments, creates pressure that motivates innovation and progress, and levels the transitional playing field. Regulation focused on information gathering can achieve major benefits by raising corporate awareness. The Porter hypothesis rests on the idea that firms do not always make socially optimal choices for reasons such as imperfect information, organizational failures or market failures. In this situation, regulation can spur innovation through 'creative destruction'. It may force firms to identify inefficient uses of costly resources, to produce and disseminate best-practice technologies, and to overcome organizational inertia (Ambec et al., 2011, 4). Regulation can help overcome the self-control problems of managers (Ambec and Barla, 2006) or coordination problems within the industry (André et al., 2009). As returns on research and development are skewed, innovation may offset regulatory costs for some stakeholders and not for others (Popp, 2005).

Without government intervention, the development towards sustainability would have relied on market-based corporate social responsibility (CSR) and non-forced innovation in clean-tech. Cleaner fuel, cleaner air, healthier people and a healthier environment might eventually have been realized through stakeholder dialogue, negotiations, contracts, voluntary standards and branding. The impacts of the SECA rules can be compared to the scenario of letting the markets guide the development of cleaner shipping solutions. Yliskylä-Peuralahti and Gritsenko (2014) see severe limitations on the functioning of voluntary private regulation in shipping. Shipping is a transboundary and mobile B-to-B industry and still represents a 'black box' to end-users. Every shipping market transaction exists in a multitude of normative contexts, and there are jurisdictional divides and implementation gaps. This adds up to what Yliskylä-Peuralahti and Gritsenko (2014) call 'social irresponsibility' in shipping. They believe that CSR can still complement public regulation in a co-governance system based on networks of trust and the institutionalization of social norms. Buyer pressure alone is unlikely to make any field of business sustainable, and voluntary measures instead of direct regulation or economic tools can be mere "deregulatory tricks" (Bizer and Julich, 1999). Labelling, certification, and naming/faming may still have an important role in complementing binding regulation (see Taylor et al., 2012 on regulatory tools).

3.5.3. Employment

Jobs can be strongly affected by environmental regulations. Impacts on the level of employment can be expected whenever the demand or supply of a product changes or where relative prices change (e.g. between different producers). The short-term policy question is whether a regulatory shock creates more or fewer jobs or even mass unemployment. Overall (gross and net) job creation or losses can be calculated, as well as the employment impacts for specific sectors, professions, skill levels, regions and countries. (European Commission (2009) impact assessment guidelines, Tool #25: employment, working conditions, income distribution and inequality).

Most ecologists and ecological economists assert that an economy can be sustainable only if the ecological system, in its natural scientific meaning, is sustainable. Brown (2002) calls such a system an eco-economy. Obviously, this condition must also hold for the blue economy. There is a need for structural change towards an environmentally sustainable development path. Structural change always affects businesses and employment. Some industries and jobs become obsolete, but others emerge. Depending on the case, the short-term policy shocks (business and social costs) to an economy may be drastic. Some workers may become unemployed, workers who remain in the newly regulated industry may bear wage costs, and workers who reallocate may lose earnings during the transition (Walker, 2013). In cases of drastic change, temporal alleviation policies at regional or national level can be justified. A good government anticipates such costs and makes plans how society can overcome the transition phase without considerable socio-economic damage to competitiveness and welfare.

3.5.4. International cooperation

International environmental cooperation can be justified by policy coordination, if there are transboundary effects present. Obviously, SECA regulations fulfil these criteria. The overall success or failure of a regulation depends on whether the overall benefits exceed the overall costs. Even if a regulation is beneficial for the wider society, the division of benefits may be unfair. A good cost-benefit analysis will be able to identify important distributional consequences (Arrow et al., 1996, 222; Scharin et al., 2016). The SECA rules do have distributive impacts: some fields of business and some countries (Kalli et al., 2015; Jonson et al., 2015) may benefit more while others may lose more. This is true of many environmental regulations: some need them more desperately than others. Global environmental policy is therefore based on negotiations, and there will be tradeoffs and compromises.

Sometimes, compensatory transfers (cost sharing) may be needed to achieve the environmental outcome. Game theory provides guidelines to effective cooperation with reciprocity properties. There are non-cooperative games and cooperative games. For example, Kaitala et al. (1992) analysed dynamic acid rain games between Finland and the former Soviet Union. It was found that cooperation was beneficial to Finland but not to the Soviet Union. Consequently, in the non-cooperative game framework, Finland should have had to offer monetary compensation to induce the USSR to commit to pollution control activities. The European Union has supranational decision-making power. It would be advisable also to consider compensation schemes between its member states,

especially in the turbulent times of Brexit and the consequent political crisis in the EU. Such a 'fair game' burden share analysis of SECA regulations has not yet been made. Hyytiäinen et al. (2015) found that in order to control eutrophication in the Baltic Sea, the total cost could be halved if the mix of measures was planned in a spatially cost-efficient manner: cost sharing would allow the littoral states to achieve the optimal level of nutrient abatement.

Compensation can also be achieved through consequent pieces of regulation. The experiences of prior negotiations (including strategies, tactics and outcomes) will frame future negotiations. The SECA rules will be followed by the NECA (Nitrogen Emission Control Area) rules. If the SECA negotiations were unsatisfying for one party, it may be inclined to resist the NECA negotiations or to bend the outcome of the NECA regulations its way.

3.5.5. Country brands

There is also a strategic branding perspective to environmental regulation. Countries compete to stimulate exports, attract tourism, foreign direct investment and immigration (Fetscherin, 2010, 446; Anholt, 2002, 234). Over time, countries develop reputations in particular industries and sectors, often based on resource advantages and expertise that are seen as part of the country's heritage (Brodie and Benson-Rea, 2016). Brand building is connected to a country's whole image, covering political, economic, social, *environmental*, historical, and cultural aspects (Fetscherin, 2010). Places and country name related associations amount to brands and help buyers to evaluate products. Marketers are known to lend existing brand associations to their new product launches, to differentiate supply networks and to create social and emotional value for users. Consumers are often willing to pay a premium for their treasured and socially valued brands. (Koscheate-Fisher et al., 2012; Kotler and Getner, 2002) A strong country brand may enhance international credibility, political influence and international partnerships (Yan, 2008). Earlier studies have identified country branding contributing to the country's sustainable development (Jaffe and Nebenzahl, 2001; Kleppe and Mossberg, 2006). For a nation to gain competitive advantage in global markets, the use of strategic marketing tools and conscious branding are recommendable (Kotler and Getner, 2002). From a brand image perspective, a country brand can be understood as the sum of beliefs and impressions people hold about places (Kotler et al., 1999). By using environmental causes, ethical, and social marketing to promote their social responsibility, countries are also able to gain goodwill and win public attention and world support (Ma, 2004). In current terms, the country brand entails the collective involvement of the many stakeholders it must appeal to (Fetscherin, 2010, 468). The country-of-origin effect is known to influence brand associations and strategic branding should therefore be about facilitating these collective meanings within stakeholder networks (Brodie and Benson-Rea, 2016). According to Szondi (2010), environmental regulation builds and strengthens the country brand, which promotes public relations and fosters network relationships. In tourism context, natural environment of the region is a major attraction, and regional image factors create a unique identity for the product, and in this way bring about added value (Ittersum et al., 2003, 215). Travelers experiencing these regional environments are known to observe unfavorable behaviors and take note of where and how a destination's environmental standards and regulations are lacking behind his/her own home region (Insch, 2011, 388).

In accordance with academic research, the annual global industry evaluation of country brands, the Country Brand Index, recognizes sustainability and explicitly *the contribution a country makes to the global progress and better management of the world's resources* as a key driver of the country brand construct, along with technology and innovation (FutureBrand, 2015). Similarly, the *protection of the environment and the natural resources* is identified as a country brand success factor by another acknowledged Nation Brands Index study by Anholt-Gfk (2015). This trend of country brand development points to the trend that environmental regulation, e.g. SECA, builds and potentially strengthens the country brands that are associated with regulation compliance. However, more investigation is needed in order to obtain deeper understanding of how and on which stakeholders' country brand evaluation the SECA regulations specifically have an impact.

4. Discussion and conclusions

We propose a comprehensive regulation-impact framework for the analysis of socio-economic impacts in maritime regulations. Table 1 describes the most relevant economic impact types recognized in this study. Empirical economic impact analyses need to be based on emissions data and air quality modelling using ship emissions, and describing the pathways, or deposition, of pollution in nature. (Jonson et al., 2015). Understanding the links in the causal chain of impacts inevitably calls for a multidisciplinary impact assessment. A holistic ex-post impact analysis of the SECA rules would facilitate an evidence-based policy for the future ex-ante analyses of 'smart' environmental regulation. In an ideal world, ex-ante or ex-post impact assessment allows regulators to learn how to regulate effectively and efficiently, and this instrumental learning then makes leads to improved regulation possible. Analysis should lead to distinguishing the most favourable option of regulation in the larger sense, taking maximal social welfare and fair distribution of costs and benefits as the target. Fairness between regions, industries and groups of people is a tough target. A negotiating game can teach the negotiating parties to learn the political strategies of other actors and how to justify the legitimacy of one's goals internationally (Radaelli, 2009).

Below in Fig. 1, we have modified the categorization of impacts suggested by Renda et al. (2013). The figure shows direct costs and benefits as well as third-party costs and benefits (indirect impacts, spillover impacts). Micro-economic business impact categories

Table 1
SECA impact categories.

Impact category	Measuring task
Environmental impacts	Benefits of clean nature and biodiversity as valued by citizens and society Costs: pollution flows, pollution deposits, ecological effects
Health impacts	Benefits of reduced mortality and illness for citizens and society Costs and potential inefficiency: cost effectiveness
Business impacts: ecological goods	Benefits of enhanced commercial ecological resources (ecosystem services) for businesses and society Costs: structural change
Business impacts: compliance	Costs of compliance for the maritime industry, its customers and society
Business impacts: innovation	Microeconomic benefits for clean-tech industries, macroeconomic benefits of innovation inducement in cleaner shipping
Administrative impacts	Costs of administration, including direct and indirect administration costs. Benefits in enhanced expertise and social networks.
Macro-economic impacts	The macroeconomic perspective: dynamic possibilities for sustainable blue economies (economic growth, national competitiveness, human health, social cohesion and ecological sustainability in balance), and international cooperation (benefit and cost asymmetries between cooperating nations, compensation schemes)

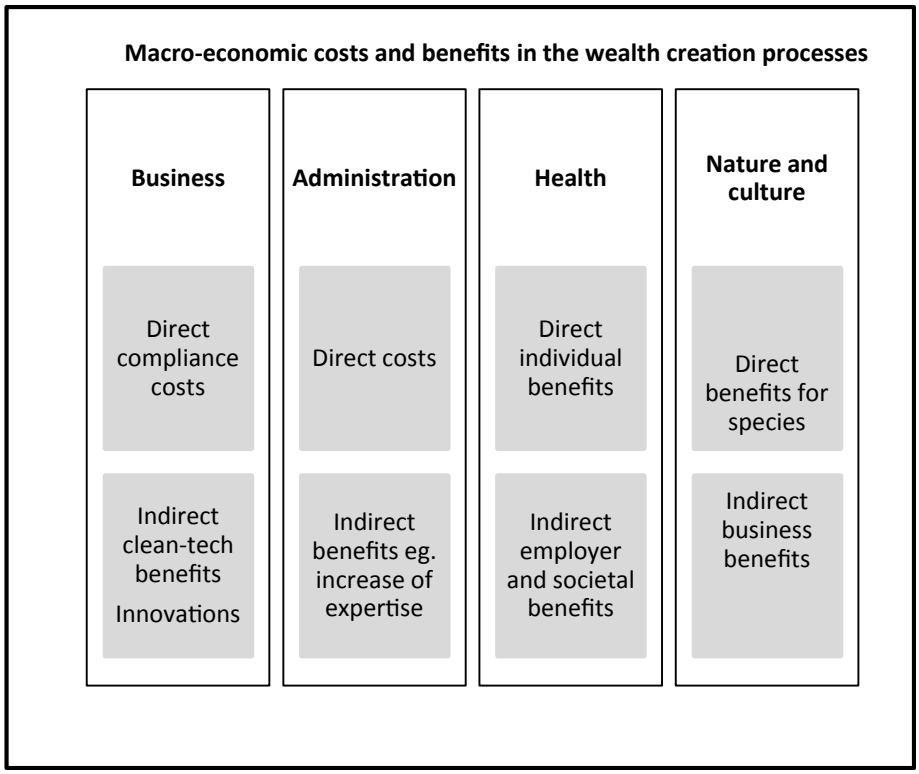

Fig. 1. Direct and indirect categorical impacts of environmental regulation.

include the maritime industry, ports, transport goods, ecological goods and services, and clean-tech industries.

In the case of SECA, substantive compliance costs encompass the investments and expenses faced by the maritime businesses to comply with substantive obligations. Administrative burdens are costs borne by businesses and public authorities as a result of administrative activities performed to comply with the obligations included in the regulations. Enforcement can be efficient or inefficient, and administrative costs are often downplayed ex-ante. Direct benefits are improvements in health (from the perspective of the individual) and improvements in the environment (from the perspective of the environment per se). In the case of SECA, third-party costs include changes in the prices, quality and availability of maritime transport services for freight forwarders (third-party costs related to compliance costs). Third-party benefits related to compliance are benefits for the providers of compliance products or services, the benefits for businesses and society of increased health, and benefits for businesses that are based on ecosystem services (Modifying Renda et al., 2013). Analysis should not be limited to the most foreseeable and evident impacts. Actors do not always behave rationally, and unpredictable outcomes must be recognized.

In impact assessment, the timing of the impacts is a highly important dimension. There are:

a) short-term impacts (shocks),
b) medium-term impacts (transition, adjustment to structural change), and
c) long-term impacts (cumulation of impacts and new balance).

The distribution of impacts needs to be studied both geographically (regional distribution of environmental, health and business impacts) and from the perspective of each societal stakeholder. The macro-economic operational environment is comprised of discretionary policies that affect economic performance, growth factors, international competitiveness, employment and international cooperation. Impact pathways are not isolated but embedded in national policy systems. Each nation state can, through its own policy framework, try to enhance the realization of the SECA benefits and to mitigate the costs of implementing SECA.

System-level impacts are more than the sum of the listed impacts, and are typically long-term. From a sociological perspective, regulations *transform values* and how people see society and relationships therein (Cotterrell, 1995, 10). One categorization of impacts is between material and symbolic impacts. Material impacts can be verified and measured as changes in the natural environment and/or as behaviour changes in the social world. The symbolic impact means that regulation represents a common opinion in the middle of multiple value systems and competing interests. A new rule signals a change in power structures and dominant values. (Cotterrell, 1995). Symbolic impacts may become measurable in our attitudes: country brands may change in the eyes of stakeholders, and regulation targets may settle with accepting their responsibility in sustainable development. A particularly significant impact may be in how environmental regulations impact the consciousness, values, ideas and moralities of various societal actors in relation to sustainable development.

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