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How has the EU Ship Recycling Regulation affected European Shipbreaking?

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To our knowledge, there has not been conducted previous research on the effect of the EU Ship Recycling Regulation. Therefore, we hope that our thesis contributes to existing knowledge, addresses the challenges of implementing an international ship recycling regulation, and sheds light on an industry that is dangerous to human beings and damaging to the environment. Furthermore, we hope our thesis will contribute to put unsafe shipbreaking practices on the agenda, influence shipowners' decisions, and inspire to cleaner and safer ship dismantling practices.

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Executive Summary

The global ship recycling industry poses danger as ships are being dismantled in ways that are harmful to the environment and to workers. Therefore, effective international regulations are needed to improve the industry. This thesis provides an analysis of how the EU Ship Recycling Regulation has affected European shipbreaking. A policy effect analysis, controlling for country and year fixed effects, has been conducted to measure the effect of the regulation. We test whether the probability of vessels being dismantled using harmful practices, known as beaching, has been reduced after the regulation was implemented 31.12.2018.

Results show that vessels with registered shipowners from EU member states have significantly reduced the probability of beaching after implementation of the regulation. Conversely, results indicate that the regulation has no effect on beneficial shipowners from EU member states. The thesis concludes that there is a problem of group comparability between the EU treatment- and non-EU control group in addition to unobserved trends in the data. Further, this is likely to contribute to a violation of parallel trends between the groups prior to implementation of the regulation. Hence, we cannot infer that the reduced probability of beaching for vessels with registered shipowners from the EU, is strictly causally linked to the implementation of the regulation.

Lastly, recommendations for increasing the effectiveness of the regulation include enhancing the financial incentives of compliance, and limiting legal loopholes and circumvention of the regulation by preventing re-registration of shipowners to countries outside the EU.

Keywords – Beaching, EU Regulation, Shipbreaking, Ship Recycling.

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1 Introduction

Environmental issues, climate and sustainability rank high on the current international political agenda. Still, we see continued anthropogenic emissions of greenhouse gases and waste, along with poor working conditions within the global shipping, and ship recycling industry. The world is facing a huge environmental and occupational problem in regards of how the world's fleet of ships is being dismantled and recycled, also known as shipbreaking. This thesis aims to assess how the Ship Recycling Regulation enforced by the European Union (EU), affects shipbreaking practices. Moreover, we aim to provide relevant information that can be used to facilitate an open and transparent discussion on the effectiveness of the regulation. In that way, we will also discuss how the regulation might be further developed to improve the environmental and occupational issues of the shipbreaking industry.

Today, about ninety percent of shipbreaking is handled in Bangladesh, India and Pakistan (UNCTAD, 2019). The practice in these countries harms the environment and poses great danger to the workers (ILO, s.a.). Hazardous chemicals and toxic materials are not removed from the vessels by the time they arrive to the shipbreaking yards. Further, the chemicals are disposed directly into the environment, which affects workers, biodiversity, agriculture and the local population. Working conditions are poor as the dismantling of ships is completed manually, without proper safety equipment. There is also a lack of training and access to health facilities which poses a threat of injury or even death to the workers (European Union, 2020).

A challenge of foreseeing the effects of the EU Ship Recycling Regulation, is the lack of information and of transparency in the shipping industry. There are also legal loopholes that shipowners can exploit to avoid costly regulations such as the EU Ship Recycling Regulation (Galley, 2013). Shipowners worldwide contribute to disguising information as they sell their end-of-life vessels to countries with poor implementation of international laws (European Commission, 2016). Re-selling vessels aims to facilitate recycling in countries with low protection of worker rights and of the environment, as this contributes to maximizing profits when dismantling a ship. Hence, the development of effective international laws and regulations is essential to improve global ship recycling practices.

Furthermore, we will conduct a quantitative regression analysis to analyse the effect of the EU Ship Recycling Regulation that was put into force the 31 of December 2018. The analysis will estimate the extent of harmful shipbreaking activity in EU member states compared with non-EU member states. More specifically, we will see how the implementation of the regulation affects the probability of a ship from an EU member state to be dismantled harmfully. This has further led to the formulation of the following research question:

How has the EU Ship Recycling Regulation affected European shipbreaking?

More specifically, “European shipbreaking” will in this case refer to shipowners from EU and EEA member states, as the regulation itself targets ships that fly the flag of an EU or EEA member state. In that way, we will assess to what extent shipowners change their shipbreaking behaviour as a result of the regulation. As the regulation has been in place since the 31.12.2018, we will assess its effect throughout 2019. The analysis does not include data from 2020 due to the limitations of the dataset.

1.1 Structure of the Thesis

This thesis consists of nine chapters. Chapter 1, “Introduction”, describes the background and relevance of the study, research question and the structure of the study. Chapter 2, “Theory”, discusses background information on the shipbreaking industry including a presentation of relevant legal frameworks and our hypotheses. Chapter 3, “Data”, presents our dataset with limitations and relevant variables. Chapter 4, “Method”, presents our methodological approach and models that will be used in the analysis. Chapter 5, “Analysis”, presents the descriptive and empirical results from the analysis and chapter 6, “Discussion”, discusses findings from the study with limitations. Further, chapter 7, “Conclusion”, sums up the study. Lastly, chapter 8, “References”, and “Appendix” are listed.

1.2 List of Acronyms

Table 1.1: List of Acronyms

Acronym	Explanation
BO	Beneficial owner
DWT	Dead-weight tonnes
FOC	Flag of Convenience
GT	Gross tonnage
HKC	Hong Kong Convention
IHM	Inventory list of hazardous materials
LDT	Light displacement tonnes
NGO	Non Governemntal Organization
RO	Registered owner
PPP	Polluter Pays Principle
SRR	EU Ship Recycling Regulation

2 Theory

In the theoretical discussion, we present background information contextualizing shipbreaking and the shipping industry. This includes explaining the most important existing legal frameworks regulating the shipbreaking industry, and economic considerations of shipowners regarding ship recycling practices. Lastly, the theoretical chapter leads to our hypotheses, which form the base of our analyses.

2.1 Definitions

There are a number of terms that are relevant to define prior to discussing the maritime and ship recycling industry. Firstly, both words “ship” and “vessel” will be used frequently. Moreover, a ship is defined as: “a large boat for transporting people or goods by sea” and vessel is a more general term for any type of watercraft (Lexico, s.a; Oxford Thesaurus of English, s.a). Thus, “vessel” is a broader term and should arguably be the primary choice to cover the recycling industry. Still, the main scope of this thesis, namely the EU Ship Recycling Regulation, uses the term “ship”. In the regulation, a ship is defined as any kind of vessel operating in the marine environment including floating platforms and self-elevating platforms (EU Ship Recycling Regulation, 2013). In that way, this definition of a ship is aligned with our definition of a vessel, and we will therefore refer to both terms interchangeably.

Further, the terms “ship recycling”, “ship dismantling”, “beaching” and “shipbreaking” will repeatedly occur. “Shipbreaking” is defined as old ships being broken up for scrap and is the preferred term by the International Labour Organization (ILO) and the European Union (EU) (Stuer-Lauridsen et al., 2007). Scrapped metal from ships is thereafter discarded for reprocessing. Furthermore, “beaching” refers to the process in which a ship is scrapped directly on an intertidal mudflat (NGO Shipbreaking Platform, 2019a). The tide allows breaking up ships using manual labour during low tide as workers then can access the ship. Such practice relies heavily on low labour costs as it involves very little mechanisation (Stuer-Lauridsen et al., 2007).

“Ship recycling” is the official term used in the EU Ship Recycling Regulation (2013), and is defined as the dismantling of a ship at a ship recycling facility to recover components for re-use, whilst simultaneously ensuring the management of hazardous and other materials on site. It is further the preferred term used by the shipping industry (Stuer-Lauridsen et al., 2007). Lastly, “ship dismantling” is used by the Basel Convention and refers to the process of taking a ship apart (ibid.) In that way, “ship recycling” will in this thesis refer to practices that according to the European Union are safe and environmentally sound. “Beaching” will on the other hand refer to the practice of sending ships to beaches in South Asia, namely Bangladesh, India and Pakistan, where international safety standards are not adequately maintained. Finally, “ship dismantling” and “shipbreaking” are viewed as neutral terms relating to any practice of breaking up a ship. “Shipbreaking” is used in our research question, as it is the official term utilized in the EU Ship Recycling Regulation.

2.2 Environmental Issues

The ship recycling industry facilitates the re-use and recycling of valuable materials, and contributes to the circular economy by minimizing waste (European Commission, 2016). Further, the recycling of ship materials reduces the need for mining virgin materials which is beneficial as mining generates greenhouse gas emissions and has ecological impacts such as erosion and loss of biodiversity (European Commission, 2016; Jain et al., 2016). Still, today’s practice within the ship recycling industry, undermines the contribution to sustainable development.

Galley (2014), stresses how there has been a significant focus on how to reduce CO_2 emissions in the shipping industry when ships are under operation, but this seems to have been neglected in the process of recycling ships. This is a challenge because vessels that end up at beaching facilities in South Asia, contain toxic chemicals and hazardous materials that are not removed prior to arrival (European Commission, 2016). Oil, asbestos and toxic paints are released into the local environment and disrupt biodiversity. These negative externalities, or pollutants, impact local wildlife, farming, and communities. In addition, the atmospheric pollutants lead to health issues for the workers of the shipbreaking industry.

Studies from India show significantly higher levels of heavy metal and petroleum hydrocarbons in sediment and seawater, relative to a control site (Mallampati et al., 2006; Tewari et al., 2001). This has led to polluted water with high levels of bacteria.

There are also findings of small plastic fragments in sediment, which is stated to be a direct result of shipbreaking. Further, high levels of material residuals such as copper, manganese, lead and zinc have been discovered at the beaching yards of Alang, India and Chittagong, Bangladesh (Mallampati et al., 2004). Researchers conclude that this pollution is an urgent threat to local and global marine life and biodiversity (European Commission, 2016).

2.3 Health Issues

The ILO speak of the shipbreaking industry as one of the most dangerous occupations with high levels of fatalities, injuries and work-related diseases (ILO, s.a.). Additionally, the ILO has developed an overview of all the hazardous exposures, working conditions and work activities that exist in Bangladesh, China, India, Pakistan and Turkey. Among others, these include exposure to asbestos, PBBs, heavy metals, compressed gas, batteries, radioactive materials, and welding fumes (ILO, 2004). This danger is further supported by Wei-Te et al., (2015), who have found that exposure to asbestos increases the risk of cancer among shipbreaking workers. The proportionally high rates of cancer result in increased mortality. Mercury polybrominated biphenyl (PBBs) and radioactive substances are also among the materials that the EU considers as hazardous (EU Ship Recycling Regulation, 2013, Annex II).

Other hazards include inadequate accident prevention and a lack of access to medical facilities for the industry workers (ILO, 2004). Thus, there is a risk of fire and explosion, falling objects, electrocution, falls from height inside ship structures and oxygen deficiency in small spaces. The lack of medical facilities also increases the risk of infectious diseases as malaria, dengue fever and hepatitis, and hinders the reporting of injuries and diseases (ibid.). Consequently, it is challenging to map the extent of these issues. Missing incident reporting could also be a deliberate strategy of the shipbreaking yards to conceal hazardous and protect their flow of income. Consequently, the severe environmental and health issues related to shipbreaking are central drivers for implementing international regulations such as the EU Ship Recycling Regulation.

2.4 Regulations

In this part, we look towards some of the international regulations and conventions that exist to regulate the shipbreaking market. Additionally, we will discuss the positive and negative sides with the regulations and present why it is challenging to agree on global political solutions in the shipbreaking industry.

2.4.1 The Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (The Basel Convention) of 1989, aims to protect human health and the environment against hazardous wastes by reducing its movement and effects (Basel Convention & UNEP, 2011). It entered into force in May 1992, and 160 states are party to the Convention (Galley, 2014). Firstly, the Basel Convention regulates the transboundary movements of hazardous wastes. Here, it is illegal to ship waste between parties to the convention and non-parties, unless there exists a special agreement. Secondly, each party of the convention is obliged to control that hazardous wastes are managed and disposed in an environmentally sound manner. Wastes are further defined as: "substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law" (ibid.). The Basel Convention also considers vessels that have reached end-of-life to be hazardous waste, as toxic waste such as asbestos, lead and mercury can be found in their structures (Basel Convention & UNEP, 2011, Annex VIII, List A).

It is up to each party to enforce relevant national or domestic legislation to prevent and hold breachers of the law legally accountable. This means that the country of which the vessel departs once it has been sold to scrap, also known as the exporting state, is responsible to enforce the convention. This has been criticised as the Polluter Pays Principle (PPP) is not followed when the parties are held accountable rather than the shipowners. The definition of waste when applied to a ship is also legally unclear, which has led to discussions regarding the applicability of the convention on ships (Alcaidea et al., 2016). It has further been argued by companies that a ship cannot be defined as waste, when it is still able to sail under its own power (Galley, 2014). Contradictory, the advocates of the convention state that a ship can be both a ship and hazardous waste at the same time, as the ship becomes waste in the moment when it is decided to be scrapped. One challenge here, is to determine at what time a ship has reached the end of its life (ibid.)

On the other hand, the Basel Convention has loopholes in which allows companies to circumvent the legislation. A vessel does not become waste before the shipowner states that the ship has reached its end-of-life and that it going to be recycled. In that way, shipowners or intermediaries selling the ships, can hide that a vessel is sent on its last voyage to a shipyard or sent to a port outside the OECD and thus avoid the convention (Alcaidea et al., 2016). As a result of negotiations to improve the loopholes of the Basel Convention, the Hong Kong Convention was developed.

2.4.2 Hong Kong Convention

The Hong Kong Convention for the Safe and Environmentally Sound Recycling of Ships (HKC), was adopted by the International Maritime Organization (IMO) in 2009 (IMO, s.a.-c). It aims to ensure that ships do not pose any unnecessary risk to human health and safety, or to the environment when being recycled. Additionally, it was developed to be the first legally binding ship recycling regulation. Nevertheless, due to a lack of ratification among the IMO member states, the HKC has yet to enter into force. At least 15 countries representing 40% of the world merchant fleet by gross tonnage (GT) needs to ratify the agreement before it can enter into force. These same 15 countries must also have a combined annual ship recycling volume of at least 3% of their total gross tonnage. So far, fifteen states have ratified the HKC which represents 29,62% of the world tonnage, which means that the two last conditions are yet to be met (IMO, 2020).

More precisely, the HKC includes regulations on the design, construction, operation, and preparation of ships. In addition, all ships sent to recycling will need to have an inventory list of hazardous materials (IHM) and surveys will be conducted to verify the IHM periodically. Lastly, ship recycling yards need to provide a ship recycling plan for each ship to ensure that the recycling process complies with the HKC (IMO, s.a.-c). The IMO have also developed guidelines for the Authorization of Ship Recycling Facilities, that member states of the HKC are responsible to use within their jurisdiction.

Nevertheless, the HKC has faced strong criticism for its reliance on flag states and national legislation. The HKC does not ban the scrapping of ships in South Asia and does not set requirements for the management of hazardous waste once it leaves the recycling facility. In addition, only ships that fly the flag of an IMO member state would be obliged to follow the convention, which entails 174 countries as of 2020 (Hong Kong Convention, s.a.; IMO, s.a.-b).

To sum up, the HKC includes several aspects that resemble the Basel Convention. However, it targets the ship recycling industry directly by following each vessel from its cradle to grave. This includes the IHM, an obligation to use authorised ship recycling facilities and the duty of member states to share information with the IMO (Galley, 2014).

2.4.3 EU Ship Recycling Regulation

In lack of a ratified and legally binding international agreement for safe and environmentally sound ship recycling, the EU Ship Recycling Regulation (SRR) was adopted by the European Parliament and the Council of the European Union on 20 of November 2013 (EU Ship Recycling Regulation, 2013). The regulation was put into force the 31 of December 2018, and aims to facilitate the ratification of the HKC.

The SRR follows a “cradle-to-grave" approach which entails reducing the negative health and environmental impacts throughout a ship’s lifespan. In that way, the regulation includes requirements from a ship is built until it reaches end-of-life and is dismantled. Further, the regulation is more stringent than the HKC, as it includes stricter environmental, safety and health standards. The SRR mainly affects ships flying an EU or EEA member state flag, hereafter referred to as EU member state. When also referring to EU flag or EU shipowner, we include the EEA countries. When the SRR was put into force, similarly to the HKC, all new ships were required to have a certified inventory list of hazardous materials (IHM). This part of the regulation also covers ships flying the flag of a third country calling at a port or anchorage of an EU member state. A third country is defined by the EU as: “a country that is not a member of the European Union as well as a country or territory whose citizens do not enjoy the European Union right to free movement” (European Commission, s.a.). The IHM requirement enters into force from 31 of December 2020 (EU Ship Recycling Regulation, 2013, Article 12). In that way, the SRR will be fully put into force at this date. Ships flying the flag of a third country may also be warned or excluded from the ports of a member state if they fail to comply with the IHM.

From the regulation was put into force, EU flagged commercial vessels above 500 gross tonnage must be recycled in safe and environmentally sound ship recycling facilities. The EU have developed a European List of approved ship recycling facilities. These facilities comply with EU safety and environmental specifications but might be located anywhere in the world given that they comply with the standards. The list is further updated periodically based on new applications from shipyards wanting to be included. It was last updated in November 2020 and includes 43 yards, where 34 facilities are located in EU/EAA member states, 8 in Turkey and 1 in the USA (European Commission, 2020a).

Prior to recycling a ship in a facility included in the European List, shipowners shall have developed a ship recycling plan to address matters that require special procedures. This plan must include information on the type and amount of hazardous materials and waste and how it will be managed and stored in the ship recycling facility (EU Ship Recycling Regulation, 2013, Article 6 & 7). In addition, shipowners must hold a ready-for-recycling certificate which approves the ship recycling plan. The Port State Controls of each member state are responsible for issuing the recycling certificates.

The European List requires ship recycling facilities to be "designed, constructed and operated in a safe and environmentally sound manner" (EU Ship Recycling Regulation, 2013). In order to reduce and prevent the number of human health risks and effects on the environment, management and monitoring systems and procedures are put in place. Further, hazardous materials and waste are stored in a safe and environmentally sound manner. The facilities also provide training for workers, ensuring the use of protective equipment. Additionally, they track the number of unwanted incidents such as accidents and occupational diseases.

Moreover, some extra requirements apply for facilities in third countries, such as which waste management processes are followed. This is to ensure the same standards across all the recycling facilities. Moreover, recycling facilities located in a third country must submit their application to the European Commission for inclusion in the European List, whereas national authorities in member states evaluate whether facilities located in their country comply with the standards (European Commission, 2020a).

According to article 22, each member state is responsible to apply necessary sanctions to enforce the regulation (EU Ship Recycling Regulation, 2013). These penalties shall further be "effective, proportionate and dissuasive" (ibid.). Moreover, member states must report to the European Commission the provisions of their national law enabling enforcement of the SRR. If a member state does not properly enforce the SRR, the European Commission can intervene and hold the state accountable (Jenssen, 2020). In Norway, the Ship Safety and Security Act regulates the shipping market (Akselsen & Bruås, 2018). Here, a shipping company may be fined, and individuals face up to 2 years imprisonment for not taking extensive measures to avoid pollution and environmental damage, such as having the IHM in place or recycling in an approved facility.

2.4.3.1 Weaknesses

As the regulation is based on flag state, shipowners can re-flag their ship to a third country to avoid having to recycle their ship in an approved facility. Another concern is that the various member states do not enforce the regulation or sanction shipowners in the same way (Jenssen, 2020). For instance, varying enforcement might occur as each member state conducts their own port state control. As member states also determine which recycling facilities comply with the standards of the European List, there is a risk that the SRR is interpreted differently and consequently the recycling facilities to some extent vary in how they provide safe and environmentally friendly ship recycling.

Jenssen (2020), especially draws attention to Malta and Greece as poor implementors of European regulations. Greece has the world's largest fleet in terms of ship ownership (UNCTAD, 2019). In 2019, they controlled 17,79% of the world's dead-weight tonnage in their fleet, but 82,6% of those vessels held a foreign flag. Dead-weight tonnage (DWT) is the total weight of cargo that a ship can carry (Stopford, 2009, p. 752).This might entail that Greek shipowners can circumvent the SRR by easily re-flagging their ship to a third country. In fact, 40 Greek owned ships were beached in 2019 which makes them the largest EU member state utilizing the beaching method (NGO Shipbreaking Platform, 2020). Further, Greece's beaching practice made up about 10% of global beaching in 2019.

Another central discussion is the effect of the SRR on firm competitiveness. Companies and states have voiced their concern regarding how the regulation might have a negative effect on EU flagged ships who compete with companies from third countries (Akselsen & Bruås, 2018). This is because the requirements related to selection of recycling facility, IHM and port state controls, are costly for shipowners. Here, one concern is that business might be diverted from Europe altogether as customers will register their vessels in third countries. This is also stated as one of the reasons why the HKC has not yet been ratified. On the contrary, some of these effects might be evened out for ships operating in Europe from the 31 of December 2020 when the SRR is fully implemented among third country vessels calling at an EU port or anchorage (ibid.). Still, the obligation to use a recycling facility from the European List is not required for third country vessels, which might reduce the total impact.

Furthermore, the SRR has been criticised for not having a sufficient amount of recycling capacity. There is especially a concern that the European listed facilities do not have the capacity to recycle larger vessels (Mikelis, 2019; Rahman & Kim, 2020; Stuer-Lauridsen et al., 2007). The Norwegian Maritime Authorities assume that this challenge will be the largest disadvantage for EU flagged ships and state that the costs related to recycling consequently might increase (Akselsen Bruås, 2018). This increased cost and challenge of recycling ships might hence work against its intention and incentivise companies to re-flag their end-of-life vessels to a third country. This is something we aim to figure out in our analysis. Lastly, some EU member states and representatives from the maritime industry have voiced a concern regarding the pace and process of approving recycling facilities in third countries. They state that the process is too slow, and that the global recycling capacity hence is too small (ibid.).

On the other hand, the NGO Shipbreaking Platform and Transport Environment, argue that the EU listed facilities have capacity to recycle all EU flagged ships (Gilliam & Jenssen, 2018). They claim that other studies analyse the historical recycling volume of recycling facilities, which does not properly reflect the potential scrapping volume. For example, it is stated that newly opened facilities are listed with zero recycling capacity in the European List as they have not yet started their operations. The amount the facility is licenced to handle has allegedly only been labelled as "theoretical" capacity.

2.5 Flag of Convenience

European shipowners operate over 40% of the world's merchant fleet, but only 22% of them fly an EU member state flag (European Commission, 2016). Shipowners may have an economic incentive to re-register, known as re-flagging, their ship to another country to avoid costly policy regulations. This re-flagging is known as flag of convenience (FOC) and refers to the practice where states grant nationality to vessels without there being a genuine link between the ownership of the ship and the flag state (Galley, 2013). The practice in such states is also known as open registers, and may entail a more relaxed enforcement of financial and regulatory control (Galley, 2013). In relation to shipbreaking, exploiting flag of convenience is attractive as it might be cost saving for shipowners and allow them to beach their ships.

In many cases, ships are re-flagged to countries with poor implementation of international laws and regulations and low corporate taxes (European Commission, 2016). In fact, closely to 40% of all beached ships in South Asia in 2014, were flagged in countries with particularly weak record of international law enforcement. In the same year, only 7,7% (GT) of all beached ships were registered under an EU flag, whilst 32% were still under EU ownership (ibid.). This illustrates how the probability of ships being re-registered increases as the ship becomes older and reaches the end of its life.

Some of these states such as Comoros, Tuvalu and St. Kitts and Nevis, are recognised as tax havens, where shipowner anonymity also might be granted. In that way, shipowners can avoid regulations as the Basel Convention of handling hazardous waste and the SRR, whilst also hiding their identity. The owner anonymity makes it difficult to track the previous shipowner before it is sent for scrapping. On the other hand, it is stated that several flag states with open registers wish to move away from the flag of convenience label (Galley, 2013). As an example, Liberia do not accept ships older than 20 years and the Bahamas do not accept older than 12 years. Nonetheless, these flag states may make exceptions from the rule after inspecting older vessels.

In addition, flag state might be connected to the registered owner of a ship. The registered owner is the legal entity of a ship and is responsible to make sure that applicable laws and regulations are followed (NGO Shipbreaking Platform, 2019a). The country of which the registered owner is based in, will determine what laws and regulations are applicable for the ship and its operations. Therefore, shipowners, who have an economic interest in the ship, can use the registered owner to lower costs. For instance, registering the ship in a third country can allow lower maintenance and crew costs and lower taxation.

Some flag states with relaxed enforcement of international regulations, such as Panama, also demand that the registered owner is listed in the same country as the flag (Jenssen, 2020). Thus, one entity may have full control of what laws and regulations need to be complied with. In our analysis, we will also use the term "beneficial owner" for shipowner. This is to underline that the shipowner is the commercial entity with economic interest in the ship and makes all decisions such as when and to whom the ship is sold for scrap. The registered owner is on the other hand the legal title of the ship and has little influence on a ships' operations.

In January 2019, 41% of the world total DWT was registered under the flag of Panama, Liberia and the Marshall Islands (UNCTAD, 2019). In January 2020, one year after the SRR implementation, the three countries controlled 42% of the world tonnage (UNCTAD, 2020). Another report shows a shift among the top 25 flag states when vessels reach their breaking destination (COWI, 2009). Here, states that do not appear in the operational list, are among the top 25 flag states. These countries include Tuvalu, St. Kitts-Nevis, Mongolia, the Comoros Islands, Cambodia and Dominica. Panama and Libera are still leading flag states at the point of dismantling, which is explained by the large size of their fleets. Lastly, the report states that the inclusion of new flag states appear due to their low fees, low crewing standards, high anonymity and short-term registration that is offered as FOC (COWI, 2009).

The enforcement of maritime regulations such as the SRR are complex (Rafferty, s.a.). The existence of flag state, registered owner, beneficial owner and even commercial operator, which is the charterer who pays rent to the beneficial owner, makes it challenging to enforce and hold an entity criminally liable if ship recycling is not done in a safe and environmentally sound manner. The system with several owner entities that might be anonymous, makes enforcement even more complex and might confuse governments who attempt to investigate illicit behaviour. This leads to a lack of transparency in the shipping industry and it enables shipowner to increase profits by circumventing costly regulations.

As previously discussed, beaching yards offer better prices to shipowners because of low labour costs, negative health safety externalities and negative environmental externalities. In that way, utilizing beaching facilities might also breach other multilateral environmental agreements developed by organizations such as the UN and the European Commission. Still, negative environmental externalities are allowed under WTO rules as they are not an environmental agency and do not wish to intervene in environmental policies (WTO, s.a). However, there are ways of incentivising compliance with the SRR. The NGO Shipbreaking Platform (2016) argue that it is necessary with a financial incentive to implement the PPP into the SRR and to make sure that flags of convenience are not exploited. For instance, states could subsidize the usage of facilities from the European List. In that way the profit gap between recycling your ship in a beaching facility and a facility from the European List would be removed (European Commission, 2017).

Another suggestion is the establishment of a ship recycling license (Devaux & Nicolaï, 2020). This was suggested to be part of the SRR but was not ratified. The recycling license was to apply for all ships calling at ports located in the EU, regardless of flag registration, which removes the issue of FOC for ships operating in Europe. Moreover, shipowners would have to pay an annual payment to obtain a licence to access EU ports. Once the ship reached the end of its life, the sum of payments would be returned given that the ship is recycled at a yard from the European List. Further, the ratification of the HKC could accelerate through a financial incentive (ibid.). Nevertheless, there are challenges with implementing such a license on a political level and various shipowners' associations are reluctant to adopt it.

2.6 Shipping Industry

The shipping industry is important as it facilitates and carries about 90% of the world's trade (ICS, s.a.). In that way, today's globalised economy which depends heavily on free trade, relies on shipping to transport raw materials and manufactured products. Historically, shipping has been central for economic development as it allowed countries to specialise in producing different kinds of goods and then export them, known as trade based on comparative advantages (Stopford, 2009, p. 4-5). In this way, a country was no longer fully dependent on producing all the goods they needed to sustain themselves but could rather trade with others.

Also, transporting goods by sea has long been the most efficient mean of transport as vessels can carry large and heavy amounts of goods (ibid.). In addition, vessels are utilized for commodity trades such as oil and gas, iron ore and coal. The demand for sea transport is in that way strongly dependent on the fluctuations in the world economy and trade activity (Stopford, 2009, p. 136). In fact, the world economy is the most important single influence on ship demand (Stopford, 2009, p. 140)

As the world demand for shipping services is highly volatile, the shipping market cycles consist of irregular peaks and lows (Stopford, 2009, p. 139). In that way, business cycles lay the foundation for shipping cycles. For instance, if there are sudden changes in the oil price, the demand for ships can quickly change (Stopford, 2009, p. 140-141). To best understand what is going on in the shipping market, it is useful to analyse additional supply and demand variables (Stopford, 2009, p. 139). The most important demand variables in shipping cycles are seaborne commodity trades, average haul, random shocks and transport cost, which make it difficult to predict market development. In supply, the most important variables are the world fleet size, fleet productivity, shipbuilding production, scrapping and freight revenue. The supply side of shipping will be further discussed in the next chapter on shipping company investments.

The Review of Maritime Transport 2019 presents a moderate world economy growth rate in 2018 (UNCTAD, 2019). In 2017, the maritime trade volumes expanded at 4,1%, whereas the 2018 growth rate was 2,7%. This slowdown is explained by fluctuations in the world economy such as the "Brexit" announcement, trade tensions between USA and China and protectionism, which manifest through weaker import demand. Further, trade volumes only expanded by 0,5% in 2019, which is explained by continued trade tensions and high policy uncertainty.

Nevertheless, total volumes of seaborne trade reached 11 billion tons in 2018, which is an all-time high. It is also estimated that less fuel-efficient vessels will be scrapped in the next years, which will reduce the growth in the world fleet by 0,8% in 2020 (UNCTAD, 2019). On the other hand, the world fleet grew by 4,1% in 2019, which is the highest growth rate since 2014 (UNCTAD, 2020). Despite this development, the COVID-19 pandemic in 2020 is expected to reduce fleet growth rate to 1,6% in by the end of 2020. The expected increase in ship recycling levels, is still supported as the shipping industry faces plans to scrap older vessels that are not fuel efficient (ibid.) Lastly, the world fleet growth in 2021 will depend on how demand for ships, economic activity and ship recycling development will recover from the pandemic.

2.7 Shipping Company Investments

In this section, we will analyse investment relevant decision factors from the perspective of shipping companies. Further, we will discuss the economies of shipping and shipbreaking, and what determines when and where a ship is sent for dismantling. As the SRR was enforced almost two years ago, our economic analysis will concentrate around a short-term perspective.

The supply side of shipping is affected by demand, as discussed in 2.6 Shipping Industry. The supply of ships in the maritime industry can further be divided into four markets (Stopford, 2009, p. 150-151). Firstly, we have the shipbuilding market. Secondly, the freight market which is sea transport services. Thirdly, shipowners can sell and buy used ships. Lastly, the shipbreaking market removes ships from the shipping market. Despite all these influences, a drop in the supply of ships is a somewhat slow process as it takes 1-4 years to build and deliver a new ship, and once it is built, the ship lives for 15-30 years (Stopford, 2009, p. 150). In the mid-1970s, the freight demand collapsed, and it took about 10 years for supply to adjust. Therefore, the industry is a long-cycle business where the growth of the global fleet depends on the balance between new ships and demolished ships (Stopford, 2009, p. 152-158). In that way, our analysis of the shipping market will focus on short-term market changes. This is supported by our research question which analyses the immediate effect of the SRR, the first year after its implementation.

Supply and demand are linked in the freight market as shipowners and shippers who order the transportation service, negotiate a freight rate which reflects the availability of ships in the market. Assuming perfect market competition, we can use a supply and demand model to illustrate the momentary equilibrium price (freight rate) at which has been negotiated. This reflects the spot market price and thus illustrates the short-term price (Stopford, 2009, p. 160-163). The equilibrium is fixed in the short-run, as adjusting the fleet size by selling or buying ships can only be done in the long-run. Further, the shipowner provides a certain amount of transportation for different freight rates. Once the freight rate falls below the lowest tolerable level, the owner does not offer any transportation and the ship is put into lay-off. The lowest tolerable freight rate depends on a ships' operating costs such as usage of fuel and need for maintenance and repairs. As ships depreciate, the lay-up point for older ships will occur at a higher freight rate, than for newer and more efficient ships (Stopford, 2009, p. 163).

When ships cannot longer be operated profitably, they are sold to shipbreakers. The timing when this happens is challenging to define. Shipowners face operating costs such as crew and maintenance, voyage costs such as fuel and port charges, capital costs such as amortization, and cargo handling costs when goods and materials are transported (Stopford, 2009, p. 220). All of these will impact the lay-up point for ships. Still, the timing of when a ship is sent for recycling, depends mainly on the age of the ship. At this point, the ship cannot be resold in the ship market and the shipbreakers are the last-resort buyers (Mikelis, 2019). However, there is no certain age at which a ship is recycled, which makes it difficult to predict the development of the global shipping capacity. The importance of age as scrapping determinant indicates that shipowners are not expected to dismantle their ships overnight to avoid costly regulations such as the SRR. In addition to age, market factors such scrap prices, technical obsolescence, current earnings, and market expectations, affect the timing of shipbreaking.

As mentioned in 2.6 Shipping Industry, the shipping market is very volatile. The annual rate of return has historically been low in comparison to other investments, such as the "S&P 500" (Stopford, 2009, p. 323). In addition, the standard deviation has been much bigger, which makes the shipping industry a risky investment choice. Nevertheless, its volatile nature also creates the opportunity for rewards of 20-30% or even larger (ibid.). Hence, shipowners will not send ships for recycling if they believe that the business cycle soon will go upwards, and the recession will end. This is supported by the argument that ships only are sent for recycling as a last resort due to their old age. To control for volatility, sudden market fluctuations, and other macro trends, we will add year fixed effects to our analysis. This is because we wish to isolate the effect of the SRR and generate results that are not driven by sudden and random fluctuations in the market that occur in specific years, and that affect vessels differently. Adding year fixed effects to the analysis, will in that way remove the year-to-year fluctuations in the shipbreaking market, and hence help to control for variation over time that is invariant across individual vessels.

Shipowners generate revenue when selling old ships to shipbreakers. Therefore, selecting shipbreaking facility is a matter of maximizing discounted profits by selling ships to the highest bidder. Scrap metal from the ships is recycled and re-used for new purposes. In that way, the negotiated price for the vessel depends on the availability of ships for scrap and the demand for scrap metal (Stopford, 2009, p. 212-213). In Bangladesh, India and Pakistan, there is a higher demand for scrapped metal, than in more developed countries (Stopford, 2009, p. 619). This is because there are stricter regulations for the re-use of scrapped materials in for instance, Europe. Hence, the beaching countries can offer a higher price for the scrap and shipowners expect high discounted profits in these countries.

The introduction of the SRR will from a company perspective impose a reduction in revenues. According to Stuer-Lauridsen et al., (2007), recycling in a fully safe and environmentally friendly recycling facility located in the EU, will give the shipowner a net revenue of -$20 to $130 per LDT in comparison to $400 in beaching countries. Light displacement tonnage (LDT) is the weight of a vessel as built, without cargo (Stopford, 2009, p. 753). This means that shipbreakers in some cases will charge shipowners for recycling, rather than paying them. This is also supported by Tingyao (2018), who states that using Turkish facilities from the European List will lead to a reduction in scrap values of 50%. The remaining European Listed facilities only will offer 70-75% in comparison to the beaching countries. Subsequently, the European List of approved facilities needs to offer an economically viable solution to ship recycling to ensure compliance (MARPROF, 2019). Companies will further continue to circumvent the regulation if the negative associations related to getting caught are smaller than the possible earnings that may be obtained.

The price for scrapped metal is also volatile but has increased in the beaching countries from $100 per LDT in the 1980s to $400 per LDT in 2007 (Stopford, 2009, p. 212-213; Stuer-Lauridsen et al., 2007). Furthermore, shipowners might lose up to half price per LDT if repairing in Turkey, compared to the three beaching countries. This is because safer recycling methods and higher wages for the shipbreakers is more costly. To put it into context, the price difference equals to a loss of almost $3 million for a Panamax tanker that is recycled safely (Stuer-Lauridsen et al., 2007). Vessel size is also a relevant factor which may affect where a shipowner decides to dismantle their ship, as the loss dismantling at a facility from the European List increases with the gross tonnage of the ship. This effect will be measured and included in our analysis in chapter 5.2. The cost difference will also vary depending on the structure of the vessel. For instance, tankers and bulk carriers are easier to dismantle than non-cargo vessels, which consequently will be reflected in the price (Stuer-Lauridsen et al., 2007). This is supported by UNCTAD (2020), who state that 83,8% of beached ships measured in GT were bulk carriers, container ships, offshore vessels and oil tankers in 2019. The largest group was bulk carriers, who accounted for 40,6% of all beached ships in GT.

Determining whether a ship is sent for beaching or not, may also be affected by country specific differences. For instance, all shipowners, whether it be the registered owner or beneficial owner of a ship, originate from a specific country. Further, all these ship owning countries have individual characteristics. To enable a comparison in our analysis of where ships that are beached come from, we need to control for these individual characteristics. A way of doing this is by adding country fixed effects, which is similar to the approach year fixed effects. By adding this dimension, we also control for country-individual characteristics that are invariant across time. Examples of such characteristics are rule of law, political environment, governance, and geographical location, as they might impact the recycling destination of a ship. For instance, some European countries may have stricter laws and regulations to avoid the export of hazardous materials, namely stricter enforcement of the Basel Convention. Such factors will also affect shipowners' decision to beach or recycle their ship in a safe manner. Country fixed effects are therefore included in our analysis to remove this effect and solely analyse the impact of the SRR implementation across countries. Thereafter, we can compare the post SRR probability of beaching among different shipowners' country of origin.

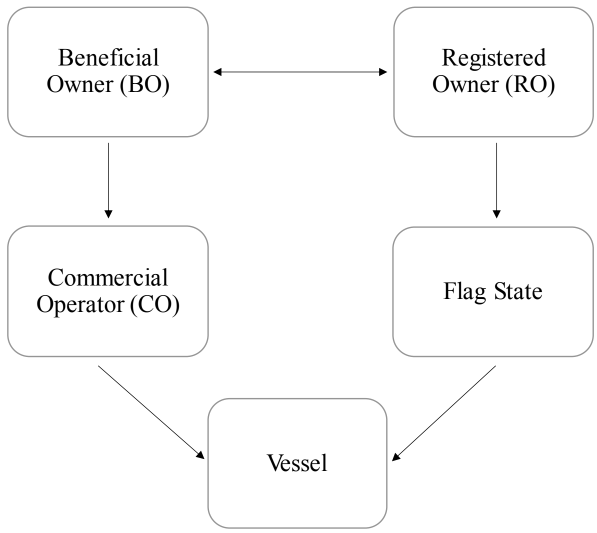
In 2.5 Flag of Convenience, we touched upon two types of shipowners, beneficial owners (BOs) and registered owners (ROs). As stated, the beneficial owner is the owner of a ship receiving revenue from the company operating the ship and they also determine when a ship is sent for dismantling. The registered owner is the legal entity of the ship (Jenssen, 2020). If something illegal was to happen, the registered owner will be investigated and potentially be held criminally liable. In our case, the registered owner can be held criminally liable if a ship is beached whilst being registered under an EU flag.

Nevertheless, defining beneficial owners and registered owners in a precise manner is a challenge. Even though we have defined RO and BO, it is not certain that the two entities have the same meaning in all countries. Another reason why these entities are challenging to interpret, might be because some companies aim to disguise ownership to avoid criminal liability. The IMO (2002), have stated that: “in many cases the publicly available information regarding the ownership of vessels is extremely limited”. The lack of public information makes it difficult to connect RO and BO to each other.

In Norway, international shipping companies who wish to register in the Norwegian International Ship Register (NIS) are required to appoint a Norwegian representative to receive lawsuits on behalf of the international owner (Norwegian International Ship Register (NIS), 1987, § 1). Further, Jenssen (2020), states that the RO often is located in third countries with poor implementation of international law. For instance, open registers and post office companies are exploited to complicate investigation processes. She further exemplifies Panama as a country who demands that flag and RO are in same country to control what laws and regulations need to be followed. Nonetheless, Jenssen also stresses that different practices occur across countries.

To sum up, figure 2.1 below illustrates how we interpret BO, RO and flag state, and how they interact with each other. As mentioned, this is subject to our own interpretation due to the lack of transparency in the industry. This model will consequently form the basis for further analysis. The model illustrates that BO and RO operate within different mandates but are at the same level, namely at the top of the hierarchy making decisions that affect the ship throughout its life cycle. RO is further connected to flag state as the RO will face lawsuits if a ship flying the flag of an EU state is beached. In addition, the BO rents out the ship to the CO and receives profits from the CO. Hence, the CO is directly linked to the vessel as they operate it on a daily basis. Flag is also directly connected to the vessel.

Figure 2.1: An Overview of Shipowner Entities and Their Assumed Relationship



2.7.1 SRR Effect Hypotheses

Due to the complexity of the owner entities and the lack of information on how RO and BO will be affected by the SRR, we have decided to analyse both entities. This is further supported by our model assumption that RO and BO both affect a ship throughout its operational life. Still, we cannot say how each of the shipowners control the ship due to differences in countries' laws and regulations. To answer our research question, we have developed two hypotheses that will be tested in our analysis. Based on our theoretical discussion, we do not expect the SRR to affect beaching levels measured by EU flag states, as FOC easily can be exploited. Therefore, we do not believe that many flags are registered in Europe. Hence, it would not form a representative sample for an analysis. In that way, we wish to test the effect of the SRR on registered owners and beneficial owners from the EU. Nevertheless, there is a risk that also ROs have been re-registered to countries with poor enforcement of international law (Jenssen, 2020). In addition, we expect that BOs might continue with beaching as they do not face legal consequences of breaching the SRR. Lastly, the uncertainty of how the SRR will affect ROs and BOs, has led to the conclusion of analysing both entities.

Hypothesis 1: SRR effect on Registered Owners from the EU

Hypothesis 1 explains the effect we believe the SRR will have on registered owners from EU member states. This entails compliance with the regulation and whether the probability of beaching for ships with registered owners from EU member states, is reduced:

H_0: *The SRR will **not** lead to a reduction in the probability of beaching for ships with a registered owner from EU & EEA member states.*

H_A: *The SRR will lead to a reduction in the probability of beaching for ships with a registered owner from EU & EEA member states.*

We expect the SRR to significantly reduce the beaching probability in countries with ROs from EU member states. This is explained by two reasons. Firstly, BOs who want to circumvent the regulation are expected re-register the RO to a third country. This means that the number of EU ROs decreases, but the total number of beached vessels worldwide, does not necessarily decrease. As the RO risks criminal sanctions for breaching the SRR, they have a strong incentive to re-register to a country with open registers or poor implementation of international regulations. If many ROs already are re-registered outside the EU, we risk having a small sample size, like our assumption regarding flag state.

Secondly, some BOs are expected to comply with the SRR. Therefore, it is also expected that some companies still have their RO in Europe, and hence comply with the SRR. In that way, we expect the beaching probability of vessels with ROs from EU countries, to decrease. At the same time, we believe there will be fewer ROs in Europe after the implementation of the SRR, as some will re-register to third countries to circumvent the regulation.

Hypothesis 2: SRR Effect on Beneficial Owners from the EU

Hypothesis 2 explains the effect we believe the SRR will have on beneficial owners from EU member states:

H_0: *The SRR will **not** lead to a reduction in the probability of beaching for ships with a beneficial owner from EU & EEA member states.*

H_A: *The SRR will lead to a reduction in the probability of beaching for ships with a beneficial owner from EU & EEA member states.*

Even though Hypothesis 1 and Hypothesis 2 are alike, we do not expect the regulation to affect BOs as strongly as ROs. This is because BOs do not risk criminal sanctions if they breach the SRR. Hence, believe that the incentives for BOs to adhere to the SRR, are smaller than for ROs. On the other hand, it is relevant to analyse BOs because they often need to be registered in the country where they operate. Therefore, we believe that there is a substantial number of BOs registered within the EU and are interested in examining how they will adapt to the SRR.

2.8 Strategic Implications of the SRR

From a shipowner perspective, the strategic implications of the SRR include the evaluation of dismantling a ship either in a facility from the European List or outside the list. As established, there is a strong financial incentive to beach ships. This is at the risk of being caught and either face social sanction, or criminal persecution which entails economic sanctions, if the ship flies the flag of an EU member state.

Low wages, long working hours, under-aged workers and aggressive behaviour, are also widespread problems in the beaching industry (ILO, 2004). In India, workers are paid better than in Bangladesh (Kumar, 2008). According to the International Metalworkers' Federation, the average wage per day in India scrapping yards is 84 rupees, which equals to about 1 euro (2007). Further, the Metalworkers' Federation states that many workers suffer from minor accidents such as burns and cuts. The rate of injury is 50 per day among the 60 000 employed workers at Alang-Sosiya, India (ibid.). Indian workers also work eight hours a day and have an insurance plan. On the other hand, Bangladesh workers might work up to 14-hour shifts, 6 days per week, and have no insurance plans (Kumar, 2008). Child labour also make up over 10% of the labour force in Bangladesh. In Pakistan, there lacks information about working conditions. The issue of poor working conditions may have reputational consequences for shipowners and hence act as an incentive to improve recycling practices. Recycling in a facility from the European List will secure safe working conditions and the SRR will in that way contribute to improving the working conditions in the industry.

In recent time, environmental issues have been prevalent on the international political agenda. Nevertheless, the power of social sanctions might not be that strong, as we have seen continuous shipbreaking in South Asia parallel to political engagement. In fact, Bangladesh, India and Pakistan scrapped 91,6% of the world's ship tonnage in 2018 as they offer the highest price for vessels that have reached the end of their lives (Mikelis, 2019). The decision to beach a ship can be explained by the shareholder primacy view which entails that the only moral responsibility of a firm, is to maximize profits for its shareholders (Friedman, 1970). Still, one can argue that Friedman's theory is outdated and that companies who wish to survive today ought to be sustainable whilst making ethical decisions. This is called strategic CSR and has also been found to be profitable for companies (Flammer, 2015).

Further, the world is constantly developing with technological progression and continuous globalisation. Shipping companies need to be able to adjust and manage the rapid change and innovation that the industry and world economy faces. In the short run, firms might well worry about the consequences of lost revenue from using ship recycling services from the European List. Nevertheless, in the long run, being able to obtain sustainable value creation can create a competitive advantage and ensure the survival of a company (Porter, 1996). For instance, more costly recycling is an incentive to invest in ships that have a longer life expectancy, so that they can operate and generate profit over a longer period.

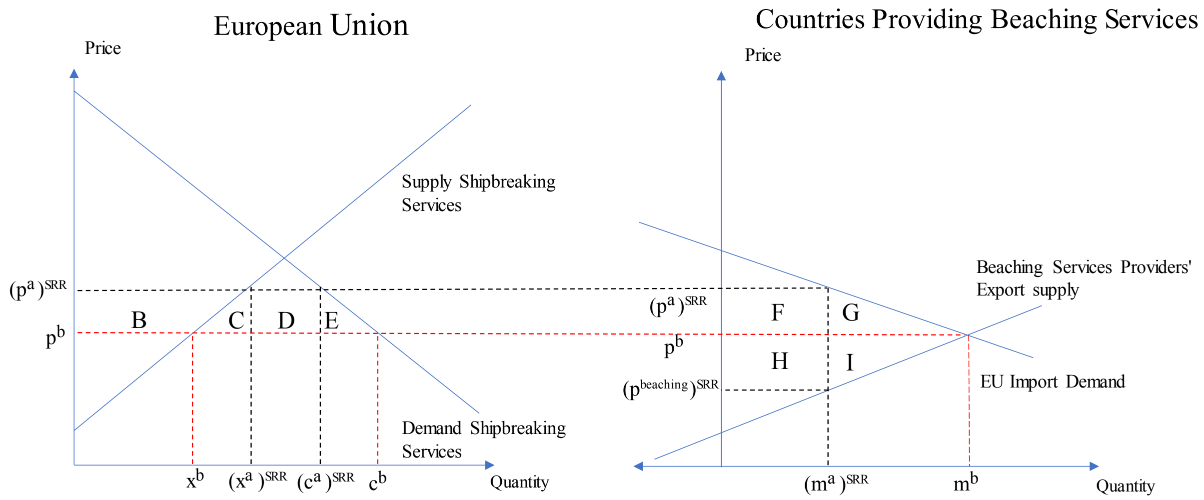
The potential sanctions from the general society for beaching ships, could have strategic implications for companies if the sanctions contribute to determine where a ship is dismantled. Even though a ship does not fly the flag of an EU member state, the population of the country at which the shipowner comes from might revolt if they find out about beaching practices. In that way, media coverage could lead to putting this topic on the political agenda and hence engage local populations, NGO's and activist groups.

2.9 Why has the EU Implemented the SRR?

The EU state that they have implemented the SRR to facilitate the ratification of the HKC. To build upon this, we will analyse if it also may be in the self-interest of the EU to implement the SRR. The EU aims to govern its member states' waste management strategies (Morris & Emden, 2018). Among others, member states are required to ensure that waste is managed in a safe and environmentally sound manner, implementing the PPP to bear the cost of waste (ibid.) Nevertheless, we have seen that the polluter does not pay according to the SRR as recycling facilities are bound to comply with strict and costly obligations, whereas shipowners to a lesser extent bear these costs. The polluters are arguably the shipowners, as they profit from operating the ship.

To explain the implications of the regulation, the SRR could be viewed as a toll on ship recycling services imported by the EU from countries providing beaching services. Here, we consider the EU as one country that imports the service of ship recycling from Bangladesh, India and Pakistan, hereafter referred to as countries providing beaching services. The model assumes a market with perfect competition and free trade prior to the introduction of the toll (Norman, 2010, p. 263). As Figure 2.2 illustrates, the toll, namely SRR implementation, directly increases the price of recycling a ship for EU shipowners from p^b to $p^{a(SRR)}$. The increase in price, reduces the EU demand for ship recycling services from c^b to $c^{a(SRR)}$ and increases the local EU supply of ship recycling services from x^b to $x^{a(SRR)}$. The price obtained for recycling services after the SRR implementation also drops in the beaching countries, as fewer EU shipowners are buying beaching services. This can be seen in the shift from p^b to $p^{beaching(SRR)}$

Figure 2.2: Toll Model - EU versus Countries Providing Beaching Services.



Similarly, the beaching countries export supply and EU import demand decrease from m^b to $m^{a(SRR)}$. The increased EU supply of ship recycling services and drop in beaching countries export of ship recycling services, increases the quantity of ships recycled in the EU and reduces the quantity recycled in countries providing beaching services. In other words, EU member states could benefit from the new workplaces that are generated at the EU ship recycling yards. From a political point of view, it is beneficial for the EU if these workplaces reduce unemployment as it might improve the EU's reputation if they contribute to developing new workplaces. This occurs at the expense of the countries providing beaching services because shipowners would choose the cheapest ship recycling service if the market were not regulated.

Further, implementing a toll creates profit-shifting (Norman, 2010, p. 265). Area H represents a shift of profits of the producer surplus from the countries providing beaching services, to the European listed recycling facilities. This supports the introduction of the SRR. As European shipowners operate over 40% of the worlds merchant fleet, they are a large player in the ship recycling industry (European Commission, 2016). In that way, European shipowners can impact the market price as they represent a large share of the global ship recycling demand. This is exemplified in the price moving from p^{b} to $p^{a(SRR)}$. Additionally, the European shipowners face a reduced consumer surplus which is transferred to the EU recycling facilities.

The introduction of a toll in a market with perfect competition creates an efficiency loss, which does not support the SRR implementation (Norman, 2010, p. 265). Specifically, the EU shipowners have an efficiency loss equal to the area of (B+C+D+E) due to the price increase. The EU ship recycling facilities then profit area B. Further, the loss of EU shipowners, namely (B+C+D+E) exceeds the benefit of the EU facilities, namely B, because there is a larger demand than supply of ship recycling services in the EU. This effect occurs as ship recycling services historically have been an imported service. If the SRR was a toll, the EU would earn area (F+H) in toll incomes.

Nevertheless, this is not the case for the SRR as the EU does not receive toll income. In that way, we modify the effect of the model and the total economic effect of the SRR implementation is negative. In addition, the facilities providing beaching services lose (H+I) due to the price drop. At the same time, shipowners who still beach their ships in Bangladesh, India or Pakistan, will benefit, as the price now is lower at point $p^{beaching(SRR)}$. This can be criticised as the EU now have created an even bigger economic incentive for shipowners to avoid the SRR by exploiting FOC. Lastly, the beaching facilities' loss of area (H+I) is greater than the benefit of local consumers who still buy their services. The world market for ship recycling services has a total loss of (G+I), which is a pure efficiency loss. In that way, (G+I) does not support the implementation of the SRR.

Viewing the EU as a large country and a substantial market player, facilitates a discussion on their interest in implementing the SRR. As the EU are first movers in the safe and environmentally sound ship recycling market, they might gain more influence on the same industry development in other countries. Introducing a regulation which aims to protect workers and the environment, is likely to have a positive impact on their reputation (Berliner & Prakash, 2015). Nonetheless, it is relevant to question the effectiveness of the SRR and if the EU has a real positive impact on the world by introducing the regulation. There is a danger that the EU is conducting "greenwashing" to picture themselves as practitioners of best-practice shipbreaking (William, 2003). Still, we cannot be certain of what effect the SRR has on the occurrence of beaching. Also, smaller countries worldwide might wish to follow safe shipbreaking practices, but it could be more costly and less accessible for them than for the EU, who have access to a wide range of resources.

Another reason for implementing the SRR, can be to reduce the negative health and environmental externalities from the beaching industry. As the environment is known as a public good, which is non-excludable and non-rivalrous, harmful recycling practices would decrease its general quality (Grafton, 2004, p. 37). Even though the negative externalities are not directly illustrated in figure 2.2, the EU supply of ship recycling services with a higher recycling price, could be interpreted as a solution internalizing costs of negative externalities, known as the social cost (Goolsbee, 2013, p. 645). In the beaching yards, the price of scrapping is lower because the negative externalities are not reflected in the private cost. In that way, the introduction of the SRR could lead to a reduced level of negative externalities because the EU ship recycling facilities try to incorporate some of the external costs into the market price (ibid.).

To sum up, the EU does not have a direct economic incentive to implement the SRR but could rather gain positive reputational consequences due to the SRR's potential long term environmental and health benefits.

2.10 Market Implications of the SRR

By introducing a legally binding regulation, firms are automatically compelled to comply with its standards. In other words, the EU has chosen to enforce a certain behaviour on the shipping industry rather than creating economic incentives for them to change. What do we know about the efficiency of such regulatory policies? Do they work to reduce the occurrence of unwanted behaviour?

When regulatory policies are introduced, there is arguably an incentive for companies to find loopholes to maximize profits. In other words, they might find ways of avoiding the policy, and the global goal of making the shipbreaking industry safer might be neglected. This is also the case for the SRR as the regulation is bound to flag state membership, which easily can be circumvented and deviates from the PPP. The principle says that those who pollute, should also bear the costs of managing it to reduce the impact on human health and the environment (LSE, 2018). This is relevant for shipbreaking as hazardous wastes contaminate the land, water, and air where ships are being scrapped. One argument for using PPP in this case, could be that it lays the responsibility on the shipowner directly rather the ship recycling facilities to comply with the standards. If everyone is to pay for the negative externalities they impose on the environment, irrespective of where they recycle their ship, the economic incentive of deviating from the standards will be removed. Hence, this could improve the standards of the overall shipbreaking industry.

On the other hand, shipowners might evaluate the risk of negative reputational consequences to be so big, that they adhere to the SRR. In other words, the cost of circumventing the regulation can be high as beaching and the use of tax havens globally has received negative media coverage. Given that EU shipowners do adhere to the SRR and recycle their ships in facilities from the European List, the beaching yards have a financial incentive to become members of the European List. This could reduce the negative externalities of the shipbreaking business. Nonetheless, it poses a challenge as the beaching yards do not have the real capacity to adhere to such costly obligations, due to the lack of machinery and the heavy reliance on manual labour. Since 2013, South Asian countries have raised their concern, stating that an international regulation such as the HKC, would have a deeply negative impact on their national economies and communities (Pastorelli, 2014). In Bangladesh alone, 300 000 people depend on the beaching business. Further, this does not follow the PPP as the beaching yards bear the costs of changing their practices.

Additionally, ships around the world are being dismantled earlier than before. UNCTAD (2019), states that there is an oversupply of tonnage in the market, even though the world fleet has reached its slowest growth rate of the decade. Hence, ships are being scrapped younger and younger. In 2019, the average age of a ships being scrapped, was 21 years (ibid.). In comparison, the average age was 23 years in 2009 (UNCTAD, 2011). The oversupply of tonnage can be explained by unexpected economic crisis', stricter regulatory and international policies, and the strategic decision of shipowners to upgrade ships with newer technologies, such as investing in fuel efficient vessels (European Commission, 2016). For instance, the IMO implemented a regulation 1. of January 2020, which limits the amount of sulphur for marine fuel oil to 0,5% (UNCTAD, 2019). This expected to reduce the supply of vessels in the short run, especially of large vessels, as those who do not comply with the regulation will be withdrawn from the market.

As previously mentioned, 32% of all beached ships in 2014 were under EU ownership, but only 7,7% held an EU flag (European Commission, 2016). This implies that many EU shipowners exploit FOC to beach their ships. If this trend is still occurring, the beaching countries might not suffer too much from the implementation of the SRR. This is exactly what we aim at discovering in our data analysis. Also, the world fleet, excluding the EU-area, is still of significant size and the beaching yards will hence still have business after the SRR implementation. This uncovers a limitation of the SRR and calls for the necessity of ratifying the HKC.

Even though no countries might support the negative health, safety and environmental consequences of today's shipbreaking industry, the ratification of international agreements and cooperating on a global level is challenging. The EU state that they wish to enable the ratification of the HKC through the SRR. This is supported by Wooldridge et al. (2012), who state that cooperating yields higher collective benefits than the total contribution from smaller coalitions or individuals. Nevertheless, this is challenging to implement due to reluctance from shipowners and political entities. The reluctance might come from stakeholders' fear of not being able to maintain their self-interest. For instance, complying with the SRR by not exploiting FOC, can lead to loss of profits. Another challenge is to decide which governing body should have the power to decide what is the best course of action to handle the challenges of the industry. Here, it is likely that some stakeholders fear that their opinions will not be considered. Another issue, as mentioned under the SRR weaknesses, is the concern of the SRR not being enforced similarly across the different EU member states.

Another critique of the SRR, is that it is conflicting with the HKC as it goes further than the HKC (Akselsen & Bruås, 2018). The market implications of the SRR might in the worst case therefore work contradictory to the ratification of the HKC. The issue of free riding might also be discussed here. Free riding is when individual participants can benefit from results of actions supposedly meant to be done by all, by not contributing (Kolstad, 2011). This harms the achieved results from a regulation. If members of the IMO view that Europe does enough to ensure cleaner and safer ship recycling, they might no longer feel obliged to improve their industry policies.

Free riding also occurs when shipowners exploit FOC to circumvent the SRR. This indicates that the sanctions related to breaching the SRR are too mild (ibid.). EUs approach is further explained by Devaux & Nicolaï (2020). They state that: "As a global player, they EU aspires to curb the globalized practice of ship dismantling by mobilizing an innovative approach based on incentives rather than constraints". This supports the argument that the EU benefit from being the first mover is the ship recycling market. The EU can benefit from operating by themselves as they can influence the global development of policies by demonstrating their own experiences. The desire to follow an approach based on incentives rather than constraints might also support the statement that today's sanctions of breaching the SRR might be too mild.

3 Data

In this part, we will first provide relevant insights about our dataset and its origin. Second, we will explain how the dataset has been refined to enhance data quality. Third, we present the variables used in the analysis.

3.1 Data Source

The dataset used in this thesis is provided by the NGO Shipbreaking Platform, an international human rights and environmental organization working for sound ship dismantling and recycling worldwide (European Commission, 2020b). Further, the organization especially sheds light on the health and safety dangers of beaching. Utilizing data from a non-governmental organization (NGO) who have interest in exposing misconduct and hazardous practices, could potentially be a weakness for our study if the data is biased (Kaisler & O'Connor, 2020). The NGO Shipbreaking Platform intends to raise awareness about shipbreaking, beaching and any shipowner-behaviour conflicting with national policies and international regulations, that aim to protect people and the environment (NGO Shipbreaking Platform, s.a.).

Having established the subjective intentions of the NGO Shipbreaking Platform, we might question the objectivity of the dataset and have a natural scepticism towards its quality. Additionally, the NGO Shipbreaking Platform receives grants from the US State Department and the Norwegian Municipality and Health Pension Fund (KLP) (European Commission, 2020b; NGO Shipbreaking Platform, 2019b). Consequently, the NGO Shipbreaking Platform could potentially be lobbyists and promote certain stakeholders to secure future funding. The dataset we have retrieved from the NGO Shipbreaking Platform consists of several primary data sources that have been compiled into one dataset. We aim to maintain a critical mindset as we work with secondary data that already has been collected through primary data sources. This is especially important as the primary data is hard for us to cross-check due to being non-official, restricted to members, or available only after purchase.

On the other side, there are several strengths with the data provided by the NGO Shipbreaking Platform. They use primary data sources that also are utilized by the

IMO and the European Commission (Jenssen, 2020). The CEO of the Shipbreaking Platform, Ingvild Jenssen (2020), states that the most important primary data sources are: Equasis (2020), an organization trying to enhance transparency in the shipping industry by delivering data on beneficial owners, IHS Markit (2020), who deliver information on ship identification numbers and registered owners, and Lloyd's Register, a company providing maritime information, which is used by the NGO Shipbreaking Platform to compliment and check any missing data (Lloyd´s Register, 2020). Lastly, the NGO Shipbreaking Platform takes advantage of satellite imagery, harbour data and customs documents, to track ship movement and cross-check information (Jenssen, 2020).

Further, the NGO Shipbreaking Platform has collaborated with the European Commission on developing the SRR (European Commission, 2020b). This collaboration supports the notion of the NGO Shipbreaking Platform as a serious and trustworthy international organization, with knowledge of value to the European Commission. The credibility of the European Commission could then reflect on NGO Shipbreaking Platform by adding a certain trustworthiness to their independent work.

3.2 Dataset Content

More specifically, the compiled dataset spans from 2012 to 2019 and contains 7377 data points. Further, each data point represents a scrapped vessel, and each vessel is identified by a unique IMO-code. The seven-digit IMO code is required by all commercial ships above 100 gross tonnage (GT) and should remain visible on the hull of the ship throughout its lifetime (IMO, s.a.-a). As most large commercial ships fall within this category, it is possible to track its origin, ownership, and end-of-life destination. In section 3.4, we will present in-depth information about the qualitative and quantitative dataset information including which variables we will use in our analysis.

As established, information related to a vessel appears in the dataset once the vessel has been scrapped. Consequently, the dataset has a pooled cross-sectional nature (Wooldridge, 2016, p. 5-8). Essentially, this means that the dataset has attributes of cross sections alongside features from time series. Firstly, the cross-sections are represented in vessels being scrapped in one given year. Further, we assume that the cross-sections consist of vessels that are scrapped independent of each other. This implicates a random sampling of vessels where we observe the datapoints at one point in time, namely at the end of each year, creating one cross section per year. Secondly, the time serial aspect is intuitively given by the dataset stretching through eight years, from 2012 to 2019. In that way, an overview of owner entities and countries involved in the vessel's end-of-life period can be identified.

3.3 Refining the Dataset

As we are interested in an analysis which is as precise as possible, the dataset needs to be refined to improve overall information quality. Some observations could potentially add severe noise or uncertainty to the analysis and results, if not removed. This could either be due to missing data, or high levels of ambiguity caused by non-affirmable information, e.g., "unknowns". In table 3.1 below, the structural amendments and results are presented.

Table 3.1: Steps in Refining the Dataset

No. Observations	Data Remaining	Reason to Removal
7377	100%	-
7333	99,4%	Duplicate IMOs
7039	95,4%	Unknown Beneficial Owners
7016	95,1%	Unknown End-of-life destination
3607	48,9%	Dataset adjusted to RO content

Through removal of duplicates and missing data in certain vessel specific variables, we end up keeping around 95% of the original dataset. As mentioned, our hypotheses aim to measure the SRR's effect on both beneficial shipowners (BO) and registered shipowners (RO). To test the hypotheses, we need to segment BOs and ROs into two groups, based on geographical origin. All BOs registered within the EU or EEA form one group, whereas all BOs from other countries form the second group. The same accounts for ROs.

Moreover, the dataset does not contain information on RO in EU or EEA countries prior to 2015. Subsequently, as we aim to compare how the beaching probability among the two owner entity groups has been affected by the SRR, we need to adjust the BO data to match the available data on RO. We will further discuss this in chapter 6.5.2, where all BO data will be included in a robustness analysis. Due to the missing RO data, 48,9% of the original dataset, about 3600 observations, remain and form basis for the regression analysis.

3.4 Variables of Interest

In this part, the variables we use from the original dataset are listed along with a short variable description in table 3.2 below. These variables will be used in our analysis and have also been utilized to create new variables that are necessary for the scope of our analysis.

3.4.1 Original Variables

Table 3.2: Utilized Variables from the Dataset

Variable Name	Variable Unit	Variable Description
Beneficial Owner (BO) Country	Country	BO's Country of Origin
Built	Year	Vessel construction year
Country	Country	Country of scrapping
Gross Tonnage (GT)	Tonnes	Vessel volume, proxy for ship size
Registered Owner (RO) Country	Country	RO's Country of Origin
Year	Year	Year vessel is scrapped

In table 3.2, we have listed the main variables that are utilized in the analysis: *Beneficial Owner* (BO): the owning entity receiving profits from the vessel operations; *Built*: the year the vessel was built; *Country*: the country where the vessel is scrapped; *Gross Tonnage* (GT): the internal volume of the permanently enclosed areas of a ship from keel to funnel, thus a proxy of ship size (European Commission, 1969); *Registered Owner* (RO): the legal entity in charge of the vessel; *Year*: indicating the year the vessel was scrapped. In other words, BO- and RO country, gross tonnage and year are variables linked to each vessel, namely vessel specific information. This means that each vessel can be sub-categorized and identified by having BO- and RO countries of origin, gross tonnage and scrapping year.

3.4.2 Created Variables

Table 3.3: Created Variables

Variable Name	Variable Unit	Variable Description
Vessel age	Year	Lifetime of ship (Year scrapped - Year built)
Beached	Dummy	"1" if vessel is scrapped in BIP, "0" otherwise
d16	Dummy	"1" if *year* is post 01.01.2016, "0" otherwise
d17	Dummy	"1" if *year* is post 01.01.2017, "0" otherwise
d18	Dummy	"1" if *year* is post 01.01.2018, "0" otherwise
d19	Dummy	"1" if *year* is post 01.01.2019, "0" otherwise
EU_BO	Dummy	"1" if BO origins in EU or EEA, "0" otherwise
EU_RO	Dummy	"1" if RO origins in EU or EEA, "0" otherwise
bocountry_num	Integer	Numerical ID for BO country
rocountry_num	Integer	Numerical ID for RO country

To assist our analysis, we created the variables shown in table 3.3 above. These include; *Vessel age*: the vessel's age when scrapped based on the difference between scrapping and construction year; *Beached*: a dummy variable taking on value "1" if the vessel is scrapped in Bangladesh, India or Pakistan and "0" otherwise; *d16-d19*: dummies taking on the value of "1" if a vessel is scrapped after the first day in the respective years of 2016, 2017, 2018 and 2019, and "0" otherwise. For 2019, 01.01.2019 is practically equivalent to 31.12.2018 when the SRR is implemented; *EU_BO*: is a dummy taking on the value of "1" if the BO is registered within an EU or EEA country, and "0" otherwise; *EU_RO*: is a dummy taking on the value of "1" if the RO is registered within an EU or EEA country, and "0" otherwise; *BO Country Number* or *bocountry_num*: this variable groups vessels based on the country where the BO is registered, by giving each country an individual and unique number; *RO Country Number* or *rocountry_num*: this variable groups vessels based on the country where the registered owner, namely the vessels legal entity, is registered.

3.4.3 Dependent Dummy Variable, *Beached*

Our dependent, also known as explained, variable is the dummy $Beached_{\mathrm{ijt}}$ for vessel, i, registered in BO/RO-country, j, in year, t. Repeating an important point, this dichotomous dummy variable operates on an individual basis taking on value "1" if a vessel is beached in Bangladesh, India or Pakistan or "0" otherwise. This is repeated formally below:

$$Beached_{ijt}\ ,\ where \begin{cases} i \in I, & \text{IMO: Individual 7-digit code } \textit{unit}\text{, I, I = (1, 2, ..., 3607.)} \\ j \in J, & \text{Beneficial/Registered Owner Country, J = (1, 2, ..., 122/128.)} \\ t \in T, & \text{Year, T = (2015, 2016, ... 2019.)} \end{cases}$$

3.4.4 Independent Variables

Each independent variable is supposed to have an explanatory role on the dependent variable in the regressions. Firstly, we will introduce *bocountry_ num* and *rocountry_ num*. The SRR targets the flag a vessel flies, namely under which registered country the vessel operates. Only looking at flag state would not give insight into who benefits from the beaching activity, because it does not say anything about who the real shipowner is. Therefore, we look at the effects based on RO and BO countries of origin. Further, we group the countries into EU and non-EU member states. To achieve comparability between the groups, we control for individual RO or BO country fixed effects by adding *rocountry_ num* in Model 1 and *bocountry_ num* in Model 2.

Additionally, we control year fixed effects by adding year to both models. This is done to rule out the impact of the development from one year to another within individual countries. Now that the fixed effects in the respective hypothesis models are accounted for, the regression result will be comparable between RO and BO countries, and more importantly between EU and non-EU groups. As these effects are not needed to complete a formal interpretation of our results, they are later left unreported in the regression analysis.

Moreover, we categorize the following as explanatory variables age_{ijt}, GT_{ijt}, $d16_{\mathrm{ijt}}$, $d17_{\mathrm{ijt}}$, $d18_{\mathrm{ijt}}$, $d19_{\mathrm{ijt}}$, and the respective treatment group specific independent variables EU_RO_{ijt} for Model 1 and EU_BO_{ijt} and for Model 2. The same subscripts account for the independent variables as for the dependent variable:

$$Var.\ X_{ijt}\ ,\ where \begin{cases} i \in I, & \text{IMO: Individual 7-digit code } \textit{unit}\text{, I, I = (1, 2, ..., 3607.)} \\ j \in J, & \text{Beneficial/Registered Owner Country, J = (1, 2, ..., 122/128.)} \\ t \in T, & \text{Year, T = (2015, 2016, ... 2019.)} \end{cases}$$

In our main regressions which will be presented extensively in chapter 5 Analysis, the dummy variables $d19_{\text{ijt}}$, EU_BO_{ijt} and EU_RO_{ijt} are particularly central and we will therefore repeat them figuratively:

$$d19_{ijt} = \begin{cases} 1, & for\ t\ after\ \text{01.01.2019,} \\ 0, & Otherwise \end{cases} \quad , EU\_BO/RO_{ijt} = \begin{cases} 1, & for\ BO/RO\ in\ EU \\ 0, & Otherwise \end{cases}$$

4 Methodology

In the following chapter, we will explain the methodology behind building a model which combines independent variables with a dummy dependent variable. To infer that one variable has a causal effect on another, especially concerning governmental policy effects, it is not sufficient to state a relationship between them. The notion of *ceteris paribus* (all else equal) is crucial in determining causality (Wooldridge, 2016, p. 10-11). By holding all other independent variables fixed, we can specifically test each variable's impact on the dependent variable. We strive to estimate this through the models in our econometric analysis, by using the methodology presented in this chapter. Since the SRR implementation happens in the real world we try to account for differences in data properties to manage isolating any regulatory effect comparable for all vessels.

In short, our research question on analysing how the SRR has affected European shipbreaking practices, will be answered by performing a study on a treatment group which is affected by the regulation, and a control group which is not affected by the regulation (Wooldridge, 2016, p. 407-411). More precisely, we look at developments of the groups' respective regression estimates before and after the SRR implementation, while controlling for fixed effects between countries and through time. In its essence, the development of the groups is assumed to be parallel prior to the SRR implementation, as both groups ideally have the same average composition based on vessel characteristics. Further, we will investigate if any difference in the groups development after the implementation is significant and could be linked to the effect of SRR.

Moreover, our method is much alike the "Difference-in-Differences" (DD) methodology which is frequently used when evaluating policy effects in quasi-experimental event studies (Wooldridge, 2016, p. 407-412). The standard DD method is usually connected to panel data as one normally controls for any fixed effects on an observational individual level (Wooldridge, 2016, p. 413). Due to the repeated cross-sectional data structure, we are only able to control for country-level fixed effects in multiple time periods as we cannot follow the same individual vessels over time. This makes our multilevel method different from a standard DD (Imbens & Wooldridge, 2007). Nevertheless, we have the same goal as in a DD estimation, namely measuring a treatment effect coefficient caused by the regulation.

4.1 Analytical Tool

"Ordinary Least Squares" (OLS) forms the fundament of our regression analysis, though with some model specific interpretational amendments. The method of OLS is widely known for statistical econometric analysis, and is thus a robust choice (Wooldridge, 2016, p. 27-32). The main idea of OLS is to estimate a line which best fits the data points, named a regression line. Technically, this is done by minimizing the sum of squared residuals between observed and predicted, or estimated, values. In other words, this is to find the minimum average difference between the actual dependent variable values and its best fit to the data in each cross section through time. As the latter is true for a continuous dependent variable, it is somewhat different when the dependent variable takes on values of "1" or "0".

In our case, the dichotomous qualitative dependent variable *Beached* takes "1" if the vessel is beached in Bangladesh, India or Pakistan, or "0" otherwise. Even though the basis of the OLS regression remains the same, our estimation model changes to become a "linear probability model" (LPM) (Wooldridge, 2016, p. 224). This is due to the restricted continuity in the dependent variable which makes it limited (Wooldridge, 2016, p. 524). Moreover, the independent variables are interpreted to affect the probability of the dependent variables' "success". In other words, how they change the probability of *Beached* taking the value "1" (Wooldridge, 2016, p. 225). A "success" in this context has an objective purpose and does not represent a subjective wanted outcome.

Nevertheless, the actual estimation of the LPM model remains as it would be under OLS, and the data does therefore not need any modification. Essentially, this means performing the regression as for a continuous dependent variable, assuming the OLS assumptions to hold. One occurring issue with the LPM model is that not all OLS assumptions are met. We will revisit this topic in the end of this chapter, and in chapter 6 Discussion.

4.1.1 Analytical Tool Discussion

A general issue with having a dummy dependent variable is that the coefficient value of the independent variables must not exceed the upper or lower limit to make practical sense (Wooldridge, 2016, p. 526). In other words, it would not be particularly meaningful to interpret aggregated coefficients, and their sign, if they turn out to exceed the relative probability value upper bound of "1" (100% probable) or the lower bound of "0" (0% probable). The diverging estimates could occur due to the magnitude of the variable coefficient(s) or due to a large change in the number of variable units (Wooldridge, 2016, p. 225). Therefore, the LPM should be used with care when dealing with predictions including many relative unit changes or dealing with relatively high or low coefficients close to these limits.

Furthermore, as we do not believe our estimates to be outside or close to corner solutions based on the change in beaching probability, the LPM should be a valid tool. As stated by von Hippel (2017), a rule of thumb for using LPM and achieving unbiased and consistent estimates, is when the expected relative change in probability ranges between 20-80%. Under certain circumstances, this could hold even closer to the lower- or upper bound. Alternative estimators to the LPM, are the "Probability Unit" (probit) and "Logistical" (logit) regression models as they estimate values within an interval from "0" to "1" (Wooldridge, 2016, p. 528). By transforming data, thus the coefficient values, the results are assured not to violate the interval of "meaningful" probabilities. On the other hand, these results are more challenging and counter-intuitive to interpret compared to the LPM.

In short, the probit and logit models are both initially based on another set of standard error distributions and set of assumptions, than the LPM (Wooldridge, 2016, p. 224-227; p. 525-530). Further, logit and probit estimate nonlinear probability functions, in contrary to the continuous LPM function. Despite this, LPM could deliver similar precision, especially if many of the independent variables are categorical, hence non-linear (von Hippel, 2017). More precisely, in categorical-, or dummy estimations, there is not performed modelling of a continuous probability function. This occurs as such variables are already based on discrete probabilities associated by different categories, such as "0" or "1", of the independent variables. Hence, the estimation through LPM could be equivalent to using logit, particularly as we have interactions between dummy independent variables (Angrist & Pischke, 2009, chapter 3; Pischke, 2012). Regarding probit, results in similar cases are often practically very close to results from LPM (Friedman, 2012).

To sum up, results from LPM estimation measure change in the probability towards "success" and is easier to interpret than logit or probit estimations. By using LPM, we still have a "response probability" of independent variable effects on the binary dependent variable taking the success value of "1" (Wooldridge, 2016, p. 525). Further, LPM could lower accuracy if relative variable unit changes or the coefficient magnitude largely divert from the lower- and upper bounds. Still, this is seen as very unlikely as we only measure the regulation effect for one year. Since we look at relatively short time intervals and small relative unit changes while mainly focusing on the estimated treatment group effects sign of direction, we consider the LPM as an adequate estimator.

To analyse, and potentially causally link, multiple variables in a OLS-, or LPM regression, certain assumptions need to be met to claim it as the best suited unbiased estimator (Wooldridge, 2016, p. 89-92). "Best" refers to lowest possible variance, while "unbiased" means that the estimator has the lowest difference between the estimate and the true parameter value which we try to estimate. The most important assumptions are known as Gauss-Markov assumptions and include: "linearity in parameters", i.e., that there exists a linear relationship between dependent and independent variables. Second, "random sampling", meaning that all scrapped vessels in the world fleet should have the same probability of being sampled. Third, "no perfect collinearity", which means that no independent variables are constant or that none have too close linear relationships to another independent variable. Fourth, "zero conditional mean", which says that the expected value of the error term is zero. Fifth, "homoscedasticity", which is the assumption of the error term having a constant variance given any value of the independent variables. As most of these assumptions play a minor role in our analysis, only the most important will be discussed in chapter 6.

4.2 Policy Effect Analysis

As our research question states, we aim to investigate how the SRR has affected shipbreaking practices in the EU. Using a policy effect analysis by accounting for fixed effects allows us to investigate the development of the probability of a vessel being beached in both the treatment group, consisting of EU entities, and the control group, of non-EU entities, after implementation of the SRR.

As presented, we account for fixed effects in our models trying to bypass any omitted variable effects through adding independent variables as controls. Thus, we will calculate the difference between control and treatment group effects to isolate any effect of the SRR. The treatment groups, namely BOs and ROs within EU member states, face the regulatory change, hence need to adapt to its implementation (Wooldridge, 2016, p. 412). We aim to identify and measure their change in behaviour and compare this with the control group. The control group, namely BOs and ROs from non-EU countries, does not face any regulatory change in the same period. We will estimate the "treatment effect" by comparing differences between the pre- and post-treatment period averages in the treatment and control group. If we find a difference in the two groups, we could potentially argue the change to be caused by the implementation of the SRR, given that the right conditions are met.

Moreover, our aim is to clarify if the difference between the treatment and control group could come from the SRR implementation. Concretely, we want to discover how the regulation, along with different variables, increases or decreases the probability of a vessel being beached. In what we name Model 1, the probability difference of beaching a vessel owned by a RO within EU member states versus a RO outside EU member states, is estimated. In Model 2, BO substitutes the role of RO. Thus, we expect to find the actual "treatment effect" or "policy effect" from the SRR on the average probability outcome of the dependent variable taking the value "1". Eventually, the treatment effects from each model are compared to assess our hypotheses. By the formal inspection of any change between groups, the treatment effect, or delta-notation (δ), is explicitly represented in equation 4.1 below:

$$\delta = \{(Y_{2019_{Treatment}}) - (Y_{<2019_{Treatment}})\} - \{(Y_{2019_{Control}}) - (Y_{<2019_{Control}})\} \tag{4.1}$$

To clarify, equation 4.1 illustrates the difference in the prior and post policy period for the treatment and control group. Further, the years prior to 01.01.2019 define the pre-policy period, and 01.01.2019-31.12.2019 is our post-policy period. As the mathematical representation above states, we measure the change before and after 2019 for the models' treatment and control groups. Hence, in this event study, we compare what had been the beaching trend without the SRR implementation depicted in the control group, with how the treatment group has changed its behaviour due to the regulation.

4.3 Regression Models

In this section, we present the models used to answer our hypotheses on how the SRR affects shipbreaking practices of registered owners and beneficial owners from EU member states.

4.3.1 Model 1 - Registered Owners

In Model 1, we define Beached as the dependent variable together with the independent variables, *d19*, *EU_RO*, *rocountry_num* and *year*. First, the constant term is related to β_0, and the error term to ε, as seen in equation 4.2. The SRR treatment effect on registered owners from the EU, is measured through the interaction term coefficient β_1 for ***I***, representing *d19*EU_RO*. In an attempt to isolate the SRR treatment effect from unobservable variation over time, we account for fixed effects in years 2015 to 2019 by adding *year*. Second, we do the same to account for country specific fixed effects by adding *rocountry_num* over the same period. Explicitly adding each independent variable to the regression removes any interrelated effects on the dependent variable from time- and country unobservable specifics. Hence, we reduce any omitted variable bias and other confounding effects related to time and country of RO origin on the dependent variable *Beached* (Wooldridge, 2016, p. 78-83). The RO country fixed effects are represented by alpha (α), and the year fixed effects by gamma (γ). These remain unreported in the actual analysis due to the irrelevance of their individual interpretation. See equation 4.2:

$$Beached_{ijt} = \beta_0 + \alpha_j + \gamma_t + \beta_1 \boldsymbol{I}_{j\epsilon EU,t=2019} + \lambda \boldsymbol{X}_{ijt} + \epsilon_{ijt}$$

j, RO Country

(4.2)

4.3.1.1 Model 1 Extended

After controlling for the RO time- and country fixed effects, we add the independent variables "Vessel age", and "Vessel gross tonnage". The latter is scaled to measure increments of thousands. The vaiables are added to establish any clearer link between the age and size of a vessel and the probability of beaching. These are noted as components of **X** in equation 4.2 above. Adding more independent variables aims to remove any effect that could be explicitly stated from the error term (Wooldridge, 2016, p. 61). As it is possible to overfit the model, we stick to age and gross tonnage in our extended models to attempt to enhance accuracy while reducing the possibility of an omitted variable bias (Wooldridge, 2016, p. 77-78).

4.3.2 Model 2 - Beneficial Owners

Model 2 resembles Model 1, except that we will analyse the SRR effect on beneficial owners instead of registered owners. The treatment effect, namely the interaction coefficient, β_1 for *d19*EU_BO*, illustrates the SRR effect on beneficial owners in terms of the probability of a ship being beached with a BO from an EU member state. The same reasoning applies as for Model 1 when interpreting the fixed effects and interaction term, as illustrated in equation 4.3:

$$Beached_{ijt} = \beta_0 + \alpha_j + \gamma_t + \beta_1 \boldsymbol{I}_{j\epsilon EU,t=2019} + \lambda \boldsymbol{X}_{ijt} + \epsilon_{ijt}$$

j, BO Country

(4.3)

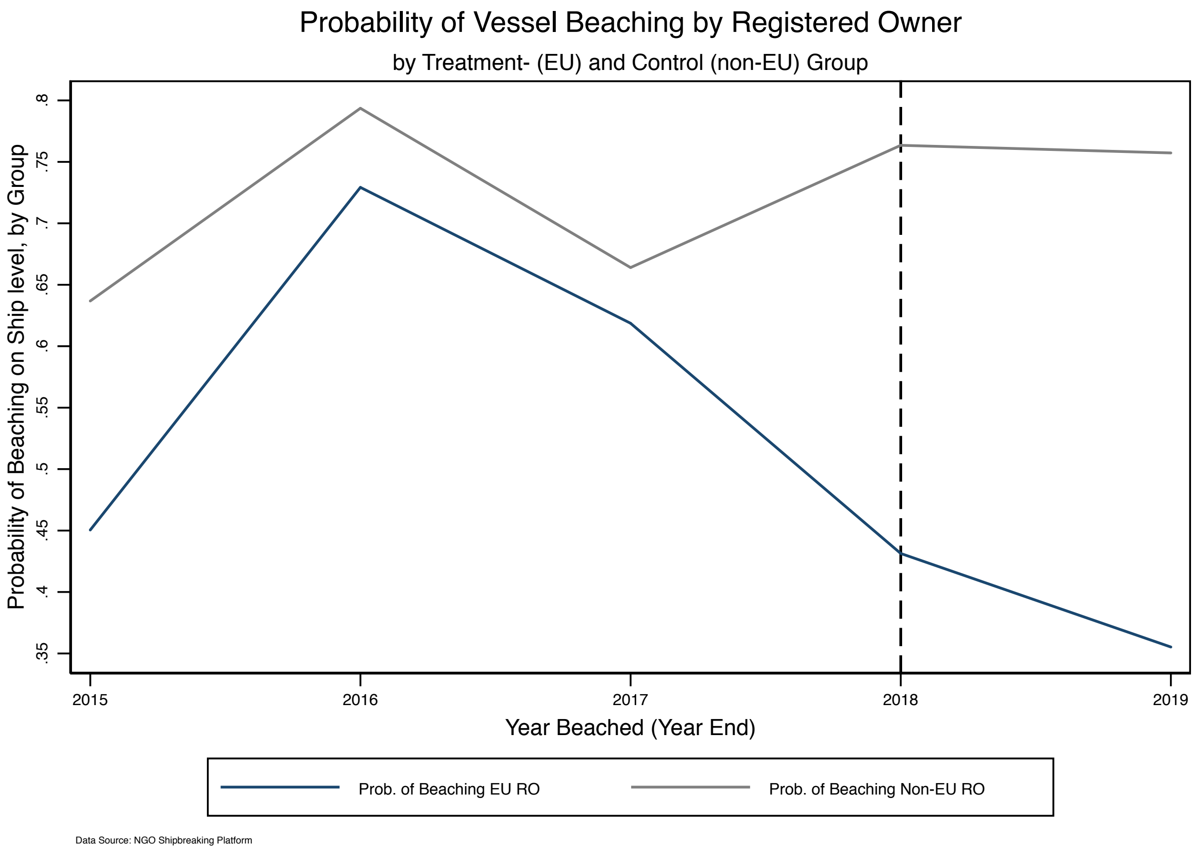
4.3.2.1 Model 2 Extended

We further extend Model 2 for the same reasons as the extension of Model 1. Thus, we keep the adaptation concerning BO country origin and time fixed effects, while adding vessel age and gross tonnage.

4.4 Parallel Trend Assumption

The policy analysis assumes that there are parallel trends through time between the development of beaching probability for vessels in both control and treatment group (McKenzie, 2020). This means that the development of the dependent variable should follow the same path, but not necessarily occur at the same level, in the control and treatment group before the SRR is implemented. This assumption is necessary as the development of the control group aims to represent the expected development within the treatment group in the post treatment period, given a hypothetical scenario of which the SRR is not implemented. In other words, if the policy was not implemented, the treatment and control group should have followed parallel trends. To capture the SRR effect, we measure differing development in treatment and control group trends, while controlling for fixed effects. Any changes between groups can potentially be assigned to the policy.

Figure 4.1: Registered Owners' Probability of Beaching

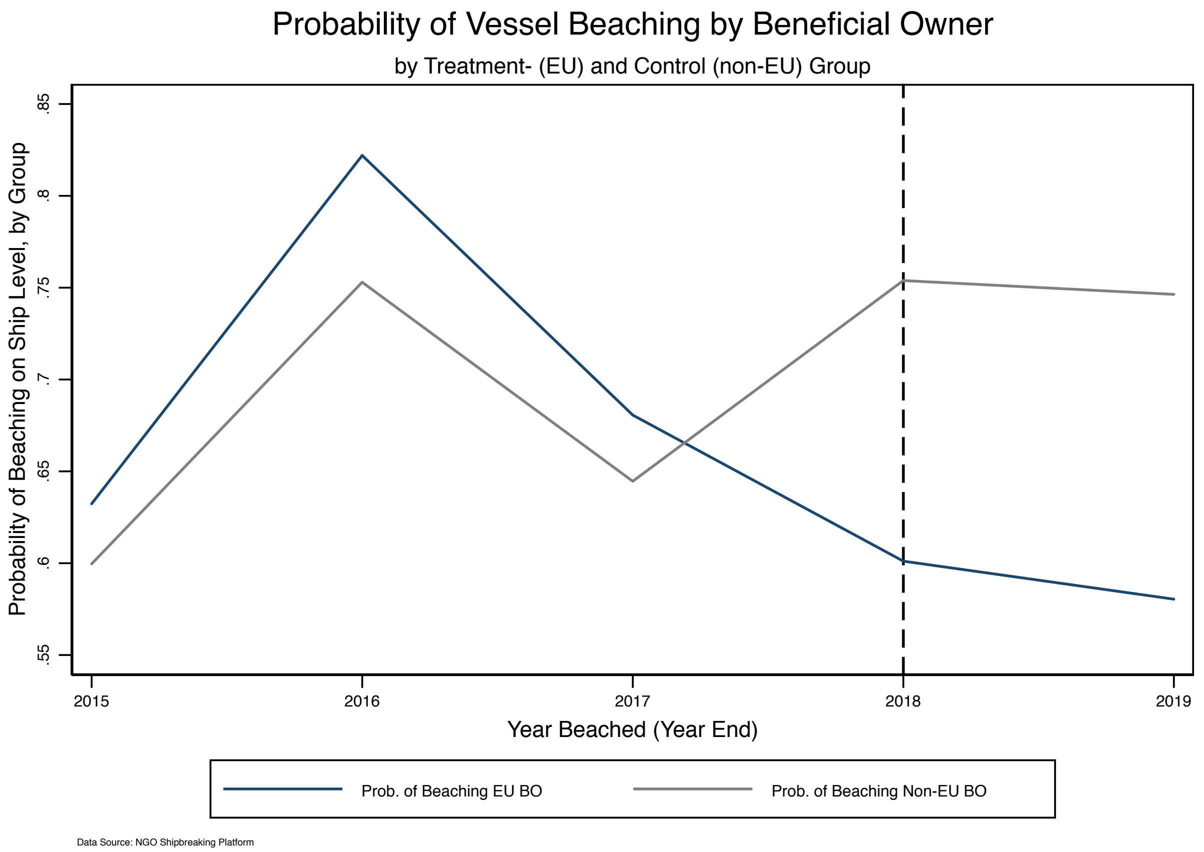


In Figure 4.1, the yearly trends in beaching probability for vessels with ROs in EU countries, treatment group, and vessels with ROs in non-EU countries, control group, are presented. The graphical representation illustrates the beaching probability at the end of each year, when the cross sections are sampled. This means that the continuous lines between each year do not tell us anything about the development through the twelve months of the year. Consequently, moving to the right in the graph takes us to the following year. Additionally, we see the dotted vertical line in 2018 representing the implementation of SRR.

Figure 4.1 further illustrates that both treatment and control group of ROs seem to follow parallel trends from 2015 to the end of 2017. From 2017 to the end of 2018, vessels with ROs from non-EU member states shift and face an increase in the probability of beaching, whilst the vessels in the EU member state treatment group, continue the previous trend of a reduction in the probability of beaching. This large distinction between the treatment and control group, indicates that there is a violation of parallel trends. Hence, we might have factors affecting treatment and control groups differently. This might result in difficulties of interpreting the SRR effect in 2019, which will be further discussed in chapter 6.3.

When the SRR is implemented at the end of 2018, the probability trend for EU member state vessels, continues to fall and reaches a total beaching share of just below 36% at the end of 2019. The non-EU RO trend at the same point in time is about 73% and continues with a slight downward slope, which is in contrast to the previous year. To conclude, it seems like the SRR has reduced the beaching probability for vessels with ROs from EU member states. On the other hand, the graph depicts a clear problem with parallel trends in the year prior to the SRR implementation. This makes us question whether the control group development is a good representation of how the treatment group would develop without the presence of the SRR, or if there are any other factors that we do not capture in this graphical model.

Figure 4.2: Beneficial Owners' Probability of Beaching



In figure 4.2, the development of beaching probability for ships with BOs in EU and non-EU member states, is presented. Firstly, it seems like vessels with BOs from EU and non-EU member states, roughly follow the same movement from the end of 2015 to the end of 2017. From the end of 2017 to the end of 2018, the two groups have diverting trends, just like ROs in figure 4.1. The EU treatment group continues with a downward slope, whereas the non-EU control group shifts and faces an increased probability of beaching for ships, from the end of 2017 to the end of 2018.

From the end of 2018 until the end of 2019, the non-EU BO control group stagnates and reaches a beaching share of about 74%. Similarly, for BOs from EU member states, the trend from 2018 to 2019 evens out and reaches a beaching share of about 55%. The reduced probability of beaching for BOs from EU member states, is aligned with the expected effect of the SRR. As for ROs, the BOs seemingly violating of parallel trends could originate in the same reasons. To sum up, there also seems to be a violation of the parallel trend assumption in the years prior to the SRR implementation for BOs.

5 Analysis

The first part of this chapter contains a descriptive analysis of the most important dataset features related to our research question. The next part presents the empirical analysis, in other words, how we conduct the policy effect regression analysis. Additionally, we elaborate and test the hypotheses connected to the effects of the SRR implementation.

5.1 Descriptive Analysis

Figure 5.1: Trend of Total Scrapping and Beaching of Vessels

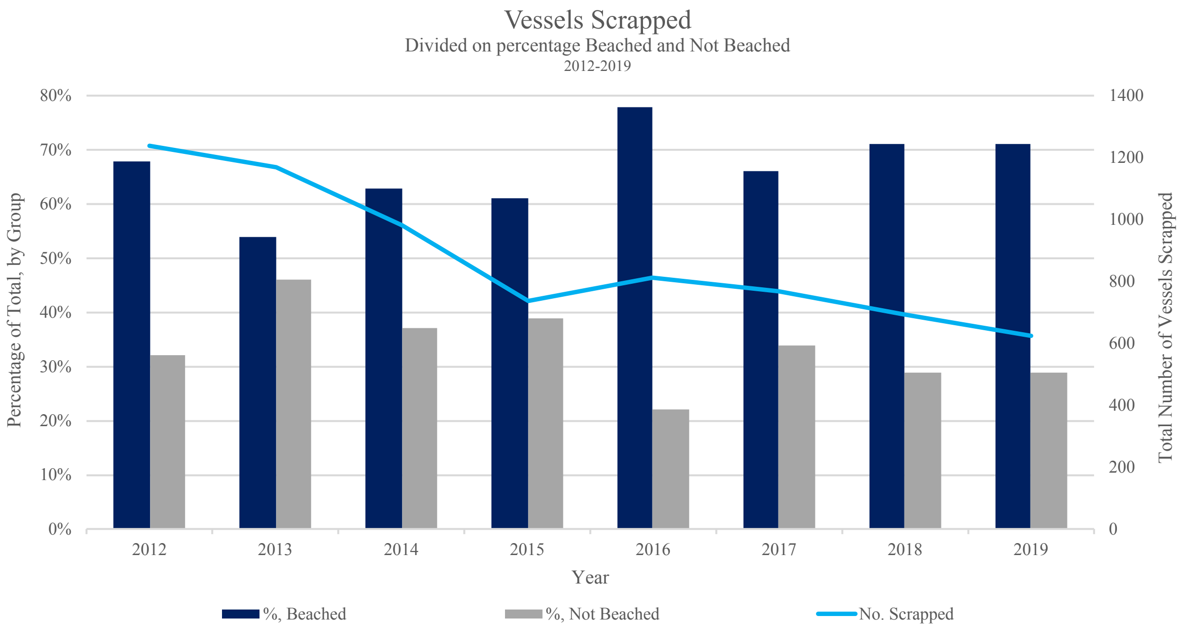


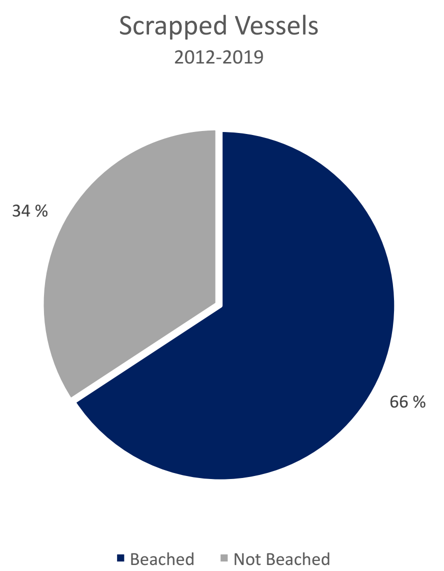
Figure 5.1 above shows the scrapping trend of vessels without taking owner entity and geographical location into account. As seen, the x-axis illustrates years from 2012 to 2019. Further, the left-hand y-axis depicts the share of beached vessels, “Beached” and the share of vessels dismantled by other means, “Not Beached”. Additionally, the right-hand y-axis represents the total number of scrapped vessels, namely the sum of “Beached” and “Not Beached”. The yearly number of scrapped vessels can be read from the downward-sloping trend line. We can see that beaching seems like the preferred method of shipbreaking. In the eight-year period, more than 4600 vessels are beached and approximately 2400 are

scrapped outside the defined beaching countries. As the trend line illustrates, there is a stable decline from about 1200 scrapped vessels in 2012 to around 600 vessels in 2019. Nevertheless, the percentage distribution of "Beached" vessels remains quite high and stable of around 60-70%.

Further, we look towards trends within specific years. Two examples are the decline of beaching between 2012 and 2013, and the peak in 2016. Referring to chapter 2.7 Shipping Company Investments, market determinants such as scrap price, freight rates, oil price and vessel age, play a role when a decision is made to scrap a vessel. From a company perspective, a relative optimal alignment of such market factors could be desirable when a decision is made to scrap an end-of-life vessel. This is especially prominent if the economic projections are not good enough for the vessel to earn future revenues based on the industry, or industry segment outlook.

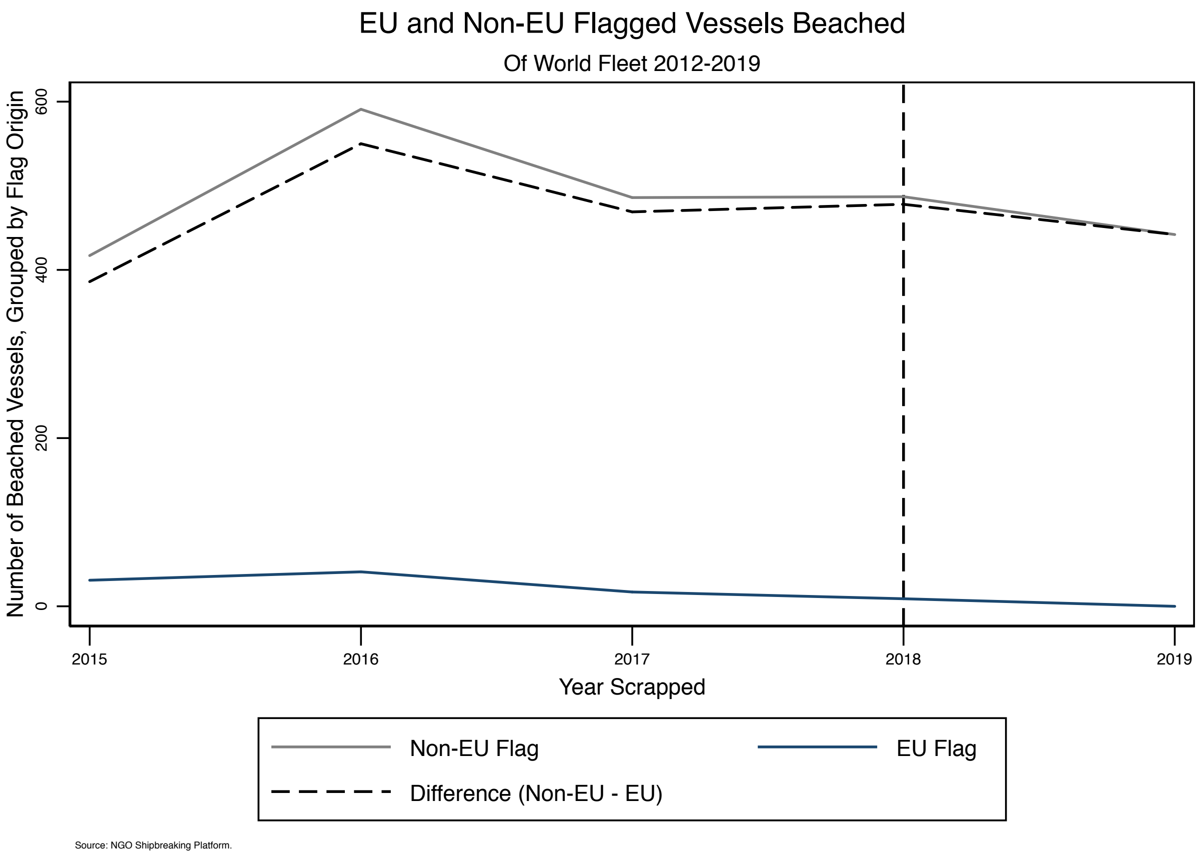
In all, the general trend in our data shows that about 66% of scrapped vessels are beached through the entire eight-year period, which is displayed in figure 5.2 below. Nevertheless, beaching is more nuanced than this. As presented in chapter 2 Theory, Bangladesh, India and Pakistan, are responsible for about 90% of the world's shipbreaking (Mikelis, 2019; UNCTAD, 2019). In contrary, our findings indicate a beaching level of about 70% in 2019. This difference is likely to occur as our calculations are based on the number of ships, whereas UNCTAD and Mikelis use ships' GT for estimating beaching levels.

Figure 5.2: Pie Chart of Share Beached and Not Beached



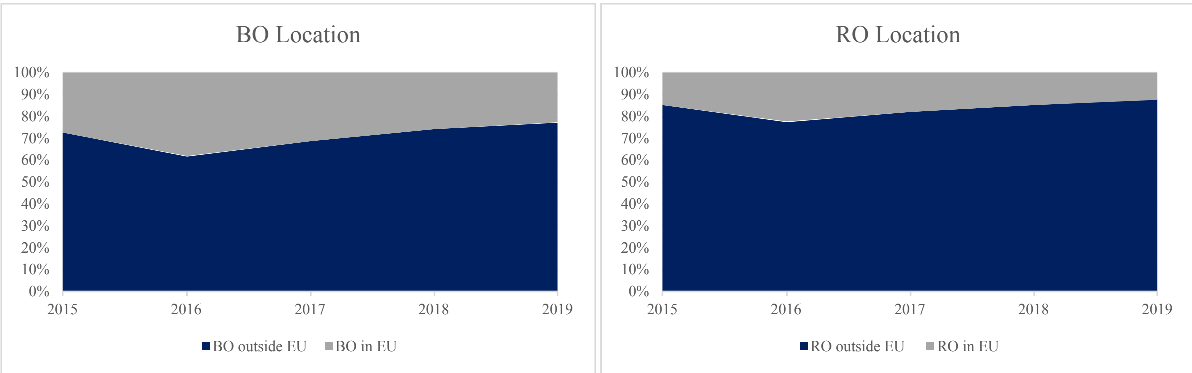
As explained in 2.7.1 SRR Effect Hypotheses, we do not expect that it is possible to perform an analysis on beaching levels based on flag state. Figure 5.3 below confirms this assumption and illustrates the total number of EU and non-EU flagged vessels that have been beached between 2015 and 2019. In 2016, 2017, 2018 and 2019, respectively 41, 17, 9 and 0 EU flagged vessels are beached. This is represented by the dotted line computed to depict the difference in beaching between EU and non-EU flagged vessels. These descriptive statistics support our choice of focusing on BO and RO to analyse the effect of the SRR as both owner entities have a vessel decision-making power. Most importantly, we do not have a big enough data base for an analysis on flag state, as there seems to very few vessels flying an EU flag. Hence, there are not enough treatment group observations for an analysis to yield reasonable results (NCBI, 2020).

Figure 5.3: Trends, Grouped by Vessel Flag.



In further analysis, we are interested in assessing the geographical location of BOs and ROs, namely if they are located in the EU or not. Figure 5.4 below illustrates that most BOs and ROs are located outside the EU. As we lack information on the geographical location of ROs before 2015, the time period is adjusted to only represent the period 2015-2019. As stated, our cross sections are sampled at the end of each year. This means that the percentages depicted on the y-axis represent the status quo at the end of each year. In that way, the intervals between years do not represent the RO- and BO country of origin trend through each of the twelve months of the year. Further, figure 5.4, illustrates an increase of almost 3% of BOs outside EU throughout the period, approximately the same as for BOs.

Figure 5.4: BO- and RO Location.



5.2 Empirical Analysis

In the following sections, we will comment the analytical results from implementing the method on our data. As discussed under chapter 4 Methodology, two regression models will be analysed. Model 1 is related to Hypothesis 1 and tests whether the SRR leads to a reduction in the beaching probability of vessels with RO from EU member states. Model 2 is linked to Hypothesis 2, which also predicts that the beaching probability of vessels with BO from EU member states will be reduced due to the regulation. Lastly, we discuss some key differences and similarities between the models and results.

As presented in chapter 4, the LPM is used as our analytical tool. Hence, the estimated output coefficients can be interpreted as relative probabilities and we are mainly interested in the added probability of a vessel being beached after the SRR implementation. This means that we focus on the change in probability caused by the SRR. Through our hypotheses, we wish to test whether this change can be significant for any of our treatment groups, by focusing on the magnitude, sign and significance of the treatment effect in

Model 1 and Model 2. Because we expect the SRR to reduce the probability of a vessel being beached, we perform one sided hypothesis testing (Wooldridge, 2016, p. 110-114). Therefore, the null hypotheses do not anticipate any effects of the SRR on the regression coefficients. On the other hand, the alternative hypotheses state a significant negative nonzero difference, as we expect a decreased probability of vessel beaching due to the SRR.

To further evaluate the hypothesis results, we make use of the probability value (p-value) (Wooldridge, 2016, p.118-119; p. 698-702). Most commonly, the p-value states the empirical support against the null hypothesis. Moreover, we choose a significance level of 5%, meaning that we reject the null hypothesis for p-values showing significant evidence against the null hypothesis below the 5% threshold. On the other side, p-values above 5% are considered to demonstrate too little evidence to reject the null hypothesis. Lastly, we will not extensively comment N (number of observations), R-squared (model explanation power), p-value or fixed effects, when not specifically intended. Additionally, we will exclude commenting the non-reported constant term, as models combining continuous and discontinuous variables with different units, makes it difficult to interpret.

5.2.1 Model 1 - Registered Owners

Table 5.1: Regression Table Model 1

	(2.0) Beached^{RO}	(2.1) Beached^{RO}	(2.2) Beached^{RO}	(2.3) Beached^{RO}
Treatment Effect, RO.	-0.181**	-0.159**	-0.196***	-0.177**
(EU_RO*Post 2018)	(0.0626)	(0.0575)	(0.0589)	(0.0560)
Vessel age (years)		-0.00921***		-0.00657***
		(0.00100)		(0.00101)
Vessel gross tonnage (in '000)			0.00300***	0.00235***
			(0.000201)	(0.000207)
Adj. Fixed Effects Years	Yes	Yes	Yes	Yes
Adj. Fixed Effects RO Origin	Yes	Yes	Yes	Yes
N	3607	3605	3605	3603
R^2	0.337	0.363	0.369	0.381

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2.1.1 Interpretation

In table 5.1, regression results from Model 1 are presented in column 1. Model 1 solely contains the interaction between the treatment group, namely RO from EU countries, and the implementation year of the SRR, namely 2019, adjusted for fixed effects through years and between RO countries. Holding everything else equal, the coefficient "Treatment Effect, RO" has a negative sign, which tells us that the SRR reduces the probability of a vessel being beached by 0.181 percentage points. In other words, the chance of a vessel being beached with a registered owner from the EU, decreases by 18,1 percentage points after the SRR implementation. Additionally, the treatment effect is significant due to relatively small standard errors compared to the coefficient, confirmed by a low p-value.

5.2.1.2 Extended Interpretation

Moreover, other control variables are added to explain explicit effects of single variables on the probability of beaching. In Model 1.1, "Vessel age" is added as control variable and we can see that the "Treatment Effect, RO" increases by more than 12% in comparison to Model 1 and lowers the standard errors from 0.0626 to 0.0575. The lowered standard errors indicate that the coefficient estimate becomes more accurate. Further, "Vessel age", along with the treatment effect coefficient, is significant. Again, this provides enough proof in the p-value of the coefficient being different from zero. Additionally, "Vessel age" shows, holding everything else equal, that as a vessel becomes one year older, the relative probability of being beached is reduced by 0.00921 percentage points each year.

As established in the theoretical discussion, ship age is a central scrapping determinant, and we would therefore expect that older vessels have a higher and relatively higher probability of being beached than younger vessels. One reason for the counter-intuitive sign of "Vessel age", could be that there exists a higher residual value for younger than older vessels. This would increase the scrapping frequency of younger vessels in comparison to older vessels, as shipowners may increase earnings by beaching younger vessels. The residual value could also be affected by where a vessel is beached which could result in a density function reducing the probability of beaching as a vessel grows older.

Furthermore, ship type or other industry characteristics that we cannot account for in our dataset, could affect the sign of "Vessel age". This could create a confounding effect, namely that the variable relationship is either representing another effect than its purpose, or a that there is a false association between variables (Skelly et al., 2012). In conclusion, there seems to be something unobserved, or explicitly unexplained, in our model giving "Vessel age" a counter-intuitive negative sign, as our literature review shows evidence of the opposite.

Moreover, in Model 1.2, the variable "Vessel gross tonnage" is added. Holding everything else equal, every additional thousand gross tonnage of a vessel, increases the probability of beaching by 0,3 percentage points. In other words, the probability of beaching increases with ship size, hence there is a higher probability of bigger ships being beached than smaller ships. Further interpreting what kind of ships this includes, we can look towards the discussion in 2.7 Investment Theory, where bulk carriers were listed as the largest group of beached ships in 2019.

In Model 1.3, both "Vessel age" and "Vessel gross tonnage" are included. In addition, we control for the fixed effects. The sign of "Treatment Effect, RO" is still negative and significant, and the model provides the most precise standard errors so far. Hence, the probability of a vessel being beached, while holding everything else equal, is reduced by 17,7 percentage points after implementing the SRR. "Vessel age" and "Vessel gross tonnage" are highly significant showing correlation with the dependent variable. They illustrate ceteris paribus beaching probabilities reduced by 0,66 percentage points and increased by 0,24 percentage points respectively. Moreover, we can see that Model 1.3 has the highest R-squared of all the models, seemingly explaining 38,1% of *Beached.* As R-squared will grow larger by adding any variable, we chose not to rely too heavily on its interpretation even though this could be a good indication of model fit (Wooldridge, 2016, p. 83-86).

Moreover, the treatment coefficient illustrates an inconsistent magnitude as controlling for additional variables should not change the magnitude of the treatment coefficient. The changes should not occur because our treatment and control group are assumed to be similar. Nevertheless, in Model 1 to Model 1.3, the magnitude of the treatment effect beta coefficient grows by 2,2 percentage points. If the natural experiment was properly randomized, this should not be observed as added controls, on average, should affect every vessel in the treatment- and control group the same way, even for such a small change. In our case, this inconsistency means that there seems to be a difference between the vessels with EU- and non-EU owners and we have a problem with either random sampling or the group's vessel composition, i.e., group similarity. A discussion on the implications of these results, will be presented in chapter 6.

5.2.1.3 Summary and Hypothesis 1 Conclusion

Connecting the results to Hypothesis 1, there exists a SRR effect on vessels with RO from EU member states. As the estimated sign of the treatment coefficient corresponds with the expected reduction in beaching probability, the alternative hypothesis is supported by the analysis' result. Since the Model 1.3 treatment coefficient's relative low standard errors yields significance, the produced estimate confirms a relationship between the explained and explanatory variables. Given that the listed assumptions hold, this correlation might be casual (Wooldridge, 2016, p. 10-14). Hence, we reject our null hypothesis of the SRR not having a significant effect on reducing the probability of beaching for registered owners from the EU, as seen in the p-value below 5%.

5.2.2 Model 2 - Beneficial Owners

Table 5.2: Regression Table Model 2

	(1.0) Beached^{BO}	(1.1) Beached^{BO}	(1.2) Beached^{BO}	(1.3) Beached^{BO}
Treatment Effect, BO. (EU_BO*Post 2018)	-0.0302 (0.0426)	-0.0171 (0.0402)	-0.0358 (0.0412)	-0.0245 (0.0397)
Vessel age (years)		-0.00991*** (0.000877)		-0.00773*** (0.000876)
Vessel gross tonnage (in '000)			0.00289*** (0.000218)	0.00213*** (0.000214)
Adj. Fixed Effects Years	Yes	Yes	Yes	Yes
Adj. Fixed Effects BO Origin	Yes	Yes	Yes	Yes
N	3607	3605	3605	3603
R^2	0.333	0.365	0.361	0.378

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5.2.2.1 Interpretation

In table 5.2, regression results from Model 2 are presented. Model 2 has the same setup as Model 1 but analyses the SRR effect on beneficial owner instead of registered owner. Here, the "Treatment Effect, BO" coefficient in column 1 has the same negative sign as Model 1. In contrast to Model 1, the coefficient is insignificant shown in a relative high p-value. Therefore, we find no explicit effect of the SRR on beneficial owner.

5.2.2.2 Extended Interpretation

In extending Model 2, we add the same independent variables as in Model 1. First, "Vessel age" is added in Model 2.1 and is highly significant. We see that the precision of the treatment coefficient is improved by the decrease in standard error magnitude, but it is still insignificant. Second, in Model 2.2, "Vessel gross tonnage" is also significant, but lowers the insignificant treatment effect coefficient precision compared to Model 2. Third, the full extended Model 2.3, demonstrates that, other than the treatment effect coefficient, the independent variables are significant showing a correlation to the dependent variable. This strengthens the choice of independent variables, even though there is no causal effect. The latter also holds for Model 2.3, which has the highest R-squared. As for Model 1, the sign of "Vessel age" is not what is expected. Additionally, the treatment coefficient illustrates an inconsistent magnitude throughout the models in the same way as discussed for Model 1.

5.2.2.3 Summary and Hypothesis 2 Conclusion

As the "Treatment Effect, BO" in Model 2.3 is insignificant, there is little support of a SRR effect on BOs. In the context of Hypothesis 2, this points in the direction of failing to reject the null hypothesis as the p-value exceeding the 5% level of significance shows little evidence against it. Hence, given that our controls are sufficient, we conclude that there is no causal effect of the regulation on reducing the probability of beaching when the beneficial owner is from an EU member state. Not rejecting the null hypothesis of Hypothesis 2 tells us that the evidence of the SRR effect in our sample is inconclusive.

5.2.3 Compared Model Results

We have seen that results in the two models differ. In Model 1.3, the treatment effect concerning registered owners is significant, which contradicts the null hypothesis in Hypothesis 1. These results indicate that the reduced probability of beaching for vessels with registered owners from EU member states is causally linked to the SRR. On the contrary, the treatment effect in Model 2.3 shows no causal effect of the SRR on beneficial owners from EU member states.

Furthermore, these results are relatively aligned with our expectations. As stated in Hypothesis 1 and Hypothesis 2, we anticipated that the SRR would affect both ROs and BOs. Still, we expected the SRR to have a weaker effect on BOs than on ROs. Our analysis results support this assumption, and even indicate that there is no effect of the SRR on BOs. We will further discuss why this difference between RO and BO might occur in chapter 6 Discussion.

6 Discussion

In this part, we will discuss results from the analysis including limitations and weaknesses of the study. In addition, we will test some methodological assumptions regarding the LPM and policy effect analysis. The aim of these tests is to assess the quality of our analysis and results by considering their robustness, validity and reliability.

6.1 Regression Results and Graphical Trends

To further discuss the differing results in Model 1 and Model 2, we return to the challenges of defining beneficial owners and registered owners. The lack of public information makes it difficult to fully comprehend how shipowners will react and adapt to the SRR. A continuous challenge throughout this study has been to find information that defines RO and BO, as the NGO Shipbreaking Platform has not defined all variables in the dataset. Even though we have defined RO and BO based on desktop research and a phone call with the CEO of the NGO Shipbreaking Platform, it is not certain that the two entities have the same definition in all countries. Consequently, it is more challenging to interpret our results, even though we account for fixed effects.

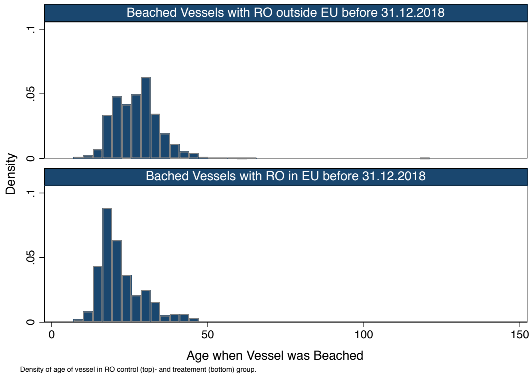
Most importantly, we believe that the SRR affects ROs rather than BOs, because a potential breach of the regulation will have legal consequences for the RO. Even though BOs might face social sanctions, investigators will target ROs if there is belief that the SRR has been violated. Therefore, the incentive is bigger for ROs to either follow the SRR and reduce beaching practices, or re-register to countries with open registers and relaxed enforcement of international regulations. This is supported in figure 4.1 which illustrates a higher probability of beaching for ROs from non-EU countries in comparison to ROs from EU countries. In that way, there seems to be some ROs from EU member states that re-register their vessels to countries outside the EU to circumvent the SRR.

Furthermore, the trends in beaching probability for vessels with registered owner from EU and non-EU member states support that in addition to FOC, “registered owner of convenience”, could be introduced as a new term. The beneficial owner can circumvent the SRR and maximize revenues by registering flag and RO outside an EU member state. In such case, the BO can continue to be registered within an EU country without risking criminal persecution. We expect this circumvention to be part of the explanation of why results in Model 2 on BOs are not significant.

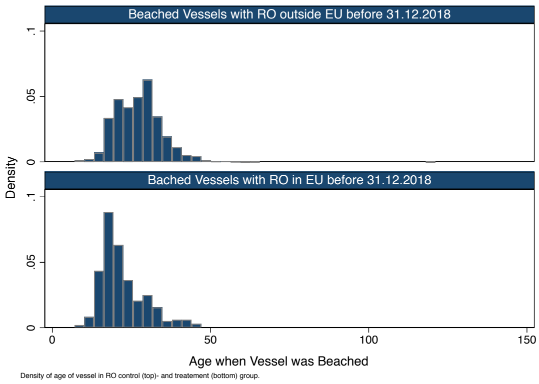
Exploiting the "registered owner of convenience" after 2019 is further supported in diagram 5.1, which illustrates that the global beaching percentage per vessel has not been reduced in 2019, compared to 2017 and 2018. In that way, it does not seem like the SRR has affected global beaching practices to a large extent. On the other hand, figure 5.1 does not specify whether vessels are registered with owners from EU or non-EU member states. Therefore, we can look towards figure 5.4, which indicates that the number of ROs registered outside the EU, have grown in 2019 compared to 2017 and 2018. This supports the regression results that indicate that there is an actual reduction in the probability of beaching for vessels with RO from an EU member state despite the lack of any reduction in global beaching. More specifically, figure 5.4, supports the argument of "registered owner of convenience". Even though there seems to be a lower probability of beaching for ROs in the EU after the SRR is introduced, global beaching levels do not seem affected. Hence, this supports the hypothesis of re-registration of vessel's RO before vessel beaching. Lastly, the differing results between BO and RO and how they are affected by the SRR, support splitting our analysis to measure the effect on both owner entities.

6.2 EU and Non-EU Group Similarity

As previously explained, it is a prerequisite that the EU and non-EU treatment and control groups in both models are assumed to be similar to discover any differences in group composition. This means that the treatment and control groups for both RO and BO should consist of comparable vessels, i.e., that vessels in both treatment and control groups on average have similar characteristics, especially before the SRR implementation. As discovered in the analysis, there seems to be variation in vessel characteristics observed in the varying treatment coefficient magnitude.



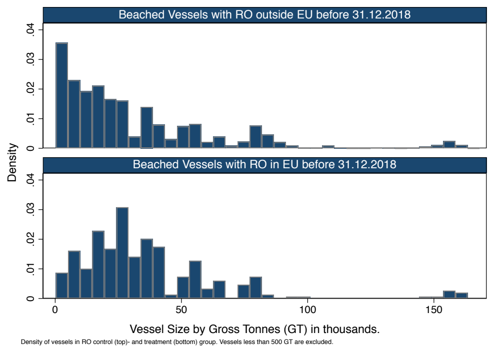
(a) RO vessels' age in control- (top) and treatment (bottom) group.



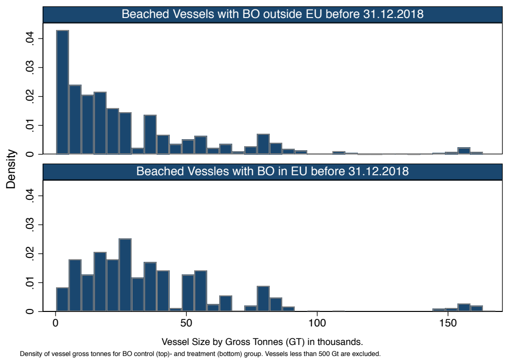
(b) BO vessels' age in control- (top) and treatment (bottom) group.

Figure 6.1: Vessels' age composition (density) by variable "Vessel Age".

To observe group similarity, we will assess the available vessel specific characteristics in our dataset, namely "Vessel age" and "Gross Tonnage". First, looking at the RO density function on age in figure 6.1.(a), we see that the distribution is slightly skewed left for the RO treatment group from EU member states. This is illustrated by the columns stretching higher than for the non-EU control group and indicates that many vessels with RO from the EU are younger than the vessels in the control group. The same observation, but to a lesser extent, seems to hold for BOs in EU member states shown in 6.1.(b). In conclusion, there seems to be a higher proportion of younger vessels inside EU.



(a) RO vessels' size in control- (top) and treatment (bottom) group.



(b) BO vessels' size in control- (top) and treatment (bottom) group.

Figure 6.2: Vessels's size composition (density) by variable "Gross Tonnage (GT)".

Figure 6.2 illustrates group composition by gross tonnage (GT). Both ROs in figure 6.2.(a) and BOs in figure 6.2.(b) show slightly skewed trends. As we have excluded vessels below 500 GT, we know that all vessels represented fall within the scope of the SRR. The RO non-EU control group seems to consist of a larger proportion of smaller vessels than the EU member state treatment group. The same seems to hold for BOs, as BOs outside the EU consist of smaller vessels than the EU treatment group. Further, a smaller visual overlap seems to be the case for vessel GT than for -age indicating a more diverse fleet based on GT. To sum up, the groups seems to be fairly similar, but not identical. This could explain the difference in both model's treatment coefficient magnitude differences, as the average vessel impact of additional model control variables affects the treatment- and control group differently.

6.3 Discussion of Parallel Trends

To further support the discussion on the parallel trend assumption in chapter 4.3, we have tested the trends of EU and non-EU ROs and BOs. This is conducted through an interaction regression resembling Model 1 and 2 to discover any significant deviation from a similar group development through time. More specifically, we test whether the development in the probability of beaching ships in 2016, 2017 and 2018, significantly differs between the control and treatment group for both ROs and BOs. Any significant coefficients would be the same as indicating that the treatment- and control group move in different directions before the SRR is implemented. A violation of parallel trends could make the measured SRR effect biased. This effect could be a continuation of previous trends driving the probability of beaching or be a combined effect of previous trends and an actual SRR effect.

When testing parallel trends, the same variables are used as in our main Model 1 (RO) and Model 2 (BO) regression analyses. Table A1.4 and A1.5 can be found in Appendix and illustrate the pre-trend interaction coefficients. These are mainly inconsistent with the trends found in figure 4.1 and figure 4.2. For instance, the coefficients state that treatment and control group trends for both ROs and BOs significantly differ in 2017. On the other hand, in figure 4.1 and figure 4.2 treatment and control groups for BOs and ROs seem parallel from the end of 2016 to the end of 2017. Similarly, the interaction coefficients indicate parallel trends between EU and non-EU ROs and BOs in 2018. According to figure 4.1 and figure 4.2, trends do not coincide in the year prior the SRR implementation. Furthermore, graph 4.1 indicates that ROs from EU member states, reached a peak in

2016 in terms of beaching share.

Further, from 2017 until the end of 2019, there has been a negative trend for this group. In that way, the reduced probability in 2019 could be a continuation of other trends from previous years, that are caused by other factors than the SRR. Such undiscovered or unobserved effects could include ship type or certain industries more common in- or outside EU, further affecting the probability of beaching a vessel of the treatment or control group differently. In addition, other legislations linked to certain ship types or industries could affect the trend. These could further make our pre-trend regressions biased and cause misleading results despite ruling out fixed effects. In other words, the mismatch between the interaction coefficients and trend graphs indicates that there are unaccounted and unobserved effects in our analysis not explained by year- or country fixed effects. Consequently, analysing parallel trends based on such fixed effects, might not be the best representation of how the beaching probability for ships with RO or BO in the EU would develop without the SRR.

Additionally, from 2017 from 2018, we see a negative trend for ROs from EU member states and a positive trend for ROs from non-EU member states. These trends could indicate an anticipatory effect of the SRR meaning that shipowners might adjust to the regulation by re-registering to a non-EU member state prior to the SRR implementation. When the SRR was ratified in 2013, it was known that the regulation would be enforced no later than 31.12.2018. Furthermore, the European List of approved recycling facilities was published in December 2016. Therefore, some ROs might adapt to the SRR from 2017 and utilise the facilities from the European List instead of beaching.

To further infer that there exists an anticipatory effect, we have conducted a limited anticipation test, found in Appendix table A.4.3. and A.4.4. The tests are constructed similarly to our main regressions, and aim to find a significant treatment effect for ROs and/or BOs in the year prior to the SRR implementation. In a brief analysis, results indicate that there does not exist an anticipatory effect for ROs, which is an effect we seem to find for BOs, at the end of 2017. This is founded in the significant anticipatory treatment effect coefficient for BOs in table A.4.4. This incentivises further investigation of the BO anticipation effect, and will be suggested as a topic in chapter 6.4 Further Research.

Furthermore, we can discuss the interaction coefficients in relation to the trend graphs in figure 4.1 and 4.2. Considering the graphical representation of the development in the control group, the decline in probability is less prominent after the SRR implementation than for the treatment group. As established, more ROs are registered in the non-EU control than within the EU treatment group. Therefore, the relative effect on beaching probability when a vessel switches group, is larger for the treatment group than for the control group. Any reduced or increased relative beaching probability in the treatment group will be larger than the corresponding reduction or increase of relative beaching probability in the control group. This would again mean that we do not necessarily see the equivalent relative increase or decrease in the control group probability simultaneous as an observed relative reduction or increase in the treatment group probability.

To sum up, the divergence between the treatment and control group trends, illustrates that we have an issue in explaining one exact reason of why we see a reduction in the probability of beaching ships with RO from the EU in 2019. This becomes even more complex when adding the interpretation of probability terms in relative percentages. As discussed, the reduction in the probability of beaching might be caused by a re-registration to countries outside the EU, or by unidentified reasons. When the parallel trend assumption is violated, we cannot explain if ROs from EU member states re-register their vessels to circumvent the SRR or if they adapt by beaching less vessels.

6.4 Validity

Validity refers to whether the chosen data collection method accurately measures what it intends to measure, and whether the research findings really entail what they proclaim to be about (Saunders et al., 2016, p. 730). Validity can further be separated in internal and external validity. First, internal validity is proven when research provides a causal relationship between two variables. Second, external validity considers whether the research can be generalised and transferred outside the context of one specific study (Saunders et al., 2016, p. 201-204).

6.4.1 Internal Validity

To strengthen internal validity, it is important to obtain high-quality data sources. In our case, the compiled dataset from the NGO Shipbreaking Platform consists of several data sources. This has enabled the NGO to cross-check data and hence strengthens internal validity (Jenssen, 2020). Another example is their use of data from IHS Markit. They assign and validate the IMO codes on behalf of the International Maritime Organization (IHS Markit, s.a.). Being entrusted by the IMO supports the quality of the data. Nevertheless, the information we have about primary data sources come from a phone conversation with the CEO of the NGO, Ingvild Jenssen. There is no public information regarding the compiled dataset on the webpage of the NGO Shipbreaking Platform. This decreases the credibility of our thesis as others cannot easily verify the information. Further, we lack complete information regarding which variables in the dataset originate from the different sources.

Another example is the satellite data used to cross-check information by tracking ship movement. There is a risk that this information is not fully correct as satellite imagery could be manipulated or difficult to interpret. Beaching is also a practice that shipowners worldwide try to disguise, as they risk social- and criminal sanctions. In that way, re-registering the flag or owner of a vessel, makes it more challenging to obtain and analyse data. Even though every ship has a unique IMO-code, the code may be re-painted or manipulated to cover up the real shipowner (Jenssen, 2020). Thus, we do not expect that our dataset contains information on all ships that are sent for dismantling, or that every vessel in our dataset is correctly specified, which decreases validity.

6.4.2 External Validity

To enhance external validity, we analyse how the SRR affects shipowners' recycling practices rather than analysing how ships flying an EU flag respond to the regulation. This broadens the scope of our research question, as it raises issues related to circumvention of the regulation. In this way, our results can also be of interest when analysing other maritime laws and global initiatives. Furthermore, the SRR is designed similar to other EU regulations, namely that each member state is responsible for its national enforcement by adopting relevant laws. Hence, our research raises awareness regarding the challenges of homogenous law enforcement across EU member states. Additionally, our results show a marginal improvement in EU beaching levels, but little improvement on a global level, which supports the discussion on the need for financial incentives to secure SRR compliance.

In addition, our findings might be relevant for other studies on EU regulations and what factors need to be considered to increase the likelihood of compliance. On the other hand, maritime law is industry-specific and differs from other laws as it is challenging to regulate international waters, known as the "high sea" (Rafferty, s.a.). In these international areas, the laws of the country owning the vessel, namely flag nationality, will be responsible to enforce relevant laws. Further, the complex ownership structure of ships with flag nationality, beneficial owner and registered owner, makes it difficult to investigate environmental and safety crimes committed at high sea and might weaken external validity.

6.5 Reliability

Reliability is defined as "the extent to which data collection technique or techniques will yield consistent findings, similar observations would be made, or conclusions reached by other researchers or there is transparency in how sense was made from the raw data" (Saunders et al., 2016, p. 726). Therefore, if there are consistent findings for research and data collection that is repeated later or conducted by someone else, the research is considered as reliable (Saunders et al., 2016, p. 201-204).

One weakness is that the dataset only consists of data points from the first year after the SRR was implemented. This means that we analyse the effect of the SRR on ships that were beached during 2019. If the study was conducted at a future point in time, the research sample would be bigger which could make results more reliable. Consequently, the relevance of this study will depend on the development of shipowner's compliance with the regulation and to what extent beaching prevails. In addition, the relevance of the study could be challenged by the implementation of other regulations such as the HKC. It might be challenging to isolate the effect of the SRR if several new regulations aim to affect shipbreaking, thus effect the occurrence of beaching. Moreover, implementing a recycling licence or other financial incentives to ensure compliance with the SRR, might lead to different results in future studies.

Furthermore, our own manipulation of the dataset could also weaken reliability. To complete the analysis, we created the dummy variable Beached. As discussed, this is defined according to online data sources and concluded that Bangladesh, India, and Pakistan are countries where the predominant method of scrapping is beaching. One weakness is that we do not have information on specific scrapping yards in the dataset. Consequently, we have assumed that all ships that are scrapped in these three countries, have been beached, which is not necessarily the case. Similarly, there might be beaching yards outside of these three countries that are not recognised by our analysis. These manipulations and assumptions might decrease reliability of the analysis.

Another issue is whether gross tonnage (GT), is a relevant measure for ship size. This measurement does not seem very intuitive as vessel size is measured by the volume in the vessel's enclosed spaces (European Commission, 1969). This is confusing as a tonnage usually is measured in weight. Other measures include light displacement tonnage (LDT) and dead-weight tonnage (DWT). LDT is the weight of a vessel as built, without cargo and DWT is the cargo-carrying capacity of a vessel (Stopford, 2009, p. 752-753). The three different tonnage measurements will consequently not give the same results when estimating ship size, and LDT and DWT might arguably be more intuitive than GT.

On the other hand, international organizations responsible for shipping regulations such as Eurostat and the European Commission, frequently use GT in their work. Most importantly, the SRR utilises GT when defining what kind of ships are covered by the regulation. In that way, it is seen as the most relevant measurement in this study. In addition, our dataset mainly contains observations on GT and lacks information on LDT and DWT, which supports using GT for ship size.

Additionally, we have attempted to perform objectivity by basing our statements on critically assessed and cross-checked references. Nevertheless, we cannot be sure that all the data sources we have used are correct. One example is how the NGO Shipbreaking Platform and Transport Environment have conducted a study measuring the EU recycling capacity differently than shipowners, who argue that there is a lack of recycling capacity in the EU (Gilliam & Jenssen, 2018; Mikelis, 2019; Rahman & Kim, 2020). In this way, we cannot be sure which data source is correct and therefore have chosen to give a representation of both viewpoints. As a matter of fact, neither data source needs to be more correct than the other, as they might measure and focus on different aspects. Discussing political issues is naturally a source of conflicting viewpoints which we have strived to balance.

6.5.1 LPM Assumptions

As presented, LPM, built upon OLS, allows a binary dependent variable where the independent variable ceteris paribus effects are interpreted as relative probabilities, instead of slope parameters, on to the dependent variable. We concentrate on homoscedasticity, collinearity, zero conditional mean and random sampling, as they might affect the causal precision of our assumed nonbiased estimator.

Firstly, we have a heteroscedastic problem in the standard errors as the LPM is dichotomous (Friedman, 2012). Robust standard errors are used in both models to account for this. Secondly, there does not seem to be a problem of perfect collinearity between either of our variables, as shown in the correlation matrix in Appendix A1.3. Here, the pairwise variable matches indicate that no independent variable perfectly explains another as no values are close to 1 or −1. Thirdly, we can problematize the "zero conditional mean" assumption, as omitted- or miss-specified variable functional form may occur in both models (Wooldridge, 2016, p. 62-63: p. 152). One example is the counter-intuitive negative sign of "Vessel age". If this result is not reasoned in beaching due to a higher residual value for younger- than older vessels, a functional form misspecification of the variable "Vessel age" could be evident. This would mean that "Vessel age" may have a non-linear relationship to the dependent variable caused by a misspecification in the model.

Lastly, we could have a problem with random sampling of the control and treatment group for both ROs and BOs. Since certain conditions such as ship type and industry, seem to make some vessels more exposed to being beached, we could question if the random sampling assumption holds. This could be the case if the treatment and control group consist of differing amounts of ships, for instance from different industries, or different types of ships, affected differently by beaching determinants. As discussed in the analysis, the magnitude of the treatment effect coefficients in our models point in this direction. Hence, there might seem to be a problem with randomness of the sampling, or the average vessel balance between the different EU- and non-EU groups.

6.5.2 Model 2 Robustness

In this section, we will execute a robustness test to assess the quality of our data sample. As mentioned in 3.1 Refining the dataset, there is missing data in the dataset for ROs from EU member states prior to 2015. This poses a potential weakness in the analysis as we have also removed BO datapoints prior to 2015, to enable similar samples for RO and BO. Therefore, we wish to test whether the sample size reduction has influenced the results.

All available datapoints for BO are added and a new regression test is run. Please see table A1.2 in Appendix for a full overview of the results. Using the full dataset of 7016 observations, results the same as for our adjusted sample in Model 2. The SRR has no significant effect on the probability of beaching for ships with BO from the EU. In Model 2, the non-significant coefficient has a value of -0,0245 and in table A1.2, the non-significant coefficient has a value of -0,0217 in Model 2.3a. The similarity between the coefficients validates our previous results and strengthens the quality of our analysis.

6.6 Further Research

If we had extra time and access to more data sources, additional variables could be included in the analysis. Variables of interest could be scrap price, type of ship, ship industry of operations, steel price and freight rate. These are market determinants that could increase the precision of our analysis. Steel price is estimated to affect scrap price, as beaching yards re-sell scrap metal from ships. Shipowners will consequently receive higher bids for their end-of-life vessels when scrap prices are high. This financial incentive increases the relevance of analysing how these prices influence beaching levels. Type of ship would also be of interest, as it could help distinguish if some types are more likely to be beached than others. This information could further give an indication on specific industries that hold a fleet majority of certain ship types that are more likely to be beached. Mapping out such industries could have been interesting to discover whether certain EU member states are more likely to utilize beaching practices than other EU member states.

Additionally, the concern of heterogenous enforcement of the SRR supports the relevance of analysing the probability of beaching across specific EU member states. In that way, the analysis would have been extended to assess individual EU member states. As discussed in chapter 2.7 Shipping Company Investments, freight rate is yet another factor that is expected to affect the probability of beaching and is hence relevant. Nevertheless, we did not have access to such information in the dataset.

If possible, we would have performed a more thorough anticipation test, by adding more variables, similar to those mentioned for the main regressions. This would have increased robustness and could contribute to nuance any potential anticipatory effect hypotheses. Further, this could help explain any significant treatment effect differences between ROs and BOs in 2017 and 2018. It might also help validating if any changes in trends before SRR root in unobserved factors or in an actual anticipation effect.

Lastly, it would be interesting to carry out the analysis in the future to see if results differ when the SRR has been in place for a longer period. This would be relevant as we could have tested the interaction coefficients in the following years after the SRR implementation, to check if the treatment effect intensity changes over time.

7 Conclusion

The aim of our research question was to analyse how the EU Ship Recycling Regulation from 31.12.2018 has affected the probability of beaching vessels with shipowners from EU member states. Our scope was to conduct a policy analysis controlling for country- and year fixed effects, and test whether the probability of beaching vessels has been reduced by the regulation.

Our findings state that the probability of a ship being beached with a registered owner from an EU or EEA country, has been reduced. This reduction can further be explained by an adaption to the SRR concretized in less beaching or due to re-registration of registered owners to non-EU member states. For beneficial owners, the SRR has not affected the beaching probability as regression results were inconclusive. This is aligned with our expectations outlined in the theory chapter of the SRR having a weaker effect on beneficial owner than on registered owner, as registered owners risk criminal sanctions for violating the SRR.

In addition, we conclude that there is a violation of parallel trends for the treatment and control group of registered- and beneficial owners. The violation could indicate that there are other factors besides the SRR, namely previous trends or unobserved effects, that drive the beaching probability. This is also evident in the mismatch between parallel trend graphs and our parallel trend test stating that other factors besides the year- and country fixed effects, explain the trends. Assumingly, the problem might be caused by determinants impacting the average vessel in the treatment- and control group differently, such as ship type or industry of operations. Additionally, other regulations that are related to specific vessel types or industries could also affect the differences between groups' beaching probability. This means that the significant effect for registered owners not necessarily is caused by the implementation of the SRR. Hence, if we had accessible data on unobserved factors, our model could have increased its accuracy in explaining the beaching probability development.

Moreover, the reduced probability of beaching vessels for registered owners in EU countries, indicates that there are sufficient sanctions in place to ensure compliance with the SRR. On the other hand, the significant effect of the SRR on registered owners and the stable share of beaching on a global level, support that re-registration of registered owners occurs. The same issue accounts for flag state. This is one of the reasons why industry stakeholders such as the NGO Shipbreaking Platform call for an economic incentive such as a recycling licence to increase compliance with the regulation. This is further supported in our toll model, where we state that the implementation of the SRR might create an even bigger economic incentive for shipowners to avoid the SRR.

In conclusion, our analysis result illustrates a significant relative reduction in the probability of beaching vessels with registered owners from EU countries by 17.7 percentage points. Still, we cannot with certainty infer that this effect is solely caused by the EU Ship Recycling Regulation. Complex owner structures disguising recycling information, facilitates continuous beaching. The lack of transparency makes it challenging to gather adequate data, and confusing industry definitions makes it even harder to conduct research on this topic. In total, the effects of the EU Ship Recycling Regulation are limited, but certainly contribute in a positive direction putting beaching on the political agenda.

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Appendix

A1 Original Variables in the Dataset*

Table A1.1: Variables in the Dataset

Variable Name	Variable Unit	Variable Description
Arrival	Date	Date at scrapping facility
Beneficial Owner (BO)	Company Name	Profit recipient decision maker
BO Country	Country	BO's Country of Origin
Built	Year	Vessel construction year
Date of change	Date	Date change of flag
Date sold for breaking	Date	Date sold for scrapping
Commercial Operator (CO)	Company Name	Operate Vessel
Country	Country	Country of scrapping
Former name	Name	Vessel name prior name change
Gross Tonnage (GT)	Tonnes	Load capacity
IMO	Number	Vessel unique identification
Last flag	Flag	Vessel last registered flag
Light Displacement Tonnage (LDT)	Tonnes	Vessel weight as built
Place	Locations	Location of scrapping facility
Previous flag	Flag	Flag before last flag
Registered Owner (RO)	Company Name	Legal title of vessel ownership
RO Country	Country	RO country of registration
Sold for LDT	Dollars	Ship scrap price per LDT
Type of ship	Type	Cargo/operations vessel operates
Year	Year	Year vessel is scrapped
USDton	USD	Achieved scrap price per tonnes

- *All original variables are listed, independent of the information quality they hold.

A2 Model 2 Robustness Test

Table A2.1: Model 2: Robustness of Regression Test

	(2.0a) Beached	(2.1a) Beached	(2.2a) Beached	(2.3a) Beached
Treatment Effect, BO.	-0.0673	-0.0540	-0.0335	-0.0217
(EU_BO*Post 2018)	(0.0411)	(0.0384)	(0.0404)	(0.0389)
Vessel age (years)		-0.0119***		-0.00802***
		(0.000712)		(0.000805)
Vessel gross tonnage (in '000)			0.00295***	0.00216***
			(0.000208)	(0.000205)
Adj. Fixed Effects Years	Yes	Yes	Yes	Yes
Adj. Fixed Effects BO Origin	Yes	Yes	Yes	Yes
N	7016	7013	4608	4606
R^2	0.269	0.303	0.344	0.361

Note: similar regression results to descaled dataset made for BO with full (N=7016) BO dataset, & Robust standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A3 Variable Correlation Table

Table A3.1: Pairwise Correlation table

Variables	2012	2013	2014	2015	2016	2017	2018	2019	EU_BO	bocountry	EU_RO	rocountry	Year	Age	GT
2012	1.00														
2013	-0.21	1.00													
2014	-0.19	-0.18	1.00												
2015	-0.16	-0.15	-0.14	1.00											
2016	-0.17	-0.16	-0.15	-0.12	1.00										
2017	-0.16	-0.16	-0.14	-0.12	-0.13	1.00									
2018	-0.15	-0.15	-0.13	-0.11	-0.12	-0.12	1.00								
2019	-0.14	-0.14	-0.13	-0.11	-0.11	-0.11	-0.10	1.00							
EU_BO	0.08	-0.02	-0.03	-0.02	0.06	0.00	-0.04	-0.05	1.00						
bocountry	-0.02	-0.01	-0.03	-0.07	-0.04	0.01	0.11	0.07	-0.20	1.00					
EU_RO	-0.14	-0.14	-0.12	0.08	0.18	0.12	0.07	0.04	0.38	-0.04	1.00				
rocountry	0.36	0.35	0.31	-0.31	-0.29	-0.25	-0.19	-0.20	-0.02	0.23	-0.28	1.00			
Year	-0.60	-0.39	-0.17	0.00	0.16	0.31	0.44	0.55	-0.06	0.09	0.24	-0.62	1.00		
Age	-0.03	0.00	0.01	-0.01	-0.13	-0.00	0.11	0.08	-0.08	0.19	0.01	0.08	0.08	1.00	
GT	.	.	-0.06	0.02	0.10	0.00	0.00	-0.07	0.06	-0.13	-0.02	-0.08	-0.01	-0.41	1.00

A4 Parallel Trend Testing

A4.1 Model 1 Interactions

Table A4.1: Registered Owners Parallel Trends Interaction Terms

	(1) Interactions
d16*EU_RO	0.117*
	(0.0502)
d17*EU_RO	0.247***
	(0.0575)
d18*EU_RO	0.0455
	(0.0579)
Adj. Fixed Effects Years	Yes
Adj. Fixed Effects RO Origin	Yes
N	3607
R^2	0.340

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A4.2 Model 2 Interactions

Table A4.2: Beneficial Owners Parallel Trends Interaction Terms

	(1) Interactions
d16*EU_BO	0.0268
	(0.0380)
d17*EU_BO	0.115**
	(0.0416)
d18*EU_BO	-0.0396
	(0.0424)
Adj. Fixed Effects Years	Yes
Adj. Fixed Effects BO Origin	Yes
N	3607
R^2	0.335

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A4.3 Model 1, RO Anticipation Effect Test

Table A4.3: Regression Table RO, Anticipation Treatment Effect post 2017.

	Beached^{RO}	Beached^{RO}	Beached^{RO}	Beached^{RO}
Treatment Anticipation Effect, RO.	-0.0594	-0.0569	-0.0690	-0.0654
(EU_RO*Post 2017)	(0.0516)	(0.0479)	(0.0494)	(0.0471)
Vessel age (years)		-0.00929***		-0.00668***
		(0.000998)		(0.00100)
Vessel gross tonnage (in ’000)			0.00299***	0.00233***
			(0.000199)	(0.000205)
Adj. Fixed Effects Years	Yes	Yes	Yes	Yes
Adj. Fixed Effects RO Origin	Yes	Yes	Yes	Yes
N	3607	3605	3605	3603
R^2	0.335	0.362	0.367	0.379

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A4.4 Model 2, BO Anticipation Effect Test

Table A4.4: Regression Table BO, Anticipation Treatment Effect post 2017.

	Beached^{BO}	Beached^{BO}	Beached^{BO}	Beached^{BO}
Treatment Anticipation Effect, BO.	-0.0777*	-0.0798*	-0.105**	-0.0998**
(EU_BO*Post 2017)	(0.0381)	(0.0356)	(0.0366)	(0.0352)
Vessel age (years)		-0.00993***		-0.00771***
		(0.000877)		(0.000875)
Vessel gross tonnage (in ’000)			0.00293***	0.00217***
			(0.000217)	(0.000214)
Adj. Fixed Effects Years	Yes	Yes	Yes	Yes
Adj. Fixed Effects BO Origin	Yes	Yes	Yes	Yes
N	3607	3605	3605	3603
R^2	0.333	0.365	0.362	0.379

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$