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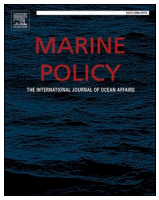

Towards an equitable transition in the decarbonization of international maritime transport: Exemptions or carbon revenues?

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ABSTRACT

The International Maritime Organization (IMO) is considering the implementation of a carbon pricing instrument in international shipping. One of the most contentious point of debate on the implementation of carbon pricing in the sector concerns how to ensure an equitable transition. This article analyzes in-depth the advantages and disadvantages of two key potential approaches to address equity considerations in the design of a market-based-measure for international shipping: exemptions, and the strategic use of carbon revenues. This in-depth analysis has two main aims: i) it *tests* arguments presented in the literature on the relative benefits and risks of exemptions and carbon revenues use against up-to-date empirical research; ii) it *adds* to existing research by identifying benefits and drawbacks related to these two approaches that have so far been overlooked in the literature. The analysis reveals that an adequate use of carbon revenues is likely to deliver greater climate benefits than exemptions, both within maritime transport and beyond. The analysis also reveals that, while exemptions have some potential merit in addressing equity considerations, they also have various drawbacks. Overall, this research suggests that carbon revenue use should be the primary approach to addressing equity considerations in the decarbonization of international maritime transport. The article concludes by suggesting principles necessary to ensure that the distribution of carbon revenues supports the equitable transition.

1. Introduction

The International Maritime Organization's (IMO) Member States are currently discussing the adoption of a basket of policies to decarbonize international shipping in line with the goals identified in the 2018 Initial IMO GHG Strategy [34] and its ongoing revision. Among the mid-term measures under consideration — i.e., those expected to be finalized and agreed upon between 2023 and 2030 — are revenue-raising market-based measures, such as GHG levies, emissions allowance trading systems, or feebate scheme.[2] Various proposals to implement such market-based measures have been submitted to the IMO's Marine Environment Protection Committee (MEPC) (e.g. [50,2,37]), and, at the 12th Intersessional Working Group on Greenhouse Gases (ISWG-GHG) in May 2022, there was consensus that a basket of measures will be implemented to reduce green-house gas (GHG) emissions from shipping [71].[3] A significant part of the debate on market based-measures at the MEPC relates to how to guarantee that the decarbonization of the sector is equitable.[4] Two main approaches[5] to address equity considerations in

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[2] GHG levies are charges that target the carbon content of fossil fuels or the GHG emitted in producing or distributing goods. Emission trading systems can take various forms. A common type of emission trading system is cap-and-trade, under which regulated entities purchase (or are allocated for free) emission allowances equal to their GHG emissions [85]. Under a feebate scheme, regulated entities that do not meet certain standards (e.g., emission intensity) pay a fee and revenues collected are distributed (fully or partially) to entities that meet the standard.

[3] In this article, the terms "carbon price" should not be interpreted as instruments that cover only carbon emissions. Instead the price could be applied to other GHGs. Similarly, "carbon revenues" could result from the application of a market-based measure to GHG emissions broadly. The use of the terms of carbon price and carbon revenues are used here only because these are the terms used most often in the literature.

[4] Equity considerations are discussed in many submissions to the IMO and in interventions at MEPC (e.g. [53,50,2,37])

[5] With this, I do not mean to say that the issue of an equitable energy transition in international maritime transport relates exclusively to the use of carbon revenues and exemptions. Other issues may be relevant too, such as issues related to procedural justice.

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the design of market-based measures have been proposed in the history of MEPC negotiations: exemptions[6] and carbon revenue use.[7] This article analyzes the relative merits of these two approaches in terms of their *climate effectiveness* and ability to *address equity considerations*.

Existing scholarly research (e.g. [66,67]) and grey literature [39,6] has *touched upon* some of the relative merits of these two approaches. This article contributes to the literature by undertaking an in-depth analysis of the advantages and disadvantages of exemptions and carbon revenue use. This in-depth analysis has two main aims. First, it aims to *test* arguments presented in the literature on the relative benefits and drawbacks of exemptions and carbon revenues use against up-to-date empirical research. The second aim of the analysis is to *add* to existing research by identifying benefits and risks related to these two approaches that have so far been overlooked. In this respect, the article *breaks new ground* by highlighting potential negative effects of exemptions that have not yet been identified in the literature. These are: uncertain price signals, reduced opportunities to decarbonize other sectors, and forgone climate co-benefits. Overall, the analysis reveals that the use of carbon revenues has many advantages over exemptions, both in terms of climate effectiveness and ability to address equity concerns. On this ground, the article argues that carbon revenue use should be the primary approach to addressing equity considerations in the decarbonization of international maritime transport and elaborates principles that could inform the distribution of carbon revenues from shipping, to ensure that the desired climate and equity-related outcomes are delivered.

The remainder of the article is structured as follows: Section 2 discusses key equity principles incorporated in the Initial IMO GHG Strategy; Section 3 illustrates options to operationalize equity considerations in the decarbonization of international maritime transport; Section 4 analyzes the climate change mitigation effects of exemptions and carbon revenue use; Section 5 examines the possibility to address equity considerations through the use of exemptions and carbon revenues; Section 6 proposes some guiding principles for the distribution of carbon revenues from shipping; and Section 7 concludes.

2. Equity principles in the initial IMO GHG strategy

There are two main equity-related guiding principles mentioned in the Initial IMO GHG Strategy: the need to be cognizant of the Common but Differentiated Responsibilities and Respective Capabilities (CBDR-RC) principle and the need to consider impacts on states. This section discusses these two principles, setting the background for analyzing how to best address them.

2.1. The need to be cognizant of the principle of common but differentiated responsibilities and respective capabilities

Paragraph 3.2.1.2 of the Initial IMO GHG Strategy recognizes the need to be cognizant of the "*principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances, enshrined in the UNFCCC, its Kyoto Protocol and the Paris Agreement*" [34]. CBDR-RC has two core components. On the one hand, it recognizes a common responsibility to address climate change. On the other, it calls for differentiating the burden sharing of mitigating and adapting to climate change by applying less stringent requirements on to states that have contributed, or are projected to contribute, less to the climate crisis or have less capacity to address it [13].

While the two core components of CBDR-RC have remained constant in the three international climate treaties mentioned in the Initial IMO GHG Strategy, the principle has evolved over time. The two earlier treaties, the UNFCCC and the Kyoto Protocol, adopt a static and black/white approach to differentiation which is operationalized by dividing Parties into Annex II (OECD countries), Annex I (OECD countries and economies in transition), and non-Annex I countries (developing countries) and assigning different responsibilities to each group [24,9]. The rigid distinction between Annex II, Annex I, and non-Annex I countries is abandoned in the Paris Agreement, which embraces a more open and dynamic approach to differentiation [82]. This newer approach recognizes that even among developing countries, there are differences in their historical and projected contribution to global GHG emissions, vulnerability to climate change, and ability to address climate change. Thus, the Paris Agreement embraces a more granular approach to differentiation that allows for operationalizing CBDR-RC in a way that reflects a multiplicity of differences in the circumstances of each country [82]. In particular, under Article 4.2 of the Paris Agreement each party has a procedural obligation to submit to the UNFCCC a nationally determined contribution (NDCs) which delineates the county's commitment to act on climate change. This commitment is self-determined by each country, and existing commitments vary significantly, both in terms of scope (e.g., whether they focus only on mitigation or also adaptation) and ambition [81].

The approach to differentiation adopted in the Paris Agreement is marked textually with the addition of "in the light of different national circumstances" in Articles 4.3 and 4.4. It is, therefore, significant that the Initial IMO GHG Strategy explicitly recognizes the need to be cognizant of the CBDR-RC principle *in light of different national circumstances*. This indicates that the Initial IMO GHG Strategy aligns with the more granular and dynamic approach to differentiation embraced in the Paris Agreement. In Section 4.1.3, the relevance of this approach for the architecture of market-based measures in international shipping will be discussed.

2.2. The need to consider impacts on states

The other key equity-related guiding principle of the Initial IMO GHG Strategy is the need to consider impacts on states from the implementation of GHG mitigating policies, especially those on Least Developed Countries (LDCs) and Small Islands Developing States (SIDS) [34]. Paragraph 4.10 of the Initial IMO GHG Strategy elaborates on the operationalization of the principle, indicating that "[p]articular attention should be paid to the needs of developing countries", especially SIDS and LDCs. Paragraph 4.10 also specifies that impacts on States should be assessed and taken into account *before* GHG measure(s) are adopted. The need to consider impacts on states seem to set some boundaries on the balancing between the need for evidence-based decision-making and the precautionary approach (paragraph 3.2.4). In particular, it indicates that the precautionary approach does not trump the principle of evidence-based decision making when it comes to assessing impacts on states. Last but not least, paragraph 4.13 of the Initial IMO GHG Strategy states that disproportionately negative impacts (DNI) should be assessed and addressed as appropriate.

Potential negative impacts on states may be linked to increases in transport costs from a GHG pricing mechanism and/or a technical measure in shipping which can result in increased prices of transported goods and reduced availability of maritime transport services — at least on some routes [11]. A review of existing research indicates that implementing GHG pricing in international maritime transport could increase transport costs by between 0.4% and 16%, though this most often translates to *marginal* increases in the prices of transported goods [69]. However, for some types of goods the price increase is likely

[6] Exemptions — together with carbon revenue use — as a way to address equity considerations are discussed in, for instance, Norway [53] and Argentina et al. [2].

[7] See, for instance, ICS and Intercargo [33]; Marshall Islands and Solomon Islands [50]; Argentina et al., [2]; Japan, [37]; World Bank, [86].

higher.[8] Furthermore, the impact of GHG pricing on the prices of imported goods may depend on contingent conditions. For instance, Kosmas and Acciaro [41] find that when economic conditions are favorable for the shipping sector —meaning that there is high demand for shipping services and corresponding high freight rates— a greater share of the costs will be bore by shippers.

The impacts on states of the decarbonisation of the shipping sector are expected to be heterogeneous. Some groups of countries —such as many LDCs and SIDS— are expected to experience a greater increase in transport costs and import prices. This is due to the absence of economies of scale in LDCs and SIDS, the less energy-efficient fleet that tends to serve LDCs and SIDS' ports, and —in some cases— LDCs and SIDS are not well connected with main sea trading routes [69]. However, whether these heterogeneous impacts will be seen as *disproportionate* is unclear. The Initial IMO GHG Strategy lists criteria to assess impacts on States, and MEPC 74 approved a procedure for assessing impacts on States of candidate measures [35]. These criteria include, for instance, remoteness, dependency on transport, connectivity to main markets, food security, and disaster response. However, what counts as a *disproportionately* negative impact has not been defined and it is unclear whether it will ever be defined. A key issue that exist in relation to defining what counts as "*disproportionately*" is that some countries —for instance many SIDS— are already subject to much higher transport costs than others [78]. Even if for all countries transport costs increase proportionally (e.g., by 2%), the absolute increase in transport costs for SIDS would be higher, simply because the baseline is higher. Would these be considered "*disproportionately* negative impacts"? Ultimately, a key issue for the equitable energy transition of international shipping is to define what "prior circumstances" should be accounted for, and this is likely to be a politically contentious terrain.

3. Operationalizing equity considerations in the decarbonization of international shipping: exemptions and carbon revenue use

Before comparing exemptions and carbon revenue use in terms of their likely GHG effects and ability to address equity concerns, it is important to clarify what is meant by "exemptions" and "carbon revenue use". To this end, Section 3.1 discusses types of exemptions and provides some examples of how these could be operationalized in the context of shipping's decarbonization. Section 3.2 focuses instead on carbon revenue use.

3.1. Exemptions

This article focuses on two types of exemptions: route-based and cargo-based. Under a *route-based* exemption, vessels traveling to or from a particular country are exempted, either totally or partially, from being subject to a carbon price [11]. Regarding a partial exemption, this could take the form of either a lower carbon price applied to the whole route or the full carbon price applied exclusively to a fraction of the emissions released on that route. Alternatively, exemptions could be *cargo-based*, meaning that the carbon price is not applied to certain cargo types deemed particularly important for importing countries, such as medicines, food, and disaster response goods.[9] Generally, IMO discussions tend to focus less on cargo-based measures than on route-based exemptions. This is possibly due to the potential administrative complexities of implementing cargo-based exemptions. For this reason, the analysis below addresses more extensively route-based exemptions.

In practice, exemptions applied could vary significantly in terms of *breadth* and *depth*— meaning the routes or cargoes to which they apply and whether they are permanent or temporary, full or partial. In terms of breadth, two approaches could be considered: i) applying exemptions to a set list of countries (perhaps updated periodically based on multilateral negotiations) or ii) apply exemptions to countries that meet certain criteria (e.g., GDP per capita, impact of the carbon price on the country GDP, impact of the carbon price on food security, etc). A hybrid approach has been adopted in the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) — the market-based measure that applies to international aviation. Under CORSIA two categories of exemptions exist: i) one based on aviation-related criteria (e.g., states whose share of international aviation activities account for less than 0.5% of global revenue tonne km are exempted); ii) one, more rigid, that applies to SIDS, LDCs, and LLDCs, which are exempted regardless of their share of revenue tonne km [31]. If the IMO follows the ICAO examples, a hybrid approach to exemptions could be applied also in the international shipping context.

In principle, other types of exemptions are possible, such as exemptions that apply to types of vessels (e.g., smaller vessels, newer vessels), but these are generally seen as inadequate in addressing equity considerations in the decarbonization of international shipping [11], and are therefore not further considered here.

3.2. Carbon revenue use

One option often discussed in existing proposals on market-based measures submitted to the IMO is to use carbon revenues to address equity considerations [2,33,37,50,86]. Carbon revenues could be raised through a carbon levy (or tax), a cap and trade system, or a feebate scheme. Cap-and-trade systems can raise revenues only when allowances are sold to regulated entities for a fixed price[10] or —as it happens much more commonly— through auctions.[11] Feebate schemes raise revenues only if they are not revenue-neutral.

Interest is peaking on the potential role of carbon revenues to address equity concerns, partially because existing research suggests that implementing a revenue-raising market-based measure in international shipping could raise significant revenue. These revenues could range between 1 and 3.7 trillion U.S. dollars by 2050 [6,49]. This is a large amount, especially considering that, according to the OECD international climate finance amounted to about 83 billion US dollars in 2020 [55]. To put these numbers in perspective, carbon pricing in international shipping alone could raise between 40 and 60 billion US dollars per year up to 2050 [18] — and thus potentially account for a large share of financing available to developing countries to address climate and other development needs.[12]

4. The GHG effects of exemptions and carbon revenue use

This section compares exemptions and carbon revenue use in terms of their likely GHG effects. The section starts by considering the likely effects of exemptions and carbon revenue use on GHGs from international shipping (Section 4.1). Besides testing existing arguments in favor of the two approaches against up to date research findings, the analysis

[8] The price of transported goods may be higher for goods with a low value per unit of mass or volume, see Rojon et al. [69].

[9] In principle, exemptions could be based also on flag. However, this would likely violate the no-more favorable treatment principle. This may explain why the this option is currently considered by submission to the IMO and, relatedly, it is not further discussed here.

[10] For instance, allowances are sold for a fix price under the German ETS [32].

[11] In many cap-and-trade systems, allowances are sold through auctions [32]. For a comparison between these two instruments to price carbon in terms of GHG effects, administrative complexity, and equity, see [27,28].

[12] Note also that carbon revenues could help catalyzing additional private climate finance. For instance, the Green Climate Fund (GCF) leveraged private co-finance for about 9.5 billion US dollars. This corresponds to about 3.5 US dollars of co-financing per dollar invested by the GCF, see Grüning, König and Menzel [29].

highlights a potential additional drawback of exemptions, which was not identified in the literature yet: uncertain price signals. The analysis is then broadened to consider the GHG effects of exemptions and carbon revenue use beyond maritime transport (Section 4.2). The analysis reveals that, overall, the adequate use of carbon revenues is likely to deliver better GHG reduction outcomes than exemptions, both within maritime transport and beyond.

4.1. Effects on GHG emissions from international shipping

4.1.1. Effects of price signals – general considerations

The key aim of market-based measures is to yield GHG emissions reductions by increasing the marginal cost of emitting GHGs. This cost increase incentivizes the adoption of operational measures (e.g., slow steaming), technical efficiency measures, shifts in consumer demand that reduce emissions, and the uptake of low- and zero-carbon bunker fuels and related technologies [60]. As discussed below, these incentives are weakened by exemptions, but not by carbon revenue use.

A drawback of route-based exemptions is that they undermine incentives to invest in zero-/low-GHG vessels and land-based zero-/low-GHG fuel infrastructure (e.g., zero-GHG bunkering facilities) on exempted routes. This will result in greater GHG emissions being released by the shipping sector compared to a situation where no exemptions are applied. In this respect, it is important to stress that in 2021 maritime trade-handling centers in developing countries accounted for more than 60% of imports and 55% of exports globally [80]. These numbers suggest that broad and deep exemptions applied on routes from/to developing countries would result in a significant decrease in the global share of GHG emissions from shipping.

Contrary to exemptions, addressing equity considerations through carbon revenue use does not reduce incentives to decarbonize. On the contrary, if adequately used, carbon revenues can complement carbon pricing and help deliver GHG emission reductions more cost-effectively and, therefore, more quickly.

Research on the effectiveness of carbon pricing to induce GHG emissions reductions highlights that various market barriers and market failures can reduce the effectiveness of the price signal to drive abatements [72]. For instance, shipping financiers may perceive investments in zero- and low-GHG shipping as too risky, and this can hinder efforts to decarbonize [56]. Similarly, past investments in infrastructure and onboarding technologies that support the consumption of fossil bunker fuels create path dependency and are therefore a major obstacle to the deployment and (indirectly) also to research and development of low- and zero-GHG technologies to decarbonize international maritime transport [72]. Carbon revenues from shipping can help address these market barriers and failures by supporting investments in zero-GHG bunker fuel infrastructure and vessels, thereby strengthening the decarbonization effects of carbon pricing.

4.1.2. Avoidance and evasion risks

In addition to reduce GHG mitigation incentives in exempted routes or for vessels transporting exempted cargoes, exemptions may result in opportunities for vessel owners to avoid or evade paying the carbon price — which further reduce the GHG emission potential of market-based measures. On the contrary, the use of carbon revenues per se does not present similar risks, and is therefore preferable on this ground.

Various strands of research provide useful information regarding the avoidance and evasion risks related to the implementation of exemptions in market-based measures for shipping. This evidence, reviewed below, indicates that even at a carbon price level significantly lower than those currently discussed in IMO negotiations, the implementation of exemptions can result in avoidance and evasion behavior.

Route-based exemptions create various opportunities to carbon price avoidance. One key avoidance strategy relates to vessel speed. Carbon pricing incentivizes ship speed reductions as this reduces fuel consumption [83]. In the presence of route-based exemptions, one avoidance option is to reduce the speed on non-exempted routes and increase it on exempted ones [20]. Evidence from simulations with regional carbon prices confirms the theoretical intuition that this avoidance strategy would be utilised [30]. Further evidence of the materiality of these avoidance risks comes from research on Emission Control Areas (ECAs)[13] [47,51].

In addition, route-based exemptions create avoidance risks if vessels can call at an exempted port sufficiently close to the non-exempted port of destination to reduce or completely avoid the carbon price signal. This avoidance strategy can be operationalized in many ways, such as: i) changing the order of ports in an existing schedule so that the exempted port is called at before the nearby non-exempted port; ii) calling at an exempted port and then transporting goods to the non-exempted port with alternative transport modes (e.g., trains or small vessels that are exempted from the carbon price) [22]. In this respect, it should be noted that some of the existing proposals for a carbon pricing scheme on international shipping suggest exempting smaller vessels —below 400 GT— to reduce administrative complexity (e.g., Norway, [54]). As highlighted above, these smaller vessels could be used to transport goods from the exempted port to the nearby non-exempted one and so avoid the carbon price. However, this would be dependent on the threshold of vessel size exemption and the level of the carbon price since transshipment may raise the question of economic viability for certain vessel sizes.

Several studies on the inclusion of shipping in the European Union (EU) emissions allowance trading scheme suggest that these avoidance risks are already present at moderate carbon price levels. For instance, Lagouvardou and Psaraftis [43] find that an avoidance strategy of this type can become profitable for carbon prices well below 25 euros per ton of carbon. A report by Transport and Environment finds that the risk of avoidance by calling at an extra port outside of the European Economic Area (EEA) is low under a carbon price of 30 euros per ton of carbon, but increases at higher carbon prices [16]. Similar conclusions are reached in two separate studies, by Ricardo AEA [64] and CE Delft [11], for the European Commission. Overall, this evidence suggests that a sufficiently high carbon price could make avoidance opportunities profitable also under an IMO carbon pricing instrument.

In this respect, note that Baresic et al. [6] find that meeting the minimum GHG abatement target of the Initial IMO GHG Strategy would require an *average* carbon price of 173 US dollars per tonne of GHG emissions by 2050. Along these lines, current proposals for the implementation of a carbon price by the IMO, suggest carbon price levels that range between 56 and 100 US dollars per tonne of GHG emissions by 2025 and 135–300 US dollars per tonne of GHG emissions by 2030 [37,50]. These are price levels well above the thresholds at which the avoidance strategies discussed above become profitable.

Of course, the profitability of such strategies will also depend on whether exemptions are total or partial. For instance, a partial exemption that takes the form of a lower —but still positive— carbon price, may prevent making these avoidance strategies profitable. However, at high levels of carbon prices, even relatively mild exemptions may result in a sufficiently high price differential. For instance, according to Baresic et al. [6], meeting the minimum decarbonization targets of the Initial IMO GHG Strategy may require implementing a carbon price above 200 US dollars per tonne of GHG after 2035. Here, an exemption of only 20 per cent, would still result in a price differential between exempted and non-exempted routes of more than 40 US dollars per tonne of GHG. The potential for such a price differential to make the avoidance strategies discussed above profitable cannot be discounted.

The profitability of such avoidance strategies will also depend on

[13] Compliance with ECAs often implies for vessels switch from consuming Heavy Fuel Oil (high in sulfur) to consuming Marine Gas Oil (a low sulfur fuel). The latter is significantly more expensive than the former. Thus, similarly to a carbon price, compliance with ECAs implies increased vessel fuel costs.

what routes are exempted and might be limited if exemptions apply only to e.g., voyages to/from or between a few ports. However, note that opportunities for avoidance are likely to grow over time. This is because, while capacity in exempted ports is a cap on the possibility of adopting this practice in the short term, in the long term, this capacity could be adjusted based on incentives set by exemptions, resulting in greater avoidance opportunities. Evidence from the inclusion of international shipping in the EU emissions allowance trading scheme suggests that exemptions may result in the formation of large transshipment hubs on exempted routes in close proximity to non-exempted ports [43]. The formation of such hubs can result in the release of additional GHG emissions if vessels increase their speed to make up for the additional distance travelled to reach the exempted port [43].

Lastly, route-based and cargo-based exemptions may allow regulated entities to evade the carbon price via document falsification [20]. For instance, if the carbon price is applied at bunkering, and exemptions applied/enacted through reimbursement for fuel burned on exempted routes or in transporting exempted cargoes, ship owners might claim higher reimbursements by falsifying documents regarding the routes covered or the cargoes transported. If proxies for fuel burned are used to estimate exemptions, such as speed and weight, the carbon price could be evaded by reporting a lower speed or lower weight on non-exempted routes or a higher weight for the exempted cargo. Thus, if exemptions are implemented, adequate monitoring and verification mechanisms must be implemented to minimize these risks.

4.1.3. Uncertain carbon price signals and the tramp sector

The previous section has highlighted that exemptions can hinder incentives to decarbonize shipping by reducing the share of GHGs covered and providing avoidance and evasion opportunities. In this section, it is argued that exemptions also risk undermining incentives to decarbonize outside of exempted routes because they make the *GHG price signal more uncertain* for many entities that are expected to invest in low-/zero-GHG shipping. These entities include ship owners, investors in land-based zero-/low-GHG infrastructure, as well as lenders that need to decide whether a particular lending opportunity presents too high risks. On the contrary, carbon revenue use does not present similar issues.

Uncertain carbon price signals can weaken the business case to invest in long-term low- and zero-GHG technologies [52]. Long-term investments are particularly relevant in decarbonizing international shipping as most vessels have a lifespan of 20–25 years, and low-/zero-GHG bunker infrastructure is likely to take many years to be built. In this context, the predictability of the carbon price level applied to shipping is an important factor in driving decarbonization.

The reduced effectiveness of uncertain price signals to yield mitigation outcomes is well recognized in the wider literature on carbon pricing policy with regards to "instrument choice" between cap-and-trade systems and carbon taxes [61,74]. This literature recognizes that a key advantage of simple forms of carbon taxes (i.e., carbon taxes where the tax rate is fixed or increases based on a pre-determined schedule) is the predictability of the price signal compared to forms of cap-and-trade that allow for variations in the price of allowances (i.e., cap-and-trade systems that do not constrain the variation of price signals, for instance through the use of price caps and price floors) [61].[14] A similar advantage exists for carbon pricing instruments applied in the international shipping sector that do not exempt routes or cargoes.

Exemptions in the international shipping sector can make the *GHG price signal more uncertain*. In particular, there may be uncertainty for vessel owners regarding the routes their vessels will cover or the destinations of the cargoes they will transport in the future. While some vessels tend to have a fixed schedule, many shipping operators, especially in the dry bulk and tanker trade, do not follow a fixed schedule (so-called tramp trade) [75]. In 2021, dry bulk cargo and oil tankers accounted for more than 42% and 29% of the global fleet (in terms of dead-weight tons) respectively. Tramp trade is, therefore, a significant share of the global fleet (and its GHG emissions) [79]. It can be difficult for a shipping company that operates in the tramp trade sector to forecast what routes will be taken in the future. Thus, unless a carbon price is applied homogeneously across routes, shipping companies operating in the tramp sector can be uncertain about the share of their future GHG emissions that a carbon price will cover. In this sense, the introduction of route-based exemptions from a carbon price can create uncertainty about the price that will be applied to specific vessels. In turn, this uncertainty may reduce incentives to invest in green shipping.

Of course, the uncertainty on the carbon price applied to GHG emissions from vessels in the tramp sector depends on what routes are exempted. If they apply on a few routes to or from countries that account for a relatively small share of global trade (e.g., LDCs and low-income SIDS), the uncertainty created by exemptions will be very small for most ship owners and shipping financers. However, if exemptions are applied to a broader set of routes, the level of uncertainty may increase significantly. Imagine, for instance, the need to be cognizant of the principle of CBDR-RC is addressed by applying different carbon price levels to different routes depending on countries' contributions to climate change and capacity to address climate change. In this context, a high carbon price could be implemented on vessels that transport goods from the US to the EU, a medium-high carbon price could apply to vessels that travel between the US and India, a medium price could apply to vessels that travel between the US and a low-income SIDS, a medium-low price to a vessel that travels from India to a low-income SIDS, and a low (or no) price to a vessel that transports goods between two low-income SIDS. It is evident that in this context, the predictability of the carbon price applied to the tramp sector is much lower than under a homogenous global carbon price. This uncertainty may reduce the uptake of low- and zero-GHG vessels in tramp trade. This is particularly problematic given that tramp trade is a sector that is already expected to struggle more to decarbonize than liner shipping due to uncertainties on the availability of zero-GHG bunker fuels on their (less predictable) trade routes.[15] The two uncertainties — one related to the price signal and one related to the availability of zero-carbon bunker fuels on routes covered — would cumulate.

Cargo-based exemptions can, in principle, present similar issues to route-based exemptions in terms of reduced predictability of the carbon price applied to vessels. If a ship owner is subject to a carbon price depending on the type of cargo transported, and the ship owner cannot fully predict the type of cargo it will transport in the future, the price applied to the ship owner's vessels is uncertain. As per above, if exemptions are applied narrowly (e.g., to medicine and food products destined for low-income SIDS and LDCs), the uncertainty created by exemptions is unlikely to alter decarbonization incentives for the vast majority of ship owners and shipping financers. However, if exemptions apply broadly (e.g., to many products delivered to and from many developing countries), the level of uncertainty increases.

Note that, contrary to exemptions, the use of carbon revenues per se does not make the carbon price signal more uncertain. In addition, the strategic spending of carbon revenues can also support the decarbonization of the tramp sector by facilitating the uptake of zero-carbon bunker fuel infrastructure in areas of the world where infrastructure investments would not take place in absence of international public finance. Thus, contrary to exemptions, adequately spent carbon revenues have the potential to facilitate GHG abatements in the tramp sector.

[14] For different forms of price control mechanisms for cap-and-trade systems, see Dominioni and Faure [19].

[15] For evidence of this slower uptake of zero-GHG vessels in the dry bulk and oil tanker sectors, see Danish Ship Finance [15].

4.2. Effects on GHG emissions beyond maritime transport

Section 4.1 has highlighted that exemptions can be detrimental to the achievement of GHG emissions reductions from international shipping. Instead, the strategic use of carbon revenues can help to reduce decarbonization costs and speed up the decarbonization of the sector. This section complements the analysis above, by considering the GHG effects of exemptions and carbon revenue use beyond maritime transport. The analysis reveals that, also in this respect, the strategic use of carbon revenues is likely to yield better climate change mitigation outcomes.

A first aspect to consider is that investments in zero-GHG bunker fuels, such as hydrogen, can strengthen a country's capacity to mitigate domestic GHG emissions outside the shipping sector. For instance, building domestic infrastructure to produce green hydrogen for shipping can help build domestic *private sector* workforce capacity to produce green hydrogen for other sectors [3]. Broad and deep exemptions can undermine these capacity-building opportunities. Similarly, reduced incentives to invest in land infrastructure to produce zero-/low-GHG bunker fuels can result in lost opportunities to increase exempted countries' *government capacity* to implement GHG regulations outside the shipping sector. This is because investments in zero-GHG bunker fuels may require implementing adequate regulatory frameworks [21], and implementing such frameworks can help build knowledge among domestic policymakers on how to act on climate change more broadly. The existence of such a possibility is supported by research showing that implementing climate policies in one sector can build a government's capacity to act on climate change in other sectors [17,57].

In addition to increasing private and public sector capacity to address climate change, investments in zero-GHG bunker fuels can create the economies of scale needed to produce zero-GHG fuels in other sectors [3]. For instance, according to the International Renewable Energy Agency (IRENA) [36], economies of scale are key to reducing the cost of production of green hydrogen — an energy source expected to be employed in the decarbonization of various hard-to-abate sectors, including shipping,[16] steel, chemical, and aviation. Thus, investing in zero-GHG bunker fuels can create market conditions to produce zero-GHG fuels for other sectors. Deep and broad exemptions can undermine these investments in exempted countries.

Contrary to exemptions, the strategic use of carbon revenues can help to yield additional GHG emission abatements out of sector, especially if a share of carbon revenues is used beyond maritime transport. Developing countries' needs for climate finance are currently far from being addressed [4,42,88]. Using a share of carbon revenues from shipping to address some of these needs, as advocated by some IMO stakeholders (e.g., [50]), could help close the financing gap and deliver additional GHG emission reductions.

Of course, the GHG benefits of carbon revenue use are contingent on how carbon revenues are actually spent. In principle, the use of carbon revenues from shipping could also result in greater GHG emissions, for instance if used to support the production or distribution of fossil fuels and related technologies. To avoid these negative climate outcomes, the distribution of carbon revenues should include environmental safeguards —such as those routinely included in existing climate funds— to ensure that revenues are not used to finance GHG intensive activities. Section 6 further elaborates on guiding principles for the distribution of carbon revenues.

5. Exemptions, carbon revenue use, and equity considerations

This section discusses whether exemptions and carbon revenue use are adequate instruments to address equity considerations in the decarbonization of international maritime transport. The analysis reveals that, while exemptions have some potential merit in addressing equity considerations, they also have various drawbacks. On the contrary, the adequate use of carbon revenues from shipping does not present similar issues.

5.1. Who benefits (and how much)?

Addressing equity considerations in international shipping would require that countries identified as deserving differential (i.e., more favorable) treatment actually benefits from measures implemented to address these concerns. This section discusses the possibility to *identify* the beneficiary of exemptions and carbon revenue use. The analysis indicates that it is sometimes difficult to identify the beneficiaries of exemptions. For carbon revenues, beneficiaries are easier to identify but only when recipients are governments instead of the private sector.

The use of route exemptions has the advantage that it makes it easy to identify from the start which ports will be exempted. This is a clear strength of exemptions compared to carbon revenue use, because with the latter it is only after carbon revenues are distributed that the beneficiaries can be identified. Such distribution can be made more predictable by reserving shares of carbon revenues to individual countries — a practice currently employed by some major climate fund, such as the Green Environmental Facility [26]. However, in most cases, funds are distributed through competitive auctions, which makes it difficult to know *ex-ante* which country will benefit from this climate finance.

If exemptions were implemented in international maritime transport, the more immediate effect would be to lower transport costs on the exempted routes. This would, generally, increase the competitiveness of importers and exporters on these routes (or of those that trade exempted cargoes) compared to traders on non-exempted routes. This can generate economic benefits for countries on these routes, for instance in terms of GDP and employment outcomes.

However, when we look more closely, it becomes less clear who would benefit from the reduction in transport costs, for at least three reasons. First, if, for instance, an exemption is implemented on a route between a developed country and a developing country, the lower transport costs could result in:[17] i) lower import prices for importers — and, perhaps, consumers — in the importing developing country; ii) higher margins for exporters in the developed country; iii) lower costs for the company transporting the goods (e.g., ship owner or charterer). How the benefit of the exemption is distributed among the importer, the exporter, and the shipping company transporting the good depends on the relative ability of the economic actors along the supply chain to capture the benefits of lower GHG costs on the exempted route (or of exempted cargoes). If the exemption aims to benefit *exclusively (or primarily)* the importing developing country, it is not guaranteed that the exemption achieves this goal. Note that, as discussed above (Section 2.2), the ability of a shipping company to pass on the cost of carbon pricing may depend on contingent conditions. This implies that it would be difficult to identify how much each economic player benefits from exemptions across time.

Second, the potential inability of exemptions to actually benefit targeted recipients is even clearer if one considers the risk of carbon price evasion and avoidance discussed in Section 4.1.2. Once these risks are taken into account, it is clear that even exporters/importers in developed countries could benefit from exemptions. For instance, as discussed above, an importer from a developed country can avoid the price signal by having goods delivered first to a nearby exempted port and then shipped through smaller (and exempted) vessels to the final destination.

Lastly, any benefit from exemptions that accrue to ship owners will often be difficult to categorize as a benefit that goes to a specific country.

[16] In shipping, green hydrogen is expected to be used primarily as a feedstock for the production of green ammonia [21].

[17] Compared to a situation where exemptions were not implemented.

This is because ship ownership may be fragmented among investors in different countries, and the vessel might be registered in a third country. Thus, the relationship between a vessel and a country is often difficult to establish clearly [39]. This is an additional limit of exemptions to address equity concerns in the decarbonization of international maritime transport.

Contrary to exemptions, it is easy to identify *ex-post* who benefits from the distribution of carbon revenues — at least as long as recipients are countries, not the private sector. As above, if carbon revenues are distributed to shipping companies (e.g., ship owners), it can be difficult to identify who actually benefits from the revenues due to the intricate ownership structure of shipping companies as well as the fact that the flag state may differ from a vessel's country of ownership [87]. However, the same problem does not apply if carbon revenues are distributed to countries, as here it is easy to track how much revenue each country receives. For this reason, the World Bank [87] argues in favor of distributing a substantial share of carbon revenues to governments, not the private sector.

Note that the fact that carbon revenues are distributed to governments does not imply that carbon revenues can not be used to finance the retrofitting of vessels. Shipping companies could access carbon revenues through governments, meaning that governments could receive carbon revenues and then distribute this revenue to shipping companies to green the fleet. This mechanism would allow to keep track of which government receives (what amount of) carbon revenues, and, at the same time, support the uptake of zero-carbon technologies on vessels.

5.2. Co-benefits

It is well-established that GHG regulations, including carbon pricing, can deliver co-benefits that go beyond climate change mitigation per se [40]. These include, for instance, improved air quality and related health and agricultural benefits [48,62] as well as additional economic activity related to the development of the green economy [63]. This applies also to market-based measures in international shipping.

This section discusses the potential for market-based measures for shipping to deliver co-benefits in presence of exemptions and carbon revenue use. The analysis reveals that the implementation of exemptions can provide some co-benefits for exempted countries but also imply foregoing some of the co-benefits that market-based measures can deliver. The net co-benefit effects are less certain compared to a market-based measure that does not include exemptions. On the contrary, the strategic use of carbon revenues is more likely to deliver net co-benefits, at least as long as adequate safeguards are put in place.

Exemptions can provide additional economic benefits to exempted countries, compared to a market-based measure that does not include exemptions. A key potential benefit is the increased competitiveness of producers in the exempted country (see, Section 5.1). In addition, as mentioned in Section 4.1.1, exemptions can result in an increased use of exempted ports located in proximity of non-exempted ones, and potentially also in the formation of large transshipment hubs on exempted routes [43]. This increased port use can benefit exempted countries in terms of economic activity [59,58], employment outcomes, [70,10], and fees/port charges collected.

At the same time, some of the co-benefits that can be delivered by the implementation of market-based measures in shipping would be forgone by exempted countries. In particular, reduced incentives to produce zero-GHG bunker fuels may translate into lower opportunities to export these fuels. These forgone opportunities may not be negligible for some developing countries. For instance, a World Bank study indicates that many developing countries — including some low and middle-low-income countries, such as Egypt and Morocco — have a high potential to produce green hydrogen and green ammonia [21]. Thus, there are economic opportunities related to developing zero-GHG bunker fuels that risk being lost if routes to or from these countries are exempted.

Besides reducing potential export opportunities, being exempted from GHG regulation can limit domestic environmental benefits from this regulation. The consumption of bunker fuels accounts for a significant share of air pollution in ports [14] and related negative health effects in surrounding areas [73]. Thus, exemptions may result in worse health outcomes for communities near exempted ports. Furthermore, and relatedly, as highlighted in Section 4.2, one of the drawbacks of exemptions is that they reduce incentives to invest in zero-GHG bunker fuels in exempted countries, which may reduce a country's capacity to address GHG emissions in various sectors of the economy. In turn, this may result in greater domestic environmental degradation and worse health outcomes even in areas far away from port facilities.

Both exemptions and the strategic use of carbon revenues can distort competition among shipping industries. Route-based exemptions can favor companies that cover exempted routes to the detriment of those operating in other areas. Similarly, the distribution of carbon revenues could distort competition among shipping companies if some benefit from the revenues more than others. To avoid these distortions, it is important that the distribution of carbon revenues complies with World Trade Organization law, especially rules set out in the Agreement on Subsidies and Countervailing Measures.

The strategic use of carbon revenues can deliver *additional* climate co-benefits, at least as long as adequate safeguards are put in place in the distribution of carbon revenues to ensure that this spending does not result in detrimental effects to the environment or development more broadly (on principles for the distribution of carbon revenues, see further below, Section 6). Indeed, investing in climate change mitigation can deliver many co-benefits ([68]). For instance, investments in cold ironing can help reducing local pollution from ships — thereby improving health of people living or working in port areas ([5,73]). In addition, the strategic use of carbon revenues —as all public international climate finance— can generate additional economic activity, create new job opportunities, and increase fiscal yields for the recipient country [63,84].

On a general note, it is important to recognize that the possibility for a country to enjoy some of the co-benefits discussed above depend on choices made by other entities. For instance, countries that are services primarily by vessels from other countries (in terms of ownership and flag of registration) —such as many SIDS and LDCs— may have limited control over whether vessels calling their ports are green or not. Thus, these countries may have limited influence over whether the air pollution benefit of a green fleet will materialize in areas around their ports. The strategic use of carbon revenues can help addressing this issue, for instance, by supporting the development of infrastructure that allows the deployment of green vessels on routes from/to their ports.

5.3. Reduced safety of vessels

A concern of implementing route-based exemptions is incentivizing the deployment of less energy-efficient vessels on these routes. Some IMO stakeholders have raised the issue that these vessels tend to be older, and therefore less safe. Below, I test this argument against up to date empirical research on vessel age and safety. Results from this research provide a less clear-cut picture on the risks of concentrating old vessels on exempted routes.

There is a significant amount of research that focuses on vessel age and safety. Many of these studies find that vessel age is positively correlated with increased risks of accidents [1,44]. However, others find that the risk of accidents decreases with vessel age [46]. Others find less clear-cut results. For instance, [65] analyze more than 7000 accident reports and find that the frequency of accidents tend to increase up to 19 years of age of the vessel, and then decreases, while remaining at high levels. Others indicate the existence of an inverted U-shaped relationship — whereby vessel safety increases initially with vessel age and decrease after a tipping point is reached [38,45]. For instance, Li et al. [45] study total loss incidents of vessels using panel data from 1999 to

2007 and find that vessels between 17 and 42 years old are significantly riskier than younger and older vessels. Similarly, Jin et al. [38] find that accident probability for tanker vessels decreases up to 15 years of age and starts increasing afterward — with a sharp increase after the vessel reaches the age of 20 — probably due to fewer investments in maintenance as the vessel reaches the end of its economic life. Overall, the relationship between vessel age and safety might be less straightforward than assumed in the research on decarbonizing international maritime transport because various factors determine vessel safety.

At the same time, the use of carbon revenues does not lead to safety risks per se. On the contrary, if used to support capacity building (e.g., training of maritime workers related to the use of new zero-carbon technologies) and vessels' maintenance, the use of carbon revenues could help reduce accident risks. This is an advantage of carbon revenues compared to route-based exemptions.

6. Using carbon revenues as the primary way forward

The analysis above highlighted that the adequate use of carbon revenues can yield better GHG mitigation outcomes and can better address equity concerns than exemptions. This suggests that the strategic use of carbon revenues should be seen as a primary way to address equity considerations in the energy transition of international shipping. However, many of the benefits of carbon revenue use are contingent on how revenues are actually spent. In particular, a key issue related to the ability of carbon revenues to address equity considerations in international shipping is how to ensure that no country is left behind — a core principle of the United Nations 2030 Agenda for Sustainable Development [77]. Discussions on the use of carbon revenues have already begun among IMO member states [2,37,50] and other stakeholders [12,76,87]. In this respect, many issues need to be decided, such as what criteria should be used to distribute carbon revenues, the governance of the structure that distributes the revenues, and what transparency mechanisms should be implemented. Below, I propose some guiding principles to structure a distribution framework that leaves no country behind.

First, the choice of how carbon revenues will be used should account for the spending opportunities available to countries, especially the most vulnerable to climate change and, most likely, to negative impacts from the decarbonization of international shipping, such as SIDS and LDCs. In this respect, it is important that carbon revenues are not used solely to finance activities related to the shipping sector, such as financing vessel retrofits and the development of zero-GHG bunker fuels — as currently proposed by some stakeholders (e.g., [12]). Restricting carbon revenue use to maritime-related spending reduces opportunities to receive carbon revenues for countries where the shipping sector is not a major domestic industry or opportunities to obtain funding for the production of zero-GHG bunker fuels are limited [87]. Thus, ensuring that no one is left behind requires extending the possibility of obtaining carbon revenues (at least a share of it) for investments beyond maritime transport. This could be particularly useful to allow countries with small fleets, few and small ports, and low ship building capacity to still access a share of carbon revenues [87].

Second, the structure of the framework to distribute carbon revenues could account for countries' capacity to access climate finance. To this end, the World Bank has recently suggested to reserve a share of carbon revenues from shipping to selected developing countries that often struggle to access climate finance due to capacity constraints or lack of data on climate impacts — including SIDS and LDCs [87].

Third, adequate structures should be put in place to ensure that capacity to access and manage carbon revenues is build over time, especially in countries that traditionally struggle with accessing and managing climate finance (see, for instance, [23,25]). Potential interventions could include the institution of readiness programmes, the development of clear performance indicators of carbon revenue use to guide the recipient entity on the expectations of the funder and on the data that needs to be collected and collated in progress reports [7]. In addition, recipient countries could be granted direct access and enhanced direct access as this can enable them to build capacity to access and manage climate finance over time [90].

Fourth, it would be important to ensure that adequate transparency and accountability frameworks are in place to ensure that the aims of carbon revenue use are achieved. Such frameworks could include, for instance the establishment of independent monitoring entities — such as those that have been created by the Green Climate Fund. Accountability can be facilitated also by ensuring public availability of information on the decision-making processes and actual funding decisions [8]. Relying on results-based financing can also help address the principal-agent problem of traditional financing measures, thereby improving the use of carbon revenue [89].

7. Conclusions

This article has presented an in-depth analysis of the relative merits of exemptions and carbon revenue use to address equity considerations in shipping decarbonization. In particular, the analysis focuses on the potential for exemptions and carbon revenue use to address key equity considerations and deliver GHG outcomes. Besides reviewing arguments put forward by IMO stakeholders in favor of these two approaches and testing them against existing empirical research, this study has also identified new risks associated with exemptions that have been overlooked so far in the literature, such as: uncertain price signals, reduced opportunities to decarbonize other sectors, and forgone climate co-benefits. Overall, the analysis has revealed many drawbacks of exemptions compared to carbon revenue use in terms of GHG mitigation outcomes and effectiveness in addressing equity considerations included in the guiding principles of the Initial IMO GHG strategy.

Based on this analysis, the article identifies the strategic use of carbon revenues from shipping as the preferable way forward to address equity considerations in the energy transition of the shipping sector — at least when some canons in the distribution of carbon revenues are respected. To this end, the article elaborates some guiding principles for the distribution of carbon revenues to ensure that equity and climate outcomes are delivered.

Overall, the analysis suggests that policy makers should first consider whether equity considerations can be addressed adequately through the use of carbon revenues. Only when this approach is found to be not fully satisfactory —for instance, because the amount of revenue raised is insufficient to address equity concerns— the use of exemptions should be considered in parallel. In this respect, it is important that future research analyzes empirically the impacts on states from the implementation of market-based measures in shipping and identifies the amount of carbon revenues that could help address these impacts to support the equitable energy transition of the sector. Additional research is needed also regarding the amount of *carbon revenues* needed to decarbonize the sector. Existing research provides estimates of the investments needed to decarbonize international shipping (e.g., Baresic et al., [6]), Future research could identify the *international public sector investments* needed to catalyze the *private sector investments* required to decarbonize international shipping in alignment with the Paris Agreement temperature targets.

Author statement

The article is single authored.

Data Availability

No data was used for the research described in the article.

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