Green Finance in Bulk Shipping

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ABSTRACT

The worldwide growing concern about climate change is leading industries to adopt measures to reduce negative externalities. New financial instruments have been developed under the umbrella of green finance aimed at meeting the financial requirements linked to significant investments for green strategies. Bulk shipping companies are increasingly aware of the environmental impacts caused by their operations. Nevertheless, the nature and intensity of funding solutions aiming at supporting green investments from bulk shipping companies are still scarcely investigated by academics. The first objective of this paper is to examine theoretical aspects associated with the green transition in the bulk shipping industry. The second objective is to empirically investigate the current state in green finance by analysing the most adopted green financial products by major international bulk companies, taking into account the most suitable solution for each green investment strategy and option available in the market. A multiple case study methodological approach is used to shed light on the current role of green finance in the bulk shipping industry. The research outcomes provide detailed insights to academics and practitioners about the range of green investment and financial solutions in the bulk industry, in terms of preferred financing methods, magnitude of financial resources gathered and other relevant profiles.

Keywords: Bulk shipping, green finance, sustainability, green strategies, stakeholder relationship management.

1. Introduction

Although the shipping sector constitutes globally the most environmentally efficient mode of transport (Cristea et al. 2013), it still generates significant negative environmental impacts with recognized negative spillovers on the marine and natural ecosystems worldwide. The main environmental impacts caused by maritime transport include the emission of greenhouse gases (GHG) and other harmful emissions into the atmosphere, the landfill of waste at sea, noise pollution, the transfer of Non-Indigenous Species (NIS) during the loading/unloading of ballast water, the physical damage caused to the seabed (EMSA 2021), etc. According to International Maritime Organization (IMO), in 2018 sea transport was responsible for the emission of 1.056 million tons of carbon dioxide (CO_2), i.e., 2.89% of global emissions in the same year (International Maritime Organization 2018). Due to the constant and sustained growth rates of the industry, IMO declared that such emissions could increase by 90-130% by 2050, compared to 2008, if no containment measures are taken, and that in the same year sea transport could be responsible for 15% of global emissions.

To comply with international regulation, shipping companies are called to assume greater responsibility for the social and environmental effects derived from sea transport activities. Shipping companies are called to step up their efforts to balance the interests of the different categories of stakeholders, given the growing global attention awarded by several stakeholder groups to sustainability-related issues. The adoption of Environmental, Social & Governance (ESG) factors is therefore increasingly relevant within both the operational and financial strategies implemented by sea carriers. Relatedly, shipping companies can adopt different strategies aimed at mitigating the negative externalities of the sector through specific green strategies, for example, by investing in the transition towards green(er) ship fuels based on renewables (Lai et al. 2011; Psaraftis and Kontovas 2020).

The transition of the shipping sector towards a more sustainable growth opens up windows of opportunity for the financial sector. In the past two decades, commercial banks and financial institutions have been the main driving forces behind the emergence of sustainable finance (Berrou et al. 2019). This type of finance can is defined by the European Commission as '*the process of taking*

due account of environmental, social, and governance (ESG) considerations when making investment decisions in the financial sector, leading to increased longer-term investments into sustainable economic activities and projects'. In this paper, we mainly focus on environmental sustainability referring to climate change mitigation and adaptation, the preservation of biodiversity, pollution prevention and the circular economy. In the latter context, the term green finance is used. Under the umbrella of green finance, the financial sector has developed a wide range of new green finance instruments labelled "green financial products" (He et al. 2019), in line with the global objectives of growth and sustainable development.

The paper is organized as follows. The next section describes the research design and presents the research objectives. The main environmental impacts of bulk shipping and the increasing attention for sustainability in the industry are discussed in the third section. The fourth section analyses green strategies in bulk shipping, thereby distinguishing between technical solutions or hard investments; soft practices and procedures; and Market-Based Measures (MBMs). The fifth section provides an overview of the different forms and initiatives in the field of green finance in the bulk shipping industry, while the sixth section empirically examines the actual implementation of green finance instruments. The last section presents the implications of our research findings as well as the overall conclusions.

2. Research design

Although issues related to strategies aimed at improving the environmental sustainability of shipping operations are widely investigated in existing academic literature (Shi et al. 2018), little attention has so far been paid to which available green finance solutions can better support the funding of strategic corporate goals set by shipping companies with regards to both sustainability and the environment. Bulk shipping has been particularly neglected compared with other shipping market segments (e.g., cruise lines, ferries, container shipping, etc.). The few relevant academic contributions on green finance for shipping predominantly focus on the state of the art of green finance solutions and the future trends that will contribute to shaping the business (Kavussanos and Tsouknidis 2021; Rebelo 2020). In this

vein, this paper examines in detail the theoretical constructs underlying the process of the green transition that is progressively shaping the bulk shipping sector (research objective 1). This first research objective sets the stage for the subsequent pursuit of research objective 2, which is to empirically deepen our understanding of the adoption of green financing solutions for dry bulk shipping, and to identify the most appropriate solutions for different green investments, also taking into account best practices in the sector and different shipping markets. Thus, research objective 2 is aimed at understanding the mechanisms of and the opportunities for the application of financing mechanisms specifically designed to support green investments in the bulk shipping segment as referred in research objective 1.

The research design of this paper therefore firstly focuses on the numerous technological options, best practices and other market-based solutions that have been developed in order to curb the negative externalities that dry bulk shipping generates in terms of emissions, threats to marine biodiversity, noise pollution, marine litter and related issues. These investments are urging unprecedented additional resources for feeding green strategies in a well-rooted and typically "conservative" industry (Buratti et al. 2018). Relatedly, to keep the pace with market and competitive drivers and to support the environmental transition of the dry bulk shipping industry, green finance mechanisms are emerging.

The research design therefore includes both the analysis of such green investments and related suitable financial instruments, which are designed to support green strategies pursued by bulk shipping companies, by rewarding the achievement of specific environmental performance targets. The research design aims to understand the dual benefits of green finance mechanisms: on the one hand, shipping companies can access finance to improve their environmental sustainability and enjoy business benefits from reduced operating costs, while the improvement of environmental performance derived from such investments can directly impact on the social, environmental and normative drivers that are currently shaping the business.

Figure 1 presents the theoretical framework underlying the manuscript. Once having understood at a theoretical level the green investment solutions available to operators in the sector to improve their environmental sustainability performance, as well as the green finance instruments that currently exist to support their adoption, the study aims to understand, for each type of green investment or solution, which financing mechanism is most suitable and effective.

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To this aim, the research design is supported by a multiple case study analysis, aimed at empirically assessing the current state of the art concerning the adoption of green financing solutions among bulk shipping companies. According to the principles of case study research (Yin 2009; Yin 1994), the empirical research covers a global sample including all shipping companies operating in the bulk sector, that have adopted sustainable financing solutions over the past five years. Through the aforementioned business cases, the most used green financing solutions by bulk shipping companies are assessed, highlighting the different approaches adopted by dry and liquid bulk shipping companies towards green investments and related funding mechanisms.

3. Sustainability in the bulk shipping industry: an emerging issue

The identification and quantification of the environmental impacts caused by shipping is an essential prerogative to introduce innovative green strategies and procedures in the industry. Extant studies on the environmental consequences caused by the shipping industry address a wide array of topics such as oil spills (Neuparth et al. 2012), management of plastic waste (Li et al. 2016), transfer of non-indigenous species (NIS) via ballast water (Bax et al. 2003), antifouling paints (Konstantinou and Albanis 2004) and underwater noise pollution (Peng et al. 2015). However, an overall assessment of the environmental impacts of maritime transport is lacking (Jägerbrand et al. 2019). The environmental impacts of the industry can be classified into several categories for study and research purposes, and both academic literature and supranational institutions propose different conceptual frameworks (Table

1)**Error! Reference source not found.**. Among the different options proposed, this paper refers to the classification provided by the EMSA in the European Environmental Report on Maritime Transport of 2021 (EMSA 2021). The EMSA report classifies the environmental impacts deriving from shipping in atmospheric emissions, release of harmful liquid substances, landfill of solid waste, noise pollution, transfer of native species, physical damage to the seabed and risk of collision with marine species.

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Given the growing attention paid by various stakeholders to sustainability issues, shipping companies are facing challenges both internally, being urged to adopt relevant policies, for example by implementing green strategies, and externally by activating collaborations and relationships with stakeholders to fund Socially Responsible Investments (SRI). The implementation of an effective green strategy requires the adoption of quantitative and qualitative indicators or Key Performance Indicators (KPIs) that assess the economic, social, and environmental sustainability of business processes and investments (Wang et al. 2019). In specific shipping market segments, such as in bulk shipping, these practices are still underexplored and debated (Ranängen and Zobel 2014). The volatile and highly dynamic business environment drives bulk shipping companies to maximize efficiency and cost reduction, resulting in a general propension towards profit generation in the short term. Nonetheless, financial and non-financial stakeholders exert an increasing influence on bulk shipping companies' investment decisions, demanding for safer and more sustainable assets and operations.

When selecting available SRI, investors examine not only economic and financial variables but also non-financial corporate profiles, such as 'ESG' factors (Lin et al. 2022). According to the analysis carried out by Fung et al. (2010), ESG factors include the following:

- "E" factor (Environmental), i.e., environmental impact, environmental management, and eco-efficiency;
- "S" factor (Social), i.e., labour in terms of security, equality, and equity, social development;

- "G" factor (Governance), i.e., the involvement of stakeholders, the structure of the board of directors, an ethical code, etc.

The growing concern about the environmental and social impacts of bulk shipping has given rise to a proliferation of solutions that integrate ethical considerations into the investment decision process performed by the main business players. As a result, an increasing number of bulk shipping companies are starting to adopt ESG-compliant practices and investment options due to an increase in environmental and sustainable requirements imposed by their customers (Poulsen et al. 2016).

4. Green strategies in the bulk shipping industry

In compliance with environmental regulations, the shipping industry is urged to accelerate a radical transition towards innovative technologies and business practices (Köhler et al. 2022; Serra and Fancello 2020). According to extant literature, green strategies can be grouped into three primary categories of measures to reduce environmental impacts caused by shipping (Lai et al, 2011; Wan et al. 2018; Serra and Fancello 2020): i) technical solutions or hard investments; ii) soft practices and procedures; iii) Market-Based Measures (MBMs).

Hard green investments consist of interventions aimed at promoting energy efficiency and reducing environmental emissions per ton-mile through new and green(er) assets and equipment. Among the innovative propulsion systems, electrification has become a very attractive technology particularly for small and medium-sized vessels operating on shorter sea routes, providing power supply via zero-carbon electric storage systems such as batteries or super capacitors. Also, wind energy is considered one of the alternative energy sources in the maritime sector, although its application remains rather limited. As regards alternative marine fuels, the easiest way to comply with the new IMO2020 requirements consists in the use of low-sulfur fuels, such as very-low sulfur fuel oil (VLSFO), ultra-low sulfur fuel oil (ULSFO) and marine gasoil (MGO). Although these fuels are considerably greener than traditional ones, they still contribute to significant atmospheric emissions. The shipping sector is

currently focused on using more sustainable alternative fuels such as Liquefied Natural Gas (LNG), biofuels, renewable/green hydrogen, ammonia and methanol. As the production of hydrogen and ammonia requires large quantities of energy, the generation of such energy needs to come from renewables to avoid any environmental impacts. Bulk shipping companies can implement additional investment options aimed at reducing energy consumption and environmental impacts, such as through an Exhaust Gas Cleaning System (scrubber) (Pakbeen 2018); slender hull ship design (Lindstad et al. 2015); hull air lubrication; counter-rotating propellers (van Kluijven et al. 2013); the optimization of the bulbous bow (Smith et al. 2016; Rehmatulla et al. 2017) and Ballast Water Treatment System (BWTS). Since 2012, the EU and the IMO introduced mandatory requirements relating to the energy efficiency performance of ships, called Energy Efficiency Design Index (EEDI[1]) and Energy Efficiency Operating Index (EEOI[2]). Furthermore, the EU and the IMO require shipping companies to elaborate a Ship Energy Efficiency Management Plan (Łosiewicz and Kamiński 2014).

Soft green practices and procedures of an operational nature are easier to implement, do not require expensive capital outlays and can lead to the achievement of significant energy savings in the short term. Among the soft green practices and procedures, the Voyage Speed Optimization and the practice of slow steaming are essential in the bulk shipping industry because of the exponential correlation occurring between speed and fuel consumption. Also, the installation of the trim, i.e., a hydraulic piston, allows to manage the ship optimizing both speed and consumptions. Fuel consumption can be further reduced by implementing route optimization systems which optimize speed, trim, heeling and other voyage parameters basing on the navigation conditions (wind direction, waves, etc.).

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[1] The EEDI is a technical indicator for the ship propulsion systems of ships under construction and establishes a minimum level of energy efficiency for each type and size of ship. Expressed in grams of CO2 per ton-mile, a lower EEDI show a greater ship energy efficiency (Tran 2019).

[2] The EEOI is an indicator of an operational nature that can be identified as the average annual carbon intensity of a ship (in grams of CO_2 per ton-mile), considering the many variables that influence its operation (such as speed, hull deterioration, weather, and sea conditions, etc.).

Carbon Market and Market-Based Measures concerns two main alternative policies that governments or public authorities can implement to mitigate environmental impacts, i.e., the command-and-control approach and Market-Based Measures (MBMs). In a command-and-control scenario[3], a designated authority formulates direct regulation by setting benchmarks to limit the factors contributing to GHG emissions reduction (e.g., speed, power, or fuel consumption). In an international context as the shipping industry, the identification of benchmarks is however very complex (Ehlers et al. 2014). A command-and-control approach also limits investments in technology as it does not incentivize companies to innovate (Guerin 2003). MBMs are more flexible and use prices or other economic variables to provide monetary incentives to reduce emissions: polluters internalize the negative external environmental cost caused by emissions to offset this cost. In this way, carbon emission costs are internalized, fixing a price for the company, i.e., the "carbon price". The main examples of MBMs are the Carbon Tax and the Emission Trading System (ETS) (Keen et al. 2012; Christodoulou and Cullinane 2023). Through a carbon tax the competent authority sets the price and allows the market to determine the amount of the potential emissions, while with the ETS the authority determines the amount of emissions that can be released into the atmosphere and allows the market to determine the price. In April 2023, the European Union decided on the inclusion of shipping in the Emissions Trading System, i.e., to apply emissions trading to all emissions on voyages between EU ports and to half of emissions on extra-EU voyages. Regarding one of the most important MBMs in the shipping industry, i.e., the carbon/bunker levy on CO_2 emissions released in the atmosphere, different solutions can be implemented (Psaraftis and Lagouvardou 2019): the International Fund for GHG from Ships (GHG fund); a bunker tax; a tax on the amount of CO_2-equivalent (CO_2eq) emissions; a reduced tax based on specific ship criteria; the elimination of tax-free status of marine fuels at European level. Given the many MBM-related developments, several bulk shipping companies are

[3] It refers to an opposite environmental policy to the financial incentive which is based on the regulation of a specific sector (through authorizations, prohibitions, definition of rules).

setting up an internal department dedicated to managing business opportunities related to MBM, jointly with the development of green investment strategies.

Technological progress and an increased sensitivity towards environmental sustainability issues (Pettit et al. 2018; Köhler 2014) opened new opportunities for the implementation of hard and soft solutions aimed at mitigating the environmental implications arising from bulk shipping activities. Such solutions, nevertheless, usually require vast amounts of financial resources to be concretized, requiring new and more effective tools to access and raise the capital needed for the implementation of the abovementioned green investments. In this context, new opportunities arise for financial markets to support the realization of green investments in several business sectors, including bulk shipping.

5. Green Finance for shipping

Initiatives aimed at containing climate change have now become top priorities for shipping companies around the world. Additional financial resources are required for fueling green strategies and investments. Financial institutions, investors, and lenders are expected to play a key role in funding the business initiatives aimed at mitigating the environmental impacts generated by the industry.

Sustainable growth requires appropriate financial support, triggering both scholars and academics to introduce the concept of "Green Finance", defined as long-term funding schemes that simultaneously pursue the development of the financial industry, improved environmental sustainability of businesses/industries and the pursuing of social and economic growth (Stern 2006). Noh (2014) makes a distinction between sustainable finance, environmental finance, carbon finance and climate finance. Sustainable finance consists of creating economic and social value through sustainable models, products, and financial markets. Environmental finance includes financing and investment methods considering environmental damage as a financial risk and prohibiting the collection of capital resources aimed at promoting projects that are harmful to the environment. Carbon finance is the branch of green finance aimed at finding resources for CO_2 and GHG emission reduction projects. Climate finance supports climate change adaptation and mitigation activities to achieve a low emission economy.

More recently, the green finance market has seen an exponential growth in terms of financial transactions, volumes, and alternative funding solutions. The green finance market is dominated by debt products and is part of the larger sustainable finance market. The global issuance of sustainable debt instruments reached about USD 750 billion in the first half of 2022 (Bloomberg 2022). The sustainable debt market has seen strong growth in recent years and now totals about USD 5 trillion, of which USD 1.7 billion was issued in 2021. Among others, green financial products (namely sustainability-linked bonds, sustainability-linked loans, green bonds, green loans and sustainable bonds) greatly contribute to this trend. In line with the first research objective, the main green investment options and the related green funding schemes available for (bulk) shipping companies are analyzed in conceptual terms in the next subheadings.

5.1 Sustainability-Linked Bond (SLB)

Released by the International Capital Market Association, the "sustainability-linked bond principles[4]" define SLBs as bond loans, for which the financial or intrinsic value added vary depending on the issuer's achievement of sustainable or ESG objectives that are pre-established within the loan contractual agreement. These objectives are measured through specific KPIs and evaluated according to the Sustainability Performance Target (SPT). SPTs are measurable improvements in KPIs on to which issuers commit to a predefined timeline. They should be in compliance with an issuer's overall sustainability/ESG strategy.

To carry out the issuing process transparently for investors, underwriters, banks, and agents, the ICMA outlines five components of the SLB. The first one is the selection of KPIs: in the shipping industry, the main environmental KPIs are EEOI and AER[5] indicators. The second component is the weighing

[4] Voluntary guidelines highlighting the best practices related to the issuance of financial instruments in line with ESG objectives.

[5] The AER (Average Efficiency Ratio) measures CO2 emissions (using parameters like bunker consumption, sea distances and DWT) for all journeys in the last year considering both tonnage in ownership and in leasing/bareboat charter.

of SPTs as a function of the chosen KPI. The third one regards the mapping of the financial or structural characteristics of the SLB which may vary with the achievement of SPTs. The fourth and fifth components are, respectively, the reporting (about KPIs and the related compliance with SPTs) and the verification/evaluation activities by specialized external parties.

5.2 Sustainability-Linked Loan (SLL)

The Loan Market Association defines the SLL as a loan that incentivizes the borrower to achieve specific sustainable performance objectives. As for SLBs, even SLLs do not require a "use of proceeds", but they can be intended for general sustainable strategic goals. SLL incentivizes the achievement of sustainable performance by the borrower grounding on programmed shifts in the cost of capital, settled during the negotiation process with the lender. The sustainability linked loan principles indicate five core areas for SLL that are the same as those described for SLBs. According to Standard and Poor's, considering global context in all fields, the overall emission of SLL and SLB exceeded USD 130 billion in 2020, almost tripling the values recorded in 2018.

5.3 Green Bond

The biggest category in the green finance market includes various forms of green bonds with some form of ESG screening (OECD 2015; Bloomberg 2022). Like any other bond, a green bond is a fixed-income financial instrument for raising capital from investors through the debt capital market. However, a green bond paves on the commitment to exclusively use the funds raised to finance/re-finance green projects, assets or business activities (ICMA 2021). Green bonds help investors to balance risk-adjusted financial returns with environmental benefits, to meet ESG requirements and to actively hedge against climate policy risks in a portfolio that includes emissions intensive assets. In the green bond principles document, the ICMA proposes a voluntary guideline concerning the issuance of Green Bonds. The Green Bond is a form of sustainable financing through which almost USD 300 billion was raised in 2020 in all sectors combined. The most involved sector in the green financial

product is the energy sector, while the transport sector, with a capital raised of USD 80 billion, ranks third.

A recent variation on the green bond theme is the blue bond whereby funds raised are earmarked exclusively for projects deemed ocean-friendly and part of the blue economy development such as sustainable marine and fisheries projects. The World Bank defines blue bonds as '*a debt instrument issued by governments, development banks or others to raise capital from impact investors to finance marine and ocean-based projects that have positive environmental, economic and climate benefits*'. While green bonds have been around since 2008 as instruments to finance climate-friendly projects, the first blue bond was launched in October 2018 by the Republic of Seychelles.

5.4 Green Loan

The "green loan principles" by Loan Market Association (LMA[6]), Asia Pacific Loan Market Association (APLMA[7]) and Loan Syndications and Trading Association (LSTA[8]) define the Green Loan as a loan made available solely for financing or refinancing (in whole or in part) new or existing green projects. Thus, green loans are loans where the use of proceeds is linked specifically to green projects, green product development or a green project portfolio of the client. A fundamental aspect of the Green Loan is the adoption of the related proceeds for pursuing green projects focused on research and development activities. However, these purposes may vary across geographical areas and businesses involved. For example, in the maritime sector the proceeds of these loans are used for funding the purchase of LNG-powered ships or the installation of scrubbers or Ballast Water Treatment Systems on the borrower's fleet.

[6] LMA represents the syndicated loan market in Europe, Middle East, and Africa through collaboration with lenders, law firms, borrowers and regulators.

[7] APLMA is a non-profit professional association representing the interests of actors active in the syndicated lending market in the Asia-Pacific region.

[8] LSTA is an industry leading platform for all participants in the syndicated loan market.

5.5 Advances in green finance

The sustainable finance market is rather young. For many years, there was a lack of unified standards and a limited scope for legal enforcement of green integrity in for example the green bond market. This raised confusion and possibility for reputational risk if green integrity of the bond or other debt instrument would be questioned (OECD 2015). The infrastructure still lacked many of the components of a fully functioning financial market, such as agreed impact performance metrics, listings on debt or equity public markets, and retail investment instruments. At present, frameworks and regulations have created widely-accepted but often voluntary market standards. Policy makers and regulators have also worked on a broad toolbox for companies and financial institutions to develop green investment solutions. In the past few years, a lot has been achieved in the promotion of greater transparency and disclosure from financials and corporations on indicators of ESG performance.

6. The use of green financial products in bulk shipping

6.1 Methodological note on the empirical analysis

Research objective 2 is aimed at understanding the mechanisms of and the opportunities for the application of financing mechanisms specifically designed to support green investments in the bulk shipping segment. We address this second research objective by empirically scrutinizing the current state of the play concerning green financial products shaping the bulk shipping industry worldwide. The analysis allows to empirically tests the real dynamics related to green finance in the bulk shipping industry. The research design includes a business overview supported by a multiple case studies analysis.

As stated earlier in section 2 about research design, the method of analysis is the embedded multiple cases study[9] aimed at investigating different strategic approaches by bulk shipping companies when

[9] A case study containing more than one sub-unit of analysis; its methodology proposes a set of quantitative and qualitative methods in a single research study.

selecting alternative green funding schemes for green projects. For each green financial product included in the analysis, the following variables are addressed and investigated: 1) type of financing; 2) the purpose/aim of the capital raised and related sub-categories; 3) the funding amount; 4) the interest rate; 5) the loan duration; and 6) the financial entities involved.

From a data collection perspective, the sample consists of companies operating in the bulk sector that have adopted sustainable financing instruments in the last five years. Table 2 presents the list of the sample bulk shipping companies and provides valuable insights related to the market segment, the year of foundation, the headquarters, and related descriptive statistics (e.g., listing on the stock exchange, fleet size, etc.). The sample includes 29 bulk shipping companies, thus suggesting the still embryonic stage of the green finance market for the bulk shipping industry. Nonetheless, the sector is experiencing a two-digit growth rate in the past few years, demonstrating high market potential. Five of the sample companies operate in both the dry and tanker sectors, while nine of them only manage dry bulk vessels. Fifteen companies operate in the tanker market. As regards the geographical area of the headquarters, the sample includes 16 European companies and 13 companies with headquarters located in non-European countries. Moreover, the fleet size of the observed companies varies greatly within the sample, from 5 to 474 vessels (82 technical units on average). Relatedly, the sample is quite heterogeneous. More than half of the sample companies are listed on a stock exchange. This highlights three key elements: the constant growth of green finance in the stock markets, the greater attention and relevance of environmental issues to the capital market and the ease in finding sustainable capital by listed companies.

For the variables amount and duration, classes of values are used: the amount (USD) has been grouped in <50M, 50M–250M, >250M classes, while the variable duration in <=4, 5–8, >8 years classes.

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Table 3 shows a set of conceptual categories for benchmarking and comparison purposes. Annex I

presents a classification of bulk shipping companies based on the typology of green financial products, while Annex II classifies bulk shipping companies based on aim, amount, duration and interest rate of green financial products. When it comes to the strategic goal of the financial instrument, three main categories have been identified, namely vessel financing, equipment financing and corporate financing. Such categories have been further divided into subcategories. Vessel financing includes all financing methods related to the ship asset; this category has been divided into newbuilding, second-hand and existing vessels, grounding on the ship subject to financing. Equipment financing includes financing solutions associated with the implementation of green strategies (scrubbers, BWTS, etc.). Corporate financing includes financing instruments for corporate purposes; this category has been split into refinancing and new emissions in compliance with green financial requirements, respectively referring to the refinancing of outstanding debts or to the funding of corporate strategies aimed at mitigating the environmental impacts of the borrower.

Concerning the “financing typology” variable, the classification paves on the conceptual discussion in section 5, i.e., SLB, SLL, Green Bond, Green Loan are identified as key labels, thus adding a miscellaneous category "other" which includes funding solutions that do not fall into the above categories, but still represent financing mechanisms aimed at reducing the environmental impacts from business operations.

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6.2. Main findings

In the past five years, the bulk shipping sector that has been most involved in green finance procedures is the tanker market, with an amount of USD 4.2 billion (75% of total funding). The explanation can be threefold: a greater presence of tanker shipping companies within the sample; higher technological and safety standards of oil tankers compared to bulk carriers; a more stringent international environmental regulation due to the poor public image of the sector. Market needs and stringent contractual agreements fixed by the charterers are argued to have shaped this trend.

When it comes to the financial amount of the loans, more than 70% of them are in the "over USD 50 million" class, in line with the capital-intensive nature of the business. In addition, nearly 50% of the sample funding solutions range between USD 50 million and 250 million. Only bulk shipping companies operating in the tanker sector are involved in green financial products aimed at raising capital for more than USD 250 million.

Loans are the preferred financing method, representing about 75% of the sample transactions: this is also due to the historical link occurring between the shipping industry and bank finance. This trend is even clearer in the dry bulk industry, where this financing method covers 80% of the overall green financing solutions. A higher heterogeneity emerges in the tanker sector with all funding schemes being well represented. Financing mechanisms linked to sustainability performance already play a significant role in bulk shipping: about 50% of the green financial products studied consist of SLB or SLL.

Loans account for 80% of the resources gathered, thus representing the most relevant funding solution for the business, whereas bonds are not usually implemented by the observed companies for amounts exceeding USD 250M.

In the European context, the EU taxonomy[10], i.e., a classification system which establish a list of environmentally sustainable economic activities, must be considered. It provides companies, investors, and policymakers with appropriate definitions for environmentally sustainable economic activities. According to this taxonomy, vessels dedicated to the transport of fossil fuels and vessels burning fossil fuels are not classified as green assets. As bulk ships continue to run on fossil fuels for now (low sulfur fuel or LNG), green bonds and green loans for ships are still scarce in the EU shipping sector, whereas

[10] The Taxonomy Regulation was published in the Official Journal of the European Union on 22 June 2020 and entered into force on 12 July 2020. The taxonomy includes a list of economic activities which can make a substantial contribution toward at least one of six EU environmental objectives: climate change mitigation; climate change adaptation; sustainable use and protection of water and marine resources; transition to a circular economy, waste prevention and recycling; pollution prevention and control; and protection of healthy ecosystems. The activities should not do significant harm to all other environmental objectives, meet minimum (social) safeguard compliance, and should meet technical screening criteria to be established by the EC.

SLL are more widespread. The proceeds from green loans and bonds should be used for green assets, while the use of proceeds for SLL can be a corporate purpose.

As regards the tenor, a lack of disclosure emerges, with only 60% of the sample with disclosed figures: 85% of green financial products unveil a tenor longer than 5 years, consistent with the characteristics of the shipping market, where investments hold mid to long term pay back periods.

Examining the aims that push bulk shipping companies to adopt green forms of financing, almost one in two allocates the raised capital to the core assets of the business, namely ships, followed by corporate purposes and equipment purposes. The tanker sector equally prefers both vessel and corporate financing, leaving aside the investments related to the implementation of on-board equipment.

Regarding the vessel financing category, the most financed type of ship is the newbuild, due to the urgency for renewing the fleet to keep the pace with both legal and technological changes/improvements available in the market. In two out of three cases, the corporate financing category refers to the refinancing of existing debts; in the other cases, green financial products are intended to cover the needs generated by general investments aimed at reducing the company's environmental impacts.

Finally, the correlation between the green financial product typology and the corporate goal is investigated, resulting in valuable insights for both scholars and practitioners. Companies pursuing sustainable corporate goals significantly rely on sustainability-linked financial solutions in 92% of cases. In line with the sustainability-linked principles, such financial instruments are intended for corporate general purposes. However, the empirical investigation also suggests a certain interest for the adoption of Sustainability-Linked products, also for ad hoc green projects. In this vein, six Sustainability-Linked Loans are found and used for financing new vessels.

Vessel financing represents the main aim pursued through green financial products, with the loan formula accounting for about 70% of cases. The financing methods characterized by a use of proceeds, i.e., Green Loans and Green Bonds, are mainly aimed at vessel and equipment financing.

6.3 Business cases

For each financing typology, the empirical investigation includes a more in-depth analysis of valuable business cases which provide insights and guidelines to shipping managers interested in green finance solutions.

Among others, Odfjell, a leading Norwegian shipping company in the transport and storage of chemical products, has partially refinanced its debt exposure through the issuance of a SLB. In August 2020, Dun and Bradstreet Corporation and Nordea joined the team to support the development of a Financial Framework related to sustainability. Through the issued SLB, Odfjell raised NOK 850 million maturing in 2025 (around USD 100 million), in line with their corporate finance strategic goals. The contractual agreement grounds on the Average Efficiency Ratio as the most relevant KPI for assessing the actual pursuing of the sustainability-linked goals settled in accordance with the lenders.

Teekay Shuttle Tankers L.L.C. (TST) bases its business on the management of shuttle tankers (carriage and transport of crude oil extracted from offshore oil fields not equipped with infrastructure and pipelines). To reduce the negative environmental impact of its operations and to increase the fleet' energy efficiency, TST invested in E-Shuttle tankers[11]. This project received a grant of NOK 133 million from ENOVA, a public company owned by the Norwegian Ministry of Climate and Environment. According to the green project criteria established by the top management, net proceeds from the issuance of Green Bonds have been used to finance the green projects and related activities. This Green Bond is a senior unsecured bond, with a maturity of 5 years, aimed at raising USD 150 million.

In 2018, Star Bulk, a dry bulk shipping company listed on the NASDAQ stock exchange, decided to equip the entire fleet (128 assets) with scrubbers. The aim of the shipping company consisted in covering the related financial resources needs (about USD 2 million per ship) for 70% through a loan

[11] E-shuttle tankers, powered by LNG and recovered volatile organic compounds and equipped with hybrid battery technology, generate a potential reduction of 47% in CO2 emissions, 88% in NOx emissions, 99% in SOx emissions and 22% in fuel consumption.

with an average margin of less than 3% and for the remaining 30% with the operating cash flow. In October 2018, the company finalized a USD 310 million financing contract, of which USD 70 million for the installation of scrubbers on 50 ships. The remaining 240 million has been allocated to the refinancing of the financial exposure originating from the acquisition of the overall fleet (composed of 26 ships). The financial resources for funding the scrubbers have been received through a Green Loan, which has been certified by DNV GL Business Assurance Services Limited.

In 2021, Hafnia, one of the main shipowners and operators on the tanker market, signed a Sustainability Linked senior secured term loan and a revolving credit facility with a pool of 10 banks. This funding is the first syndicated SLL within the shipping sector. The loan is characterized by an amount of USD 374 million and a duration of 7 years. It is aimed at refinancing two debts of USD 676 and 128 million. Hafnia supports the objective of reducing CO_2 emissions by 40% and GHG by 50% by 2030, compared to 2008 values.

7. Implications, limitations and conclusion

This paper examines the theoretical constructs underlying the process of the green transition that is progressively shaping the bulk shipping sector, and empirically deepens the adoption of green finance solutions, also identifying the main best practices in the sector. Companies active in the bulk shipping industry can benefit from the strong development of the green finance market by incorporating their sustainability strategy and targets in corporate finance decisions, and by exploring and implementing green finance instruments to shape their sustainable transition in close cooperation with their financial partners.

When it comes to the financing mechanisms adopted by the sampled companies, corporate size, cross cultural variables, and corporate strategic goals are suggested as predictors of the strategic behaviors of bulk shipping companies when selecting green financial products. Nonetheless, preliminary findings unveil several heterogeneous approaches towards green finance solutions in the industry, thus urging for additional investigations to better identify the most valuable determinants that are shaping the

industry.

European bulk shipping companies, which constitute more than 71% of the sample, are prone to select SLL (36%) and Green Loan (36%). Among them, only 7 shipping companies operate in the dry bulk business while over 60% of them operate in the tanker business. None of the Asia-based companies (20% of the sample) adopted SLB, with only one company adopting a Green Loan and another one issuing an ad hoc Green Bond. Both Green Loan and Green Bond have been issued to contribute to equipment financing. Asiatic bulk shipping companies are argued to ground on SSL (total amount of USD 929M).

The results suggests that the sustainability-linked products are considered the most suitable financing solution for gathering resources aimed at pursuing more general sustainable corporate goals. Conversely, financial needs originating from ad hoc green projects significantly rely on both green bonds and green loans. Finally, the adoption of green strategies for supporting corporate sustainability have been demonstrated to trigger the introduction of virtuous processes in the Finance Departments of the sample companies, imposing the introduction of innovative sustainability- related competences and investment monitoring systems.

This contribution has academic relevance as it allows for the exploration of phenomena that, up today, have been scarcely investigated by mainstream shipping management literature. These research outcomes highlight how different financing mechanisms through instruments falling under the concept of "green finance" may be more or less suitable for bulk shipping companies depending on the kind of corporate strategy and investment/project the company intends to undertake. This constitutes an interesting starting point for further research into how green finance instruments can be applied to the bulk shipping sector and the conditions that differentiate the sector from other maritime transport segments. This study also presents valuable implications for industry professionals and practitioners as it lays the foundations for the subsequent architecture of a more detailed conceptual framework able to support industry players in selecting and activating the most suitable green finance solutions to finance

their projects to improve the company's environmental performance.

Despite providing valuable insights for both academics and practitioners concerning the strategies and approaches adopted by bulk shipping companies towards green investments and relatedly the most fitting financing mechanisms available for each type of green strategy or single green project/investment, it is deemed necessary to highlight certain limitations of the study that might open further research opportunities for future investigations. The main limitations envisaged within the manuscript are the relatively small number of business cases included in the multiple-case analysis, which in turn, originates from the high level of confidentiality that characterizes the shipping sector and the sensitivity of the information related to finance contracts. The still embryonic dimension of the current market of green financial products for bulk shipping also played a role in this respect. A further limitation of the research is the lack of ad hoc investigations aimed at identifying commonalities and specificities which characterize the green funding options preferred by bulk shipping companies compared to other shipping markets/segments. Also, the potential antecedents and drivers underlying the aforementioned specificities, still have to be adequately identified and discussed (see, for example, the traditional lower sensitiveness of some bulk shipping sub-sectors towards environment-related issues when comparing with the attitude of the entire shipping industry).

INSERT ANNEX I HERE

INSERT ANNEX II HERE

References

Bax, N., Williamson, A., Aguero, M., Gonzalez, E., and Geeves, W. 2003. "Marine invasive alien species: a threat to global biodiversity." *Marine policy* 27(4): 313-323.

Berrou, R., Dessertine, P., Migliorelli, M. 2019. "An overview of green finance" In *The rise of green finance in Europe: opportunities and challenges for issuers, investors and marketplaces*, edited by Migliorelli, M. and Dessertine, P., 3-29. Palgrave MacMillan

Bloomberg 2022. *Bloomberg NEF's Sustainable Finance Market Outlook*, Bloomberg Philanthropies

Buratti, N., Parola, F., and Satta, G. 2018. "Insights on the adoption of social media marketing in B2B services." *The TQM Journal* 30(5): 490-529.

Christodoulou, A., and Cullinane, K. 2023. "The prospects for, and implications of, emissions trading in shipping." *Maritime Economics & Logistics*, https://doi.org/10.1057/s41278-023-00261-1

Cristea, A., Hummels, D., Puzzello, L., and Avetisyan, M. 2013. "Trade and the greenhouse gas emissions from international freight transport." *Journal of environmental economics and management* 65(1): 153-173.

Ehlers, S., Asbjornslett, B. E., Rodseth, O. J., and Berg, T. E. (Eds.). 2014. *Maritime-port technology and development*. Crc Press.

EMSA 2021. *European Environmental Report on Maritime Transport.* European Environment Safety Agency.

Fung, H. G., Law, S. A., and Yau, J. 2010. *Socially responsible investment in a global environment*. Edward Elgar Publishing.

Guerin, K. 2003. *Property rights and environmental policy: A New Zealand perspective.* Working paper No. 03/02. New Zealand Treasury.

ICMA 2021. *Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bond*, International Capital Market Association

He, L., Liu, R., Zhong, Z., Wang, D., and Xia, Y. 2019. "Can green financial development promote renewable energy investment efficiency? A consideration of bank credit." *Renewable Energy* 143: 974-984.

Jägerbrand, A. K., Brutemark, A., Sveden, J. B., and Gren, M. 2019. "A review on the environmental

impacts of shipping on aquatic and nearshore ecosystems." *Science of the Total Environment* 695: 133-637.

Joumard, R., Gudmundsson, H., Folkeson, L. 2011. "Framework for assessing indicators of environmental impacts in the transport sector." *Transportation research record* 2242(1): 55-63.

Kavussanos, M. G., Tsouknidis, D. A. 2021. Green shipping finance: Existing initiatives and the road ahead. In *New Maritime Business*, edited by Ko, BW. And Song, DW, WMU Studies in Maritime Affairs, 95-110. Cham: Springer International Publishing.

Keen, M., Perry, I., and Strand, J. 2012. Market-based instruments for international aviation and shipping as a source of climate finance. *World Bank Policy Research Working Paper*, 5950.

Konstantinou, I. K., and Albanis, T. A. 2004. "Worldwide occurrence and effects of antifouling paint booster biocides in the aquatic environment: a review." *Environment international* 30(2): 235-248.

Köhler, J. 2014. "Globalization and sustainable development: Case study on international transport and sustainable development." *The Journal of Environment & Development* 23(1): 66-100.

Köhler, J., Dönitz, E., and Schätter, F. 2022. "Transitions for ship propulsion to 2050: The AHOY combined qualitative and quantitative scenarios." *Marine Policy* 140: 105049.

Lai, K. H., Lun, V. Y., Wong, C. W., and Cheng, T. C. E. 2011. "Green shipping practices in the shipping industry: Conceptualization, adoption, and implications." *Resources, Conservation and Recycling* 55(6): 631-638.

Li, W. C., Tse, H. F., and Fok, L. 2016. "Plastic waste in the marine environment: A review of sources, occurrence and effects." *Science of the total environment* 566: 333-349.

Lin, A. J., Chang, H. Y., and Hung, B. 2022. "Identifying Key Financial, Environmental, Social, Governance (ESG), Bond, and COVID-19 Factors Affecting Global Shipping Companies—A Hybrid Multiple-Criteria Decision-Making Method." *Sustainability* 14(9): 5148.

Lindstad, H., Verbeek, R., Blok, M., Van Zyl, S., Hübscher, A., Kramer, H., Purwanto, J., Ivanova, O., and Boonman, H. 2015. *GHG emission reduction potential of EU-related maritime transport and*

on its impacts. Report No. CLIMA. B. 3/ETU/2013/0015. Delft: TNO.

Łosiewicz, Z., and Kamiński, W. 2014. "Practical Application of Ship Energy Efficiency Management Plan." *Logistyka* (3): 3969-3974.

Neuparth, T., Moreira, S. M., Santos, M. M., and Reis-Henriques, M. A. 2012. "Review of oil and HNS accidental spills in Europe: identifying major environmental monitoring gaps and drawing priorities." *Marine Pollution Bulletin* 64(6): 1085-1095.

Noh, H. J. 2019. Financial Strategies to Accelerate Green Growth. In *Handbook of Green Finance*, edited by Sachs, J.D., Woo, W.T., Yoshino, N. and Taghizadeh-Hesary, F., 37-62. Singapore: Springer

OECD 2015. *Green Bonds: Country Experiences, Barriers and Options*, Paris: OECD

Pakbeen, H. 2018. "Comparative study of leading cruise lines' sustainability practices and environmental stewardship in contribution to SDGs' sea and water conservation goal." *European Journal of Sustainable Development* 7(3): 507-507.

Peng, C., Zhao, X., and Liu, G. 2015. "Noise in the sea and its impacts on marine organisms." *International Journal of Environmental Research and Public Health* 12(10): 12304-12323.

Pettit, S., Wells, P., Haider, J., Abouarghoub, W. 2018. "Revisiting history: Can shipping achieve a second socio-technical transition for carbon emissions reduction?." *Transportation Research Part D: Transport and Environment* 58: 292-307.

Poulsen, R. T., Ponte, S., and Lister, J. 2016. "Buyer-driven greening? Cargo-owners and environmental upgrading in maritime shipping." *Geoforum* 68: 57-68.

Psaraftis, H. N., Kontovas, C. A. 2020. "Decarbonization of maritime transport: Is there light at the end of the tunnel?" *Sustainability* 13(1), 237.

Psaraftis, H. N., and Lagouvardou, S. 2019. "Market Based Measures for the reduction of Green House Gas Emissions from ships: A possible way forward." *Samfundsoekonomen* 2019(4): 60-70.

Ranängen, H., and Zobel, T. 2014. "Revisiting the 'how' of corporate social responsibility in extractive

industries and forestry." *Journal of Cleaner Production* 84: 299-312.

Rebelo, P. 2020. "Green finance for a sustainable maritime transport system: developing a universal vernacular for green shipping." *Australian & New Zealand Maritime Law Journal* 34: 15.

Rehmatulla, N., Calleya, J., and Smith, T. 2017. "The implementation of technical energy efficiency and CO2 emission reduction measures in shipping." *Ocean Engineering* 139: 184-197.

Serra, P., and Fancello, G. 2020. "Towards the IMO's GHG goals: A critical overview of the perspectives and challenges of the main options for decarbonizing international shipping." *Sustainability* 12(8): 3220.

Shi, W., Xiao, Y., Chen, Z., McLaughlin, H., and Li, K. X. 2018. "Evolution of green shipping research: themes and methods." *Maritime Policy & Management* 45(7): 863-876.

Smith, T., Raucci, C., Hosseinloo, S. H., Rojon, I., Calleya, J., De La Fuente, S., Wu, P., and Palmer, K. 2016. *CO_2 Emissions from International Shipping: possible reduction targets and their associated pathways*. UMAS

Stern, M. 2006. *The Economics of Climate Change: The Stern Review*. Cambridge University press.

Tran, T.A. 2019. "A study of the energy efficiency management for bulk carriers considering navigation environmental impacts." *Journal of Intelligent & Fuzzy Systems* 36(3): 2871-2884.

Van Kluijven, P. C., Kwakernaak, L., Zoetmulder, F., Ruigrok, M., and de Bondt, K. 2013. Contra-rotating propellers. Rotterdam Mainport University of Applied Sciences RMU, *Maritime Symposium Rotterdam*.

Walker, T. R., Adebambo, O., Feijoo, M. C. D. A., Elhaimer, E., Hossain, T., Edwards, S. J., ..., Zomorodi, S. 2019. Environmental effects of marine transportation. In: *World seas: an environmental evaluation,* edited by Sheppard, C., 505-530, Academic Press

Wan, Z., El Makhloufi, A., Chen, Y., and Tang, J. 2018. "Decarbonizing the international shipping industry: Solutions and policy recommendations." *Marine pollution bulletin* 126: 428-435.

Wang, G., Li, K. X., and Xiao, Y. 2019. "Measuring marine environmental efficiency of a cruise

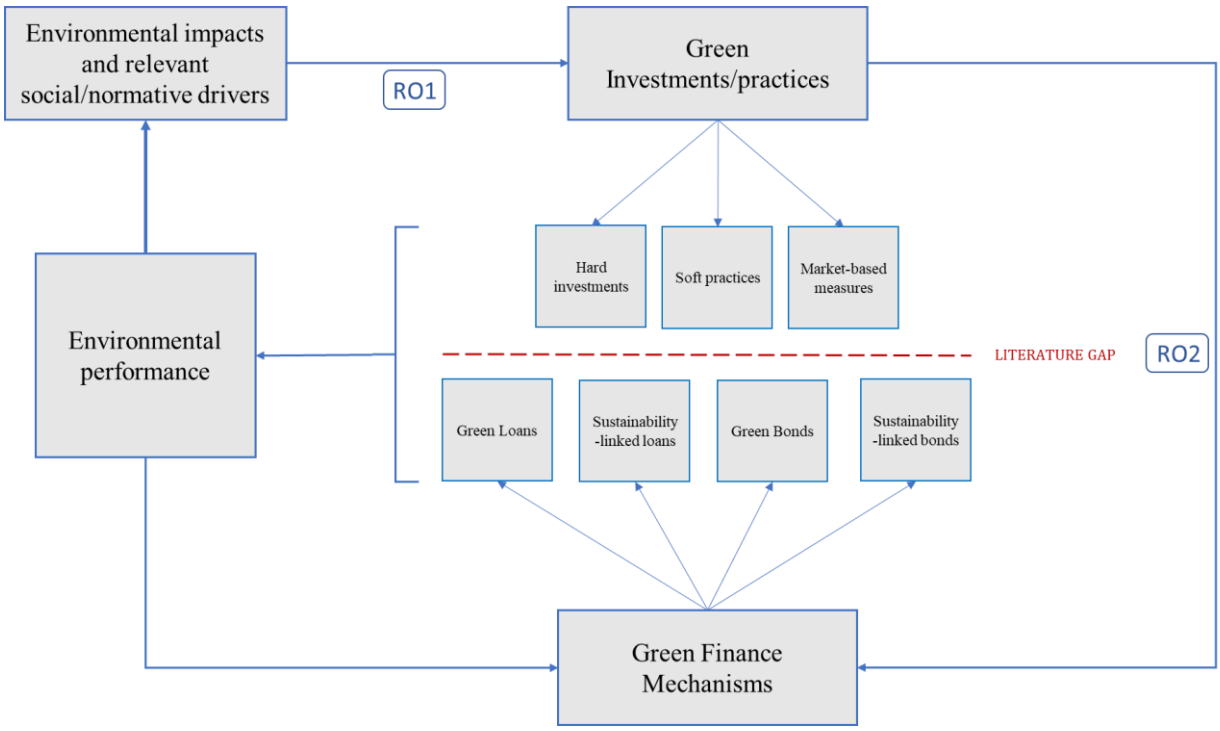
shipping company considering corporate social responsibility." *Marine policy* 99: 140-147.

Yin, R.K. 1994. "Discovering the future of the case study. Method in evaluation research." *Evaluation practices* 15(3): 283-290.

Yin, R.K. 2009. *Case study research: Design and methods*, volume 5, Sage.

Figures

Figure 1 - Theoretical Framework.



Tables

Table 1 - Classification of environmental impacts in the shipping industry.

	Source				
Classification	*European Maritime Transport Environmental Report (EMSA), 2021*	*A review on the environmental impacts of shipping on aquatic and nearshore ecosystems, Jägerbrand et al., 2019*	*Environmental Effects of Marine Transportation, Walker et al., 2019*	*Framework for Assessing Indicators of Environmental Impacts in the Transport Sector, Joumard et. al., 2011*	*Environmental Impacts of International Shipping, OECD, 2011*
Greenhouse Gas	Air emission		Air pollution	Greenhouse effect	Energy use and emission of GHG
Atmospheric pollution			Air pollution		
Air pollution	Air emission	Air emission	Air pollution	Air pollution	Exhaust emissions
Direct (restricted) toxicity of air pollution	Air emission	Air emission	Air pollution	Air pollution	Exhaust emissions
Phototermical pollution				Air pollution	
Acidification				Air pollution	
Ozone depletion	Air emission			Air pollution	
Dust	Air emission			Air pollution	Other environment problems related to Port Activity
Maritime pollution	Water pollution	Discharge to water	Effects on terrestrial habitat and marine ecosystem	Soil and water pollution	Other environment problems related to Port Activity
Oil Spills	Water pollution	Discharge to water	Spills from ships	Soil and water pollution	Other environment problems related to Port Activity
Water discharge	Water pollution	Discharge to water	Ballast water containing aquatic invasive species (AIS)	Other impacts	Other environment problems related to Port Activity
Anti-fouling	Water pollution	Discharge to water			Other environment problems related to Port Activity
Wastewater	Water pollution	Discharge to water		Soil and water pollution	
Sewage, sludge and spills	Water pollution	Discharge to water	Spills from ships	Soil and water pollution	Other environment problems related to Port Activity
Pollution of soil, surface water and groundwater	Water pollution / Physical disturbance of the seabed	Discharge to water		Soil and water pollution	Other environment problems related to Port Activity
Ballast water containing aquatic invasive species (AIS)	Non-indigenous species	Discharge to water	Ballast water containing aquatic invasive species (AIS)	Other impacts	Other environment problems related to Port Activity
Hull-fouling	Non-indigenous species	Discharge to water			
Non-indigenous species	Non-indigenous species	Discharge to water	Ballast water containing aquatic invasive species (AIS)	Other impacts	
Ship generated waste	Marine litter				
Other waste sources	Marine litter			Other impacts	
Noise	Noise	Physical impacts	Underwater noise	Noise and vibration	Other environment problems related to Port Activity
Vibration				Noise and vibration	
Visual qualities of landscape or townscapes	Physical disturbance of the seabed	Physical impacts	Effects on terrestrial habitat and marine ecosystem	Impacts on land	Other environment problems related to Port Activity

Shoreline erosion and resuspension of sediments	Physical disturbance of the seabed	Physical impacts	Ship strikes on marine megafauna	Soil and water pollution	Other environment problems related to Port Activity
Dredging	Physical disturbance of the seabed	Physical impacts	Effects on terrestrial habitat and marine ecosystem	Impacts on land	Other environment problems related to Port Activity
Risk of collision of vessel with marine species	Risk of collision of vessel with marine species				
Wildlife collisions	Risk of collision of vessel with marine species	Physical impacts	Ship strikes on marine megafauna	Impacts on land	
Ship strikes on marine megafauna	Risk of collision of vessel with marine species		Ship strikes on marine megafauna	Impacts on land	
Effects on terrestrial habitat and marine ecosystem	Risk of collision of vessel with marine species		Effects on terrestrial habitat and marine ecosystem	Impacts on land	
Ship grounding and sinking		Physical impacts	End-of-Like Ship Disposal		
Shipbreaking		Physical impacts	End-of-Like Ship Disposal		
Accident	Risk of collision of vessel with marine species	Physical impacts	End-of-Like Ship Disposal	Accident	
Artificial light		Physical impacts		Other impacts	
Land loss		Physical impacts	Effects on terrestrial habitat and marine ecosystem	Impacts on land	Other environment problems related to Port Activity
Soil erosion		Physical impacts	Effects on terrestrial habitat and marine ecosystem	Impacts on land	
Hazardous and noxious substance spills			Spills from ships	Soil and water pollution	
Hydraulic changes and risks				Soil and water pollution	
Spills and operational discharges of oil and cargo (also dry cargo release)		Discharge to water	Spills from ships		Other environment problems related to Port Activity
Ship based garbage management	Marine litter		Garbage management	Non-renewable resource use and waste handling	
Marine Litter	Marine litter	Discharge to water	Garbage management	Non-renewable resource use and waste handling	Other environment problems related to Port Activity
Non-renewable resource use	Marine litter		Garbage management	Non-renewable resource use and waste handling	
Non-recyclable waste	Marine litter		Garbage management	Non-renewable resource use and waste handling	Other environment problems related to Port Activity
Direct waste from vehicle	Marine litter		Garbage management	Non-renewable resource use and waste handling	Other environment problems related to Port Activity
Electromagnetic pollution				Other impacts	
Introduction of illnesses				Other impacts	
Fire risk				Other impacts	
Technological hazards				Other impacts	

Source: authors' elaboration.

Table 2 - Data and information of the sample examined.

Company	Sector	Foundation year	Headquarter	Listing on the stock exchange	#ships
Anthony Veder Group	Tanker	1937	Rotterdam, NLD	NO	31
Ardmore Shipping	Tanker	2010	Hamilton, BMU	YES (NYSE)	25
Avance Gas	Tanker	2007	Oslo, nor	YES (OSLO)	15
Celsius Tankers	Tanker	2012	Copenhagen, DNK	NO	36
Diana Shipping	Dry bulk	2005	Athens, GRC	YES (NYSE)	37
Eastern Pacific Shipping	Bulk	1988	Singapore, SGP	NO	112
Euronav	Tanker	1989	Antwerp,	YES (NYSE)	82
Golden Ocean	Dry bulk	1996	Oslo, nor	YES (NASDAQ)	100
Gunvor (Clearlake Shipping)	Tanker	2000	Geneva, WHICH	NO	n.a.
Hafnia	Tanker	1940	Singapore, SGP	YES (OSLO)	184
Hartreee Maritime Partners	Tanker	1997	New York, United States	NO	n.a.
International Seaways	Tanker	1996	Dubai, United Arab Emirates	NO	94
Klaveness	Bulk	1946	Oslo, nor	NO	75
K-Line	Tanker	2005	London, GBR	NO	19
MOL Group	Bulk	1991	Budapest, LORO	NO	100
Nyk Line	Bulk	1885	Tokyo, GPN	YES (TOKYO)	474
Odfjell	Tanker	1914	Mountains, nor	YES (OSLO)	90
Okeanis Eco Tankers Corp	Tanker	2018	Athens, GRC	NO	16
Oman Shipping	Bulk	2003	Muscat, OMN	YES	58
Precious Shipping	Dry bulk	1989	Bangkok, THA	YES (THAILAND)	36
Safe Bulkers	Dry bulk	2007	Monaco, MCO	YES (NYSE)	40
Sea Energy Maritime	Dry bulk	2015	Glyfada, GRC	YES (NASDAQ)	17
Sovcomflot	Tanker	1988	Saint Petersburg, RUS	NO	145
Star Bulk	Dry bulk	2006	Athens, GRC	YES (NASDAQ)	111
Teekay Shipping	Tanker	1973	Vancouver, can	YES (NYSE)	127
Torm	Tanker	1889	Copenhagen, DNK	YES (NASDAQ)	82
U-Ming Marine Transport Corporation	Dry bulk	1984	Taipei, TWN	YES (TAIWAN)	60
Viridis Bulk Carriers	Dry bulk	2020	Farsund, NOR	NO	5
Vogemann Shipping	Dry bulk	1886	Hamburg, DEU	NO	19

Source: authors' elaboration.

Table 3 - Complete sample information.

Shipping Company	*Sector*	*Type of financing*	*Aim*	*Subcategory of Aim*	*Aim explained*	*Amount ($)*	*Class ($)*	*Interest rate*	*Duration (years)*	*Class (years)*	*Financial actors involved*	*Note*
Anthony Veder Group	Tanker	Others	Vessel Financing	Newbuilding	to finance the building of 18.000 ice class super LNG carriers which uses the boil off of its cargo to fuel its own propulsion system	$ 80.000.000	50 - 250 M				ABN AMRO N.V. on behalf of Anthony Veder Group	Private Placement
Ardmore Shipping	Tanker	Sustainability-Linked Loan	Corporate Financing	Refinancing	to replace its existing receivable facility	$ 15.000.000	< 50 M				ABN AMRO Bank N.V.	Poseidon Principles-compliant
Avance Gas	Tanker	Sustainability-Linked Loan	Vessel Financing	Second-Hand	to finance two dual-fuel LPG vessels	$ 104.000.000	50 - 250 M		5	5 - 8		Poseidon Principles-compliant
Celsius Tankers	Tanker	Green Loan	Vessel Financing	Newbuilding	to expand its LNG fleet with an order of four LNG carriers from Samsung Heavy that minimize CO2 emissions and methane slip and meet IMO requirements.	$ 193.000.000	50 - 250 M					the four newbuild LNG carriers have been chartered out to Clearlake Shipping
Diana Shipping	Dry bulk	Sustainability-Linked Loan	Corporate Financing	Refinancing	to refinance 4 separate existing loans						ABN AMRO Bank N.V.	Not only cost savings, but more importantly in line with the company's commitment towards its long-term sustainability goals
Eastern Pacific Shipping	Bulk	Green Loan	Equipment Financing		to purchase scrubbers	$ 40.000.000	< 50 M				BNP Paribas	Green Loan Principles-compliant
Euronav	Tanker	Sustainability-Linked Loan	Corporate Financing	Green Financial Requirement	to reduce corporate emissions	$ 95.000.000	50 - 250 M		3	< = 4	KBC, ABN AMRO N.V., Belfius, ING Bank, Societe Generale, BNP Paribas and SEB	Poseidon Principles-compliant
Golden Ocean	Dry bulk	Green Loan	Equipment Financing		to purchase 18 modern scrubber-fitted dry bulk vessels.	$ 414.000.000	> 250 M					Financing's amount corresponding 55% of the purchase price
Golden Ocean	Dry bulk	Others	Equipment Financing		to finalize the above acquisition	$ 338.000.000	> 250 M					Private Placement
Gunvor (Clearlake Shipping)	Tanker	Sustainability-Linked Loan	Corporate Financing	Green Financial Requirement	to improve 15 sustainability criteria	$ 300.000.000	> 250 M				ING Bank	

Gunvor (Clearlake Shipping)	Tanker	Sustainability-Linked Loan	Corporate Financing	Refinancing	to refinance existing debt	$ 350.000.000	> 250 M				ING Bank, DBS Bank, Societe Generale,Credit Agricole, Cooperatieve Rabobank, ABN Armro N.V., CA indosuez, Credit Suisse, Mizuho Bank Europe, Sumitomo Mitsui Trust Bank, KfW IPEX-Bank GmbH, MUFG Banck, Raiffesein Bank Internationale, China Construction Bank	
Hafnia	Tanker	Sustainability-Linked Loan	Corporate Financing	Refinancing	to refinance USD 676M e 128M maturing in March 2022 and dec 2023	$ 374.000.000	> 250 M		7	5 - 8	ABN AMRO N.V., BNP Paribas, DBS Bank, ING Bank, IYO Bank, OCBC Bank, Skandinaviska Enskilda Banken AB, Société Générale, Standard Chartered Bank and United Overseas Bank	
Hartreee Maritime Partners	Tanker	Green Loan	Vessel Financing	Second-Hand	to purchase 2 eco-friendly VLCC	$ 108.000.000	50 - 250 M		5	5 - 8	Arab Petroleum Investments Corporation, National Bank of Fujairah	
International Seaways	Tanker	Sustainability-Linked Loan	Corporate Financing	Refinancing	to refinance $385m of existing "high-cost" debt with ABN AMRO N.V.; to repurchase outstanding 10.75% of subordinated notes; to align with the IMO's 50% industry reduction target in greenhouse gas emissions by 2050	$ 390.000.000	> 250 M	initially at LIBOR plus 2.60%; while borrowings under the transition facility at LIBOR plus 3.50%; margin may adjust by 0.20% based on carbon efficiency of the fleet	5	5 - 8	Nordea Bank, New York Branch, ABN AMRO Capital USA LLC, Crédit Agricole Corporate & Investment Bank, DNB Capital LLC and Skandinaviska Enskilda Banken AB (as mandated lead arrangers and bookrunners); Nordea Bank (also as administrative agent)	Poseidon Principles-compliant; The loan consists of a 5-year $300 million senior secured core term loan facility, a 5-year $40 million core revolving credit facility and a 2.5-year $50 million senior secured term loan credit facility
Kleveness	Bulk	Sustainability-Linked Loan	Vessel Financing	Second-Hand	financing two clean-up dry bulk carriers	$ 60.000.000	50 - 250 M				Credit Agricole CIB	
K-Line	Tanker	Sustainability-Linked Loan	Corporate Financing	Green Financial Requirement	to reduce total GHG emissions per ton miles	$ 991.000.000	> 250 M		5	5 - 8	Mizuho Bank Ltd (MHBK)	CDP rating as performance indicator
MOL Group	Bulk	Green Bond	Equipment Financing / Vessel Financing	Newbuilding	to purchase (1) Ballast water treatment system, (2) Sulphur Oxide (SOx) scrubber, (3 fuel bunkering vessel, (5) New type of PBCF, (6) Wind Challenger Plan	$ 43.861.575	< 50 M		5	5 - 8		Two bonds
Nyk Line	Bulk	Green Bond	Equipment Financing / Vessel Financing	Newbuilding / Second-hand	to purchase (1) LNG-fuelled ships, (2) LNG bunkering vessels, (3) ballast water treatment equipment, and (4) SOx (sulphur oxides) scrubber systems	$ 85.000.000	50 - 250 M	Coupon 0.290%	5	5 - 8		

Odfjell	Tanker	Sustainability-Linked Bond	Corporate Financing	Refinancing / Green Financial Requirement	to reduce GHG emissions; to reach corporate climate neutrality by 2050; to refinance existing debt	$ 100.000.000	50 - 250 M		4	< = 4		
Okeanis Eco Tankers Corp	Tanker	Green Loan	Equipment Financing		to retrofit vessels with scrubbers	$ 11.000.000	< 50 M	LIBOR + 2%	5	5 - 8	BNP Paribas	
Okeanis Eco Tankers Corp	Tanker	Others	Vessel Financing / Corporate Financing	Newbuilding / Refinancing	to purchase new building eco tankers; to raise working capital for general corporate reasons	$ 15.000.000	< 50 M					Private Placement
Oman Shipping	Bulk	Sustainability-Linked Loan	Vessel Financing	Existing	to cover two Ultramax with energy efficiency improvements	$ 35.000.000	< 50 M	margin adjusted based on Oman Shipping Company's progress against United Nations SDGs	8	5 - 8	Standard Chartered Bank	
Precious Shipping	Dry bulk	Sustainability-Linked Loan	Vessel Financing / Corporate Financing	Existing / Refinancing	to refinance four cement carriers; to pay off the remaining company's debt	$ 85.000.000	50 - 250 M	LIBOR 3months + n/a margin	8	5 - 8	International Finance Corporation, Export-Import Bank of Thailand, and TMBThanachart Bank Public Company Limited	
Safe Bulkers	Dry bulk	Sustainability-Linked Loan	Corporate Financing	Refinancing	to refinance loan facilities with the same financial institutions of an outstanding value of $71.1 million and a revolving credit facility of $6.5 million	$ 60.000.000	50 - 250 M	margin adjusted based on independently verified pre-determined emission targets	5	5 - 8	Export-Import Bank of Thailand, and TMBThanachart Bank Public Company Limited	credit facility secured to five vessels
Sea Energy Maritime	Dry bulk	Sustainability-Linked Loan	Vessel Financing	Second-Hand	to finance part of the acquisition costs of a 181.400dwt second-hand vessel	$ 16.850.000	< 50 M		5	5 - 8	European Investment Bank	$6.1M baloon
Sovcomflot	Tanker	Green Loan	Vessel Financing	Second-Hand	to finance two new 112.000dwt ice class shuttle tankers	$ 110.000.000	50 - 250 M		10	> 8	ING Bank, SMBC Bank EU AG, Unicredit	Poseidon Principles-compliant
Sovcomflot	Tanker	Green Loan	Vessel Financing	Newbuilding	to finance the construction of the world's first large-capacity tankers fuelled by liquefied natural gas	$ 252.000.000	> 250 M		7	5 - 8	Societe Generale Group (as leading organizer), ABN AMO N.V., BNP Paribas, Citibank, ING Bank and KfW IPEX-Bank	
Sovcomflot	Tanker	Green Loan	Vessel Financing	Newbuilding	to finance pre- and post-delivery of two new 174,000 cu m Atlanticmax LNG carriers	$ 297.000.000	> 250 M		10	> 8		both the vessels will operate under long-term charter contract to Shell
Sovcomflot	Tanker	Green Loan	Vessel Financing	Newbuilding	to finance the construction of a 174,000-cbm Atlanticmax LNG carrier	$ 149.000.000	50 - 250 M		10	> 8	ING Bank, KfW IPEX-Bank and Crédit Agricole Corporate and Investment Bank	the vessel will operate under long-term charter contract to Total
Star Bulk	Dry bulk	Green loan	Equipment Financing		to retrofit with scrubbers up to 50 vessels	$ 70.000.000	50 - 250 M	LIBOR + 280bp	4	< = 4	ABN AMRO Bank N.V., BNP Paribas, Danish Ship Finance and Skandinaviska Enskilda Banken	

Teekay Shipping	Tanker	Green Bond	Vessel Financing	Newbuilding	to finance four newbuilding shuttle tankers	$ 125.000.000	50 - 250 M		5	5 - 8	ABN AMRO Bank N.V., BNP Paribas, Danish Ship Finance	
Torm	Tanker	Sustainability-Linked Bond	Corporate Financing	Refinancing / Green Financial Requirement	to postpone the debt maturity for eight vessels until 2027; to provide the company $12M in liquidity	$ 150.000.000	50 - 250 M				Skandinaviska Enskilda Banken (as lead arrangers)	
U-Ming Marine Transport Corporation	Dry bulk	Sustainability-Linked Loan	Vessel Financing	Second-Hand	to purchase LNG-fuelled bulk carrier	$ 45.000.000	< 50 M				E.SUN Commercial Bank	
Viridis Bulk Carriers	Dry bulk	Green loan	Vessel Financing	Newbuilding	to order newbuilding ammonia ships delivered in 2024 onwards							
Vogemann Shipping	Dry bulk	Others	Vessel Financing	Second-Hand	to purchase green geared handy bulkers	$ 50.000.000	50 - 250 M	8%				Ethereum blockchain

Source: authors' elaboration.

Annexes

Annex I. Overview of bulk shipping companies using a typology of green financial products

	Typology of Green Financial Products				
Company	***Sustainability-Linked Bond***	***Sustainability-Linked Loan***	***Green Loan***	***Green Bond***	***Others***
Anthony Veder Group					X
Ardmore Shipping		X			
Avance Gas		X			
Celsius Tankers			X		
Diana Shipping		X			
Eastern Pacific Shipping			X		
Euronav		X			
Golden Ocean			X		
Golden Ocean					X
Gunvor (Clearlake Shipping)		X			
Gunvor (Clearlake Shipping)		X			
Hafnia		X			
Hartreee Maritime Partners			X		
International Seaways		X			
Kleveness		X			
K-Line		X			
MOL Group				X	
Nyk Line				X	
Odfjell	X				
Okeanis Eco Tankers Corp			X		
Okeanis Eco Tankers Corp					X
Oman Shipping		X			
Precious Shipping		X			
Safe Bulkers		X			
Sea Energy Maritime		X			
Sovcomflot			X		
Sovcomflot			X		
Sovcomflot			X		
Sovcomflot			X		
Star Bulk			X		
Teekay Shipping				X	
Torm	X				
U-Ming Marine Transport Corporation		X			
Viridis Bulk Carriers			X		
Vogemann Shipping					X

Annex II. Overview of bulk shipping companies based on the characteristics of the implemented green financial products.

Shipping Company	**Typology of Green Financial Products**					**Aim**						*Amount ($)*			*Duration (years)*			*Interest rate*	
						Vessel Financing				**Corporate Financing**									
	SLB	***SLL***	***Green Loan***	***Green Bond***	***Others***	***Newbuilding***	***Second-Hand***	***Existing***	**Equipment Financing**	***Refinancing***	***Green Financial Requirement***	***0-50M***	***50-250M***	***>250M***	***0-4***	***5 - 8***	***>8***	***Yes***	***No***
Anthony Veder Group					X	X							X						X
Ardmore Shipping		X								X		X							X
Avance Gas		X					X						X			X			X
Celsius Tankers			X			X							X						X
Diana Shipping		X								X									X
Eastern Pacific Shipping			X						X			X							X
Euronav		X									X		X		X				X
Golden Ocean			X						X					X					X
Golden Ocean					X				X					X					X
Gunvor (Clearlake Shipping)		X									X			X					X
Gunvor (Clearlake Shipping)		X								X				X					X
Hafnia		X								X				X		X			X
Hartreee Maritime Partners			X				X						X			X			X
International Seaways		X								X				X		X		X	
Kleveness		X					X						X						X
K-Line		X									X			X		X			X
MOL Group				X		X			X			X				X			X
Nyk Line				X		X	X		X				X			X		X	
Odfjell	X									X	X		X		X				X
Okeanis Eco Tankers Corp			X						X			X				X		X	
Okeanis Eco Tankers Corp					X	X				X		X							X
Oman Shipping		X						X				X				X		X	
Precious Shipping		X						X		X			X			X		X	
Safe Bulkers		X								X			X			X		X	
Sea Energy Maritime		X					X					X				X			X
Sovcomflot			X				X						X				X		X
Sovcomflot			X			X								X		X			X
Sovcomflot			X			X								X			X		X
Sovcomflot			X			X							X				X		X
Star Bulk			X						X				X		X			X	
Teekay Shipping				X		X							X			X			X
Torm	X									X	X		X						X
U-Ming Marine Transport Corporation		X					X					X							X
Viridis Bulk Carriers			X			X													X
Vogemann Shipping					X		X						X					X	