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The impact of a global carbon tax on the maritime industry

An analysis by shipping segments

by

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I want to convey my deepest gratitude to my family for their unwavering support when I made the decision to leave my shipping career and pursue higher education. I've had a wonderful year, and I can't wait to see what lies ahead.

Abstract

The topic of climate change has been the talk of the town lately. Since potential competition consequences dominate the perspective of policy makers, discussions concerning the best combination of carbon reduction policy instruments are protracted and complex. Numerous member countries have proposed remedies, but the International Maritime Organization (IMO), a worldwide maritime organization, must act on pricing emissions from maritime transport. The IMO hasn't made any convincing propositions in this area. Thus, this study helps in contributing to the above thought process by examining "the economic, trade and transport impact of a global carbon tax on the three major shipping segments of maritime industry: containers, dry bulk, and wet bulk". A partial equilibrium econometric model (Francois and Hall, 2002) is utilized as an impact assessment tool to provide answers regarding trade flows, welfare effects, production and price effects.

The producers in the liner segment stand to lose most money from the implementation of a global maritime carbon tax. A drop in exports of $1.5 to $2.7 trillion for a tax of $75 would be particularly detrimental to the EU and China. Australia suffers since it is a significant exporter and a remote production hub; as a result, the impact as per our model in the dry bulk segment is significant. An export revenue loss of $114 billion and a producer revenue loss of $4.9 billion. China, the EU, the US, and ROA are the importing countries that are most impacted across all cargo segments. For the Wet Bulk segment, a $75 tax scenario results in a considerable drop in producer revenues and net welfare for Middle East and Russia, with export declines ranging from $113 to $418 billion. With a loss in consumer surplus ranging from $2.1 billion to $3.7 billion, consumers in China and the EU are among the greatest losers in the wet bulk market. We also see around 146,96,260 million tons reduction in CO_2 for wet bulk, dry bulk and containers respectively. The maximum transport impact is seen in the liner segment of around 210,000 TEU (or 63%).

To accomplish the objectives established for 2050, IMO, the legal global shipping body must move swiftly on a resolution to enact a carbon tax. Our research provides insight into what to anticipate if such a policy is embraced globally.

Table of contents

List of Annex

List of Tables

List of Figures

List of Equations

List of Abbreviations

AHS	Effectively applied tariff
AUS	Australia
CBAM	Carbon Border Adjustment Mechanism
CBDRRC	Common but Differentiated Responsibilities and Respective Capabilities
CD	Canal dues
CEO	Chief Exceutive Officer
CES	Constant Elasticity of Substituion
CET	Constant Elasticity of Transformation
CGE	Computable general equilibrium
COVID	Coronavirus Disease
CS	Consumer Surplus
CSC	Clean Shipping Coalition
ETS	Emission Trading Scheme
EU	European Union
FC	Fuel costs
GCF	Green Climate Fund
GDP	Gross Domestic Product
GE	General Equilibrium
GHG	Green House Gases
GSIM	Global Simulation
GTAP	Global Trade Analysis Project
ICS	International Chamber of Shipping
IMF	International Monetary Fund
IMO	International Maritime Organization
INTERCARGO	International Association of Dry Cargo Shipowners
MBM	Market based measures
ME	Middle east
MEL	Maritiime Economics and Logistics
MEPC	Marine Environment Protection Committee
NYK	Nippon Yūsen Kabushiki Kaisha
NZ	New Zealand
OECD	Organisation for Economic Co-operation and Development

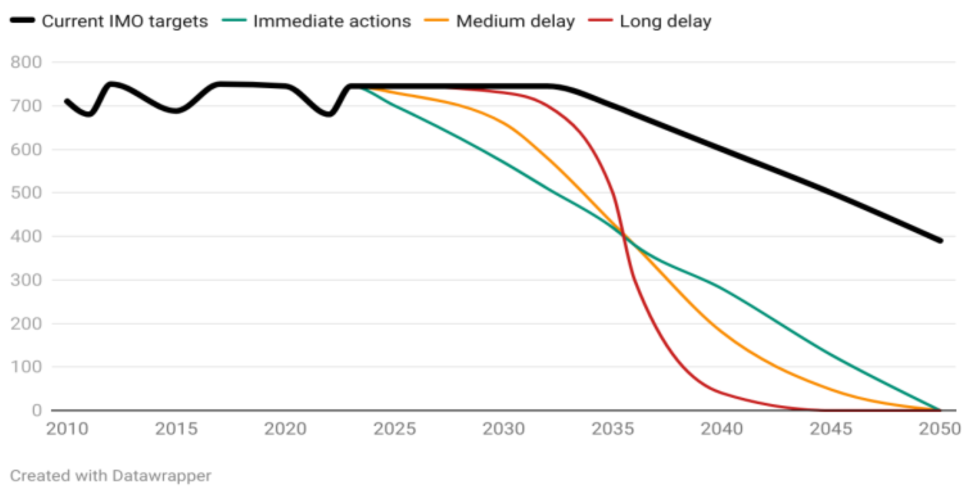
OPEC	The Organization of the Petroleum Exporting Countries
PD	Port and light dues
PE	Partial Equilibrium
PS	Producer surplus
QL	Quasi Linear
RMT	Review of Maritim Transport
ROA	Rest of Asia
ROAF	Rest of Africa
ROE	Rest of Europe
RONA	Rest of North America
ROSA	Rest of South America
SE	Substitution Elasticity
SIDS	Small Island Developing States
SVAR	Structural vector autoregressive
TP	Tugs and pilotage
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
USA	United States of America
USD	United States Dollar
VC	Voyage costs
VLSFO	Very low sulfur fuel oil
WBG	World Bank Group
WE	Welfare effects
WITS	World Integrated Trade Solution

Chapter 1 Introduction

1.1 Background

The Initial IMO Strategy on Reducing Greenhouse Gas (GHG) Emissions from Ships was adopted in April 2018 by the International Maritime Organization (IMO), the United Nations organization specifically responsible for international shipping. The initial IMO GHG strategy′s main goal is to, in accordance with the Paris Agreement temperature goals, cut total annual GHG emissions by at least 50% by 2050 compared to 2008. At the same time, efforts will be made to urgently phase out GHG emissions this century (IMO, 2018). Depending on future energy advances and projected economic growth, "business as usual" models call for shipping′s CO2 emissions to rise from 2008 levels by 2050 by 90 to 130 percent (J. Faber et al, 2020). If the IMO climate objective is to be met, further policy measures to reduce GHG emissions from shipping must be enacted and put into practice in light of these estimates.

Figure 1-1: IMO's targets and Paris-compatible 1.5℃ pathways



Source: Created by author in reference to (Bullock, Mason and Larkin, 2021)

The Initial IMO GHG Strategy requires that consequences on States of policy measures for climate mitigation are reviewed and taken into account before they are adopted, giving particular attention to the needs of developing nations, notably small island developing States (SIDS) and least developed countries (LDCs) (IMO, 2018).

The Initial IMO GHG Strategy comprises a non-exhaustive list of proposed short-, mid-, and long-term measures (IMO, 2019). These nations′ (LDC & SIDS) worries that extra climate mitigation policy measures in shipping could have a negative impact on their economies led to the requirement. The stages involved in submitting and commenting on impact assessments are outlined in an IMO method for assessing impacts on States (IMO, 2019), which also gives some specifics on the data, the assessments should contain.

There have already been a number of impact analyses done for potential short-term solutions aimed at improving ship energy efficiency (Brazil and China, 2020) (Denmark, France, Germany, 2020) (Greece, Japan, Norway, International Chamber of Shipping (ICS), 2020) (Greece, Japan, Norway, International Chamber of Shipping (ICS), 2020) (Pacific Environment (PE) and Clean Shipping Coalition (CSC), 2020). However, a later analysis by the United Nations Conference on Trade and Development (UNCTAD) critiqued that these impact assessments did not entirely address all parameters stated in the IMO procedure, highlighted several issues, such as the lack of readily available data and the existence of numerous uncertainties, and made recommendations for improving impact assessments (IMO, 2020). As a result, an extensive impact analysis of a combined IMO short-term measure was carried out. It was discovered that, in comparison to the regular market unpredictability of freight rates, the measure′s overall worldwide implications on maritime logistics costs might be regarded as modest (IMO, 2021a) (IMO, 2021c). The worldwide impact on GDP and trade flows could alternatively be viewed as little in comparison to the longer-term effects of other disruptions (such as pandemics, climate change factors). However, it was discovered that some SIDS, LDCs, and developing nations would probably need assistance to help offset rising marine costs and the resulting detrimental effects on their actual income and trade flows (IMO, 2021a) (IMO, 2021c).

The discussion shifted to the mid-term measures, which include market-based measures (MBMs), once the short-term energy efficiency measures were adopted in 2021 (IMO, Further shipping GHG emission reduction measures adopted, 2021). Previous IMO negotiations on MBMs failed to reach a consensus and were suspended in 2013 (among other reasons because of concerns about potential negative economic repercussions). The studies from (Chircop, A et al, 2018) (S. Lagouvardou et al, 2020) (Y. Shi, 2016) entail the history of IMO regulation changes related to lowering GHG emissions as well as a summary of prior MBM proposals. Recent submissions (Belgium et al, 2019) (Denmark et al, 2021) (France, 2018) (Netherlands, OECD, 2021) and a new, detailed proposal for a GHG levy that has been presented to the IMO for debate (Marshall Islands and Solomon Islands, 2021) show the Member States′ desire to resume the MBM negotiations. We concentrate on the economic, trade and transport effects of carbon pricing schemes in light of this.

1.2 Problem Identification

According to ICS′s comments, "[w]hen the Member States of IMO commence the development of an MBM, the preference of the global shipping industry is for a levy-based system linked to fuel consumption/CO2 emissions, as this is the form of MBM that the global industry has determined will be least likely to have an adverse impact on the industry as a whole." (Steptoe et al., 2021)

The September 2021 ICS-INTERCARGO proposal similarly states that a piecemeal approach to the introduction of MBMs would most likely fail to achieve the Organization′s goals. The Organization must now act quickly to develop an MBM in order to discourage the unilateral application of MBMs to international shipping and to demonstrate continued leadership for the decarbonization of shipping via its global regulatory framework.

Importantly, support for a universal carbon tax has been expressed by other important parties. The CEO of Maersk, the largest shipping company in the world, demanded on June 2, 2021, shortly before the MEPC conference in June, that the IMO get ready to introduce a carbon tax on ship fuel starting in 2025 that would cost at least $150 per ton (or $450 per ton of fuel) (Wittels, 2021). Despite the fact that Maersk lacks consultative status at the IMO and is thus unable to present suggestions to the MEPC, its support for a carbon tax lends credibility to those that have already been made.

The American government hasn't publicly stated what it thinks about a global maritime carbon tax. However, it has pledged to collaborate with other IMO members to support the target of reaching net zero emissions from international shipping by no later than 2050, which may necessitate the adoption of MBM by the IMO.

It appears likely that the MEPC will now take an MBM into serious consideration given the need for additional action to meet its goal of reducing emissions by 50% from 2008 levels by 2050, industry pressure for consideration of a carbon tax, and the upcoming expansion of the EU ETS. The IMO will likely be under more pressure to make sure it keeps up with any new GHG-reduction pledges as a result of meeting after COP26. MBMs are still debatable. Concerns have been voiced about the related legal, administrative, and governance issues as well as the possible effects on Small Island Developing States (SIDS) and Least Developed Countries (LDC), which may have trouble finding the money to finance the energy-efficient ship upgrades and the purchase of newer, more modern ships. But compared to before, the likelihood of achieving an agreement now seems significantly higher. The main cause of this is the enthusiastic backing from important industry players who are hoping for a clear pricing signal from the IMO to encourage the switch to zero-carbon fuels. (Steptoe et al., 2021)

1.3 Research question and sub-research questions

We may infer from the background information on the subject, that the research question should be sufficiently general to characterize the effects of the carbon tax across the board while being particular to named shipping sectors. In light of this, the primary research question is: "**What is the economic, trade and transport impact of a global carbon tax on the three major shipping segments of maritime industry: containers, dry bulk, and wet bulk?**"

We must also look at the following sub-research questions in order to adequately respond to the main research question:

1. *How do we categorize the maritime industry into three sectors?*
2. *What is the current situation and are global trends in shipping?*

3. *What is the rationale behind a carbon tax?*

4. *What types of costs are impacted by a carbon tax and to what extent?*

5. *What is the best methodological approach to quantify the economic and transport effects of carbon tax on the maritime transportation?*

6. *How do we define economic, trade and transport impact?*

1.4 Research Methodology

This research's methodology will be focused on quantitative study of the economic impact of actions taken by IMO to impose global carbon tax and its impact on the economy, trade and transport on current major trade routes. To examine and assess the effects and variations in arbitrage between various shipping routes for various commodities in major shipping segments, an econometric partial equilibrium model will be utilized.

We will first investigate and assess the main shipping routes for the three shipping segments for our quantitative study, and then we will use the trade data to identify the significant nations for our econometric model. The trade volumes and elasticities for these segments will then be calculated and assumed. The many potential worldwide carbon taxes explored in various literatures will be used to build scenarios. The initial and final NTMs of the econometric model will then be determined using the method described in (Anderson and Wincoop, 2004). An econometric model will then be used to analyze the implications of the global carbon tax by the IMO on trade values, economic and transport parameters. The results of the investigations mentioned above will then be discussed.

1.5 Structure of the thesis

The structure of this thesis is as follows: After the topic is introduced, the issue is identified, and the research methodology is discussed in **Chapter 1, Chapter 2** includes a literature review that provides a general overview of carbon pricing, then examines the characteristics of the maritime industry in relation to potential carbon pricing. Finally, we look at more specialized literature that links the maritime sector to carbon pricing. In **Chapter 2**, where we review the current situation and the worldwide trends in shipping, we will also go into the most recent events in relation to the global climate levy (carbon pricing). This Chapter will also examine how various ship operational expenses may change as a result of the implementation of a carbon tax. To do this, we will first categorize these costs and then further investigate which costs will be most impacted. In the **third chapter**, the author will outline the three primary shipping categories, country selection based on trade statistics, the primary trade routes and volumes along these routes, initial and final tariffs, and elasticities for the aforementioned important trading nations. Model selection, model description, data collection, and scenario construction will come next. Based on the results of econometric model calculations, linear programming, and the author′s assumptions, the effects of the global carbon tax on the economy, trade, and transportation will be reported in **Chapter 4**. We′ll finish off by summarizing our research′s findings and making some suggestions for further research in **Chapter 5**.

Chapter 2 Literature review

2.1 Current situation

As discussed in (Parry et al., 2018) paper on "Carbon Taxation for International Maritime Fuels: Assessing the Options" more people are becoming aware of the environmental benefits of a maritime carbon tax. With regard to reducing emissions, maritime carbon taxes encourage and strike a cost-effective balance between the full range of possible opportunities (given the current state of technology) (For instance, updating the ships′ technological and operational capabilities, expanding the fleet with larger, more powerful ships, etc.), as opposed to most alternative mitigation instruments (e.g., technological efficiency requirements for new ships). They also differ from other pricing instruments (e.g., emissions-based pricing) in that they do not impose a fixed price.

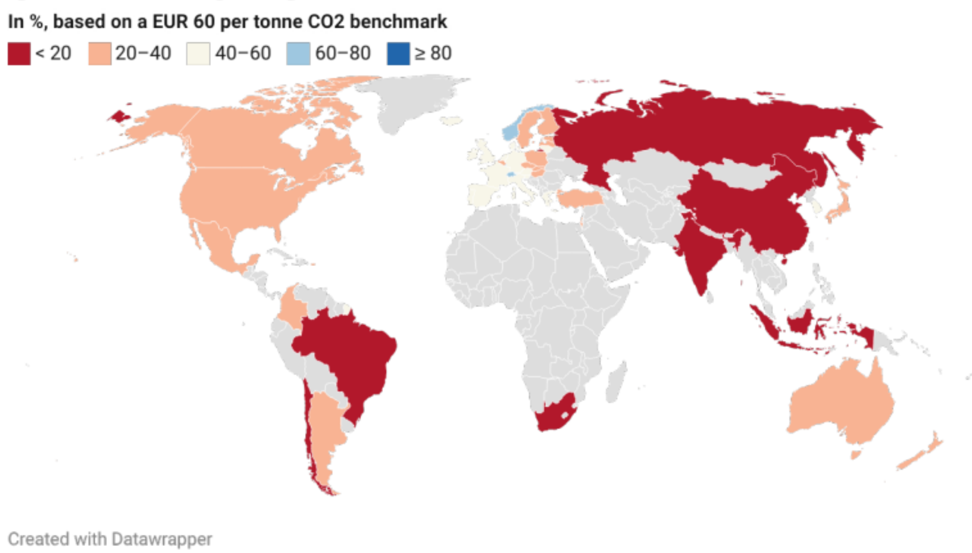
The IMO′s guiding concept of non-discriminatory treatment of all ships regardless of flag state would be in line with the global implementation of a marine carbon tax. While there is currently little agreement on how to accomplish this, member states stress the importance of addressing the principle of common but differentiated responsibilities and respective capabilities (CBDRRC) (UN 1992), which states that countries should be held accountable for their contributions to GHG mitigation in accordance with their economic status and respective capabilities. The IMO emphasizes the need to prevent negative effects on small island developing states (SIDS) and low-income nations (LICs) (IMO, 2015).

According to the IMF′s World Bank Report (Farid et al., 2016), as of mid-2015, more than 20 sub-national governments and about 40 national governments worldwide have implemented or were implementing some type of carbon pricing. Currently, there are only 15 countries with clear carbon pricing (Grey, E. 2016). In 2015, it was anticipated that the total value of carbon pricing mechanisms worldwide was just under $50 billion. 30% of this comes from carbon taxes, and 70%, or around $34 billion, is ascribed to emissions trading schemes (ETSs). That enormous number, though, can be misleading. Only 12% of the world′s yearly emissions of greenhouse gases (GHGs), or 7GT of CO2e, are addressed by carbon pricing, and only 4% of this is due to carbon levies.

The shipping industry may make a substantial contribution by enacting broad regulations on carbon taxes. Even after compensating developing nations, a global $30 per ton CO2 fee on fuels used in shipping and aviation combined may have brought in around $25 billion in climate money in 2014. To raise money for climate change mitigation, The International Chamber of Shipping (ICS) opposes a carbon tax. They made this position known in 2015 when they rejected a $25 per ton CO2 fee proposed by The Organization for Economic Co-operation and Development (OECD). Instead, if the International Maritime Organization thought it essential, ICS would accept a "simple fuel levy". (Grey, E. 2016).

2.1.1 Global trends in shipping

Figure 2-1: Carbon pricing scores, 2018



Source: Prepared by author using data from (OECD, 2021)

France stated its conviction in MBMs' ability to establish the proper economic environment for low- and zero-carbon fuels and technologies in 2018. This plan calls for a carbon fee that rises over time based on how much carbon a ship emits. In addition, Antigua and Barbuda published a proposal in 2018 advocating for monetary incentives, R&D investment, and legislation in order to reach the Initial Strategy's levels of ambition. They state that they would prefer a carbon tax or tariff on bunker fuel that is simple to administer and transparent. The Marshall and Solomon Islands were one of the first nations to make a significant proposal for a carbon shipping tax, recommending a fee of $100 per ton of carbon dioxide (CO2) beginning in early 2021. Other nations′ reactions to the proposal were unenthusiastic, and ever then, there have been several tax suggestions.

Japan suggested a financial incentive to decarbonize shipping in May 2022. The maritime industry would be required to pay $56 per ton of CO2 starting in 2025 under the proposed global carbon tax. The tax, if implemented, is expected to bring in more than $50 billion annually. According to the current proposal put forth by Japan, the tax would rise every five years, reaching a maximum of $637 per ton of CO2 by 2040, from $135 per ton in 2030. Given that each ton of bunker fuel creates around three tons of CO2, the idea also predicts that the carbon price on bunkers would be three times higher. This is especially exciting because, as the second-largest ship owner in the world, Japan′s suggestions will be taken seriously and used as a model by other countries.

The EU unveiled its "Fit for 55" package, which outlines a strategy to cut emissions throughout the bloc starting in 2023, in July 2021. A carbon tax on shipping emissions is one of the Fit for 55 plan′s recommendations. It′s essential to mention that the concept has come under fire for posing a risk of "carbon leakage." In fact, one issue with the EU′s plan to charge carbon emissions is that businesses may seek out shipping hubs outside the EU to cut costs. Therefore, it is possible for operators to dock their huge cargo ships outside of the EU before transferring their cargo onto smaller ships with lower carbon output and sailing into Europe. Japan′s proposal, in contrast, addresses all worldwide shipping emissions and is, thus, more onerous on the maritime sector as a whole. However, as all businesses will be treated equally and given the same opportunity to develop greener methods with the same amount of time to complete the transition, it may create a more level playing field. Tax subsidies for zero-emission ships will encourage those who have begun the switch early.

The question of whether zero-emission ships are practical in this short timeframe or whether it would be better to provide incentives for lower-emission ships during the transitional phase as technology is developed still needs to be answered. This is a crucial factor to take into account given the significance of the shipping sector to the supply chain at a time when the world is already experiencing significant disruption due to supply chain issues, rising living expenses, the ongoing effects of COVID-19, and the conflict between Russia and Ukraine.

2.1.2 Effects on Maritime linked Supply Chains

Companies inside and outside the shipping industry would face difficulties and opportunities as a result of a global maritime carbon tax. The majority of ships use heavy fuel oil, which produces a lot of pollution. When accessible, a GHG tax would force shippers to switch to more expensive low- and zero-carbon fuels, increasing gasoline costs for consumers. Even a slight increase in gasoline prices could be problematic for some shippers who are still working to recover from the COVID-19 outbreak. Companies would try to pass on the expense to their customers if fuel prices rose. Although this cost may occasionally be minimal and readily passed on to consumers, other times businesses may be forced to make tough decisions that need reorganizing their supply chains. Maersk has claimed that in order to fully transition to carbon-free fuel, it would have to increase costs for its own customers by 20% (Josephs, 2021).

An international maritime carbon tax might give some businesses a competitive edge. Even with a charge, many of the bigger shipping businesses would maintain or even increase their competitive edge because they have already made effective investments in lowering their GHG emissions. For instance, Maersk has been looking at alternative fuels including methanol and ammonia. The company also plans to run the world′s first carbon-neutral vessel by 2023 and has a fleet-wide carbon-neutral goal of 2050. Major charterer Cargill is said to have reduced its fleet′s gross carbon emissions by almost 1.5 million tons since 2017. The Maersk McKinney Moller Center for Zero Carbon Shipping is a research and development facility founded in 2020 with a goal on decarbonizing the industry. Members include Maersk, Cargill, AN Energy Solutions, Mitsubishi Heavy Industries, NYK Lines, and Siemens. Smaller and medium-sized businesses, on the other hand, would be at a relative disadvantage due to their lower capacity to invest in R&D related to decarbonization and build/retrofit with new technologies, as well as their restricted or no access to the bunkering facilities required to supply ships with alternative fuels.

The IMO′s decision-making process moves slowly, so any global levy that is approved would not go into effect right away. However, the shipping industry is under pressure to decarbonize from a variety of sources and is looking to the IMO for leadership. Customers and consumers are becoming more concerned with lowering product emissions throughout their life cycles, particularly those from transportation. Thanks to the EU, the IMO cannot continue to put off a comprehensive discussion of this matter without running the risk of severely disrupting the shipping industry with multiple, conflicting levies on carbon emissions. Although the IMO may not introduce an obligatory carbon fee anytime soon, it is in the works and would have an impact on all global supply chains.

2.2 Rationale behind the Carbon tax

One of the main justifications for carbon taxes is that, given the level of technology, it is the most effective tool for stimulating all possible behavioral responses for reducing international maritime emissions and striking the most cost-effective balance among them (UNCTAD, 2016). This signal encourages the following reactions as the carbon tax is passed on in the form of higher pricing for carbon-based fuels (IMF-WBG, 2011):

1) Enhancements to the technical design efficiency of new vessels, such as design changes to reduce their light weight, increase engine/propulsion efficiency, and integrate reduced carbon technology like batteries, biofuels, LNG, and hydrogen (in the long run).
2) optimization of average ship speeds, distances traveled, and port stays, as well as improved maintenance or refurbishment of existing ships′ engines, propellers, and hulls, can all increase operational efficiency (for a given cargo weight)
3) Other operator reactions include switching to larger (more efficient) ships (among various cargo categories) and boosting load factors.
4) changing customer demand away from heavy, long-distance products, whose costs rise in comparison to light, nearby products (such as high-value electronics), as well as

locally produced and unshipped goods and services (Parry et al., 2018).

The carbon tax offers the same compensation every ton of CO_2 decreased, regardless of how it is achieved, which encourages equalization of the cost of the last ton lowered among mitigation options, resulting in cost-effectiveness. And in a changing environment, enacting a strong and predictable carbon tax is probably the single most crucial tool for encouraging investment in emissions-reducing technologies.

Carbon taxes can also generate substantial sums of money. If taxes were only collected domestically, it would make sense that the money would go to national budgets, but if taxes were collected internationally, the money might be better used for climate finance because national governments have less of a claim on the tax base (which is combusted in international waters). In reality, given that many developing nations' (more ambitious) mitigation obligations are dependent on getting outside funding, it could be particularly appropriate to establish a new revenue stream for the Green Climate Fund (GCF) (Parry et al., 2018).

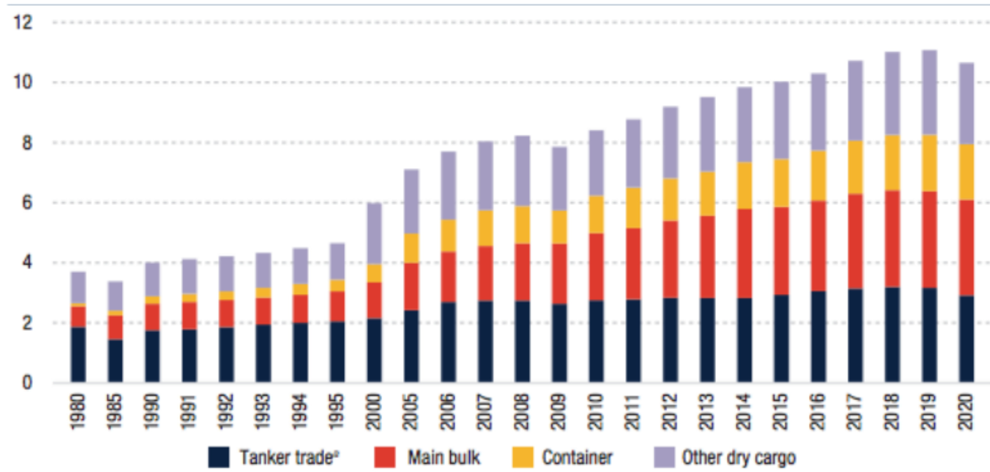
2.3 Categorization the maritime industry into three sectors

It is challenging to estimate the value of global seaborne trade in monetary terms since trade estimates are typically expressed in terms of tons or ton-miles, which make them incomparable to statistics measuring the size of the global economy. However, according to the United Nations Conference on Trade and Development (UNCTAD), the operation of commercial ships generates roughly 380 billion US dollars in freight rates for the worldwide economy, or about 5% of all trade. (ICS, 2017)

Estimates of the volume of shipping trade (or "transportation work," as it is sometimes called) are frequently calculated in ton-miles. A general pattern of growth in the volume of global trade has been observed in the maritime industry throughout the past century. The expansion of free trade and the demand for consumer goods have been fueled by rising industrialization and the liberalization of national economies. Technology advancements have also increased the effectiveness and speed of shipping as a mode of transportation.

Estimates of global seaborne trade during the past 40 years have quadrupled, rising from just over 8 trillion ton-miles in 1968 to over 32 trillion ton-miles in 2008.

Figure 2-2: International maritime trade by cargo type (in million tons)



Source: UNCTAD *Review of Maritime Transport*, various issues. For 2006–2020, the breakdown by cargo type is based on Clarksons Research, *Shipping Review and Outlook*, Spring 2021 and *Seaborne Trade Monitor*, various issues.

Note: Given methodological differences, containerized trade data in tons sourced from Clarksons Research are not comparable with data in TEUs featured in tables 1.8 and 1.9 and figures 1.8 and 1.9 of this report and which are sourced from MDS Transmodal.

[a] Tanker trade includes crude oil, refined petroleum products, gas, and chemicals.

Source: UNCTAD, Review of Maritime Transport

The entire volume of crude oil traded was 1716 million tonnes, and the volume of other tanker trade was around 1202 million tonnes, according to the publication Review of maritime transport (2021) (UNCTAD RMT (2022)). The total volume of dry bulk trade for 2019–2020 was 5167 million tons, of which the main bulks—coal, grain, and iron ore—took up around 62% (or 3181 million tons), while the minor bulks—steel and forest products—took up the remaining 38%. (amounting to 1986 million tons). Data on container - based trade for 2021 was available, and it showed a roughly 7% increase from the figures for 2020 to 160 million TEU.

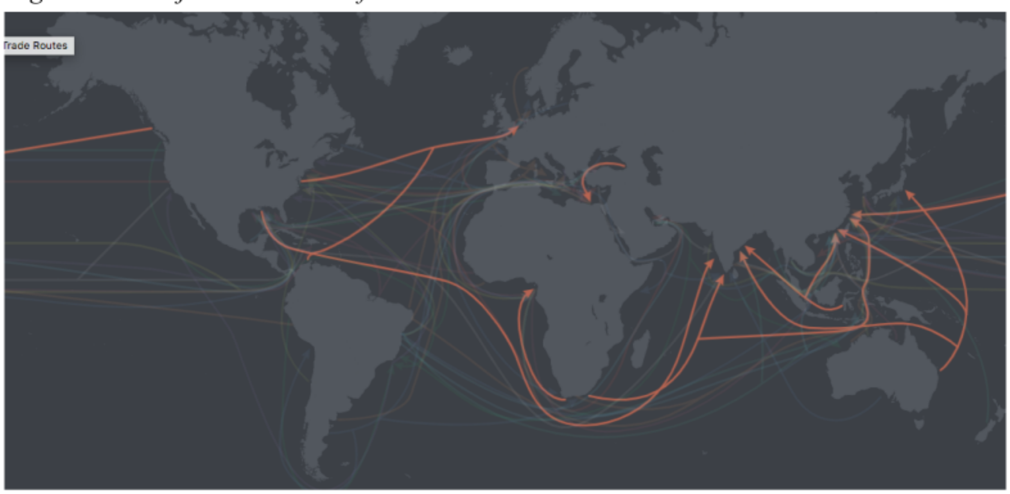
The data makes it clear that, with the exception of a few specialized vessels, the segmentation of maritime trade into the three categories of dry bulk, wet bulk, and container - based cargo will encompass substantially all of it. This has no bearing on the amount of cargo that is traded, and it has even less bearing on the value of the cargo (which is the important input for our econometric modelling).

2.3.1 Dry bulk trade

It represents around 54% of all seaborne trade, or more than 5 billion tons or 70,000 voyages annually. The three "Major Bulk" commodities account for 60% of dry bulk trading.

Coal (24%): Coking coal is used primarily in the making of steel (20%) and as thermal coal for the production of electricity (80%). 37% of the world's electricity is produced by coal-fired power plants. Major trade routes are as shown below:

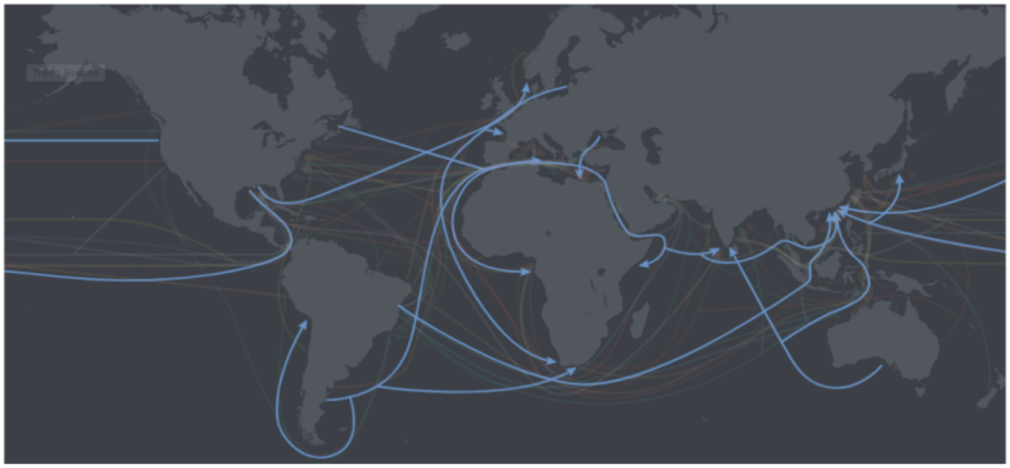
Figure 2-3: Major trade routes for Coal



Source: (Eagle Bulk Shipping, 2021)

Grain (9%): 30% of soybeans and 70% of other cereals. Used as both animal feed and food for humans. Due to seasonality and erratic crop yields from year to year, trade patterns vary greatly. Major trade routes are as shown below:

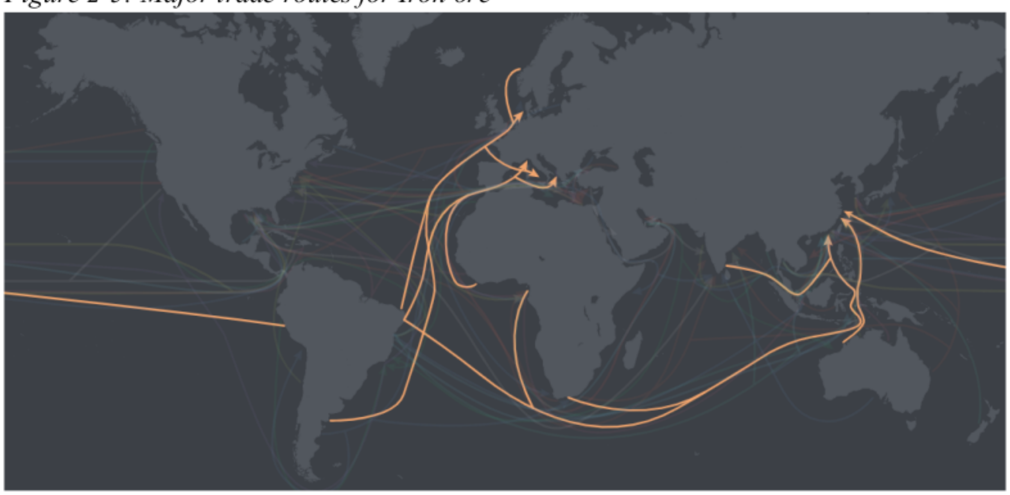
Figure 2-4: Major trade routes of Grain



Source: (Eagle Bulk Shipping, 2021)

Iron ore (27%): any of a number of rock types with a high iron concentration (often 50% or higher). Used in the manufacture of steel. Brazil and Australia together export around 60% of the world's iron ore. Major trade routes are as shown below:

Figure 2-5: Major trade routes for Iron ore



Source: (Eagle Bulk Shipping, 2021)

2.3.2 Wet bulk trade

Crude oil and product oil are the two primary commodities in wet bulk commerce. The global petrochemical and related sectors rely heavily on the trade of crude oil. Around the world, large amounts of crude oil are transported from oil-producing regions to developed and growing economies with significant fossil fuel consumption. Bulk oil traffic has historically been linked to routes from the Middle East to other locations across the world. However, greater trade flows from the Atlantic basin to east Asian markets have been observed due to growing US exports and refining capacity as well as geopolitical considerations like the oil export embargo against Iran. China continues to be the world's top importer of crude oil, primarily from Saudi Arabia, Iran, Oman, Russia, and Venezuela.

Maritime transportation, which follows extremely particular routes and is restricted by strategically placed passes known as chokepoints, is used to deliver the majority of the oil (62%). Oil from the *Persian Gulf* is a key supply that is transported by sea, with routes through *the Strait of Malacca, the Suez Canal, China, Japan, and South Korea*, as well as *the Cape of Good Hope*, connecting it to *Europe, Asia, and North America*. Through the *Oresund Strait, Russian oil* is mostly exported to *European markets*. Since there are few major producers, there is little oil trade over the *Pacific*. While *Indonesia* no longer exports much oil, *Mexico* still sends the majority of its oil to the *US*. Petroleum from *Russia* and *the former Soviet Union* that is *pipelined* to *Europe* as well as petroleum from *Alaska* and *Canada* that is *pipelined* to the *United States* represent significant continental migrations. Additional significant oil exports come from *South America* to *North America*, the *North Sea to Europe*, and *Africa to North America* (Notteboom, Pallis and Rodrigue, 2020).

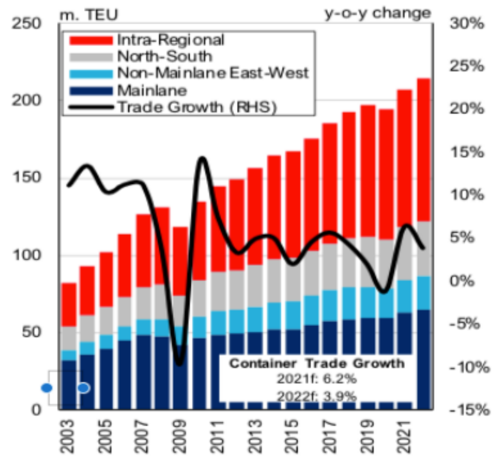
Figure 2-6: Oil Transportation and Major Chokepoints

Source: Notteboom, Pallis and Rodrigue, 2020

2.3.3 Container trade

The container and the roro vessel, two significant developments from the 1960s that modernized the way we transport goods, transformed the world. Prior to the container, goods were either shipped loose or in haphazard bundles and packaging. Waste and damage were significant, and crates, bags, and barrels had to be manually removed off the ship. These liner ships transport all of our necessities, including food, medicine, computers, cars, and heavy equipment. Together, they move more than US$ 4 trillion worth of commodities annually, or nearly 60% of the value of all seaborne trade (World Shipping Council, 2021). The trade corridors with the biggest volume and value are Trans-Pacific, Trans-Atlantic, and EU-Far East. This rise has been fuelled by rising US and Chinese imports as well as the EU economy recovering from the Eurozone crisis.

Figure 2-7: Seaborne container trade



Source: Clarksons research, Shipping review & outlook (September, 2021)

Figure 2-8: Major container ship trade routes

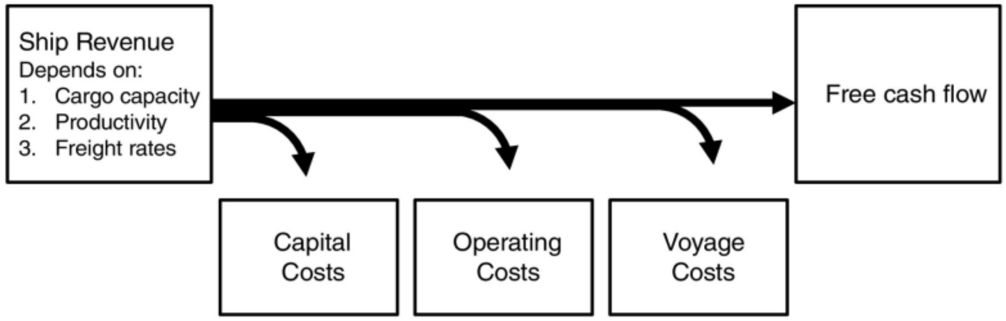
Source: (GPF Team, 2016)

2.4 Types of costs impacted by carbon tax and by how much?

We will start by applying Stopford's shipping cash-flow model (Stopford, 2009). It explains how ship's earnings after expenses are deducted produce free cash flow, which is then utilized to pay taxes, dividends, and make profit for the ship's owner.

Below is the pictorial representation of simplified Stopford's shipping cash-flow model.

Figure 2-9: Shipping cash flow model



Source: (Stopford, 2009)

Ship running costs, which have to do with the ownership and operation of the vessel, are what the carrier uses to calculate the percentage of the freight rate that is demanded to move goods between two places. Fixed or varying factors impact how much it costs to operate a ship. (Stopford, 2009) identifies five main cost categories in the absence of a globally recognized standard cost classification for the shipping industry:

1. *Operating costs* - on-going charges for maintaining and repairing the ship as well as costs for the crew, supplies, and other consumables. excluding fuel expenses.

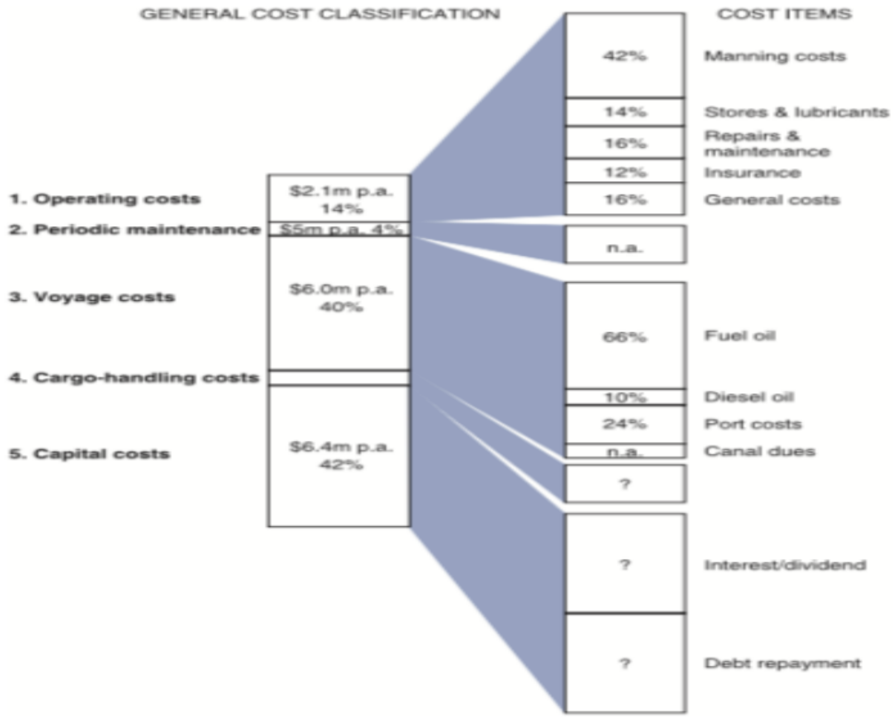
2. *Periodic maintenance costs* - incurred while the ship is docked for significant repairs.

3. *Voyage costs* are expenses related to making a certain voyage, such as fuel or diesel, port fees, and canal dues (if applicable).

4. *Cargo-handling costs*: the price of loading, stowing, and unloading cargo.

5. *Capital costs* - these expenses are determined by how the ship is financed and may include interest, dividends, and the gradual repayment of loans.

Figure 2-10: Analysis of major costs of running a bulk carrier



Source: (Stopford, 2009)

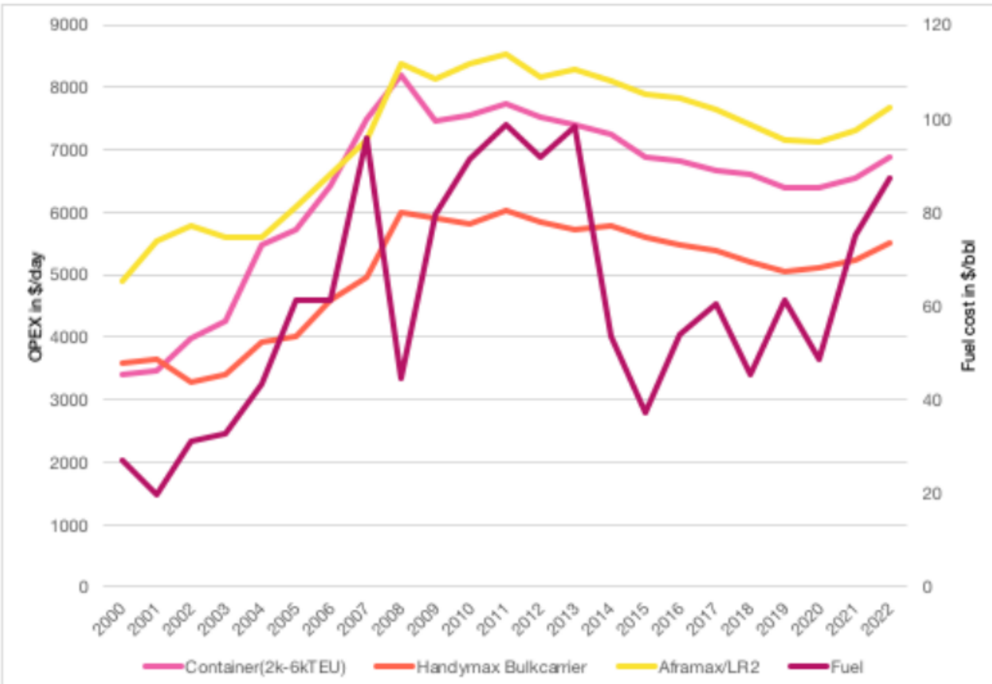
The main ideas we shall discuss are summarized in Figure 1 above. Each box in the diagram includes the percentage cost for a ship that is ten years old, along with a summary of the major cost categories, factors that affect its value, and other information. In the remaining portions of this part, we will look at how the four major cost groups—operating costs (14 percent), routine maintenance (4 percent), voyage costs (40 percent), and capital costs (42 percent)—are combined to determine the ship′s overall financial performance. The trends in fuel, capital, and other expenses illustrated in Figure 2 below demonstrate how these costs, which are combined to determine the cost of sea transport, are exceedingly volatile.

A careful examination of a ship′s operating expenses reveals that a global carbon tax imposed by the IMO will have a direct impact on voyage costs. The following equation can be used to explain voyage costs:

$VCtm = FCtm + PDtm + TPtm + CDtm$ ***Equation 2-1***

where VC is voyage costs, FC is the fuel costs for main engines and auxiliaries, PD port and light dues, TP tugs and pilotage, and CD is canal dues.

Figure 2-11: Inflation in operating costs for three segments 2000-2022



Source: Prepared by author based on data from (Clarksons Research, 2022)

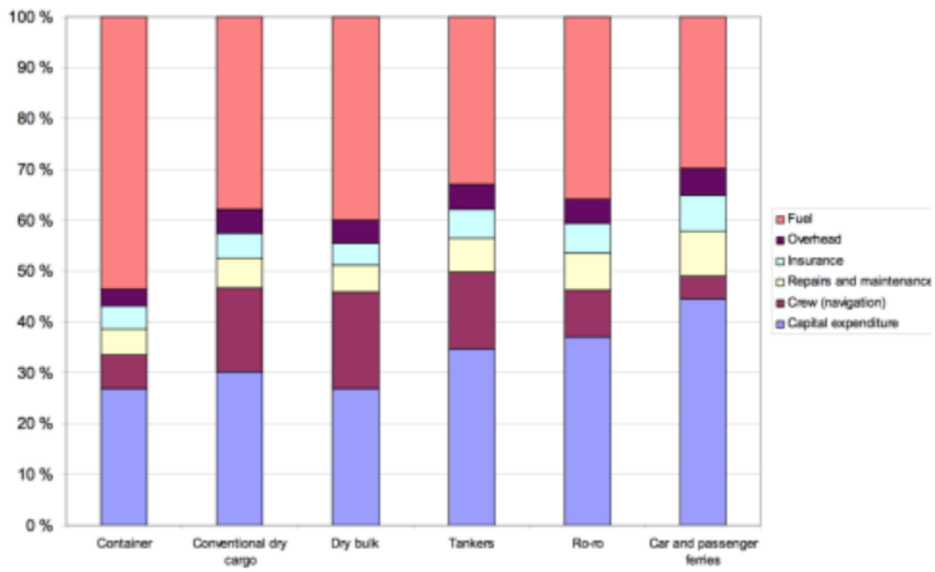
The below figure, which was provided by Stopford, shows that a significant portion of voyage costs goes toward paying for fuel. The increased global carbon tax will result in higher taxes on ships that burn fossil fuels, increasing overall fuel costs as well as overall voyage costs.

According to the cost breakdown below, which is based on a report by Kalli, J., Karvonen, T., & Makkonen, T. (2009), fuel costs range from 30% (for car and passenger ferries) to 53%. (for containers) of total costs. When a carbon tax is implemented, as Japan has suggested, the price on bunker fuel would be roughly three times higher per ton because each ton of bunker fuel creates around three ton of CO2 (Executive, 2022). This requires a threefold increase in fuel prices, which equates to 90 percent of the entire costs incurred previously (for vehicle and passenger ferries) and 159 percent of the total expenditures incurred previously (for containers). This may result in an increase in the percentage of fuel expenses in overall operating costs to

(3*30%) / (1+60%) = 56.3% of new total cost (For car and passenger ferries)

(3*53%) / (1+106%) = 77.2% of new total cost (For containers)

Figure 2-12: Running costs of ship



Source: Kalli, J., Karvonen, T., & Makkonen, T. (2009)

The statistics for other carriers will fall somewhere between the extremes mentioned above.

Chapter 3 Model description and research methodology

3.1 Choice of model and model description

Because of its interaction and spillovers with other regulatory policies and sectors as well as its macroeconomic consequences in the short and long term, it is challenging to assess any disturbances or shocks brought in the global trade in their whole. It is crucial to do a thorough empirical study using trade values, consumption and production data, and elasticities of the commodities involved because the global carbon tax is supposed to constitute a significant shock to the shipping industry. Gravity models, partial equilibrium models, and computable general equilibrium models are three models that are frequently employed in the business for this similar goal. (Chemingui, 2018)

Since they are factually founded on Newtonian gravity principles, gravity models are basically named that. According to gravity theories, trade between two nations is directly related to each nation′s GDP and inversely proportionate to their distance from one another (similar to the Newton′s gravitational law). The negative effects of distance have historically included rising freight costs as well as escalating linguistic and cultural barriers between distant places. Any change in trade policy, however, only has an impact until there has been significant trade penetration and integration. This can be done by utilizing simulation models of computable general or partial equilibrium.

Computable General Equilibrium (GE) and Partial Equilibrium (PE) models can be used to simulate the economic and trade effects of any shocks to the trade. The CGE model is based on the Ex-ante technique, which entails evaluating the impact of a new policy in the future through computer simulations while accounting for the interactions between the service, capital, labor, and other sectors (Chemingui, 2018). It is created by considering how supply and demand interact in various markets as modeled by (Marie-Esprit Léon Walras, 1984). These models are especially helpful when major, important policy choices entail cross-sectoral interactions. Although CGE models do offer a thorough overview of the economic and trade effects of different policy decisions, these models have a tendency to be extremely complex and are typically applied at a national or worldwide level. In a partial equilibrium analysis, just the markets that are directly impacted by a policy move are looked at. Curves of supply and demand are used to show how policies affect prices. Utilizing producer and consumer surplus, one can gauge how well market participants are doing. A partial equilibrium study either overlooks the effects on other economic sectors or assumes that the relevant industry is extremely small and has little to no influence on other economic sectors. Below is a general overview of both the models

Table 3-1: General overview of both models

	Partial Equilibrium	**General Equilibrium**
Capturing economy wide linkages	*NO*	*YES*
Consistency with budget constraints	*NO*	*YES*
Capturing disaggregated effects	*YES*	*NO*
Capturing complicated policy mechanisms	*YES*	*NO*
Use of timely data	*YES*	*NO*
Capturing short and med. term effects	*YES*	*NO*
Capturing long term effects	*NO*	*YES*

Source: Prepared by author based on comparison from (Bacchetta et al., 2007)

Despite being extremely thorough and practical for projecting long-term effects on all sectors of the economy, the CGE model,use of the PE model is advantageous for a variety of reasons given that this research is focused on the effects of a global carbon tax by IMO on the primary three shipping segments. First, it is challenging to get precise trade information because the shipping industry database is still largely hypothetical. Additionally, the effects of shipping on other industries, like labor and capital, are very subtle and long-lasting, necessitating substantial study and extensive quantitative exercise. Due to the wide variety of cargoes, the elasticity of the commodities supporting the primary three shipping segments is also poorly studied in the literature and challenging to assess.

3.2 The Econometric model (GSIM)

Francois and Hall created GSIM as an expansion and enhancement of SMART (2003). It shares the same understanding that a reasonably straightforward yet adaptable PE framework was required for a thorough analysis of trade policy. One oversimplifying premise of SMART was that global markets are neglected and everything is considered in terms of bilateral partnerships. Therefore, the main distinction between the two tools is that in SMART, only import markets are subject to the market clearing rules, whereas in GSIM, the entire global market is cleared. In the most straightforward scenario, we examine a change in trade policy between two nations, such as a reduction in tariffs, and we also analyze how it will affect the rest of the globe. Global markets increase the model′s complexity and need more computing power, both of which are currently readily available. Following the formulation of Jammes and Olarreaga (2005), the theoretical model on which GSIM is built up can be summarized as follows.

3.2.1 The Setup

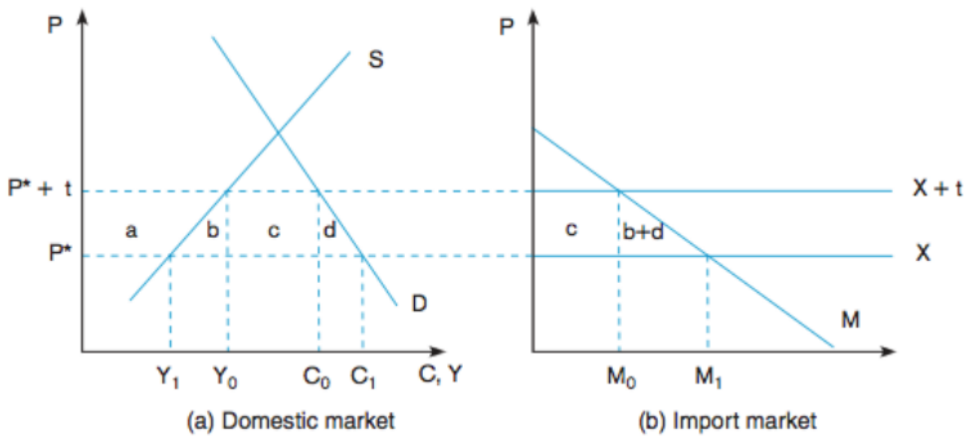
"Below *extract is from UNCTAD publication (Bacchetta et al., 2007) written in own words by the author". In addition, a detailed description of GSIM model with relevant equations as per (Francois and H Keith Hall, 2002) can be found in the appendix.*

If we want to assess ex ante how a change in trade policy will affect prices, trade flows, tariff revenues, and welfare. We begin with a visual representation of the most basic scenario, which is the impact of a small country with set global pricing, P*, eliminating a tariff (see Figure below). *(Bacchetta et al., 2007)*

Domestic supply is Y_0, domestic demand is C_0, and imports are M_0 at world price $P^* + t$. The removal of the tariff t lowers the domestic price by the full amount t, increasing domestic demand to C_1 and domestic supply to Y_1, as a result. M_0 to M_1 imports grow.
Because the domestic price has changed, consumers can now afford to buy more items, which results in a rise in consumer surplus (a+b+c+d) (i.e. $C_1 - C_0$). The removal of tariffs results in a loss of producer surplus (a) and a reduction in tax income from tariffs (c). The triangle beneath the import demand curve, or the region (b + d), represents the net gain of

eliminating tariffs. The deadweight loss is influenced by the tariff's square in the same way that the triangle's height and base are determined by the tariff. *(Bacchetta et al., 2007)* Overall, we see that when an import tax is removed for a small country, the domestic price is reduced by the whole amount of the duty (t). Additionally, it raises imports and decreases revenue from tariffs. The net gain from eliminating a tariff, however, always depends on the square of tariff.

Figure 3-1: Tariff reduction in small country case

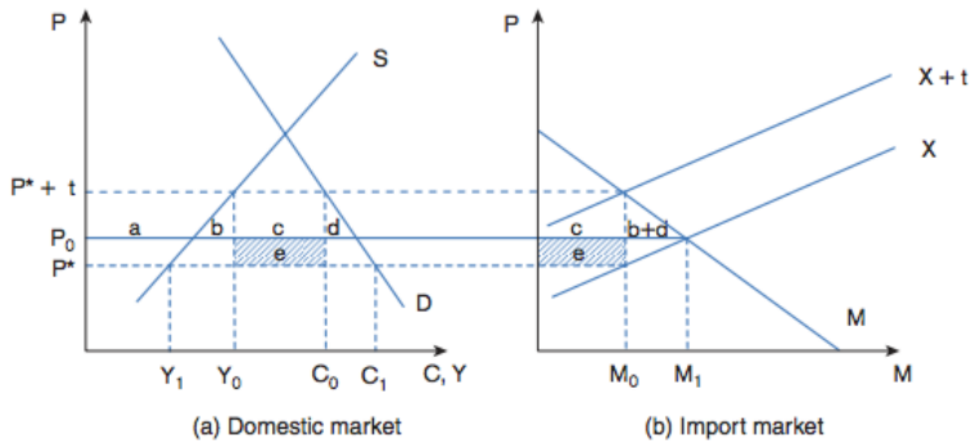


Source: (Bacchetta et al., 2007)

We suppose that, in the case of a big country, the foreign supply curve X slopes upward, as shown in panel (d) of Figure below. The pricing equilibrium with the tariff is at $P_0 + t$. When the tariff is removed, the export supply transfers to X, creating a new domestic price P_0. Because of the upward slope of the supply curve, the domestic price decline is not equal to the whole tariff t. As a result, the foreign price (P) in the existence of the tariff is less than the free trade price (P_0), resulting in a terms of trade benefit (e) for the importing country. Recall that the price of a country's exports divided by the price of its imports typically defines the terms of trade. *(Bacchetta et al., 2007)*

Eliminating a tariff (or NTM) results in lower domestic pricing, more imports, and less domestic supply, just as in the case of a tiny country. All three effects, however, are mitigated by the assumption that the foreign supply curve is upward sloping. Given that there have been improvements in terms of trade, the welfare change now appears to be slightly different. The region e multiplies the price decline by the new import demand, M_1, to calculate the terms of trade losses. The net gain triangle still depends on the tariff square, t^2, and corresponds to (b + d). Therefore, for suitably small tariffs and for big tariffs, the net welfare impact, shown by the symbol e - (b + d), is positive. *(Bacchetta et al., 2007)*

Figure 3-2: Tariff reduction in large country case



Source: (Bacchetta et al., 2007)

3.2.2 The Harberger triangle

Now let's look at a theoretical examination of how the removal of a tariff would affect trade flows, tariff income, and welfare. Think of a situation where the representative person in the economy has quasi-linear (QL) preferences for two different goods: good zero, the numéraire, and good one (without a subscript), the import-competing product. Thus, the utility of the customer is:

$$U = C0 + u(C) \qquad \textbf{Equation 3-1}$$

where u (.) is a rising, concave sub-utility function and C_0 and C are the quantities of numéraire and good that have been ued, respectively. The following are two advantages of QL preferences:

- "The indirect utility function is the sum of income I and consumer surplus *u (C) – PC*, where *P = P*. (1+t)* is the domestic price with t being the tariff rate (it can be shown that the consumer derives no consumer surplus from good zero)." (Bacchetta et al., 2007)
- Since the marginal utility of income is always 1, $u' = P$ when the consumer is acting optimally. *(Bacchetta et al., 2007)*

Profits π and tariff revenue *tM* are added together to create income. So, after accounting for the representative person′s ideal decisions, welfare as a function of the tariff is

$$\boldsymbol{W(t) = I + u(C) - PC} = \pi + tM + u(C) + PC \qquad \textbf{\textit{Equation 3-2}}$$

and the derivative of this expression with respect to the tariff is

$$\begin{aligned} W' &= u'C' - (C + PC') + \pi' + M + tM' \qquad \textbf{\textit{Equation 3-3}} \\ &= (u' - P)C' - C + Y + M + tM' \\ &= Y + M - C + tM' \\ &= \boldsymbol{tM'} \end{aligned}$$

Hotelling′s lemma, which states that the profit function′s price derivative is output (i.e., $\pi = Y$), was used to move from line one to two of (*Equation 3.3*), and the second property of QL preferences was used to move from line two to line three (namely that the marginal utility of income is one). Finally, while you read from the third to the last paragraph, keep in mind that, by definition, consumption (C) for the commodity that competes with imports equals the total of domestic output (Y) and imports (M). *(Bacchetta et al., 2007)*

Now let us take a second-order Taylor approximation of (*Equation 3.3*) around t = 0:

$$W(t) \cong W(0) + tW'(t) + ½\, t2\, W''(t) \qquad \textbf{\textit{Equation 3-4}}$$

so, noting that at $t = 0$ $W''(t) = 0$ and that $W''(t) = M'$ (this can be directly derived from simply noting that $W'' = M' + tM'' = M'$ if $t = O$),

$$\Delta W \equiv W(t) - W(0) \cong ½ t2 M''$$ ***Equation 3-5***

The welfare change is $t\Delta M/2$, or the area of a right-angle triangle whose height and base are respectively the tariff and import changes—the well-known "Harberger triangle"—because $tM' = dM$ (that is, the change in imports from a position of zero tariff is the tariff times the price derivative of import demand). *(Bacchetta et al., 2007)*

It is helpful to translate expression (*Equation 3.5*) in terms of the elasticity of import demand because functional forms in simulation models are frequently of the constant-elasticity type. To do this, express *M'* as *dM/dP*, where *P* is the domestic price (p* is the world price), and before $P = P^* (1+t)$ was the domestic price. then write:

$$M' = \frac{M}{P}\left(\frac{P}{M}\frac{dM}{dP}\right) = \frac{M}{P}\varepsilon$$ ***Equation 3-6***

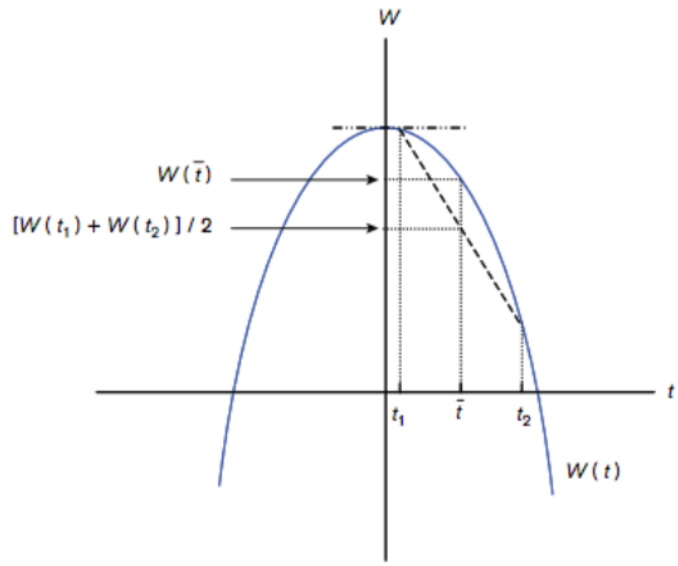
where the price elasticity of import demand ε is in algebraic form (i.e. negative); so, finally,

$$\Delta W = \frac{1}{2}\frac{M}{P}\ \varepsilon t \leq 0$$ ***Equation 3-7***

According to this formula, the net welfare gain ΔW brought about by the removal of a tariff t is solely dependent on the demand's own-price elasticity and the tariff itself. Where did we err in making the necessary assumption to eliminate cross-price elasticities? Going back to the utility function, it stands to reason that there could only be one cross-price elasticity if there were only two items. Because the utility function is highly (i.e. additively) separable, even that option has been ruled out.

We could easily generalize it to $X_0 + u(X_1) + ... + u(X_n)$; as long as it remains additive, no cross-price elasticity will appear in (*Equation 3.7*). But we need to remember that this is only an assumption on preferences and not a feature of the data. *(Bacchetta et al., 2007)*

Figure 3-3: How tariff elimination increases welfare



Source: (Bacchetta et al., 2007)

Tariff variation alone lowers welfare since it decreases with the square of the tariff in equation (*Equation 3.7*) for many items. Consider a two-good economy with the following policy alternatives to show why:

- a low tariff t_1 on good one and a high tariff t_2 on good two
- a uniform tariff $t = (t_1 + t_2)/2$ on both.

Average welfare generated in the two markets is shown in Figure as a parabolic function of tariffs, with a maximum at $t_1 = t_2 = 0$.

Welfare is $W(t)$ under a uniform tariff; under two differential tariffs, it is the average of $W(t_1)$ and $W(t_2)$. Because the arc is above the chord, it is clear that the former is higher than the latter; this is a straightforward application of the mathematical idea known as Jensen's inequality. *(Bacchetta et al., 2007)*

3.2.3 Product differentiation

Most simulation models make use of the "Armington assumption," which states that different types of goods are distinguished by their place of origin (Armington, 1969). According to evidence cited by Schott (2004), the price of commodities imported into the US is connected with the amount of income in the exporting nation at a highly disaggregated level. This shows that wealthy nations export higher-quality or more advanced types than do developing nations. When types are imported from nations with comparable wealth levels, the Armington assumption's justification becomes less obvious. The presumption of uniformity among national variants should be avoided for a more technical reason.

The first issue has to do with specialty and price. In a Heckscher-Ohlin model with an equal number of factors and goods, all nations are fully diversified, all products' outputs are determined by full employment (one per factor of production), and factor prices are set by zero profit conditions (one per good). In this scenario, as anticipated by the Stolper-Samuelson theorem, a tariff shift will result in factor-price changes.

Things are less smooth when there are more commodities than factors, which is the common scenario in simulation exercises. Two scenarios can then occur:

- In general, the sectoral output levels of our interest country are indeterminate if the vector of good prices is such that the country is fully diversified because there are insufficient instances of full employment to decide all output levels.
- Each nation produces the same number of items as its factors, placing them in separate "diversity cones" if the price vector diverges from the specific value that ensures diversification. *(Bacchetta et al., 2007)*

As a result, the quantity of goods produced is now determined by good prices rather than only factor prices. This makes analysis more challenging. There are numerous remedies available. Assuming domestic varieties are not exact equivalents of one another is the alternate and typical solution to our issue; this is known as the Armington assumption. The concept of a product has now been split into two categories: "goods," like bananas, and "varieties," such bananas from Cameroon, Costa Rica, or St. Lucia. The Armington premise, however, adds a fresh challenge. Imagine that we give all of our demand functions constant-elasticity forms, leaving us with nothing but elasticities to worry about. We must keep in mind, though, that the benefit of PE is to "go disaggregate," so if we import items from, say, 50 different nations and 5,000 different goods (at the HS-6 level). We may have 250,000 own- and cross-price elasticities to estimate with one distinct variant per nation. Of course, this is far too many. Kee et al. (2006) provided own-price elasticity values at the HS-6 level, but cross-price estimates have not yet been discovered, and even if they had, it would be difficult to evaluate a model with 250,000 elasticities.

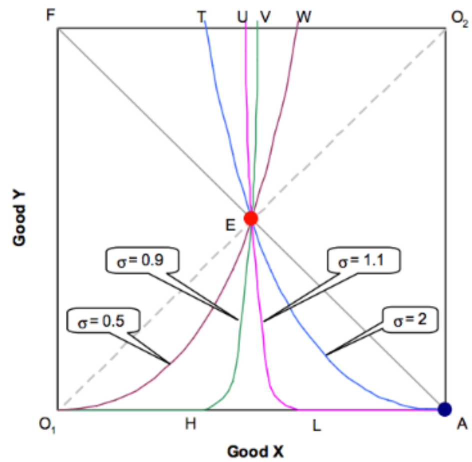
3.2.4 Constant Elasticity of Substitution (CES)

Therefore, based on the discussion in section 3.2.3, a further decomplicating component—referred to as "two-stage budgeting"—must be included. In simulation exercises, individual utility function forms are typically assumed to ensure strong separability between goods. As a result, cross-price elasticities between goods (as opposed to national varieties) are all equal to zero, and CES (constant elasticity of substitution) is assumed to be constant for national varieties.

All of these presumptions may be adjusted in accordance with the modeler's requirements, although doing so will add complexity. On the supply side, a similar premise is frequently made, according to which export markets are only insufficient alternatives to one another. A CET (constant elasticity of transformation) function is the equivalent of the CES function, and changes in producer pricing result in smooth substitution across export markets rather than total withdrawal.

As per a research by (Commission, 2006) and as illustrated in the figure below Four home country offer curves with σ (CES) set at *2, 1.1, 0.9, and 0.5*. The offer curves only take on the typical shape seen in a traditional trade model when the elasticity setting is considerably above unity; they achieve this by passing through both the point E (equilibrium consumption) and the point A (endowment point).

Figure 3-4: Home offer curves with different substitution elasticities in an Armington model



Source: (Commission, 2006)

3.3 Setting up the econometric model

We'll use a partial equilibrium (PE) econometric model, which accounts for trade values between nations and regions as well as the elasticity of these trade values (as discussed in section 3.2). We must take into account all nations in the world in addition to the top trading nations mentioned above because it can only be employed when all global trade is taken into account. To better reflect all geographical regions, the other countries will be put together in regions due to the diverse nature of the three shipping categories and the economic diversity and objectives between the regions.

3.3.1 Country selection

We will choose the countries to utilize in our econometric model based on the description of the three main categories of international maritime trade as well as the primary routes linked with those segments. In order to match our model, this choice will also take into account the remainder of the world's regions and the major shipping hubs/ports associated with each sector.

1. **Australia/ New Zealand**: A sizable portion of Oceania is represented by this region. Bituminous coal and (non-agglomerated) iron ores and concentrates (not agglomerated) are the main products traded from. Petroleum oils (product) and crude

oil are the two main imports into this region. China is its main export and import partner, followed by Japan and the United States. Although Australia and New Zealand also engage in significant intra-regional trade. In actuality, Australia is New Zealand's second-largest exporter and importer.

2. **Brazil**: Brazil has the largest economy in South America and is a major exporter of cereals like soybeans as well as iron ore to the global market. Additionally, it is a significant commerce hub for the South American region and one of the world economy's fastest-emerging markets. Brazil used to be a major exporter of goods, including crude oil, to North America and other South American nations, but as domestic consumption has increased recently, it has turned into a net importer. It is a wise choice to represent South America because it is the biggest nation with a growing economy.
3. **China**: We have selected China as one of the nations for our model because it has the second-largest economy in the world and is one of the greatest maritime nations. This country will be significantly impacted by the IMO's introduction of a global carbon price in shipping due to its sizable fleet of ships and substantial reliance on maritime trade. China is a major exporter of manufactured goods such monolithic integrated circuits and transmission apparatus. Additionally, it is a significant importer of big bulk goods and crude oil. As a result, it is crucial to all three of the shipping-related businesses.
4. **Indonesia**: Indonesia is a significant exporter of low-grade coal, mostly to satisfy the substantial regional demand from China and India. It is a developing nation in Southeast Asia with a special geographic setting that gives it easy access to major commerce routes that run via the Malacca Straits and the ability to serve as a transit place for liners. The country now has a high demand for both dry and wet bulk commodities due to rising population and per capita energy consumption.
5. **Japan**: It is the next largest economy to China in the Asia region. It is also the home to one of biggest liner shipping companies. Its major trading partners are China and the United States. Its major imports are crude oil and the major exports includes finished products like automobiles and monolithic integrated circuits.
6. **Least developed countries (LDC)/ Small island developing states (SIDS)**: We have

considered this group based on the study of (IMO, 2018) where it was stated that "*extra climate mitigation policy measures in shipping could have a negative impact on their economies*". To bolster this claim, it would be sage to research how these countries in these regions might be affected.

7. **EU-27**: Since the EU permits free market access among its member states, it will be taken into consideration as a whole. The EU's developed economies import the majority of their raw commodities, including crude oil, coal, and iron ore. The block exports finished goods and industrial products in large quantities. Given its extensive nautical history, the EU is home to numerous important ports, particularly in Western Europe's Le Havre–Hamburg region, which also serves as the entryway to the hinterland market. Along with being one of the major ship-owning nations in the world, it is also important since it has the second-largest economy after the US. The EU is a leader in both the implementation of market-based policies like ETS, CBAM, and carbon taxation.
8. **Middle eastern nations**: Large oil and natural gas deposits are found in the Middle East, and the region's economies are reliant on these resources. Over the past few decades, it has been a significant provider of products and crude oil to the rest of the world. Although Middle Eastern nations have recently worked to diversify their economies to lessen their reliance on oil, this fossil fuel nevertheless remains the most important export good and the region's primary source of income. Geographical distances to demand centers in China will be crucial in determining if any rises in freight charges will result in a change in supply and trade routes, especially with the development of the US and other nations as prospective competitors in the global market for petroleum.
9. **Nigeria**: Nigeria is a significant developing African economy and a big producer of petroleum products. Given its potential and changing demography, it will undoubtedly have a significant effect on the economic growth of the area and of Africa as a whole. In order to better comprehend the effects of trade and the economy on the region, it was decided to portray a significant African economy.
10. **Russian Federation**: Russia is the leading non-OPEC producer of crude oil, supplying numerous EU nations primarily through pipelines. However, given its proved reserves, it is currently the 2nd largest producer of natural gas and hopes to overtake it when the

Arctic sea route becomes more frequently ice-free throughout the year. Although Western Europe, a major hub for bunker supplies and an exporter of refined goods, has seen its economy grow increasingly dependent on petroleum products in recent years, it also provides the majority of the crude oil needs for those countries' refineries. Even though it is currently a small player in maritime trade, the potential and relevance it has in terms of fossil fuels makes it a worthwhile nation to research.

11. **United Kingdom**: In our research, the UK was taken into account as a different country. This is mostly due to the fact that its economy is distinct from the EU and significant enough to be taken into account in our econometric modelling. Its main imports are fuel from non-EU countries, mostly driven by rising gas imports, while its main exports are crude oil (to EU states) and also manufactured goods (e.g. Aircraft parts).
12. **United States**: The US is the largest economy in the world and is the top exporter and importer of important dry and wet bulk commodities. It is also growing as a significant provider of petroleum products in international trade. The largest exporter of agricultural goods, including grain and soybeans, to Asia and South America is the US Gulf Coast. Instability in the maritime sector has already been brought on by recent trade policies of the US administration, including higher taxes on some raw material items (such as aluminium and steel) and tariffs on Chinese imports, in expectation of retaliation actions by other countries.
13. **Rest of Africa**: We have included all the maritime nations of African continent except Nigeria in this group.
14. **Rest of Asia**: It is challenging to fully comprehend Asia as a whole due to its size, diverse economies, and uneven levels of economic progress. This region will comprise major maritime nations of this region other than the ones already included as separate countries.
15. **Rest of Europe**: This includes all the European maritime nations excluding the UK and EU-27.
16. **Rest of North America**: Aside from the weaker economies of Central America, the rest of North America will consist of Canada and Mexico
17. **Rest of South America**: This region consists of all the maritime nations of Latin

America except Brazil

With the above selection of countries and regions we have tried to completely encompass the effect of disruption brought by the global maritime carbon tax. We have also posted the snippets from WITS database in **Annex 2** where the groups as mentioned in this section were created to use the advanced query module available on their website.

3.4 Trade value calculation for three shipping segments

The World Bank publishes data on imports, exports, and tariffs in the WITS database. First, we took the total bilateral trade values for the countries/regions listed above from the WITS database. This was done using the advanced query module available on the WITS website[1]. In order to focus solely on marine trade, we calculated the proportion of maritime transit for each bilateral trade pair, excluding transport via pipeline, pipeline, road, and air. Finally, we divided marine trade flows into the three major shipping segments—wet bulk, dry bulk, and container trade—in terms of value.

3.4.1 Bilateral trade value from WITS

We were able to determine the bilateral trade values for the nations/regions indicated in section 3.4.1 from WITS. Then, using these values, the bilateral trade flow matrix (18x18) was created. All trade values were calculated c.i.f. Where more than one country was bundled together, intra-regional trade was also taken into consideration. Below is a 6x6 snap shot for the trade matrix.

Table 3-2: 6x6 snapshot of Bilateral trade value matrix (in million USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	11070,0	1342,9	179885,1	18035,2	10384,4	55005,7
Brazil	871,3	0,0	109877,9	41210,1	2621,5	9885,3
China	84705,4	53464,0	0,0	642306,5	56227,2	185664,5
EU-27	55603,9	42868,2	335470,1	3887115,3	14155,6	92737,5

[1]http://wits.worldbank.org/WITS/WITS/AdvanceQuery/RawTradeData/QueryDefinition.aspx?Page=RawTradeData

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Indonesia	4775,5	1933,1	63886,5	22427,8	0,0	21530,9
Japan	20383,9	5427,9	205523,7	99494,2	17976,7	0,0

Source: Compiled by author using data from WITS/ UN Comtrade

3.4.2 Conversion of Bilateral trade value to maritime trade values

Trade between two nations does not always occur by sea. Different modes are used to conduct international trade. A sizable portion of it involves international maritime trade. The geography, the distances between trading partners, and the accessibility of the infrastructure all affect the mode of trade. For instance, trade in the EU-27 is split between land, rail, and sea transportation, mostly due to the close proximity of the trading nations and the availability of the infrastructure for multimodal transportation. We have accounted for these variables while determining the maritime trade values for each bilateral trade value in our matrix. As per a new release by Eurostat[2], in specifics, shipping accounted for 53% of EU imports and 48% of EU exports to third countries. Similar data is also available for the US from BTS (2020). 3.44

After taking into consideration the above factors, we found out the share of maritime trade between the several bilateral pairs in our matrix. Below is an extract for the trade entering EU by sea.

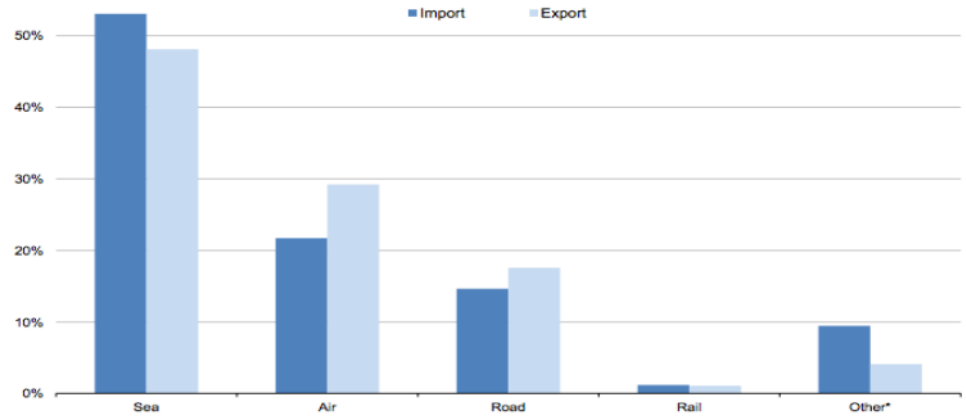
Table 3-3: 6x6 snapshot of Maritime trade value matrix(in million USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	9963,0	1329,5	178086,2	17854,8	10280,5	54455,6
Brazil	862,6	0,0	108779,1	40798,0	2595,3	9786,5
China	83858,4	52929,4	0,0	635883,5	55664,9	183807,8
EU-27	55047,9	42439,5	332115,4	2332269,2	14014,1	91810,1
Indonesia	4727,7	1913,8	63247,7	22203,5	0,0	21315,6
Japan	20180,1	5373,7	203468,5	98499,2	17796,9	0,0

Source: Compiled by author using data from WITS/ UN Comtrade

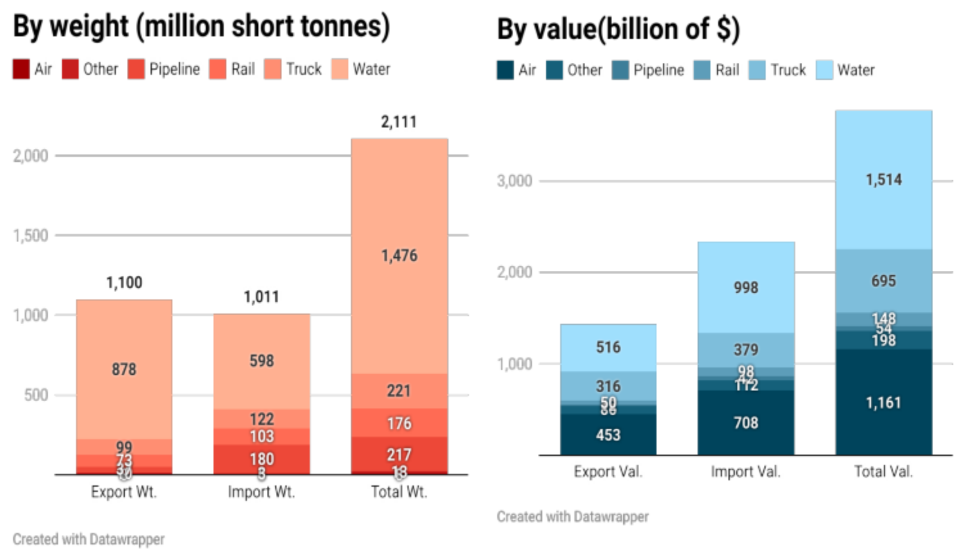
[2] https://ec.europa.eu/eurostat/documents/2995521/7667714/6-28092016-AP-EN.pdf

Figure 3-5: EU international trade in goods by mode of transport, 2015 (based on value)



Source: Eurostat news release, 2016[3]

Figure 3-6: U.S. International Trade Carried in 2020 by Cargo Type (Weight/ Value)



Source: Prepared by author based on data from BTS (2020)

3.4.3 Extracting trade values for three shipping segments

In order to obtain the trade values for our particular set of product groups—such as wet

[3] https://ec.europa.eu/eurostat/documents/2995521/7667714/6-28092016-AP-EN.pdf

bulk, dry bulk, etc.—we once again employed the WITS database. The values for each trade were taken from the database using the underlying major commodity. The maritime share of that trade type was then calculated by subtracting a similar percentage (as described in section 3.4.2) from the trade value.

Table 3-4: 6x6 snapshot of Maritime wet-bulk trade value matrix(in million USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	583,4	0,0	17344,5	90,8	943,5	15712,0
Brazil	0,5	0,0	16305,7	4389,1	15,1	77,1
China	1580,7	46,6	0,0	620,5	475,4	466,4
EU-27	655,0	2481,3	6519,9	108314,4	487,4	666,0
Indonesia	1213,7	0,0	4641,4	223,5	0,0	3293,8
Japan	2582,9	26,0	1607,6	33,6	102,1	0,0

Source: Compiled by author

Table 3-5: 6x6 snapshot of Maritime dry-bulk trade value matrix(in million USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	218,7	927,1	112498,3	3883,0	4029,2	27339,0
Brazil	65,2	0,0	38793,7	4727,3	293,4	5699,5
China	290,2	276,0	0,0	239,2	530,6	1319,5
EU-27	39,5	87,7	2040,7	17830,9	58,7	25,0
Indonesia	6,4	0,0	9825,0	340,6	0,0	3131,6
Japan	4,3	0,0	371,2	362,1	46,5	0,0

Source: Compiled by author

Table 3-6: 6x6 snapshot of Maritime container trade value matrix(in million USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	9160,8	402,5	48243,4	13881,0	5307,9	11404,7
Brazil	797,0	0,0	53679,7	31681,6	2286,8	4009,9
China	81987,5	52606,7	0,0	635023,8	54658,9	182021,9
EU-27	54353,3	39870,5	323554,9	2206123,9	13468,0	91119,2

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Indonesia	3507,7	1913,7	48781,3	21639,4	0,0	14890,2
Japan	17592,9	5347,6	201489,7	98103,6	17648,4	0,0

Source: Compiled by author

3.5 Tariff and Non-tariff barriers

For finding out the initial tariffs, the WITS database was used. The AHS (effectively applied tariff) was checked and weighted average calculation was done to arrive on the final bilateral tariff in case of country groups/ regions. Below is the 6x6 snippet of initial bilateral tariff as secured from the WITS database.

Table 3-7: 6x6 Snippet of initial bilateral tariff matrix

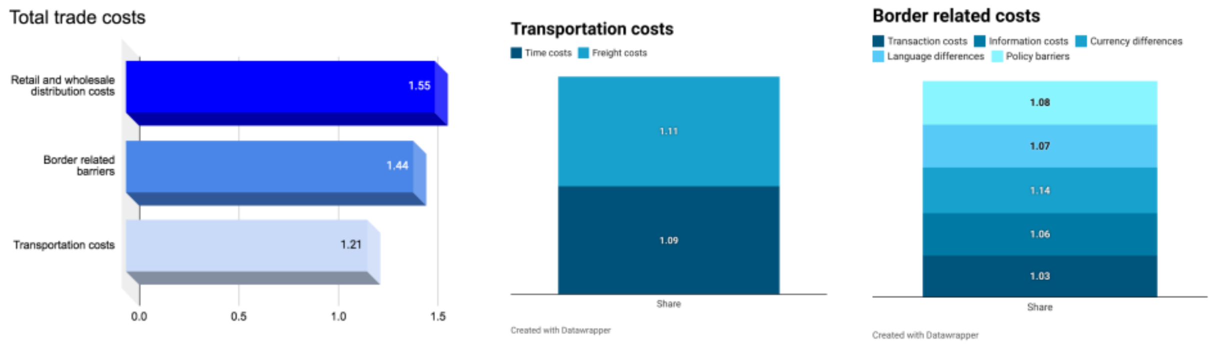
Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	1,000	1,126	1,004	1,042	1,011	1,028
Brazil	1,031	1,000	1,068	1,041	1,074	1,065
China	1,000	1,149	1,000	1,042	1,009	1,039
EU-27	1,030	1,142	1,068	1,000	1,088	1,014
Indonesia	1,000	1,167	1,004	1,027	1,000	1,009
Japan	1,001	1,132	1,070	1,002	1,011	1,000

Source: Compiled by Author with data from WITS database

Initial non-tariff measures (NTM)

As per research by (Anderson and Eric Van Wincoop, 2004), the trade costs are significant; a representative nation ad valorem tax equivalent estimate of a 170% overall trade barrier is constructed below. Costs for shipping, crossing borders, and local distribution are all included from the overseas producer to the domestic consumer. Economic policy and trade costs are intricately related. Tariffs, the tariff equivalents of quotas, and trade barriers connected to the exchange rate system are direct policy instruments that are less significant than other policies (transport infrastructure investment, law enforcement, and related property rights institutions, informational institutions, regulation, language). Trade costs have significant effects on wellbeing.

Figure 3-7:Tariff equivalents per trade costs type



Source: Prepared by author based on (Anderson and van Wincoop, 2004)

Trade costs encompass any cost involved in delivering a good to a final consumer other than the marginal cost of manufacturing the good itself. These costs include transportation costs (both freight costs and time costs), policy obstacles (tariffs and non-tariff barriers), information expenses, contract enforcement expenses, expenses related to the use of various currencies, legal and regulatory expenses, and local distribution expenses (wholesale and retail). The trade costs are normally reported in terms of their ad-valorem equivalent. According to the formula (1.7=1.55*1.74-1), the 170% headline figure consists of 55% costs for local distribution and 74% for overseas trade.

For industrialized nations, a rough estimate of the tax equivalent of "representative" trade costs is 170%. The breakdown of this figure is as follows:

$$1.21(transportation\ costs)\ x\ 1.44(border - related\ costs)\ x\ 1.55(retail\ costs)\ =\ 2.70 \quad \textbf{Equation 3-8}$$

$$2.70 - 1\ =\ 1.70\ or\ 170\%$$

Transportation expenses account for 21%, border-related trade obstacles for 44%, and retail and wholesale distribution costs for 55%. Therefore, the overall cost of foreign trade is almost 74% (0.74=1.21*1.44-1). The benchmark cost of retail and wholesale distribution is set at 55%, which is about typical for industrialized nations.

As per a paper (Hummels, 1999), he studied the geography of trade costs encompassing the findings of various previous research already done on the topic (McCallum (1995), Helliwell (1996, 1997), and Wei (1996)) showed a "home bias" in the consumption of trade flows. He also stated a well-known fact that trade reduces with increasing distance as discussed earlier w.r.t. the gravity theory of trade. A technical relationship was developed between the freight and the distance to calculate the substitution elasticities and trade barrier equivalents. A different but a fruitful approach was also used by (Elswijk, 2012) in his research where he found the freight cost tariff equivalent for European region. We will be applying a similar approach in calculating the freight cost tariff equivalents taking the distances between the trading countries into account.

To determine a freight cost tariff equivalent, we must first create a distance table that takes into consideration the distances between the various ports and the areas we have chosen for our econometric model. Based on the assumption that the majority of the freight arrives at each nation's major port, the distance between ports is calculated. For smaller countries, this presumption is negligible, but for larger countries like Brazil, China, and Russia, it grows exponentially. Additionally, a distance assumption was made while computing the distances between regions and ports as well as between regions themselves. Since Singapore controls 80% of SIDS's trade, those countries' distances from other countries and regions were largely determined by Singapore's location. A matrix consisting of (18x18) 324 distances was created. Below is a snippet of the distance table with the full distance table available in the Annex 9.

Table 3-8: 6x6 Snippet of bilateral distance table matrix(in nautical miles)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	4270,0	8627,0	3307,0	9461,0	1276,0	3548,0
Brazil	8627,0	1200,0	11065,0	5430,0	8541,0	11500,0
China	3307,0	11065,0	700,0	10525,0	2523,0	933,0
EU-27	9461,0	5430,0	10525,0	2050,0	8550,0	11078,0
Indonesia	1276,0	8541,0	2523,0	8550,0	862,0	3125,0

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Japan	3548,0	11500,0	933,0	11078,0	3125,0	226,0

Source: Compiled by Author based on (Bertoli, Goujon and Santoni, 2016)

After completing the distance table matrix, next step is to use the tariff estimated for the trade pairs in Section 3.4.2 and apply it to all the distances to find out the freight cost tariff equivalent using below:

$$Freight\ cost\ tariff\ equivalent\ = \left(\frac{Distance}{6154.17}\right) x\ Initial\ tariff + 1 \qquad \textbf{\textit{Equation 3-9}}$$

The bilateral distance table matrix was used to calculate an average distance of 6154.17. A new tariff was determined to take into account the effect of distance between the two maritime trade nations after this average distance was fixed at the original bilateral tariff from Section 3.4.2. As a result, the cost barrier will be larger for far-off countries and vice versa. Below is a 6x6 snippet of the freight cost tariff equivalent

Table 3-9: 6x6 Snippet of the initial tariffs corrected for distance

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	1,000	1,176	1,002	1,064	1,002	1,016
Brazil	1,044	1,000	1,122	1,036	1,103	1,121
China	1,000	1,267	1,000	1,071	1,004	1,006
EU-27	1,047	1,126	1,116	1,000	1,123	1,025
Indonesia	1,000	1,232	1,002	1,038	1,000	1,004
Japan	1,001	1,247	1,011	1,004	1,005	1,000

Source: Compiled by Author

The 21% transport cost comprises 9% in taxes to reflect the time worth of products in transit as well as **directly assessed freight charges**. To obtain our initial trade cost equivalent, we must subtract the freight rates from the transport cost component because we are separately accounting for them in our model. This must be subtracted from the 21%

transportation costs as shown below:

$$(1.21 - (Initial\ tariff\ corrected\ for\ distance - 1))\ x\ 1.44\ x\ 1.55$$ ***Equation 3-10***

The NTM computation is performed in the same manner for other trade pairs. Below is a 6x6 snippet of initial NTMs after freight and distance correction.

Table 3-10: 6x6 Snippet of the initial NTMs corrected for freight and distance

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	2,701	2,307	2,695	2,558	2,696	2,665
Brazil	2,603	2,701	2,429	2,620	2,470	2,431
China	2,701	2,104	2,701	2,542	2,692	2,688
EU-27	2,597	2,421	2,442	2,701	2,427	2,646
Indonesia	2,701	2,183	2,697	2,616	2,701	2,691
Japan	2,699	2,149	2,677	2,693	2,689	2,701

Source: Compiled by Author

3.6 Supply and demand elasticities

Elasticity is a term used in economics to describe how a good or service's total quantity required changes in response to changes in its price. If the amount demanded of a product changes more than proportionally as its price rises or falls, it is said to be elastic. In contrast, a product is said to be inelastic if changes in price have minimal effect on changes in quantity demanded.

Demand for a product or service is influenced by a number of variables, including price, income level, and personal preference. The quantity requested of the commodity or service changes whenever one of these variables changes. Demand's sensitivity to a change in price is quantified economically as price elasticity of demand. Price elasticity of demand is the measurement of the change in quantity required as a result of a change in the price of a good or service.

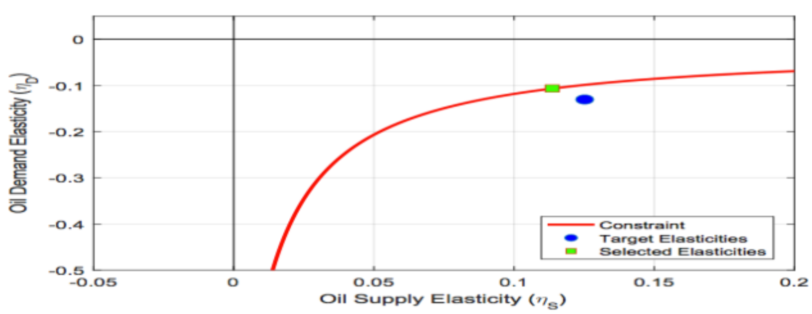
A good or service's responsiveness to supply after a change in its market price is measured by its price elasticity of supply. Basic economic theory states that when a good's price grows, so will its supply. A good's supply will fall when its price rises, on the other hand.

Wet bulk cargoes

We know that the volume and total value of trade in the wet bulk segment are both dominated by crude oil transport. As a result, evaluating the elasticity for this segment depends heavily on the demand elasticity of crude oil. Crude oil's demand and supply elasticity are thought to be inelastic in the short run. This is primarily caused by the fact that all major economies are dependent on fossil fuels and that producers change oil output and long-distance transportation with relative lag times. As a result, despite rising crude oil prices, only a slight drop in demand is seen (Caldara, Cavallo and Iacoviello, 2019). In the same study, it was determined that the elasticities of supply and demand were roughly -0.13 and +0.13, respectively.

For the purpose of our study we will be taking a uniform export supply elasticity of 0.2. The composite import demand elasticity input is done considering the sensitivity of an importing nation to the crude oil price. For e.g. (Dayo and Adegbulugbe, 1987) suggested the value of -0.846 for Nigeria. (Ashraf et al., 2018) suggested demand elasticities of -0.18 for China, -0.08 for India and -0.07 for Pakistan. All these elasticities are for short-term. For Turkey a value of -0.11 was calculated by (Kavaz, İsmail. 2020). Furthe studies like (Tsirimokos, 2011) also suggested vey low price elasticity for import demand of crude oil.

Figure 3-8: Oil Demand and Supply Elasticities Implied by the SVAR



Source: (Caldara, Cavallo and Iacoviello, 2019)

Dry bulk cargoes

The demand for steel on the global market dominates the dry bulk category, which is also dominated by the volume and trade of the key raw materials for steel manufacturing, namely coal and iron ore. Since bauxite ore is also one of the main dry bulk cargoes being transported, the demand elasticity of aluminum, in addition to steel, has an impact on the overall elasticity in this segment. The study report calculated the composite demand elasticities of numerous mineral commodities utilizing the divisia moment technique, price flexibility, and working expenditure model (Fernandez, V. , 2018). Using data from 1980 to 2015, it identifies the demand elasticities of 25 nations as well as several global areas.

Supply and substitution elasticities in the US were assessed to be between 1 and 3 and 4 to 7, respectively, according to a report by (US international trade commission, 2007). In this research, we will take into account supply elasticity of 2 and substitution elasticity of 5 as was similarly considered in a research by (Sathe, A. (Amit), 2019) on “Economic and trade impact of IMO 2020 Sulphur regulations on main shipping segments”.

Container cargoes

It is exceedingly challenging to determine the precise elasticities of the underlying commodities in this segment because the majority of these commodities are very varied and can include both elastic and inelastic goods, including luxury or subpar goods.

In fact, as nearly all cargoes, even minor amounts of dry and wet bulk cargoes, are transported in container ships, the heterogeneity of the commodities carried in these vessels can also be portrayed as combined elasticities of global trade in general. Therefore, from a global trade prospective, liner segment elasticities were estimated. A supply elasticity of 0.75 and substitution elasticity of 2 is considered in this research.

3.7 Model scenarios

The policy change at the core of this research is the introduction of a global carbon tax for shipping by IMO. At present there is no confirmed price of a carbon tax or fuel levy decided by the IMO but there are already some member states and even some shipping lines who have proposed a figure. This was earlier discussed in the Chapter 2.

In summary of the review in Chapter two, one of the first countries to make a serious proposal for a carbon shipping tax was the Marshall and Solomon Islands, which suggested a cost of $100 per ton of carbon dioxide (CO2) starting in early 2021 (Lo, 2021). Under the proposed global carbon tax, the maritime sector would be compelled to pay $56 per ton of CO2 beginning in 2025. The tax would increase by $5 every five years, from $135 per ton of CO2 in 2030 to a maximum of $637 per ton by 2040, according to the Japan's current proposal. The major shipping company Maersk imposed a $150 carbon tax on shipping fuel, which equates to a $450 rise in fuel costs, in another article by (Wittels, 2021b). On the other hand, the International Chamber of Shipping (ICS), a global trade group for ship owners, asked for a $2 per ton fuel tax to fund research into cleaner fuels and superior propulsion (ICS, 2021). Present carbon taxes outside shipping range from $1.03 per ton (Ukraine) to $137.3 per ton (Uruguay).

Based on the foregoing discussion and for the purposes of this research, we will take into account a moderate carbon tax of $75 per ton in Scenario 1 and an ambitious carbon tax of $150 per ton in Scenario 2. For reporting purposes, we have decided to add an additional scenario with a midway tax between above two scenarios of around $100 per ton (Scenario 3).

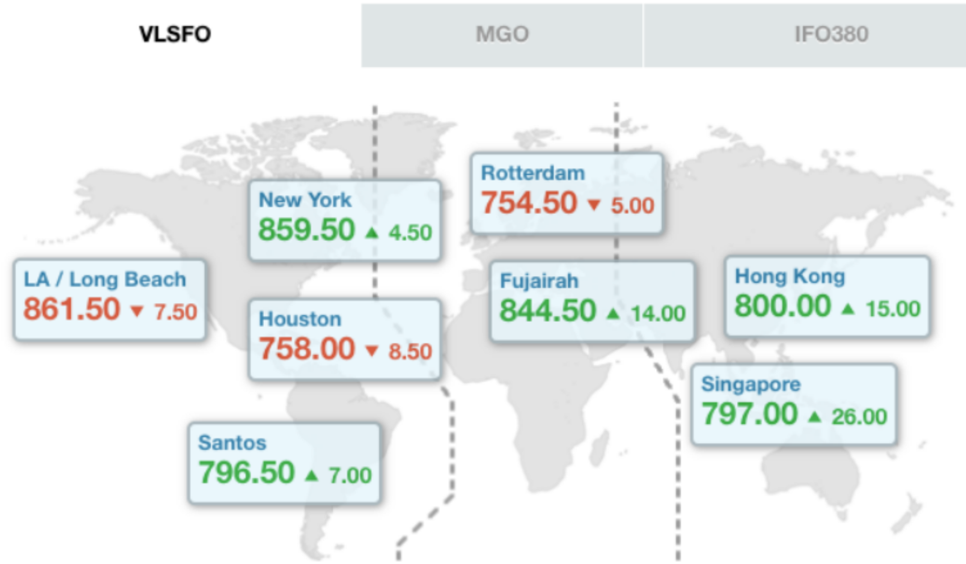
3.7.1 Cost calculation for both scenarios

For converting fuel to carbon, we'll use a 1:3 conversion factor. The ultimate change in fuel price should then be calculated by multiplying all of the carbon tax amounts by 3. For calculational purposes, we must also learn the national average fuel price, which changes depending on region.

Scenario 1 – Moderate scenario ($75 carbon tax)

A $75 per ton carbon tax amounts to an increase of $225 per ton of marine fuel.

Figure 3-9: World bunker prices - VLSFO



Source: (Ship&Bunker, 2022)

The average cost per ton of VLSFO may be calculated to be $770 per ton when taking into account the aforementioned information and major bunkering centers like Rotterdam, Houston, and Singapore.

Initial fuel price (f) = $770 per ton

Note: Only VLSFO is considered in our research as it is the most widely used fuel by the marine vessels. Almost 72% vessels by GT use this type of fuel for their main propulsion (UNCTAD RMT, 2022).

$$Final\ fuel\ price\ (F)\ =\ \$770\ +\ \$225\ =\ \$995\ per\ ton \qquad \textbf{Equation 3-11}$$

$$\%\ increase\ in\ fuel\ cost\ =\ df\ =\ 225/770\ *\ 10\ =\ 29.22\ \% \qquad \textbf{Equation 3-12}$$

Fuel cost as share of total running costs for the vessel varies with the vessel types. As per the study by Kalli, J., Karvonen, T., & Makkonen, T. (2009), fuel costs range from 30% (for car and passenger ferries) to 53%. (for containers) of total costs.

$Wet\ bulk\ (tankers)\ =\ 32\%\ ;\ Dry\ bulk\ =40\%\ ;\ Containers\ =\ 53\%$ **Equation 3-13**

Based on above information

$$\%\ increase\ in\ total\ running\ cost\ of\ Wet\ bulk\ =\ dTwb\ =\ 0.2922\ x\ 0.32\ =\ 9.35\%$$ **Equation 3-14**

$$\%\ increase\ in\ total\ running\ cost\ of\ Dry\ bulk\ =\ dTdb\ =\ 0.2922\ x\ 0.40\ =\ 11.69\%$$

$$\%\ increase\ in\ total\ running\ cost\ of\ Containers\ =\ dTcon\ =\ 0.2922\ x\ 0.53\ =\ 15.49\%$$

A similar calculation is also done for scenario 2 and scenario 3 with below results

Scenario 2 – Ambitious scenario ($150 carbon tax)

$$\%\ increase\ in\ total\ running\ cost\ of\ Wet\ bulk\ =\ dTwb\ =\ 0.5844\ x\ 0.32\ =\ 18.70\%$$ **Equation 3-15**

$$\%\ increase\ in\ total\ running\ cost\ of\ Dry\ bulk\ =\ dTdb\ =\ 0.5844\ x\ 0.40\ =\ 23.38\%$$

$$\%\ increase\ in\ total\ running\ cost\ of\ Containers\ =\ dTcon\ =\ 0.5844\ x\ 0.53\ =\ 30.97\%$$

Scenario 3 – Additional midway tax scenario ($100 carbon tax)

$$\%\ increase\ in\ total\ running\ cost\ of\ Wet\ bulk\ =\ dTwb\ =\ 0.3896\ x\ 0.32\ =\ 12.47\%$$ **Equation 3-16**

$$\%\ increase\ in\ total\ running\ cost\ of\ Dry\ bulk\ =\ dTdb\ =\ 0.3896\ x\ 0.40\ =\ 15.58\%$$

$$\%\ increase\ in\ total\ running\ cost\ of\ Containers\ =\ dTcon\ =\ 0.3896\ x\ 0.53\ =\ 20.65\%$$

3.8 Final NTM calculation

We can then determine the final NTMs, using the same methodology that was used to get the initial NTM, based on the cost change information provided by section 3.7.1.

$$\{\{\{[1.21 - (Initial\ tariff\ corrected\ for\ distance - 1)] - 1\}\ x\ (1 + 0.0935)\} + 1\}\ x\ 1.44\ x\ 1.55$$ ***Equation 3-17***

Finally, we assume an additional barrier in relation to the cost of a global carbon tax in order to account for the effect of the magnitude of trade between the regions, i.e., the regions with more trade will be more affected with the introduction of a global carbon tax and vice versa. This is accomplished by computing the weighted average of trade from a specific country (export value). We first calculate this weighted export value for each nation or region, and then we recalculate the weighted average across all regions using the share in global trade. The additional cost that takes into account the volume of bilateral trade is then calculated using this final weighted average value as a benchmark.

$\left[\left\{\{\{[1.21 - (Initial\ tariff\ corrected\ for\ distance - 1)] - 1\}x\ (1 + 0.0935)\right\} + 1\right\}x\ 1.44\ x\ 1.55\Big] + \left[\left(\left(\frac{0{,}0935}{2}\right)x\ Final\ weighted\ avearage\right)\right]$	***Equation 3-18***

Equation 3.18 and *Equation 3.10* are compared, and it is clear that the worldwide carbon price of $75 per ton has added to the costs, causing the NTM for the Aus/NZ-EU trade pair to change/increase from 2.5583 to 2.5888. The other segments, such as dry bulk and containers, are calculated in a similar manner. Below is a 6x6 snippet of initial NTMs after freight and distance correction.

Table 3-11: 6x6 Snippet of the final NTM for Scenario 1(a)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	2,745	2,315	2,739	2,589	2,739	2,706

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Brazil	2,638	2,745	2,448	2,656	2,493	2,449
China	2,745	2,092	2,745	2,571	2,735	2,730
EU-27	2,631	2,438	2,462	2,745	2,445	2,684
Indonesia	2,745	2,178	2,740	2,652	2,745	2,734
Japan	2,743	2,141	2,719	2,736	2,732	2,745

Source: Compiled by Author

A final NTM table with 3 scenarios segregated into three shipping segments is available in the Annex 12, 13, 14.

Chapter 4 Results and analysis

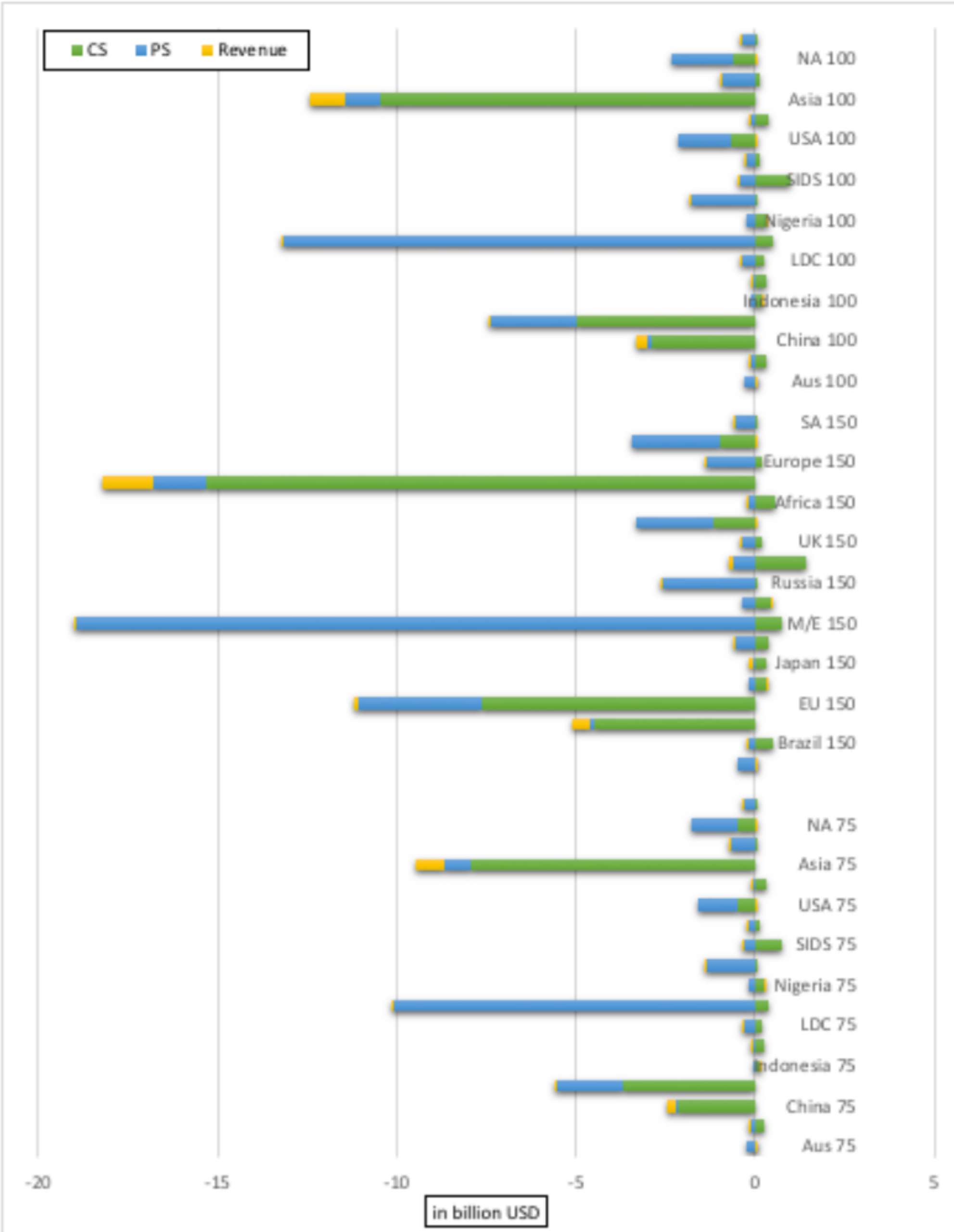
We offer the findings and analyses for the mentioned scenarios and shipping segments in this chapter. This is how we organize the results chapter because our research focuses on the various implications for each shipping segment. We examine the various techniques and their impacts on welfare, output, and trade for each of the shipping segments. The cumulative effect on all sectors will be shown when we have reported and examined the results for each segment. We shall divide our reporting into sections for CO2 effect, welfare effect, trade effect, production effect, and pricing effect.

4.1 Wet bulk

4.1.1 Welfare Effects

Impacts on welfare measure the full economic impact of a policy shock, in this case, the imposition of a global carbon tax by the IMO. Figure 4-1 shows the welfare implications for the three scenarios from section 3.7 in billions of US dollars. Figure 4-1 shows that the key trading regions like the EU, Rest of Asia, and the Middle East are where the effects of global tax are greatest. In the first scenario, these regions anticipate losing \$5.6, \$9.5, and \$9.7 billion in terms of overall welfare in the wet bulk segment. In the third and second scenarios, when the worldwide tax is projected to be larger, this value significantly rises. As a big consumer, Asia is seeing a loss in consumer surplus, whereas the Middle East, a key producer, has witnessed a significant loss in producer surplus. Due to a significant decline in consumer surplus, big crude oil consumers like China also suffer. It is a mixed bag for the USA, reflecting its dual nature. The rise in consumer surplus benefits areas like SIDS, the rest of Africa, and nations like Indonesia, Brazil, and Nigeria since it may push domestic producers to meet home demand if global taxes are raised. The new policy has also increased government revenue for Indonesia and Australia.

Figure 4-1: Wet bulk Welfare effects for all three Scenarios



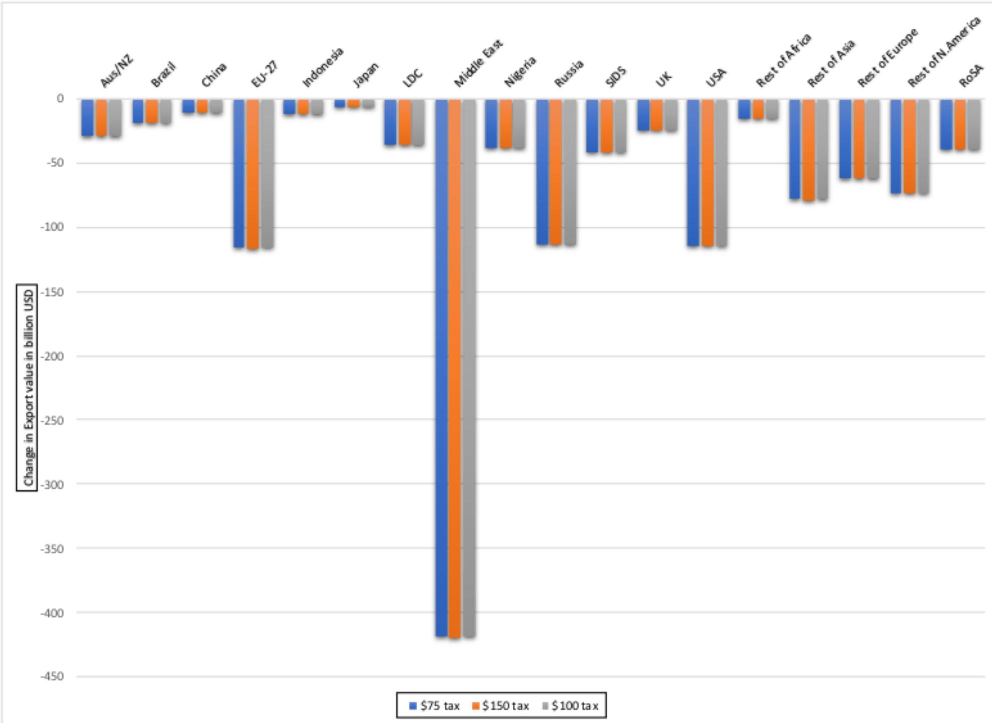
Source: Author's representation of model results

4.1.2 Trade Effects

All nations experience a drop in overall exports following the implementation of the global carbon tax, as shown in Figure 4-2. The Middle East, which is the main oil exporter in this market, will experience the most negative effects on shipments in all scenarios, which will total 418~420 billion USD. We can also observe from the below figure that, despite Scenario 2's $150 worldwide tax having an approximately two-fold effect, the effect is rather consistent across all scenarios. This is mostly due to the fact that we take into account the low elasticity of the composite import demand for crude oil, which is a core necessity for emerging nations. The largest overall decline in wet bulk exports is observed in the Middle East and EU-27 regions. As significant oil exporters, Russia and the USA follow these regions.

Exports from the Middle East region will primarily decrease to China, Japan, the EU-27, and the rest of Asia, according to the change in export value tables in the Annex. No area or country has seen a rise in exports. Additionally, due to stronger controls and a significant amount of intra EU trade, wet bulk trade will substantially fall within the EU. The effect on the nations with less price elasticity is significantly less than the effect on the countries with more price elasticity, according to our analysis of the variations across the various scenarios, with scenario 1 and scenario 2 showing the highest differences. For instance, increasing taxes to $150 causes a nearly $2 billion reduction in exports from the Middle East to China and the EU-27, whereas there is an increase in trade from the Middle East to the USA due to the latter's lower elasticity than that of China and the EU-27. Table 4-1,4-2,4-3 are snippets of the change in trade values for wet bulk for Scenario 1. Complete tables are attached in Annex 15.

Figure 4-2: Change in export values in billion USD for all scenarios



Source: Author's compilation of model results

Table 4-1: 6x6 Snippet of the change in bilateral export values for Scenario 1(wet bulk) (in billion USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	-0,4	0,0	-11,0	-0,1	-0,6	-10,0
Brazil	0,0	0,0	-9,6	-2,7	0,0	0,0
China	-1,0	0,0	0,0	-0,4	-0,3	-0,3
EU-27	-0,4	-1,4	-3,6	-70,2	-0,3	-0,4
Indonesia	-0,8	0,0	-2,9	-0,1	0,0	-2,1
Japan	-1,7	0,0	-1,0	0,0	-0,1	0,0

Source: Compiled by Author

Table 4-2: 6x6 Snippet of the change in bilateral export values for Scenario 2(wet bulk) (in billion USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	-0,4	0,0	-11,0	-0,1	-0,6	-10,2
Brazil	0,0	0,0	-9,6	-2,7	0,0	0,0
China	-1,0	0,0	0,0	-0,4	-0,3	-0,3
EU-27	-0,4	-1,3	-3,3	-72,1	-0,3	-0,4
Indonesia	-0,8	0,0	-2,9	-0,1	0,0	-2,1
Japan	-1,7	0,0	-1,0	0,0	-0,1	0,0

Source: Compiled by Author

Table 4-3: 6x6 Snippet of the change in bilateral export values for Scenario 3(wet bulk) (in billion USD)

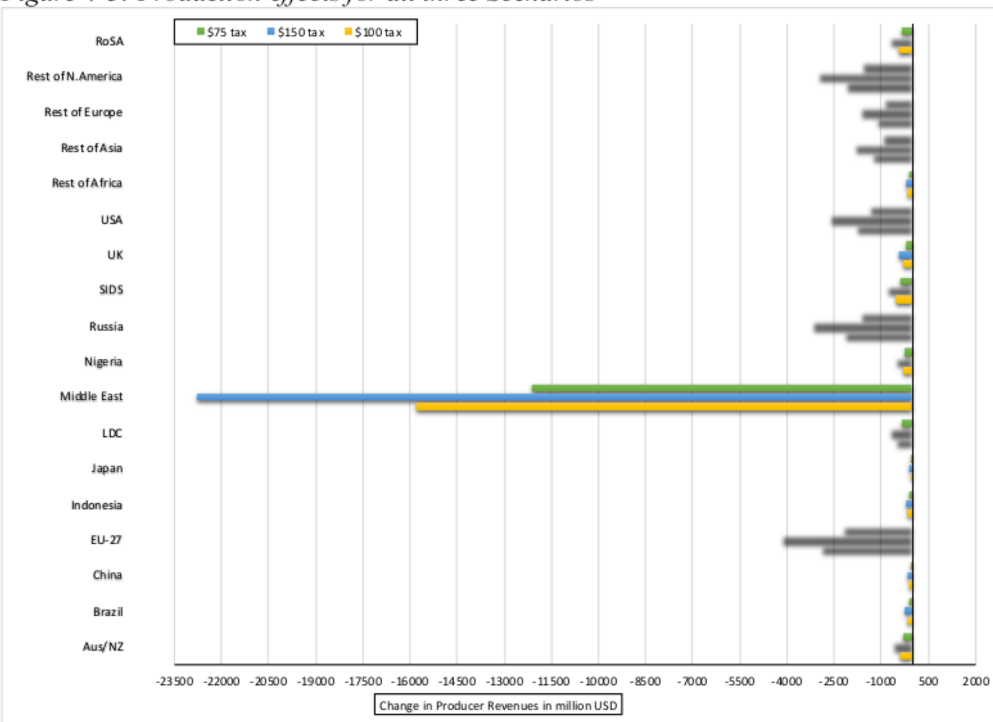
Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	-0,4	0,0	-11,0	-0,1	-0,6	-10,1
Brazil	0,0	0,0	-9,6	-2,7	0,0	0,0
China	-1,0	0,0	0,0	-0,4	-0,3	-0,3
EU-27	-0,4	-1,4	-3,5	-70,9	-0,3	-0,4
Indonesia	-0,8	0,0	-2,9	-0,1	0,0	-2,1
Japan	-1,7	0,0	-1,0	0,0	-0,1	0,0

Source: Compiled by Author

4.1.3 Effect on Producers

The production impacts of each of the three situations are displayed in Figure 4-3. After comparing producer earnings in Figure 4-3, we found that in all locations, producer revenues decline nearly twice as much under the $150 scenario as they do under the $75 scenario. This is because a greater worldwide tax entails substantially higher cost. Producer revenues in the Middle East, a major exporter in this market, are expected to decline the most, by up to $12.1 billion in the first scenario and $22.8 billion in the second. Producer revenues will also likely decline significantly in the EU, Russia, the rest of North America, and the USA. We have also analysed the effect of transition from $75 to $150 tax which entails that the impact of increasing tax will be the least on the producers of the Middle east and EU-27 in % terms due to a more substantial world share and the effect will be most significant on the small producer countries/ regions like SIDS and LDC.

Figure 4-3: Production effects for all three Scenarios

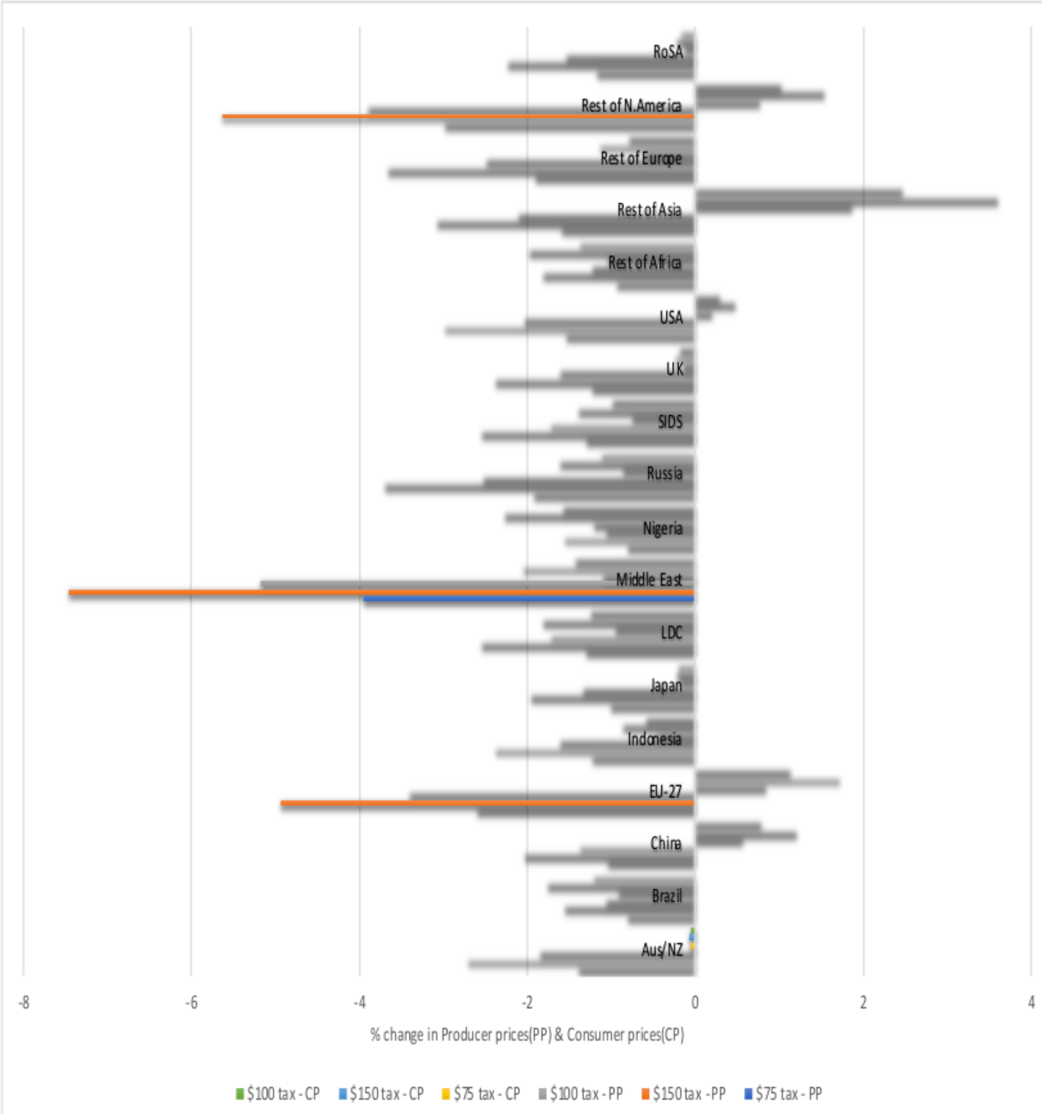


Source: Author's compilation of model results

4.1.4 Price effects

From figure 4-4 below, we observe that only China, EU-27, the USA, rest of Asia and rest of North America exhibit an increase in consumer prices. Given that these countries and areas also import the most wet cargo, this makes perfect sense. Due to these countries' low price elasticity of demand and continued need for wet bulk cargo, the impact of a carbon tax on these countries is significant. With the advancement of technology and decreasing reliance on fossil fuels, this influence could change. The largest producers in the world—the Middle East, Russia, the EU27, the United States, Nigeria, and North America—also suffer from lower producer pricing.

Figure 4-4: Price effects for all three Scenarios



Source: Author's compilation of model results

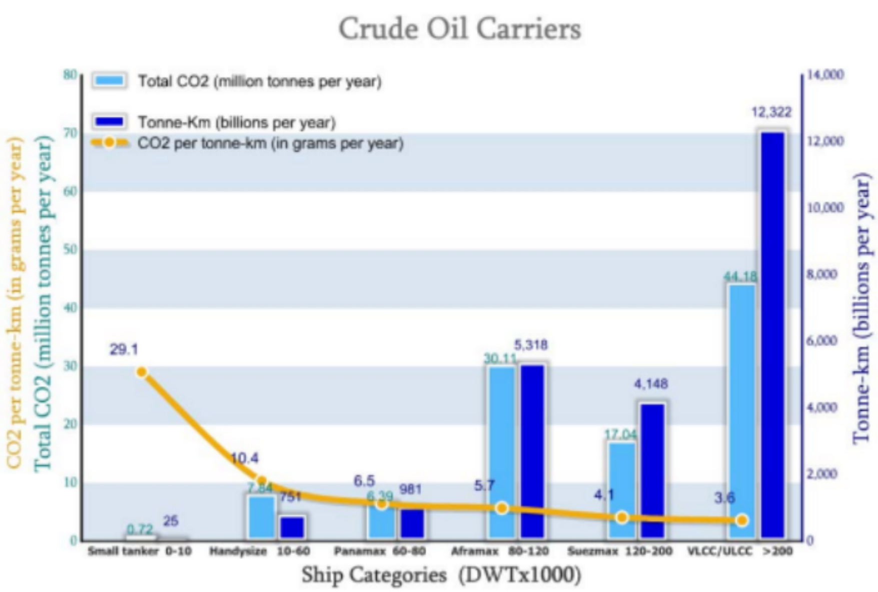
4.1.5 CO2 effects

We need to demonstrate the change in global and interregional trade in terms of CO2 in order to calculate the impact of wet bulk cargo carriers on CO2 generation globally and between regions. There are several ways to calculate CO2 emissions, and you may even make the calculations more difficult by being too specific, but that is outside the purview of this study. We gathered information from (Psaraftis and Kontovas, 2009), who investigated data on CO2 emissions for the global commercial fleet. The CO2 emissions for crude oil and product vessels for the year 2007 were then used. We reviewed the statistics for CO2 emission by shipping on (Clarksons, 2022) to verify that the values corresponded accurately to the data as of the end of the year 2021.

We then applied the research's total CO2 emissions by wet bulk carriers to our 18x18 matrix to determine the contribution of each trade lane based on the volume of cargo moved along that lane. The reduction in CO2 emissions by wet bulk carriers on each particular trade pair was calculated using the percent change in trade between the bilateral trade pairings. Globally, there was a ***146.4 million tonnes, 146.8 million tonnes and 146.5 million tonnes*** reduction in CO2 in total for wet bulk trade in scenario 1,2,3 respectively.

Table 4-4 displays a 6x6 sliver of the change in CO2 emissions for Scenario 1. The Annex 16 contains a complete table with an 18x18 matrix of CO2 emission change.

Figure 4-5: Emission statistics for crude oil tankers



Source: (Psaraftis and Kontovas, 2009)

Table 4-4: 6x6 Snippet of bilateral values for change in CO2 emission(in million tons) by wet bulk carriers due to reduction of trade in Scenario 1

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	0,0	0,0	-1,3	0,0	-0,1	-1,2
Brazil	0,0	0,0	-1,1	-0,3	0,0	0,0
China	-0,1	0,0	0,0	0,0	0,0	0,0
EU-27	0,0	-0,2	-0,4	-8,2	0,0	0,0
Indonesia	-0,1	0,0	-0,3	0,0	0,0	-0,2
Japan	-0,2	0,0	-0,1	0,0	0,0	0,0

Source: Calculated and compiled by author

4.2 Dry bulk

4.2.1 Welfare Effects

Figure 4-6 displays the welfare implications of all possible global carbon tax implementations for the dry bulk section. We discover that customers in China, the EU, Japan, and the rest of Asia are most impacted, which makes sense given the high levels of dry bulk imports from these nations and regions. 44% of all imports are from China alone. In Scenario 2, China's consumer surplus has decreased by about $15.5 billion. Australia suffers greatly on the producer side because it is the biggest exporter of dry bulk, accounting for about 36% of all exports.

Since the export from the large nations is hindered by the increased tax, producers in the lesser exporting countries/regions like Africa, Europe, and North America are marginally benefited by the movement of consumers to these regions. China's indifference to price increases also manifests in an increase in revenue from trading at high prices, which results in a higher trade value. Top importers suffered greater losses in consumer surplus in both scenarios, demonstrating that consumers—in this example, the dry bulk segment—would bear the brunt of the increase in costs.

Figure 4-6: Dry bulk Welfare effects for all three Scenarios

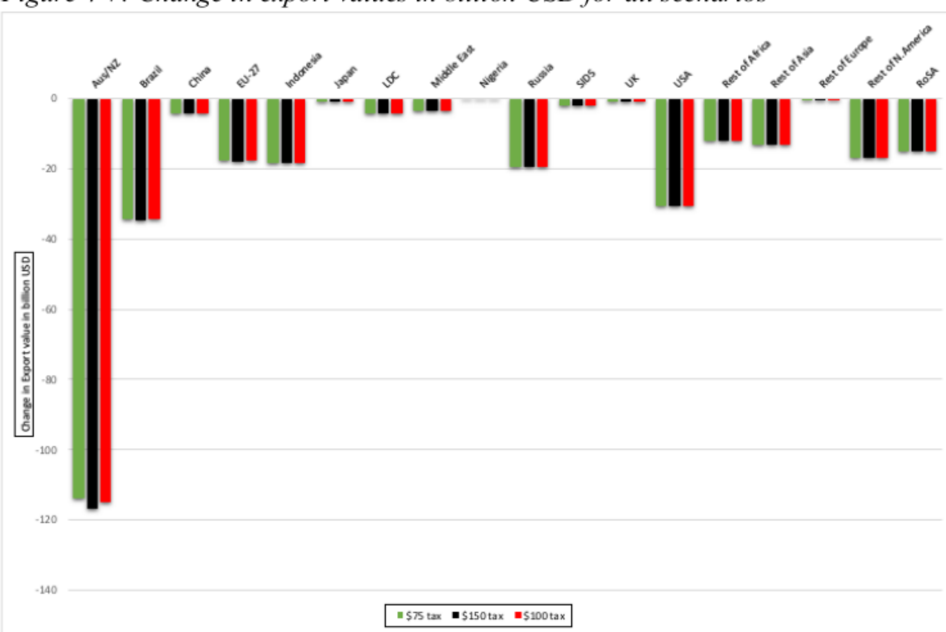
Source: Author's compilation of model results

4.2.2 Trade Effects

For each of the three situations, Figure 4-6 displays the variations in export values between the top exporters and importers of dry bulk commodities. As we can see, in each case Australia's export volume will significantly decrease. As the tax increases, exports decline. When we look at the percent decline with increased tax scenario, other countries and regions, excluding Australia, have a considerably smaller comparative decrease.

Tables 4-5 and 4-6 only display the changes in trade between the largest importers and exporters for scenarios 1 and 2 (full tables in Annex 15). China is most affected, followed by the EU, Japan, and the rest of Asia among major importers of dry bulk commodities. If we look more closely at Chinese imports, we can find that while imports from Brazil are almost untouched, imports from Australia have been significantly cut. On the other hand, there is a surge in Australia's exports to the EU, Japan, Indonesia, and the rest of Asia. This is as a result of our assumption that Chinese demand is positively elastic.

Figure 4-7: Change in export values in billion USD for all scenarios



Source: Author's compilation of model results

Table 4-5: 6x6 Snippet of the change in bilateral export values for Scenario 1 (wet bulk) (in billion USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	-0,1	-0,4	-75,7	-2,0	-2,4	-16,8
Brazil	0,0	0,0	-22,7	-3,0	-0,2	-3,4
China	-0,2	-0,1	0,0	-0,1	-0,4	-0,9
EU-27	0,0	-0,1	-1,0	-11,6	0,0	0,0
Indonesia	0,0	0,0	-5,8	-0,2	0,0	-2,0
Japan	0,0	0,0	-0,2	-0,2	0,0	0,0

Source: Compiled by author

Table 4-6: 6x6 Snippet of the change in bilateral export values for Scenario 2 (wet bulk) (in billion USD)

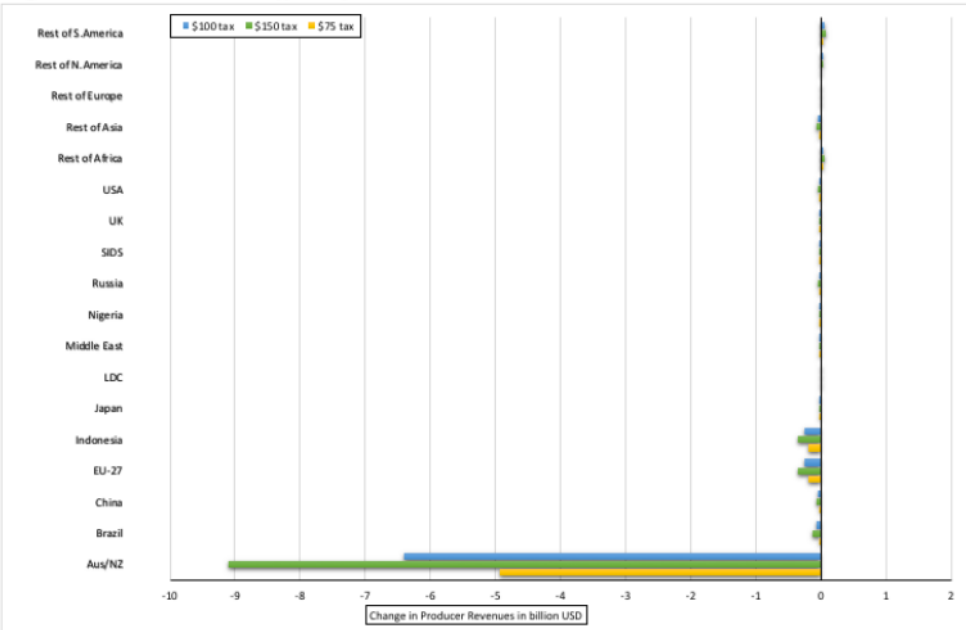
Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	-0,1	-0,3	-80,1	-1,7	-2,3	-16,6
Brazil	0,0	0,0	-22,7	-3,0	-0,2	-3,4
China	-0,2	-0,1	0,0	-0,1	-0,4	-0,9
EU-27	0,0	-0,1	-0,8	-11,9	0,0	0,0
Indonesia	0,0	0,0	-5,5	-0,2	0,0	-2,1
Japan	0,0	0,0	-0,2	-0,2	0,0	0,0

Source: Compiled by author

4.2.3 Effect on Producers

According to Figure 4-8, when we analyse producer revenues for the dry bulk segment under each scenario, we find that Australian producers suffer the greatest revenue losses because they export almost 36% of the world's goods. Additionally, we observe that 63.7% of Australia's exports go to China, 15.5% go to Japan, and 14.1% go to ROA, showing that the country is strongly dependent on trade with the Far East, with 93.3% of its overall trade going there. Due to greater fuel usage, the introduction of a worldwide carbon tax will have a significant impact on Australia's ability to conduct trade with farther countries and regions. Countries with trade segregated to nearby nations and regions will be less affected, as evidenced in the example of Brazil. Australia is followed in producer revenue losses by the EU, Indonesia, and Brazil. China, the world's largest importer of dry bulk with a 45% market share, is the recipient of almost 64% of Australian exports. This indicates that the largest manufacturers will be most impacted by China's reduction in imports, which will have an impact on global prices. The USA is an exception to this because of the uniform distribution of its exports.

Figure 4-8: Production effects for all three Scenarios

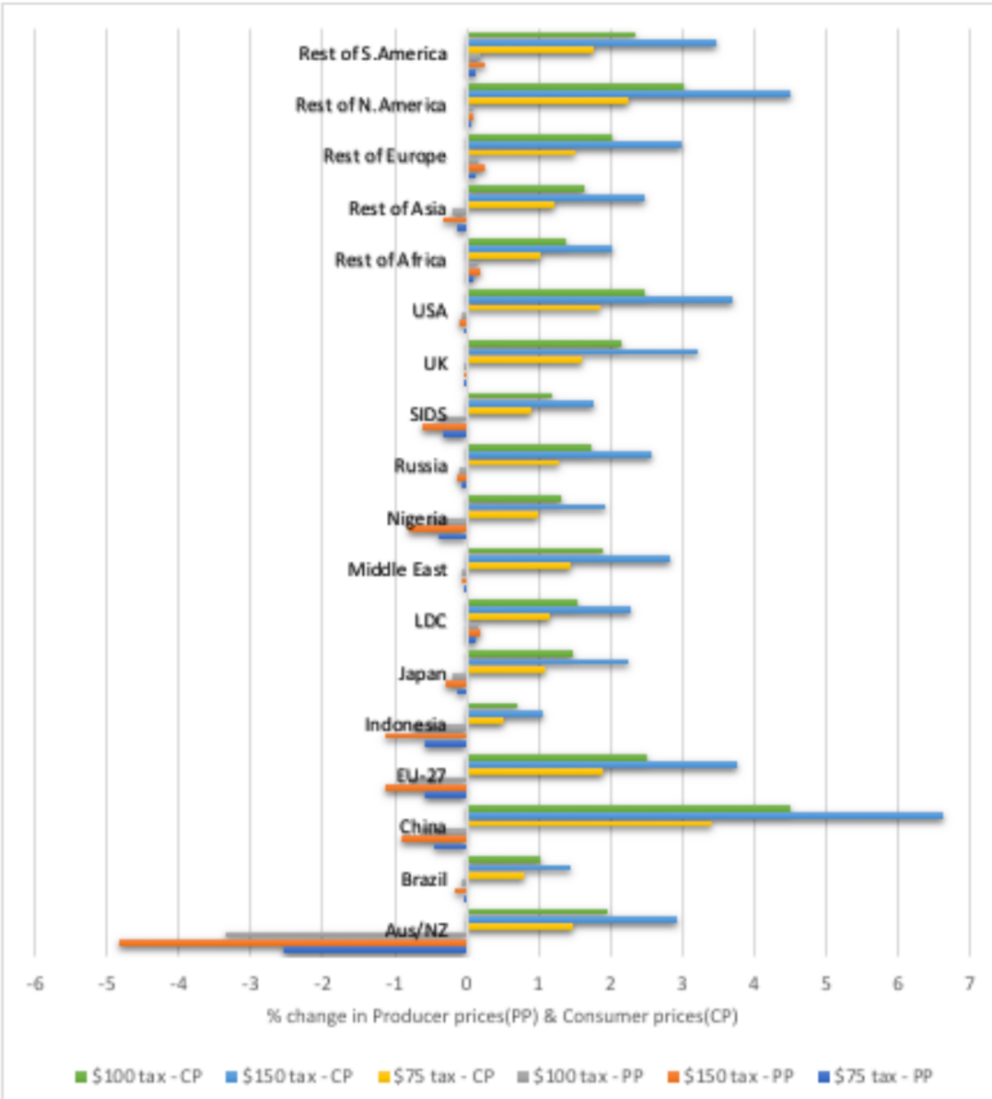


Source: Author's compilation of model results

4.2.4 Price effects

Figure 4-9 shows that the majority of the world's nations and regions are experiencing an increase in consumer prices, with China leading the pack. For major importers of dry bulk, the impact on the consumer price is likewise considerable due to high import values. China exhibits a stronger impact due to both its higher imports and its positive demand elasticity. Australia, the largest producer in the world, is harmed by decreased producer pricing. Due to their evenly spread exports and larger import demand elasticities, Brazil and the United States, the second and third largest producers, have a minimal impact on producer pricing.

Figure 4-9: Price effects for all three Scenarios



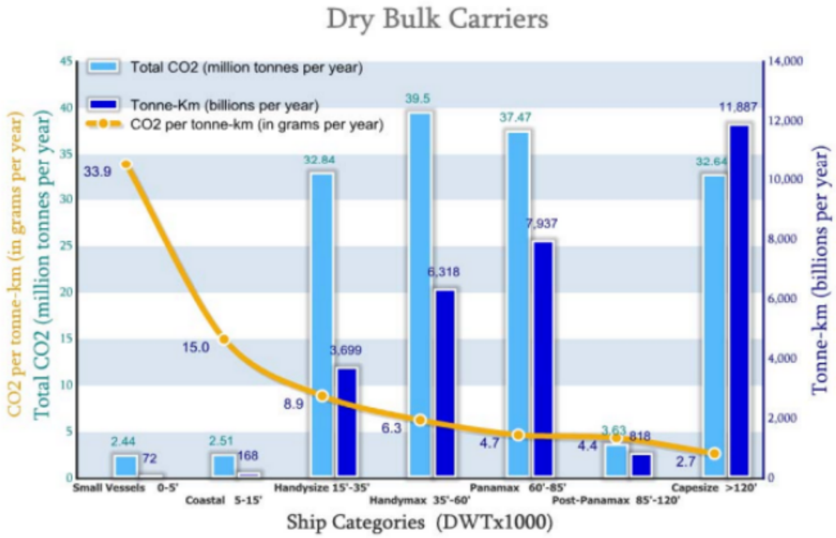
Source: Author's compilation of model results

4.2.5 CO2 effects

We have used data for CO2 produced by bulk carriers as 151 million tonnes (Psaraftis and Kontovas, 2009) as our base value. Using this value, we follow a similar methodology as described in Section 4.1.5 to obtain the reduction in CO2 emissions by dry bulk carriers on each particular trade pair using the percent change in trade between the bilateral trade pairings. Globally, there was a ***94.2 million tonnes, 95.2 million tonnes, 94.5 million tonnes*** reduction in CO2 in total for dry bulk trade in scenario 1,2,3 respectively.

Table 4-7 displays a 6x6 sliver of the change in CO2 emissions for Scenario 1. The Annex 16 contains a complete table with an 18x18 matrix of CO2 emission change.

Figure 4-10: Emission statistics for dry bulk tankers



Source: (Psaraftis and Kontovas, 2009)

Table 4-7: 6x6 Snippet of bilateral values for change in CO2 emission(in million tons) by dry bulk carriers due to reduction of trade in Scenario 1

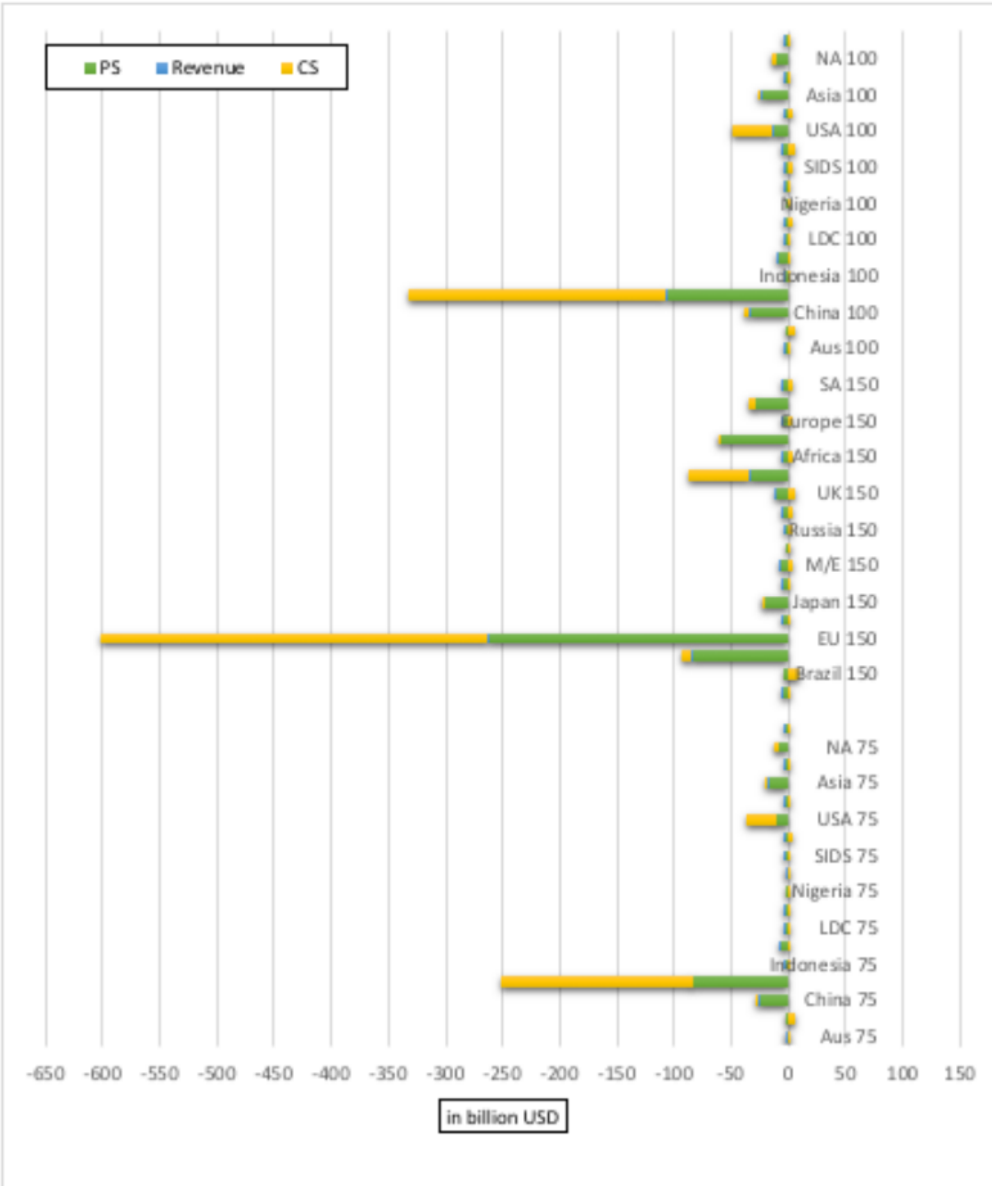
Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	0,0	-0,1	-23,1	-0,6	-0,7	-5,1
Brazil	0,0	0,0	-6,9	-0,9	-0,1	-1,0
China	-0,1	0,0	0,0	0,0	-0,1	-0,3
EU-27	0,0	0,0	-0,3	-3,5	0,0	0,0
Indonesia	0,0	0,0	-1,8	-0,1	0,0	-0,6
Japan	0,0	0,0	-0,1	-0,1	0,0	0,0

Source: Calculated and compiled by author

4.3 Containers

4.3.1 Welfare Effects

Figure 4-11: Liner shipping welfare effects for all three Scenarios



Source: Author's compilation of model results

All three scenarios for the liner shipping industry will result in significant declines in net welfare for the world's main economies, including China, the EU, the USA, the rest of Asia, and the rest of North America, with the EU losing roughly $600 billion in Scenario 2 (Figure 4-11). In these economies, the producer and consumer surplus will both decline significantly. China, the rest of Asia, and the rest of North America lose the producer surplus since they serve as the world's factories, but developed economies that also import completed goods lose more of the consumer surplus. Because of the substantially smaller trade, smaller economies exhibit a reduced impact.

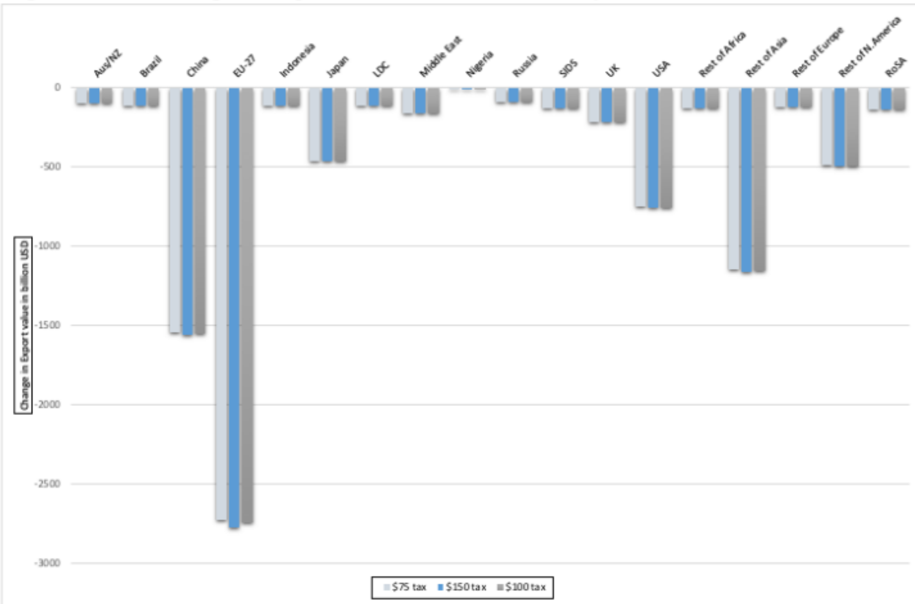
The elastic nature of liner trade causes a higher percentage of producer revenue losses since in this scenario, consumers—who may be seen as liner shipping companies—will bear a smaller share of the hardship. In this case, the shift in PS and CS overshadows the practically noticeable tariff revenues.

4.3.2 Trade Effects

According to changes in overall exports as shown in fig. 4-12, there will be a significant negative impact on exports from all areas due to the global carbon tax on liner shipping. Export losses will be greatest in major economies including China, Japan, the EU, the US, rest of Asia, and rest of NA. We discover that intra-regional trade inside the EU will experience a significant decline after comparing trade flows on key trade routes on the liner segment for both scenarios. It is anticipated that intra-EU commerce will fall by around $79.6 billion. While commerce between the EU and China is anticipated to decline by $10.5 billion, trade between the EU and China is projected to increase by $5.4 billion. Exports from China and the EU have increased to emerging markets like Brazil, Nigeria, and SIDS. Exports from the EU to the rest of Asia have also increased.

Overall, it is clear that even with the implementation of the carbon tax, the smaller and emerging nations continue to import more. This demonstrates their reliance on manufactured goods, in contrast to well-developed economies like the EU, which exhibit a marked decline in imports and exports. Although the EU has a significant amount of trade with the other EU members, the effect of distance is little; yet, in this situation, our evaluation of the magnitude of trade takes precedence over the influence of distance. Table 4-8 & 4-9 are snippets of the change in trade values for wet bulk for Scenario 1. Complete tables are attached in Annex 15.

Figure 4-12: Change in export values in billion USD for all scenarios



Source: Author's compilation of model results

Table 4-8: 6x6 Snippet of the change in bilateral export values for Scenario 1 (wet bulk) (in billion USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	-5,8	-0,2	-30,7	-8,5	-3,4	-7,2
Brazil	-0,5	0,0	-31,6	-19,9	-1,4	-2,4
China	-51,8	-25,8	0,0	-396,7	-34,4	-115,2
EU-27	-32,1	-22,0	-184,2	-1487,3	-7,4	-54,8
Indonesia	-2,2	-1,0	-31,1	-13,5	0,0	-9,4
Japan	-11,1	-2,7	-128,1	-62,6	-11,2	0,0

Source: Calculated and compiled by author

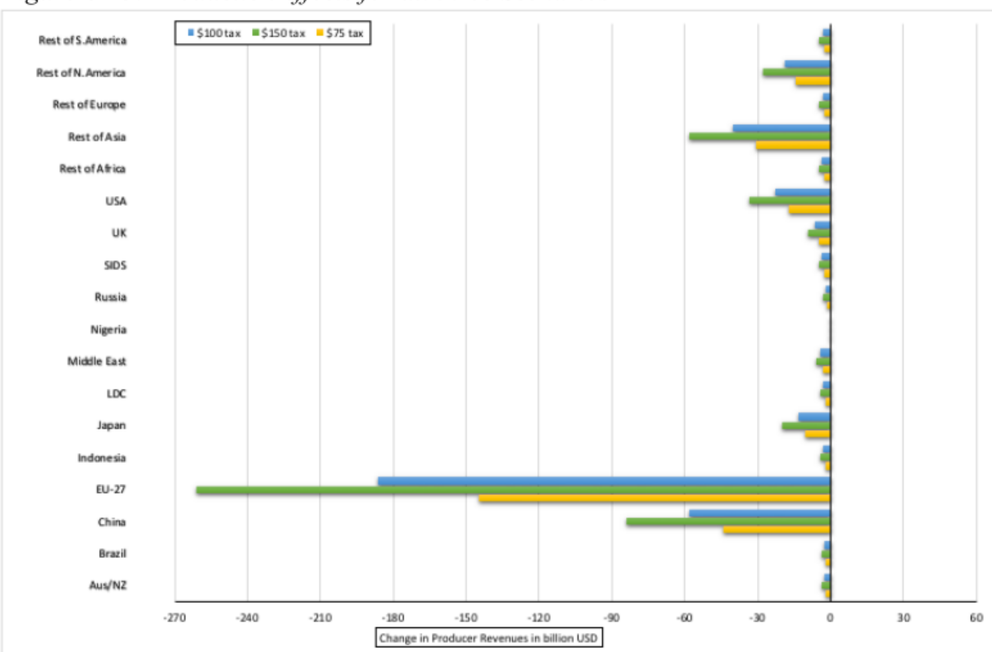
Table 4-9: 6x6 Snippet of the change in bilateral export values for Scenario 2 (wet bulk) (in billion USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	-5,9	-0,2	-31,1	-8,6	-3,4	-7,2
Brazil	-0,5	0,0	-31,6	-20,2	-1,4	-2,3
China	-52,0	-23,9	0,0	-407,2	-34,5	-116,2
EU-27	-31,0	-20,6	-178,7	-1566,9	-7,0	-53,4
Indonesia	-2,2	-0,9	-31,4	-13,6	0,0	-9,5
Japan	-11,2	-2,6	-129,9	-63,4	-11,2	0,0

Source: Calculated and compiled by author

4.3.3 Effect on Producers

Figure 4-13: Production effects for all three Scenarios



Source: Author's compilation of model results

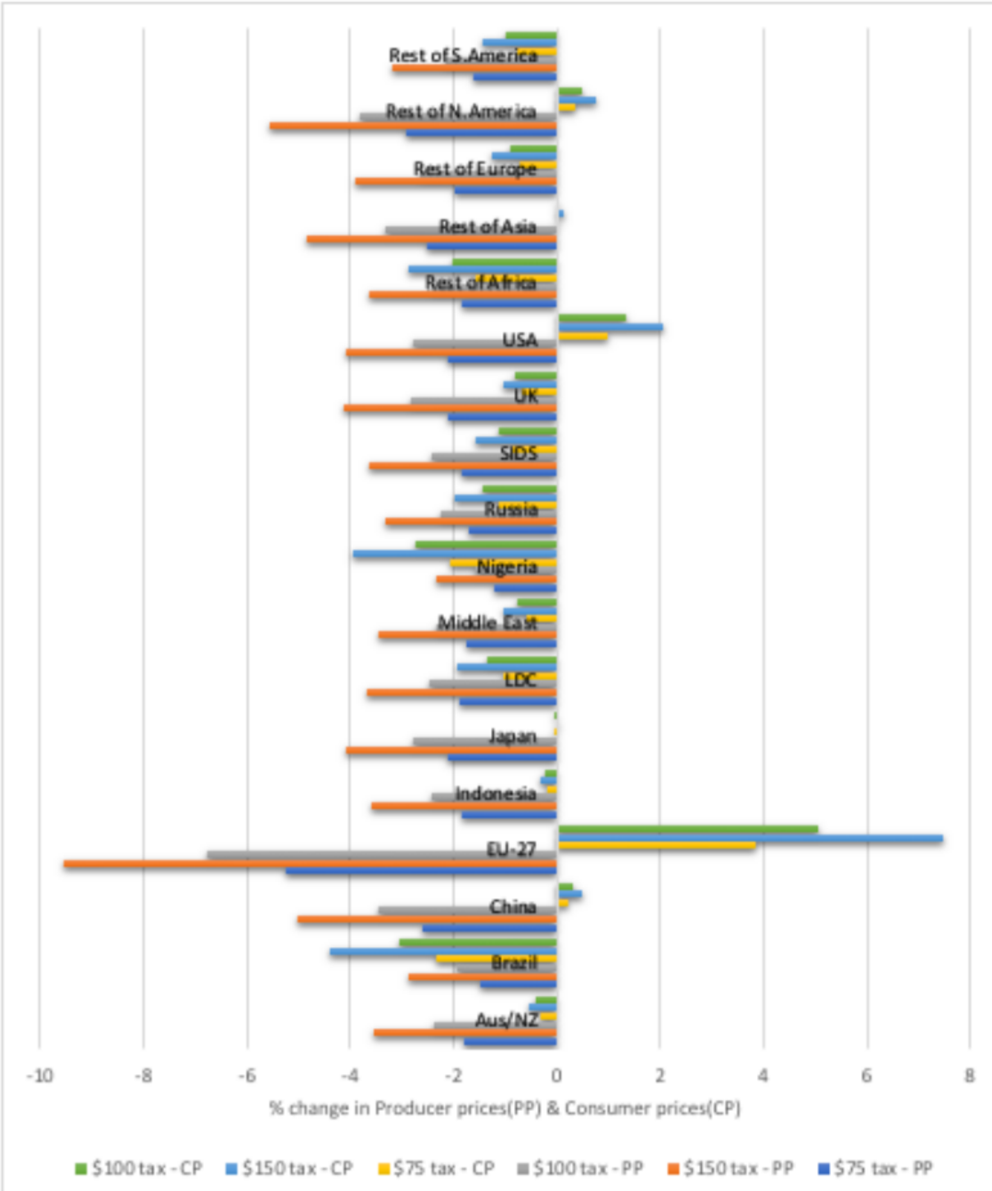
From fig. 4-13, we can observe that, all the production houses of the world suffer with the implementation of a global carbon tax. Similar to the welfare effects, larger economies which are also top exporters of consumer goods and products which are shipped via liner shipping, will face large losses in producer revenues in all scenarios. EU will have about $260 billion in loss of producer revenue in Scenario 2, while China, Rest of Asia and the USA will suffer loss of about $84 billion, $58 billion and $33 billion respectively.

Our model considers two factors while applying the effect due to the carbon tax. First is the distance between the trading nations and second is the amount of trade. All the nations/regions in the figure 4-13 showing a major change in producer revenues are also the largest exported of consumer goods via liner shipping.

4.3.4 Price effects

According to Figure 4-14, the majority of the world's countries and regions will see a decline in consumer prices, with the exception of big importers like the EU, China, the USA, the rest of North America, and the rest of Asia. Due to large import values, the impact on consumer prices is also significant for major importers of consumer products. Due to its high import values that are heavily focused on one particular location, the EU shows a stronger impact. Due to the large nations'/regions' decreased imports, consumers in emerging economies like Brazil, Nigeria, LDC, SIDS, rest of Africa, and Australia gain from this policy. The producer prices on the other hand show a decrease over all the nations/regions with EU, rest of NA, rest of Asia and China being the ones affected the most.

Figure 4-14: Price effects for all three Scenarios



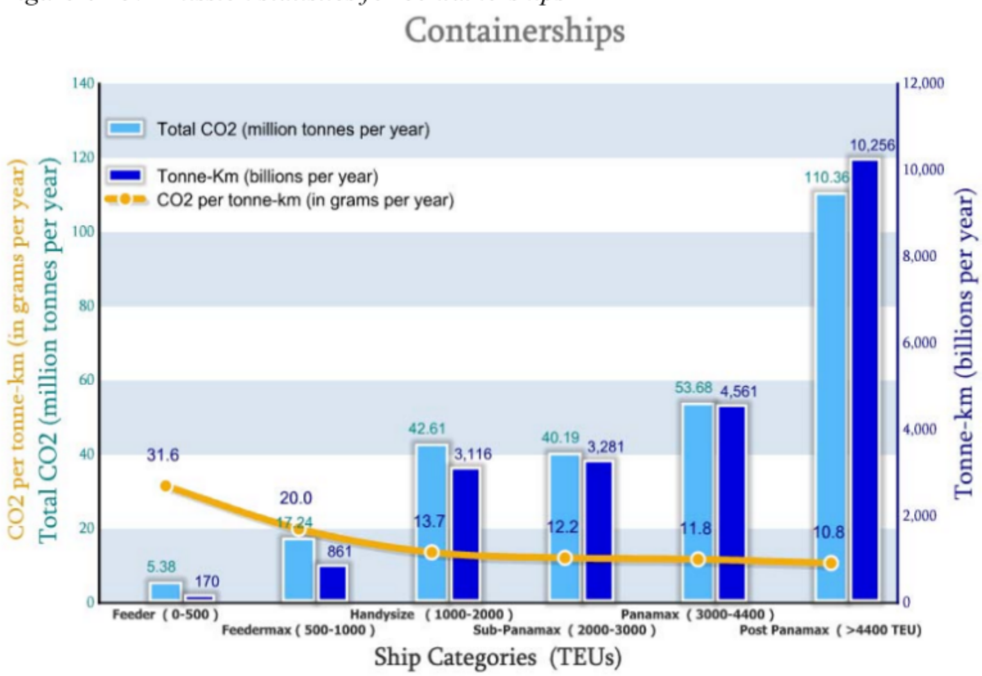
Source: Author's compilation of model results

4.3.5 CO2 effects

We have used data for CO2 produced by bulk carriers as 417 million tonnes (Psaraftis and Kontovas, 2009) as our base value. Using this value, we follow a similar methodology as described in Section 4.1.5 to obtain the reduction in CO2 emissions by dry bulk carriers on each particular trade pair using the percent change in trade between the bilateral trade pairings. Globally, there was a ***261.7 million tonnes, 265.1 million tonnes, 262.9 million tonnes*** reduction in CO2 in total for dry bulk trade in scenario 1,2,3 respectively.

Table 4-7 displays a 6x6 sliver of the change in CO2 emissions for Scenario 1. The Annex 16 contains a complete table with an 18x18 matrix of CO2 emission change.

Figure 4-15: Emission statistics for containerships



Source: (Psaraftis and Kontovas, 2009)

Table 4-10: 6x6 Snippet of bilateral values for change in CO2 emission(in million tons) by dry bulk carriers due to reduction of trade in Scenario 1

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
Aus/NZ	0,0	-0,1	-23,1	-0,6	-0,7	-5,1
Brazil	0,0	0,0	-6,9	-0,9	-0,1	-1,0
China	-0,1	0,0	0,0	0,0	-0,1	-0,3

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan
EU-27	0,0	0,0	-0,3	-3,5	0,0	0,0
Indonesia	0,0	0,0	-1,8	-0,1	0,0	-0,6
Japan	0,0	0,0	-0,1	-0,1	0,0	0,0

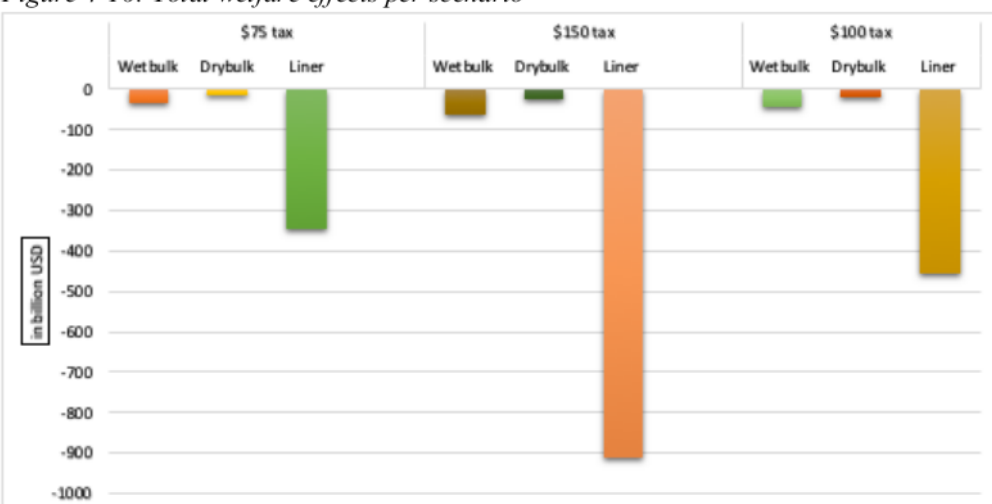
Source: Calculated and compiled by author

4.4 Total effects

4.4.1 Welfare Effects

When analyzing the results from the aforementioned sections, we find that the liner shipping sector, which is the most elastic of all segments, has significant effects of cost changes on net welfare effects and PS/CS. On the other hand, wet and dry bulk segments exhibit very modest changes in these characteristics since they are far more inelastic. We also note that, despite the fact that the wet and dry bulk segments adopt comparable tactics, the outcomes of net welfare differ significantly. Other than major importers and exporters, there was little to no influence on smaller economies in the case of dry bulk trade, however in the case of wet bulk trade, we notice that smaller economies like SIDS, the rest of Africa, and LDC show positive consumer surplus as a result of policy implementation.

Figure 4-16: Total welfare effects per scenario

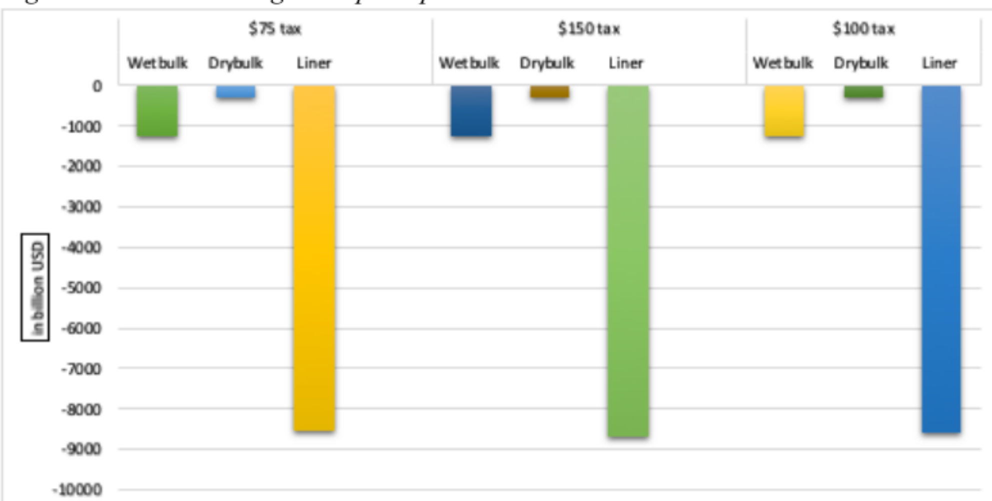


Source: Author's compilation of model results

4.4.2 Trade Effects

As was covered in the sections above, when we switch from a lower tax to a higher tax, we do not notice a significant change, but when we switch from one sort of trade to another, we do. The dry bulk trade clearly suffers the least in terms of trade, but the liner trade, which is the most elastic of all trades, is most negatively impacted (see figure 4-17 below).

Figure 4-17: Total change in exports per scenario

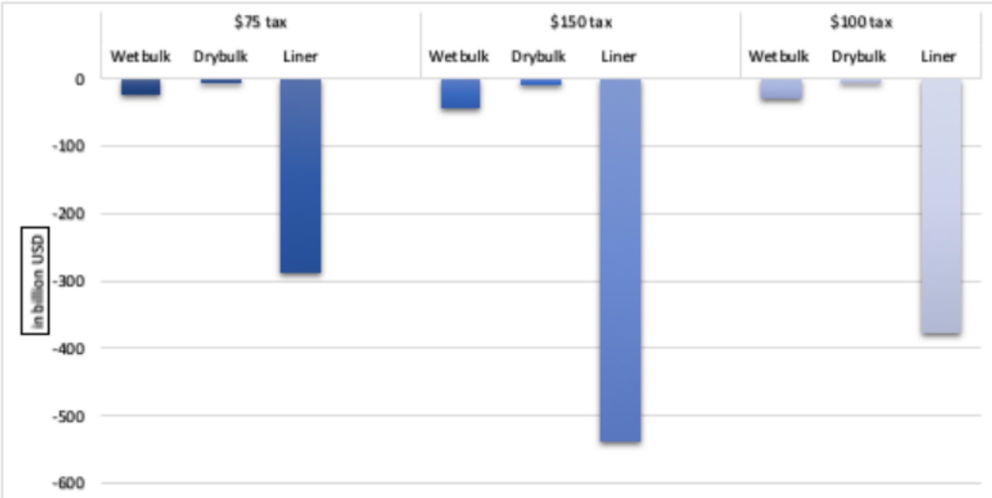


Source: Author's compilation of model results

4.4.3 Effect on Producers

Due to the larger value of trade, as shown in figure 4-18, manufacturers of consumer goods that engage in liner trade are those who are most impacted. For a similar reason, the producer revenues of wet bulk trade are likewise impacted more than those of dry bulk trade. The disruption in trade out of one country, namely Australia, had the biggest impact on producer revenues in the dry bulk trade.

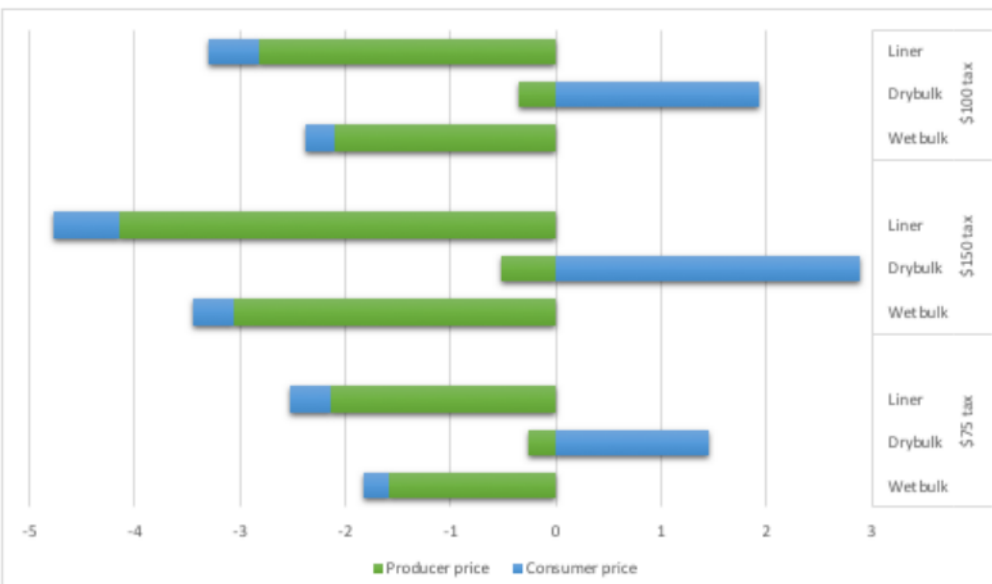
Figure 4-18: Total change in producer revenue per scenario



Source: Author's compilation of model results

4.4.4 Price effects

Figure 4-19: Total price effect per scenario

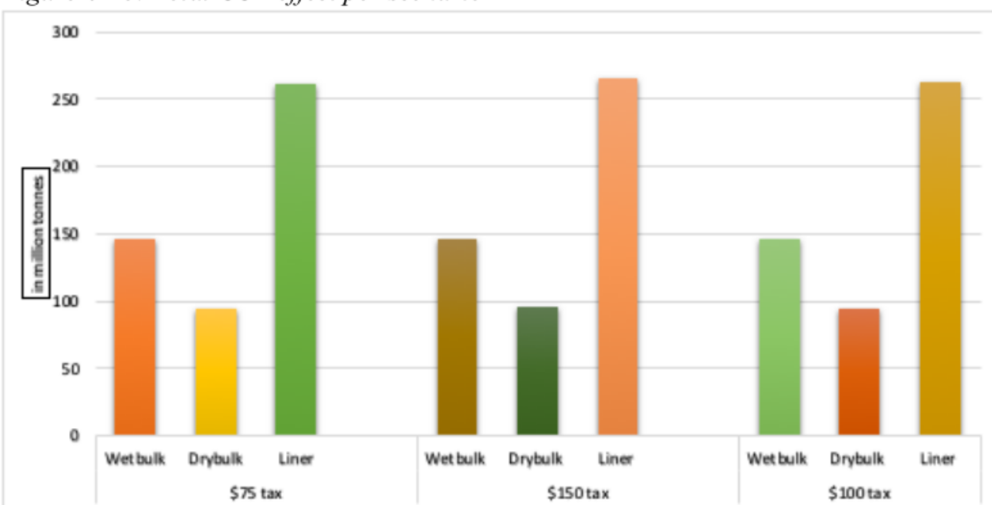


Source: Author's compilation of model results

Figure 4-19 below makes it abundantly clear that only the dry bulk trade has seen an overall increase in consumer costs. When we dig deeper, we see that imports for the dry bulk trade did not significantly change. China alone was impacted. The EU, USA, and Japan, which were ranked second, third, and fourth in terms of the volume of imports, remained untouched, which had little impact on global prices. When a tax is implemented, this causes a definite increase in domestic consumer prices across all countries and areas.

4.4.5 CO2 effects

Figure 4-20: Total CO2 effect per scenario



Source: Author's compilation of model results

It can be claimed that the impact on CO2 emissions is exactly proportionate to commerce. Increased trade causes an increase in CO2 emissions, and vice versa. Figure 4-20, which supports this idea and provides semantic outcomes, is below. The liner trade has the greatest impact on emission change, with wet bulk trading coming in second and being followed by dry bulk trading.

4.5 Transport impact of global carbon tax

In order to evaluate how the global carbon price will impact transportation, we used two independent methodologies. For dry and wet bulk cargo, where the commodity is much more concentrated and the historical data regarding the commodity price per unit is much more readily available from the World Bank data repository, we employed the average price per unit method. We used a different methodology to determine the transport impact on containerized cargo because the commodities are not uniform and are more homogeneous. The current operational fleet data from (Clarksons Research, 2022) was used in this calculation.

Average price per unit

A similar methodology was used to determine the transport impact in a study by (Ecorys, 2015), where the impact of CETA and TTIP on the Canadian and regional trade volumes was calculated. The change in trade values was transformed into change in trade volumes using the average price per unit per commodity where commodities were separated into groups using the HS code categorization. With the help of the average price per unit obtained from (World Bank, IBRD.IDA, 2019), we used a similar process to translate the change in trade values obtained from the econometric model into volumes. The region-specific table extract for both wet bulk and dry bulk cargo is shown under each scenario sub-heading below.

Operational fleet data

The most recent shipping intelligence data used to analyze the operational liner fleet was sourced from (Clarksons Research, 2022). The number of ships and the TEU currently in use were acquired. This was taken into account as the default scenario in which no tax is levied. The ultimate operational fleet in each scenario was then calculated by superimposing the % change in trade values obtained from the econometric model on the present operational fleet.

For a further subdivision into effect on major trade lanes, the bilateral trade data was divided into various trade lanes manually. The change in TEU was then calculated for each trade lane in each scenario. A graphical representation of this calculation may be seen in Figure 4-21.

4.5.1 Scenario 1 ($75/ton)

For this scenario, where a worldwide carbon price of $75 per ton is taken into consideration, the change in trade values are as listed in the Annex 15. The results are listed in below tables as change in bilateral trade volumes out of the major exporting countries for dry bulk, wet bulk and container segments. Full tables may be found in Annex 19.

Table 4-11: Change in bilateral trade volume(million tons) for wet bulk in Scenario 1

Countries	China	EU-27	Japan	SIDS	USA	ROA
ME	-129,8	-64,5	-78,2	-32,2	-33,4	-216,4
Russia	-38,5	-66,9	-7,3	-4,9	-15,7	-11,9
EU-27	-5,1	-100,3	-0,6	-4,4	-13,8	-4,8
RONA	-1,7	-6,4	-0,8	-0,5	-88,3	-4,9
ROA	-22,4	-4,4	-11,1	-19,8	-6,4	-16,5
USA	-14,7	-37,0	-9,0	-5,2	0,0	-12,9

Source: Calculated by author based on data from model and World Bank

Table 4-12: Change in bilateral trade volume(million tons) for dry bulk in Scenario 1

Countries	China	EU-27	Japan	RONA	ROA
Aus/NZ	-480,1	-12,8	-106,4	-0,2	-94,5
Brazil	-138,7	-18,1	-20,8	-0,9	-11,4
USA	-45,3	-25,3	-27,6	-0,4	-2,5
Russia	-26,3	-19,4	-9,1	0,0	-29,2
RONA	-22,2	-17,0	-9,5	-0,2	-20,5

Source: Calculated by author based on data from model and World Bank

Table 4-13: Change in bilateral trade volume('000 TEU) for containers in Scenario 1

Countries	China	EU-27	UK	USA	ROA	RONA
EU-27	-354,0	-2858,6	-365,7	-636,1	-199,8	-129,7
China	0,0	-762,5	-104,5	-675,8	-389,1	-204,0
ROA	-537,0	-342,5	-39,1	-484,4	-216,4	-97,7
USA	-172,8	-344,1	-65,3	0,0	-134,6	-390,1
RONA	-47,9	-79,0	-20,2	-643,1	-18,1	-57,4
Japan	-246,3	-120,3	-15,2	-171,7	-164,5	-35,7

Source: Calculated by author based on data from model and Clarkson's research

$$\% \, reduction \, in \, wet \, bulk \, exports \, (calculated \, from \, model)$$ ***Equation 4-1***

$$= \; 62.02\%$$

$$absolute \, wet \, bulk \, tonnage \, reduction = 0.6202x710.2$$

$$= 440.5 \, million \, tonnes$$

$$\% \, reduction \, in \, dry \, bulk \, exports \, (calculated \, from \, model)$$

$$= \; 62.38\%$$

$$absolute \, dry \, bulk \, tonnage \, reduction = 0.6238x944.1$$

$$= 588.9 \, million \, tonnes$$

$$\% \, reduction \, in \, liner \, exports \, (calculated \, from \, model)$$

$$= \; 62.75\%$$

$$absolute \;\; TEU \, reduction = 0.6275x26207.6 = 16445.3 \, '000TEU$$

From section 4.4.5 we have

$$\% \, reduction \, in \, global \, CO2 \, emissions \, (from \, model)$$ ***Equation 4-2***

$$= \left(\frac{502.26}{838.95}\right) = 59.87\%$$

$$\% \, reduction \, in \, EU \, emissions \, (from \, model) = (102.35/\; 172.83)$$

= 59.22 %

4.5.2 Scenario 2 ($150/ton)

We summarize the results for Scenario 2 using a similar methodology as described in section 4.5.

Transport impact

Table 4-14: Change in bilateral trade volume(million tons) for wet bulk in Scenario 2

Countries	China	EU-27	Japan	SIDS	USA	ROA
ME	-132,0	-62,0	-77,8	-31,2	-31,5	-225,7
Russia	-38,4	-68,3	-7,2	-4,9	-15,5	-11,1
EU-27	-4,6	-103,1	-0,6	-4,2	-13,4	-4,2
RONA	-1,5	-6,0	-0,7	-0,4	-90,3	-4,0
ROA	-22,5	-4,4	-11,1	-20,3	-6,3	-16,0

Countries	China	EU-27	Japan	SIDS	USA	ROA
USA	-14,4	-37,3	-9,1	-5,1	0,0	-12,0

Source: Calculated by author based on data from model and World Bank

Table 4-15: Change in bilateral trade volume(million tons) for dry bulk in Scenario 2

Countries	China	EU-27	Japan	RONA	ROA
Aus/NZ	-507,7	-10,5	-105,1	-0,1	-91,7
Brazil	-138,7	-18,3	-20,9	-0,9	-11,3
USA	-42,5	-25,8	-28,7	-0,4	-26,7
Russia	-24,3	-19,8	-9,3	0,0	-21,1
RONA	-20,9	-17,5	-9,8	-0,2	-9,9

Source: Calculated by author based on data from model and World Bank

Table 4-16: Change in bilateral trade volume('000 TEU) for containers in Scenario 2

Countries	China	EU-27	UK	USA	ROA	RONA
EU-27	-343,4	-3011,7	-361,4	-634,6	-193,3	-126,5
China	0,0	-782,7	-104,0	-690,9	-393,6	-204,6
ROA	-547,2	-348,0	-39,1	-492,3	-218,2	-97,1
USA	-173,5	-350,7	-65,6	0,0	-134,0	-397,6
RONA	-47,4	-79,3	-20,2	-656,1	-17,6	-57,4
Japan	-249,7	-121,9	-15,3	-173,4	-165,9	-35,9

Source: Calculated by author based on data from model and Clarkson's research

$$\%\, reduction\ in\ wet\ bulk\ exports\ (calculated\ from\ model) = 62.20\%$$ ***Equation 4-3***

$$absolute\ wet\ bulk\ tonnage\ reduction = 0.6220x710.2 = 441.7\ million\ tonnes$$

$$\%\, reduction\ in\ dry\ bulk\ exports\ (calculated\ from\ model) = 63.03\%$$

$$absolute\ dry\ bulk\ tonnage\ reduction = 0.6303x944.1 = 595.1\ million\ tonnes$$

$$\% \, reduction \, in \, liner \, exports \, (calculated \, from \, model)$$
$$= \, 63.58\%$$
$$absolute \, TEU \, reduction = 0.6358x26207.6 = 16662.8 \, '000TEU$$

CO2 impact

$$\% \, reduction \, in \, global \, CO2 \, emissions \, (from \, model) \qquad \textbf{Equation 4-4}$$
$$= \left(\frac{507.11}{838.95}\right) = 60.45\%$$
$$\% \, reduction \, in \, EU \, emissions \, (from \, model) = (104.07/172.83)$$
= 60.22 %

4.5.3 Scenario 3 ($100/ton)

We summarize the results for Scenario 3 using a similar methodology as described in section 4.5.

Transport impact

Table 4-17: Change in bilateral trade volume(million tons) for wet bulk in Scenario 3

Countries	China	EU-27	Japan	SIDS	USA	ROA
ME	-130,5	-63,6	-78,0	-31,9	-32,7	-219,6
Russia	-38,5	-67,4	-7,2	-4,9	-15,6	-11,6
EU-27	-4,9	-101,3	-0,6	-4,3	-13,6	-4,6
RONA	-1,6	-6,3	-0,7	-0,5	-89,0	-4,6
ROA	-22,4	-4,4	-11,1	-20,0	-6,3	-16,3
USA	-14,6	-37,1	-9,0	-5,2	0,0	-12,6

Source: Calculated by author based on data from model and World Bank

Table 4-18: Change in bilateral trade volume(million tons) for dry bulk in Scenario 3

Countries	China	EU-27	Japan	RONA	ROA
Aus/NZ	-489,7	-12,1	-105,9	-0,2	-93,5
Brazil	-138,6	-18,1	-20,8	-0,9	-11,3
USA	-44,4	-25,5	-28,0	-37,7	-26,6

Countries	China	EU-27	Japan	RONA	ROA
Russia	-25,6	-19,6	-9,2	-0,2	-20,7
RONA	-21,7	-17,1	-9,6	-1,1	-10,0

Source: Calculated by author based on data from model and World Bank

Table 4-19: Change in bilateral trade volume('000 TEU) for containers in Scenario 3

Countries	China	EU-27	UK	USA	ROA	RONA
EU-27	-350,2	-2913,1	-364,0	-635,2	-197,5	-128,5
China	0,0	-769,4	-104,3	-681,0	-390,6	-204,2
ROA	-540,5	-344,4	-39,1	-487,0	-217,0	-97,5
USA	-173,0	-346,4	-65,4	0,0	-134,4	-392,7
RONA	-47,8	-79,1	-20,2	-647,6	-17,9	-57,4
Japan	-247,4	-120,9	-15,3	-172,3	-165,0	-35,7

Source: Calculated by author based on data from model and Clarkson's research

$\%\, reduction\ in\ wet\ bulk\ exports\ (calculated\ from\ model)$ ***Equation 4-5***

$= \ 62.08\%$

$absolute\ wet\ bulk\ tonnage\ reduction = 0.6208x710.2$

$= 440.9\ million\ tnnes$

$\%\, reduction\ in\ dry\ bulk\ exports\ (calculated\ from\ model)$

$= \ 62.60\%$

$absolute\ dry\ bulk\ tonnage\ reduction = 0.6260x944.1$

$= 591.0\ million\ tonnes$

$\%\, reduction\ in\ liner\ exports\ (calculated\ from\ model)$

$= \ 63.04\%$

$absolute\ TEU\ reduction = 0.6304x26207.6 = 16521.3\ '000TEU$

CO2 impact

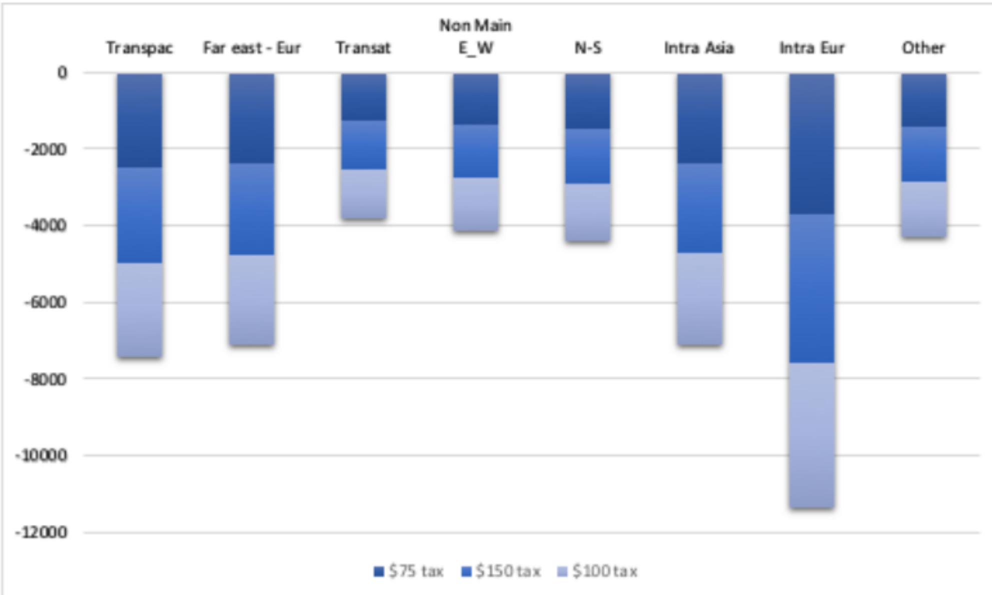
$\%\, reduction\ in\ global\ CO2\ emissions\ (from\ model)$ ***Equation 4-6***

$$= \left(\frac{503.93}{838.95}\right) = 60.07\%$$

$\%\, reduction\ in\ EU\ emissions\ (from\ model) = (102.95/172.83)$

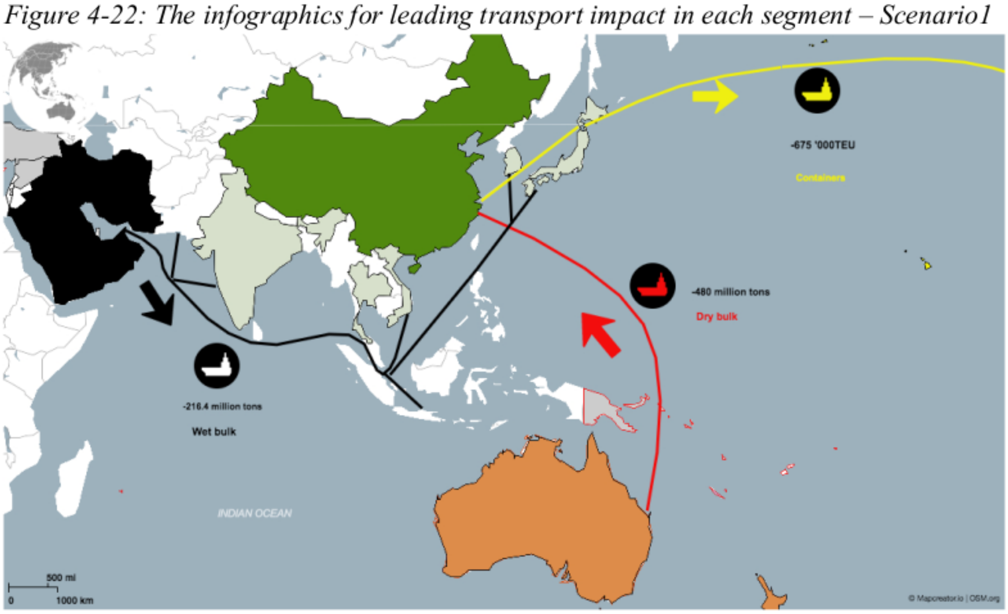
= 59.57 %

Figure 4-21: The transport impact on line shipping trade lane wise for all three scenarios (in '000 TEUs)



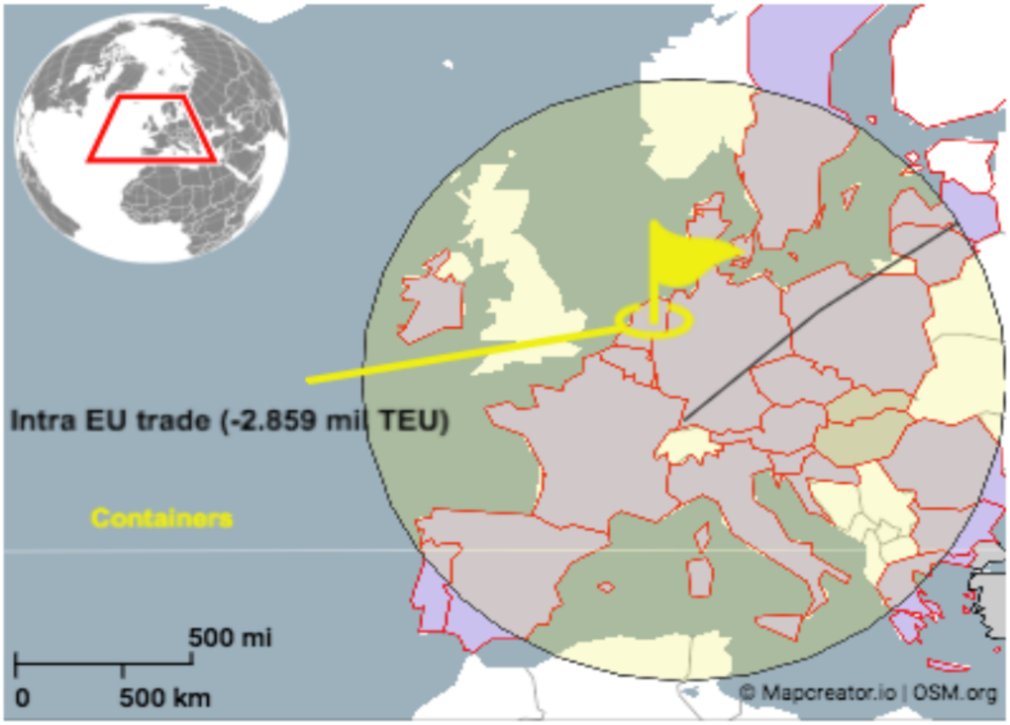
Source: Author's calculation (Data: Model, (Clarksons Research, 2022))

Figure 4-22: The infographics for leading transport impact in each segment – Scenario1



Source: Prepared by author based on calculation from econometric model

Figure 4-23: The infographics for transport impact within EU for liner trade – Scenario1



Source: Prepared by author based on calculation from econometric model

4.6 Sensitivity Analysis

The interpretation of shifting consumer and producer surplus with regard to elasticity values was muddled by the results of the econometric analyses that were given. These include the notion that wet bulk product import demand elasticity is relatively low, and that wet bulk product export supply elasticity is similarly low, based on the literature that is currently accessible. We discovered literature with somewhat low import demand elasticities for dry bulk commodities as well. In terms of import demand and export supply, the elasticities were thought to be rather constant for liners trade. Based on how customers behave toward the various product categories, reasonable assumptions about the substitution elasticities were also made.

Therefore, it is essential to research how surplus values react to variations in elasticity. This involves evaluating several inputs for the elasticities. The first section will concentrate on substitution elasticities. An international analysis will be carried out because it is presumed that they are region-generic. The second section looks at how variation in import demand and export supply elasticities of different product categories impact surplus values relative to each scenario. This will shed some light on the above-mentioned uncertainties. Additionally, because elasticity values react to broader market movements, time value is introduced. This may entail, for instance, the use of innovative technology or alternative fuel, which would increase the elasticity of import demand in case of wet bulk products. All in all, the sensitivity analysis will enable us to determine how susceptible our model is to our presumptions.

4.6.1 Substitution Elasticity

The extent to which domestically produced goods may replace imported goods is defined as substitution elasticity in plain terms. The greater the substitution elasticity, the more willing consumers are to choose the alternative that is relatively less expensive, such as sourcing internally. The PE econometric model typically employs a substitution elasticity of 1 to 5. For wet bulk, dry bulk, and liner trade, we have utilized substitution elasticities of 5, 8, and 2, respectively.

For each cargo segment, we have picked three substitution elasticities to conduct a sensitivity analysis. Low, mid, and high substitution elasticities are represented by values of 1.5, 5.0, and 10. Below for each segment, the outcomes of PS, CS, and Welfare effect are compared.

Wet bulk (Figures 4-21, 4-22, 4-23)

Only the main producing economies like the EU, Middle East, Russia, and USA are showing some effect, although the change with varying elasticity is not significant. In this segment, the original SE was regarded as 5. By changing the amount to a lower one, we can see that the largest exporters' PS has decreased ($1.6 billion for M/E). No significant changes in PS are observed when the SE is increased to a value of 10. When we compare the CS over the three SE, a similar effect is observed for major importing nations/regions like EU, ROA and China. The EU's net welfare is most negatively impacted (down by $0.6

billion). Overall, no significant effects are seen, hence it is safe to say that the model is not overly sensitive to changes in SE of wet bulk products.

Dry bulk (Figures in Annex 17)

On the producer side, Australia is the sole country most impacted. We see that when we set the SE to a low value, there is an increase of $0.65 billion or a 25% rise. Interestingly, China's CS value rises first from a low SE to a mid SE before falling for a high SE. When China moves from low SE to mid SE, there are noticeable changes in WE (+$0.74 billion, 4.5% change). There are no significant effects on the model other than these slight modifications.

Figure 4-24: Wet bulk producer surplus in billion USD (Sensitivity to SE)

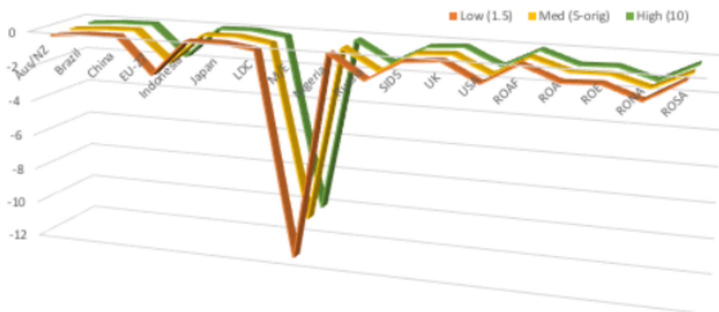


Figure 4-25: Wet bulk consumer surplus in billion USD (Sensitivity to SE)

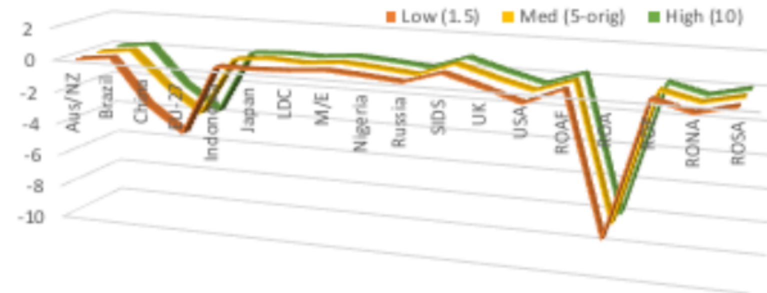
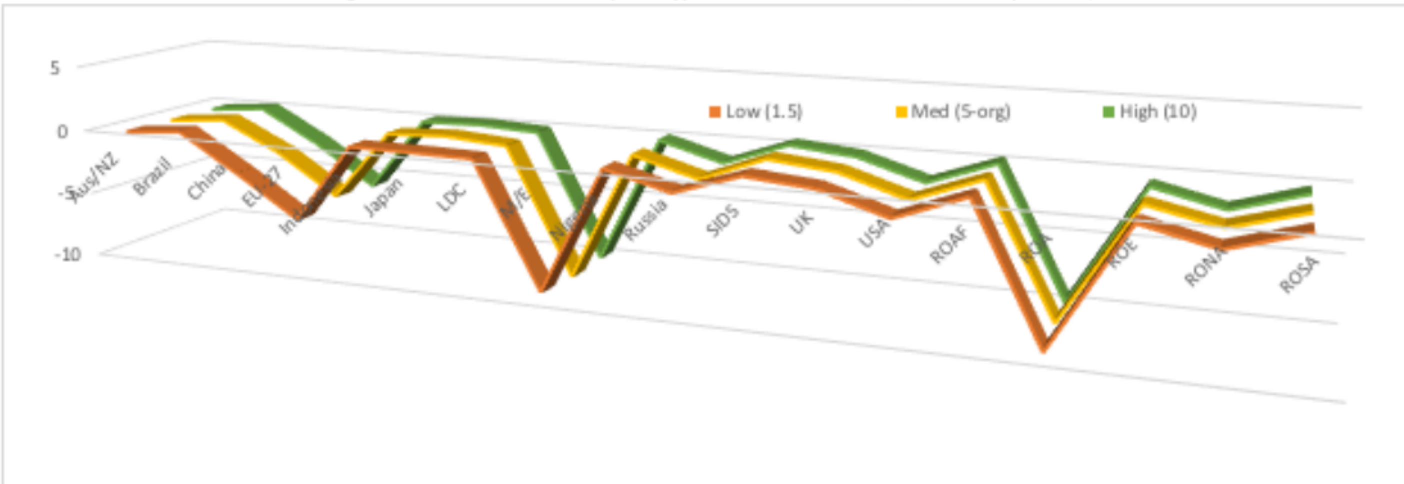


Figure 4-26: Wet bulk welfare effect in billion USD (Sensitivity to SE)



Source: Author's compilation of model results

Containers (Figures in Annex 17)

The countries or regions of interest for this study include China, the EU, the rest of Asia, and the USA. Every time the SE is increased, the PS for the EU goes up by $2 billion, or 1.9%. On the other hand, when the SE is increased to 5, the CS first falls by $7 billion or 3.2%, and it then rises by $3 billion or 1.3% when the SE is extended to 10. When the SE was changed from its current value of 2 to a high SE value of 10, welfare for the EU increased by 1.2%. The impact of change in SE on other countries is relatively small.

4.6.2 Import demand and export supply elasticity

Trade elasticities frequently change over time as a result of economic trends and developments. This could be on either the import supply or demand side, or both. A global maritime carbon tax's impact on the import and export sides can also change over time due to such conditions.

This study includes three new categories in addition to the one already in use as indicated in section 3.6, namely elastic supply and demand (S=2,D=(-1.5)), inelastic supply and demand (S=0.7,D=(-0.7)), and highly inelastic supply and demand (S=10,D=(-10)). With this in mind, it is also conceivable to state that supply and demand may become less elastic in the future. Two further elements of the completed analysis must be mentioned. First of all, just one scenario per category is examined. Secondly, both elasticity changes have been made at the same time. So, individual effect of import demand and export supply elasticities are not shown.

Wet bulk (Figures 4-24, 4-25, 4-26)

On the producer side, countries like ME, EU, Russia, USA, and RONA are of interest. On the consumer side, countries like China, EU, and ROA are. On both the supply and demand sides, our initial elasticities for the wet bulk segment were comparatively inelastic. PS for ME increased significantly by $4 billion, or 31%, when demand and supply were changed to the elastic values described above. Other significant exporters also experienced PS changes of a comparable size. The values for ME grow by about 50% when we compare the initial PS values to the PS in a highly elastic supply and demand environment. When supply and demand are made elastic, the three main importers—China, the EU, and ROA—

show a sharp increase in CS. Values for China show increase of 148% ($4.3 billion), the EU by 100% ($4.9 billion), and ROA by 60% ($6 billion). The Chinese consumers are not much impacted by further rising elasticity values, but the ROA consumer surplus continues to rise by 20% ($3.3 billion) when the supply and demand are made highly elastic. Our model shows sensitivity to D&S elasticities in this segment.

Dry bulk (Figures in Annex 18)

On the production side, we'll investigate the effects on Australia, and on the consumer side, we'll monitor the effects on China and ROA. For this sector, we employed an elastic supply and a rather inelastic demand originally. We observe a decline in PS as we move from our initial state to one where demand and supply are both made elastic. This fall in PS continues when demand and supply are both made inelastic. On the other hand, we have the highest PS values for extremely elastic D&S. When D&S are elastic for China and ROA, the CS rises significantly. A subsequent rise is shown while the D&S elasticities are made inelastic, where ROA even assumed a positive value. The CS for both China and ROA lowers significantly for highly elastic values. Yet again, the model is remarkably sensitive to variations in elasticities for this segment.

Containers (Figures in Annex 18)

We begin by examining the impact on PS for the key exporters in this sector, including the EU, China, ROA, and USA. For this sector, we initially used elastic demand and inelastic supply values. When both D&S were made elastic, PS for the EU increased significantly by $43 billion (28.9%) and by $12.4 billion (26%) for China. For values of inelastic D&S, the PS is not much impacted. The PS for all major exporters significantly rises when the D&S elasticity values are made highly elastic. EU saw a 53% increase ($79 billion) while China saw an almost 39.6% increase ($19 billion). For ROA and USA, comparable impacts are seen. EU CS declines significantly by 30.7% ($104 billion). China sees a nearly 300% decline in CS values. The D&S value margins are significantly wider for highly inelastic products. All of the major exporting and importing countries' elasticity values have a drastic impact on the model's behavior.

Figure 4-28: Wet bulk producer surplus in billion USD (Sensitivity to D&S elasticities)

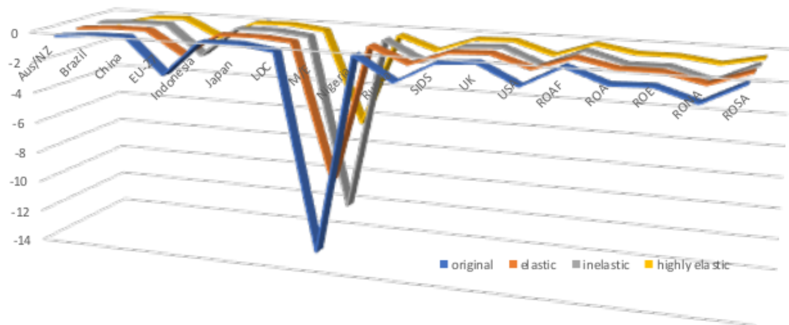


Figure 4-27: Wet bulk consumer surplus in billion USD (Sensitivity to D&S elasticities)

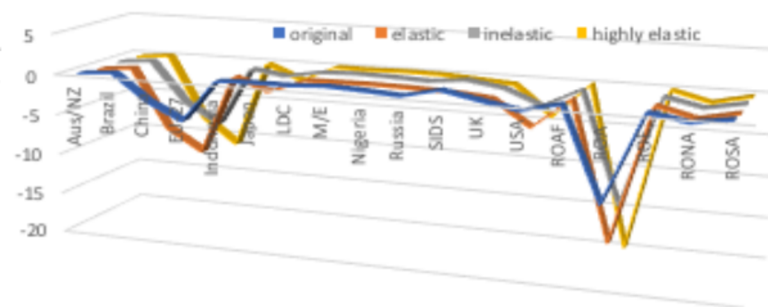
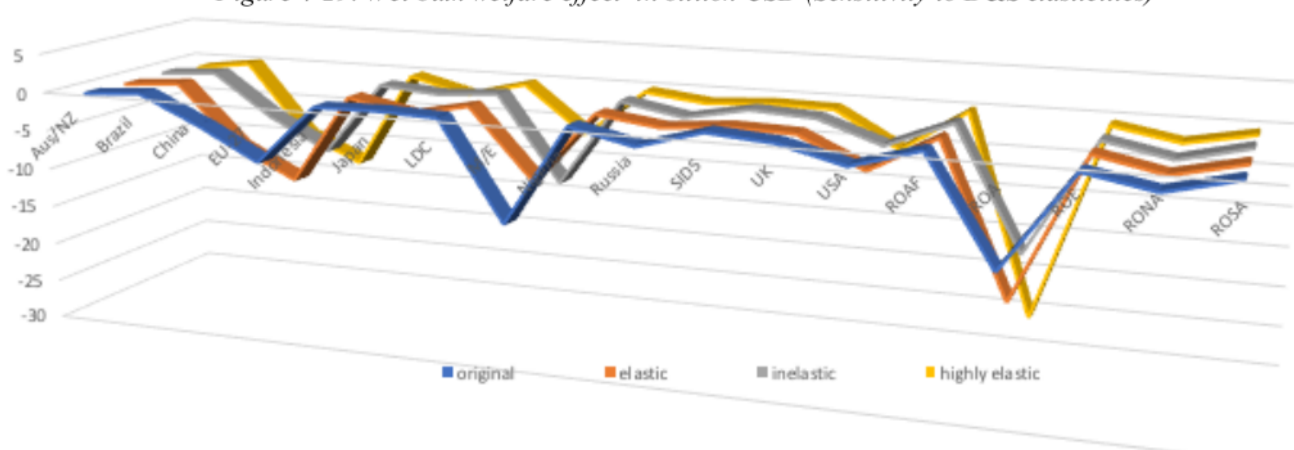


Figure 4-29: Wet bulk welfare effect in billion USD (Sensitivity to D&S elasticities)



Source: Author's compilation of model results

Chapter 5 Conclusions

5.1 Main findings

Due to the size of the study, a variety of aspects of the intricate economic, trade and transport effects of the global carbon tax were examined from a maritime perspective to report the effects of such a market-based measure. The following conclusions were reached after qualitative analysis of important shipping segments and analysis of the econometric model's results. This conclusion will also provide a summary of the research's responses to all sub-questions.

The primary research topic was broken into six sub-research questions in order to provide a thorough analysis. Organizing the maritime sector into three principal shipping sectors was the first challenge. Global seaborne trade has a significant share of global trade. 70% of all trade is carried by sea in terms of value and about 80% by volume. By further dividing trade into its component cargo segments using UNCTAD statistics, we were able to identify three major groups: liner industry, which is primarily dominated by container shipping; wet bulk, which is dominated by crude oil and oil products; and dry bulk, which is dominated by coal, steel, and iron ore. While the container trade has the largest share of the world's seaborne trade by value, dry bulk trade has the largest share by volume. We were able to respond to our first sub-research question using the statistical information provided by UNCTAD.

As a part of our research, we had to also delve into the current industry trends to have a bird's eye view of the approach taken by the key stakeholders. We discussed this in Chapter 2, where we discovered several ideas from stakeholders like shipping companies, IMO member states, and ship owner unions (ICS). The recommendation on taxing shipping was utterly different from other vantage points. This discussion was also our foundation for formulating tax values for our model scenarios. Without a justification for carbon taxes, our analysis would be lacking in both substance and foundation. This was also covered in Chapter 2, which provides a strong technological argument for a global maritime carbon price. In order to help developing countries advance toward a greener future, it is also discussed that a new revenue stream for GCF needs to be established. Additionally, the merits of a global tax over a domestic tax are explored. This will enhance climate funding rather than national treasuries, which will be more beneficial.

To answer the sub-research question (4), we had to define our experiment or, in other words, the shock we will input into our econometric model. Our shock was a non-tariff shock. There were cost changes in the operation of the ships. Various literature, including (Stopford, 2009) and (Kalli, Karvonen, and Makkonen, 2009), were referred to for this purpose. We chose the more detailed and recent study by Kalli for our research, which clearly distinguished the operational costs for various types of ships. We then used the model by (Anderson and Wincoop, 2004) to incorporate these changes into the NTMs by altering the transportation costs part of it.

Further, we found the freight cost tariff equivalent for each bilateral trade pair to introduce the effect of distance between the two nations. We did it to state that distant nations will incur more costs compared to nearer ones. Then we had also to consider the effect of the magnitude of trade between two countries, i.e., the more trade there is, the higher the costs will be. For this, we took the original cost and assigned it a value of the weighted average of the global trade and then formulated higher costs for the bilateral pairs with more trade and vice versa. In Chapters 3 and 4 combined, we were able to answer our sub-research question (4).

Finally, we concluded with the sub-research question (6), which results from our quantitative analysis using the PE econometric model. The economic, trade, and transport impact was divided into three major shipping segments to give disaggregated effects on the major shipping sectors. For Scenario 1 ($75 tax), we will present some significant numbers that came from our research in the sections below. Scenario 2 and 3 results are linearly impacted.

Firstly, the wet bulk segment, where the significant exporters are ME, Russia, the EU and the USA. The impact on these producers will be huge, ranging from \$1.1 billion to \$10.1 billion. Major importers (consumers) likewise will also encounter huge losses from \$2.1 billion for China to \$7.9 billion for ROA. The consumers of countries/regions on the lower side of import values stand to gain from these policy changes for e.g. Japan, LDC, SIDS, ROAF. Amongst the trade routes with the maximum effect on trade were the trade from ME-ROA, ME-China, ME-Japan, ME-USA, ME-EU, Russia-China & Russia-EU. The value of exports from ME will be reduced by about \$418 billion. Additionally, exports from the EU, Russia, and the USA will decrease by almost \$110 billion apiece. The producer prices will fall in all the producing countries, with ME experiencing the most price decrease (4%). High consumer prices are having an impact on the main importers, with ROA experiencing the largest consumer price rise (about 1.9%). ME's producer revenues will drop by almost \$12.1 billion followed by the EU and Russia with fall of \$2.2 billion and \$1.6 billion respectively. We estimate that a decrease in wet bulk trade will result in a reduction in CO_2 emissions of roughly 146 million tons since the impact on world CO_2 emissions is proportionate to the impact on international trade. We were able to calculate the impact on wet bulk transport of 441 million tons using the methods in section 4.5. Major trade routes that will experience a decrease in trade include ME-China (down 130 million tons), ME-ROA (down 216 million tons), and intra-EU trade (down 100 million tons).

For the dry bulk segment, trade out of Australia will be the one most affected. The trade routes Aus/NZ-China, Brazil-China, Aus/NZ-Japan, Aus/NZ-ROA, intra-EU, and Indonesia-ROA will be the most affected ones. The PS loss of \$1.6 billion will be experienced by Aus/NZ, while the highest CS loss for China amounts to \$7.9 billion. The positive PS in the ROAF, RONA, ROSA, and LDC regions is due to an increase in producer prices there as a result of a decline in imports and higher reliance on the domestic suppliers. Brazil is the second-largest bulk exporter after Australia and New Zealand, but the impact for Brazilian producers is rather minimal because Australia also engages in substantial trade with Japan and ROA (distant regions). Contrarily, Brazil trades with these areas on a relatively small scale, hence the impact of distance on Brazilian trade is lessened and only significantly affects one trade route (Brazil-China). Australian producers, who account for 36% of all dry bulk exports, also experience significant revenue losses of $4.9 billion and a 2.6% drop in producer prices. China will experience the highest increase in consumer prices, which is about 3.4%, while the EU will experience a consumer price increase of 1.9%. The USA, RONA, ROSA, the UK, and ME are next, but the impact of the consumer price increase on these countries/regions is not as great due to the lower values of import. Australia's overall trade will decline by roughly $114 billion. Brazil's exports will decrease by $35 billion, while US exports will decrease by $31 billion. The estimated reduction in CO2 emissions as a result of the decline in dry bulk export values was found to be in the range of 94 million tons. The impact on transport was calculated by converting the change in dry value export values to volumes. Results indicated that the volume of dry bulk trade globally will decline by 589 million tons. Major trade routes that will experience a decrease in trade include Aus/NZ-China (down 480 million tons), Brazil-China (down 139 million tons), Aus/NZ-Japan (down 106 million tons), and Aus/NZ-ROA trade (down 95 million tons).

The liner segment was the most affected due to the higher trade values in this segment. From the trade value data, it was apparent that the most trade is intra-EU in this segment, followed by China-EU, China-USA, EU-USA, RONA-USA, ROA-China & ROA-USA - basically, the trans-pacific, trans-Atlantic, and far east-Europe trade lanes. Not surprisingly, trade out of the EU will be the most affected, with a loss of $2.7 trillion, followed by China exports ($1.5 trillion) and ROA exports ($1.1 trillion). It is estimated that producers in key exporting nations including the EU, China, ROA, and the USA will lose roughly $83 billion, $25 billion, $17 billion, and $10 billion, respectively. With the introduction of this policy, consumers in nations like Brazil, SIDS, LDCs, and Nigeria will benefit slightly, while among the big importers, the EU will have a huge CS loss of $168 billion, followed by the USA with a loss of $25 billion. The introduction of the worldwide tax policy has had the greatest impact on intra-EU trade, which is the EU's primary source of revenue. The EU's producer revenues will decrease by $145 billion, China's by $44 billion, and the USA's by $30 billion. This is a result of a parallel decline in producer prices in these regions with a decline of 5.2% in the EU, 2.6% in China, and 2.5% in ROA. While nations like Brazil and Nigeria show the highest price drops of 2.0–2.2%, the EU's consumer prices show the biggest increase of 3.8%. When we consider the enormous trade value change connected with liner transport, it makes sense that the estimated reduction in CO2 emissions as a result of the decline in liner export values is in the range of 262 million tons. The transport impact on the liner shipping was determined by converting the change in export values to volumes. According to the findings, liner trade will decrease by 16445 ′000TEU globally. Major trade routes that will experience a decrease in trade include intra-EU (down 2859 ′000TEU), China-EU (down 763 ′000TEU), China-USA (down 676 ′000TEU), RONA-USA (down 643 ′000TEU), EU-USA (down 636 ′000TEU), and ROA-China trade (down 537 ′000TEU).

We have used two distinct approaches to determine the transport impact. We used the average price per unit method, which was also used in a study by (Ecorys, 2015), where the impact of CETA and TTIP on the Canadian and regional trade volumes was calculated, for dry and wet bulk cargo, where the commodity is much more concentrated, and the historical data regarding the commodity price per unit is much more readily available from the World Bank data repository. Since the commodities inside the containers are more homogeneous and it is much harder to estimate pricing data, the second methodology was employed for the container sector. We looked at operational fleet data from (Clarksons Research, 2022). The current fleet data was overlay with the percent change in trade values that the econometric model predicted. By doing so, we could determine how the TEU transported will change in response to the change in the value of bilateral trade.

Combining the findings and calculations from all the segments, we also calculated that the worldwide CO2 reduction under the $75 tax scenario will be around 502.3 million tons, compared to the 507.1 million tons and 503.9 million tons under the $150 and $100 scenarios. This outcome is understandable given that a greater shipping tax based on carbon emissions will make marine transportation more expensive, especially over longer distances, leading to a decrease in trade over the sea or any mode with a significant carbon emission.

5.2 Areas of further research

To answer the main research question of "the economic, trade and transport impact of a global carbon tax on the three major shipping segments of the maritime industry: containers, dry bulk, and wet bulk," this thesis examined the specifics of each trade, the underlying commodities, and the main trade routes, using partial equilibrium methodology to forecast and assess the impact.

IMO does not provide a clear indication of a carbon pricing structure. Although the market-based measures linked to levy-based systems are said to be more effective, this was covered in Chapter 1. There is little literature and discussion on this subject, and what little there is doesn't seem very authoritative. The streamlined carbon pricing structure will significantly influence future outcomes, which will be made possible by an IMO regulation and clear guidelines. Results based on existing research and a potential carbon price are presented here.

The influence of distance on freight prices to discount short sea trade if such pricing mechanisms are established is one of the central assumptions made for the research, in addition to the above. Additionally, the (Anderson and Wincoop, 2004) model, which averages the freight rate percentage to 21%, is the main foundation for calculating the initial and final NTMs. Using a different model with dedicated proportions for each segment makes it possible to distinguish effects on different segments in a more refined manner because segment proportions range greatly.

Additionally, the study by Kalli, Karvonen, and Makkonen (2009), served as the foundation for the problem description and shock calculation considering the effect of carbon tax on operational expenses of a ship. We propose delving deeper into the particulars of ship operation, where even some operational costs are impacted by a technological advancement in the marine industry. This will contribute to the assessment of additional costs brought on by the global carbon tax being strengthened. Due to the variety of goods transported on board, gathering elasticity data for the container segment was complex, thus the use of elasticities is regarded as an assumption. Results will be more refined if each sector is examined in greater detail. Last but not least, because it is a partial equilibrium model, the adoption of this specific econometric model itself precludes the occurrence of cross-sectoral effects and spillover effects to other sectors, as was covered in Chapter 3. To calculate thorough effects on related economic sectors, a CGE model, such as the one offered by GTAP, would be providing additional insights.

Further investigation into the leakage in trade and transportation is also noteworthy. In the event that a global carbon tax is implemented, trade will likely migrate to other less expensive forms of transportation because maritime shipping will become more expensive. We have read in the literature that many of the IMO member states have suggested a progressively rising carbon tax to encourage research and development in the area of reducing carbon emissions. If the higher carbon emission modes do not evolve over time, this merely implies that they will gradually be replaced.

With these exceptions, this specialized study highlights effects on economies, trade (segmented), and the impact on major transport sectors that may serve as a guide for policymakers. To keep assumptions to a minimum and deliver more accurate results, we propose conducting a segment-centric study on this subject as further research. Additionally, changes in vessel size, type, and age within a segment are crucial to fully comprehending the impact of the carbon tax. To perform this research, we had to make several assumptions about trade patterns and the utilization of specific vessel types on particular trade lanes. Although these hypotheses have a significant impact, it is required to conduct thorough research into this topic to acquire them accurately, which was out of the scope of this study. This study can serve as a basis for presenting a more valuable and comprehensive view of the evolving shipping business.

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Chapter 7 - Annexure:

Annex 1 {Econometric model(GSIM) by (Francois and H Keith Hall, 2002)}

1) **Demand function**

In this GSIM model, there are different countries and n kinds of products. Importing country v import product i from exporting country R, and at the same time, country S will also export i to country v. The demand m of the importing country V depends on the expenditure Y (i, v) of the importing country on the product, the price P (i, v), r of the product exported by country R to country V, and the price P (i, v), s of the product exported by other countries to country v $M_{(i,v),r} = f\left(P_{(i,v),r},\ P_{(i,v),s},\ Y_{(i,v)}\right)$

price elasticity and cross price elasticity of I products are as follow

$$N_{(i,v),(r,s)} = \theta_{(i,v),s}\left(E_m + E_s\right)$$

$$N_{(i,v),(r,r)} = \theta_{(i,v),s}E_m - \sum_{s \neq r} \theta_{(i,v),s}E_s = \theta_{(i,v),s}E_m - \left[1 - \theta_{(i,v),r}\right]E_s$$

In 3.22, $\theta_{(i,v),r}$ and $\theta_{(i,v),s}$ mean the ratio that the product I country v import from country r and s account for all products I the country V import from other countries. Em represents the total demand elasticity of I products in importing countries, and ES means the substitution elasticity of I products in different countries.

At the first, we assume that the world price of product I that country R export to other countries is $P^*_{i,r}$, The domestic price of product I exported to country V is p (i, v), r, as a result: $P_{(i,v),r} = \left[1 + t_{(i,v),r}\right]P^*_{i,r} = T_{(i,v),r}P^*_{i,r}$

2) **Supply function**

We assume that the export supply of a country X, country R export product i are only related to the world price $P^*_{i,r}$: $X_{i,r} = f\left(P^*_{i,r}\right)$

3) **Market equilibrium**

Because we need to think about the influence of the scheme, we need to think about the change, in the mathematical view, change means derivate, so we can derive 3.2.1,3.2.4,

$$\widehat{P}_{(i,v),r}=\widehat{P}^*{}_{i,r}+\widehat{T}_{(i,v),r}$$

$$\widehat{X}_{i,r}=E_{X(i,r)}\widehat{P}^*{}_{i,r}$$

3.2.5 as follows: $\widehat{M}_{(i,v),r}=N_{(i,v),(r,r)}\widehat{P}_{(i,v),r}+\sum_{s\neq r}N_{(i,v),(r,r)}\widehat{P}_{(i,v),s}$

The symbol "^" means the change rate of an economic quantity, Ex (i, r) means the supply price elasticity of the export I products of country R, and the product price change rate of the export country R to country V depends on the change rate of world price and tariff; the total amount of product I that imported from country r is as follow:

$$\widehat{M}_{i,r}=\sum_v \widehat{M}_{(i,v),r}=\sum_v N_{(i,v),(r,r)}\widehat{P}_{(i,v),r}+\sum_v\sum_{s\neq r}N_{(i,v),(r,s)}\widehat{P}_{(i,v),s}$$

$$=\sum_v N_{(i,v),(r,r)}\left[P^*{}_{(i,v),r}+\widehat{T}_{(i,v),r}\right]+\sum_v\sum_{s\neq r}N_{(i,v),(r,s)}\left[\widehat{P}^*{}_{i,s}+\widehat{T}_{(i,v),s}\right]$$

The price change rates of different countries under equilibrium conditions can be obtained by solving the simultaneous equations. Other economic variables can be obtained according to the rate of price change.

4) **Other economic variables**

The equilibrium price change rate is solved according to equation, and then the change rate of demand can be obtained according to equation. When the international price of the product of country V is unchanged, the change rate of the product of country R is only related to the tariff change rate of its own export products and its own price elasticity. M (I, V), R represents the import volume:

$$TC_{(i,v),r}=M_{(i,v),r}\left[N_{(i,v),(r,r)}\widehat{T}_{(i,v),r}\right]$$

When the price of the export change rate of other countries to V countries remains unchanged, the change rate is the tariff change rate of country R multiplying the cross-price elasticity. The change rate of exports from other countries s to V is:

$$TD_{(i,v),s}=M_{(i,v),r}\cdot\sum_{s\neq r}N_{(i,v),(r,s)}\widehat{T}_{(i,v),s}$$

5) **Producer surplus and consumer surplus**

We could get the producer surplus and consumer surplus from the graph of price and supply; the area is calculated by the product of the original producer surplus and the change rate:

$$\Delta PS_{(i,r)} = R^0{}_{(i,r)} \widehat{P}^*{}_{i,r} + \frac{1}{2} R^0{}_{(i,r)} \widehat{P}^*{}_{(i,r)} \widehat{X}_{i,r} = R^0{}_{(i,r)} \widehat{P}^*{}_{(i,r)} \left[1 + \frac{E_{X(i,r)} \widehat{P}^*{}_{(i,r)}}{2} \right]$$

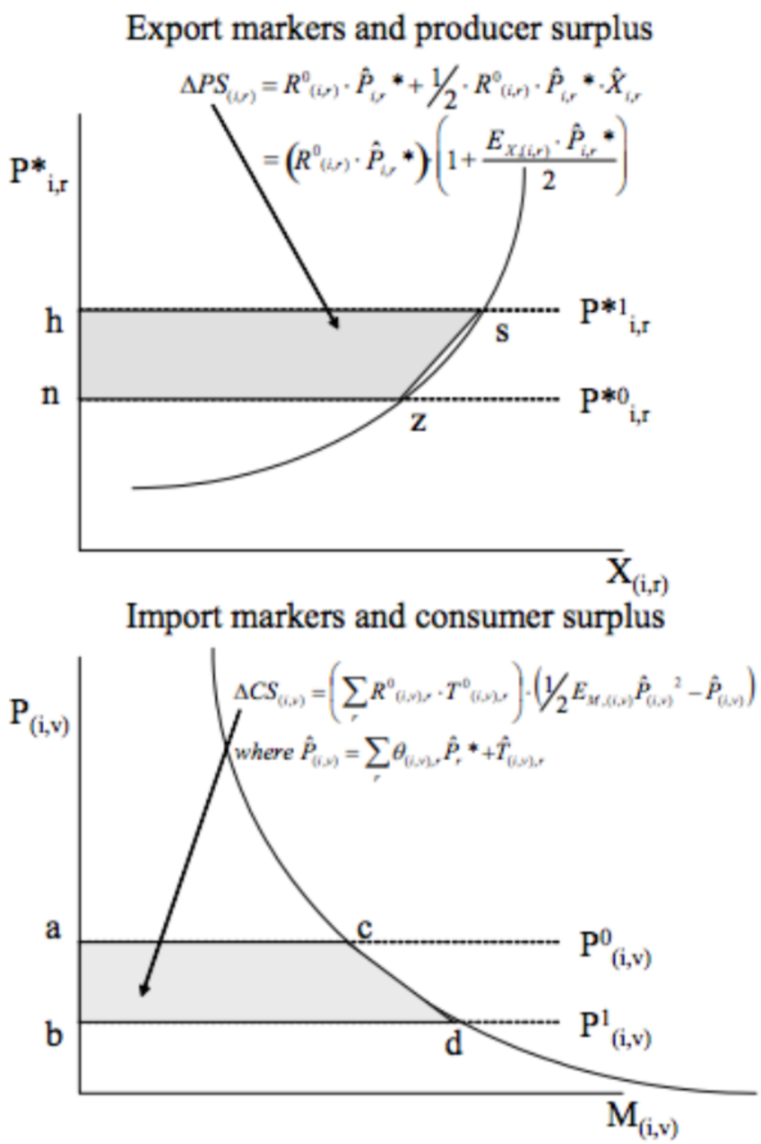
$$\Delta CS_{(i,r)} = \left(\sum_r R^0{}_{(i,v),r} T^0{}_{(i,v),r} \right) \left[\frac{1}{2} E_{M,(i,v)} \widehat{P}^2{}_{(i,v)} - \widehat{P}_{(i,v)} \right]$$

Figure 7-1: Notation

	<u>INDEXES</u>
r,s	exporting regions
v,w	importing regions
i	industry designation
	<u>VARIABLES</u>
M:	imports (quantity)
X:	exports (quantity)
$E_{m,(i,v)}$:	aggregate import demand elasticity Defined for aggregate imports $M_{(i,v)}$ and composite price $P_{(i,v)}$ $= \frac{\partial M_{(i,v)}}{\partial P_{(i,v)}} \cdot \frac{P_{(i,v)}}{M_{(i,v)}}$
$E_{x,(i,r)}$:	elasticity of export supply $= \frac{\partial X_{(i,r)}}{\partial P_{(i,r)}{}^*} \frac{P_{(i,r)}{}^*}{X_{(i,r)}}$
E_s:	elasticity of substitution
$N_{(i,v),(r,r)}$:	own price demand elasticity
$N_{(i,v),(r,s)}$:	cross-price elasticity
$T_{(i,v),r}$:	The power of the tariff, T=(1+t)
$\theta_{(i,v),r}$:	demand expenditure share (at internal prices) $\theta_{(i,v),r} = M_{(i,v),r} T_{(i,v),r} / \sum_s M_{(i,v),s} T_{(i,v),s}$
$\phi_{(i,v),r}$:	export quantity shares $\phi_{(i,v),r} = M_{(i,v),r} / \sum_w M_{(i,w),r}$

Source: (Francois and H Keith Hall, 2002)

Figure 7-2: Producer and consumer surplus measures



Source: (Francois and H Keith Hall, 2002)

Annex 2 (Country Aggregation on WITS)

Table 7-1: Markets (Reporting Countries or Regions)

	BRA	076	Brazil	**ROAF**	**Rest of Africa --- ROAF**		
	CHN	156	China		CMR	120	Cameroon
	GBR	826	United Kingdom		GAB	266	Gabon
	IDN	360	Indonesia		GHA	288	Ghana
	JPN	392	Japan		CIV	384	Coted'Ivoire
	NGA	566	Nigeria		KEN	404	Kenya
	RUS	643	Russian Federation		MAR	504	Morocco
	USA	840	United States		NAM	516	Namibia
					ZAF	710	South Africa
				EGY	818	Egypt, Arab Rep.	
RONA	**Rest of North America --- RONA**			**ROSA**	**Rest of South America --- ROSA**		
	CAN	124	Canada		ARG	032	Argentina
	CRI	188	Costa Rica		CHL	152	Chile
	CUB	192	Cuba		COL	170	Colombia
	SLV	222	El Salvador		ECU	218	Ecuador
	HND	340	Honduras		PER	604	Peru
	MEX	484	Mexico		URY	858	Uruguay
	NIC	558	Nicaragua		VEN	862	Venezuela
	PAN	591	Panama				
ROAs	**Rest of Asia --- ROAs**			**ROEs**	**Rest of Europe --- ROEs**		
	LKA	144	Sri Lanka		ALB	008	Albania
	IND	356	India		AZE	031	Azerbaijan
	KOR	410	Korea, Rep.		GEO	268	Georgia
	MYS	458	Malaysia		ISL	352	Iceland
	PAK	586	Pakistan		MNT	499	Montenegro
	PHL	608	Philippines		NOR	578	Norway
	VNM	704	Vietnam		TUR	792	Turkey
	THA	764	Thailand				

EU27 EU27 --- EU27 members --- EU27	**LDC Least Developed Countries ---**
AUT 040 Austria	**LDC**
BEL 056 Belgium	AFG 004 Afghanistan
BLX 058 Belgium-Luxembourg	AGO 024 Angola
BGR 100 Bulgaria	BGD 050 Bangladesh
HRV 191 Croatia	BTN 064 Bhutan
CYP 196 Cyprus	SLB 090 Solomon
CZE 203 Czech Republic	Islands
DNK 208 Denmark	MMR 104 Myanmar
EST 233 Estonia	BDI 108 Burundi
FIN 246 Finland	KHM 116 Cambodia
FRA 250 France	CAF 140 Central
DEU 276 Germany	African Republic
GRC 300 Greece	TCD 148 Chad
HUN 348 Hungary	COM 174 Comoros
IRL 372 Ireland	ZAR 180 Congo,
ITA 380 Italy	Dem. Rep.
LVA 428 Latvia	BEN 204 Benin
LTU 440 Lithuania	GNQ 226 Equatorial
LUX 442 Luxembourg	Guinea
MLT 470 Malta	ETH 231
NLD 528 Netherlands	Ethiopia(excludes Eritrea)
POL 616 Poland	ERI 232 Eritrea
PRT 620 Portugal	DJI 262 Djibouti
ROM 642 Romania	GMB 270 Gambia,
SVK 703 Slovak Republic	The
SVN 705 Slovenia	KIR 296 Kiribati
ESP 724 Spain	GIN 324 Guinea
SWE 752 Sweden	HTI 332 Haiti
AusNz Australia --- AusNz	LAO 418 Lao PDR
AUS 036 Australia	LSO 426 Lesotho

NZL	554	New Zealand	LBR	430	Liberia
MiddleEast	**Countries in Middle East**		MDG	450	Madagascar
--- MiddleEast			MWI	454	Malawi
BHR	048	Bahrain	MLI	466	Mali
CYP	196	Cyprus	MRT	478	Mauritania
IRN	364	Iran, Islamic Rep.	MOZ	508	Mozambique
IRQ	368	Iraq	NPL	524	Nepal
ISR	376	Israel	VUT	548	Vanuatu
JOR	400	Jordan	NER	562	Niger
KWT	414	Kuwait	GNB	624	Guinea-Bissau
LBN	422	Lebanon	TMP	626	East Timor
OMN	512	Oman	RWA	646	Rwanda
QAT	634	Qatar	STP	678	Sao Tome and Principe
SAU	682	Saudi Arabia	SEN	686	Senegal
ARE	784	United Arab Emirates	SLE	694	Sierra Leone
EGY	818	Egypt, Arab Rep.	SOM	706	Somalia
YEM	887	Yemen	SDN	736	Fm Sudan
			TGO	768	Togo
			TUV	798	Tuvalu
			UGA	800	Uganda
			TZA	834	Tanzania
			BFA	854	Burkina Faso
			WSM	882	Samoa
			YEM	887	Yemen
			ZMB	894	Zambia

SIDS	**Small Island Developing States --- SIDS**				
ATG	028	Antigua and Barbuda	BHS	044	Bahamas, The
BHR	048	Bahrain	BRB	052	Barbados
BLZ	084	Belize	CPV	132	Cape Verde
CUB	192	Cuba	DMA	212	Dominica
DOM	214	Dominican Republic	FJI	242	Fiji

GRD	308	Grenada	GUY	328	Guyana
JAM	388	Jamaica	MDV	462	Maldives
MUS	480	Mauritius	NRU	520	Nauru
VUT	548	Vanuatu.	FSM	583	Micronesia, Fed. Sts.
MHL	584	Marshall Islands	PLW	585	Palau
PNG	598	Papua New Guinea	KNA	659	St. Kitts and Nevis
LCA	662	St. Lucia.	VCT	670	St. Vincent and the Grenadines
SYC	690	Seychelles	SGP	702	Singapore
SUR	740	Suriname	TON	776	Tonga
TTO	780	Trinidad and Tobago	WSM	882	Samoa

Source: Aggregated by author on WITS

Annex 3 (Trade value matrix)

Table 7-2: Trade value matrix(in million USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	11070,00142	1342,948485	179885,0753	18035,15471	10384,37327	55005,70566	664,998721	5691,7685	341,51911	806,860002	8431,240184	4844,949867	17021,53285	1770,225443	57912,97814	1788,721714	3087,373519	1123,06968
Brazil	871,333958	0	109877,8763	41210,09128	2621,511394	9885,348141	1330,999643	5726,949455	1156,327972	2470,851234	3173,44764	3394,120784	32843,01022	2337,679578	16448,058	6127,442699	15221,01236	30116,45846
China	84705,40947	53464,01677	0	642306,5283	56227,2023	185664,4767	24690,42521	76933,30408	12879,07702	52217,63737	57206,15858	91162,19183	563203,1195	26480,70695	370299,2866	48846,7652	174977,1754	61843,95043
EU-27	55603,94493	42868,18322	335470,129	3887115,259	14155,64991	92737,49477	15077,47573	113440,467	16589,31276	89082,41421	56582,59099	356250,5876	599897,1473	61450,968	188103,7671	199501,1958	115363,3232	38605,47345
Indonesia	4775,488962	1933,11099	63886,54658	22427,75523	0	21530,89203	2275,459096	3425,736997	384,354181	1715,317903	15590,22321	2047,994846	28953,07109	1028,35421	56330,10929	2327,322789	3629,927379	1188,780802
Japan	20383,92566	5427,931111	205523,7145	99494,17391	17976,71141	0	3126,738299	20998,55223	365,919681	8821,944535	23963,46888	12917,86283	145902,2525	3715,299667	142164,2149	6986,749208	30097,93099	6534,373002
LDC	2676,43089	750,749032	63574,80545	55663,02727	1626,59974	6229,824351	5846,652821	27396,21525	280,076695	1506,88923	1605,928282	6128,601013	25085,85356	5810,729821	33212,70196	2180,70043	5152,58356	1142,654849
Middle East	6762,929034	5347,570376	188841,3875	115414,8625	9682,235852	94172,64486	9173,546461	71523,7164	1850,06648	2412,587552	48107,29079	10381,80257	74956,48335	13142,35272	287263,8242	21745,95503	6737,310089	3137,179551
Nigeria	441,969212	1587,147514	3034,654772	24418,15254	2527,457033	917,060357	692,822242	901,21395	0	33,188246	600,183632	3090,126332	5766,545651	5391,176325	16554,45052	147,559382	1648,936806	740,926837
Russia	450,916231	6228,322609	78970,61101	195639,1672	1551,117789	15591,54835	1113,015301	9829,265719	2092,83423	0	5982,895019	24851,43961	30762,2715	2622,814645	32064,73911	34656,92346	4219,271159	1901,999311
SIDS	13437,07688	4885,972874	44155,85601	35476,10904	21655,32299	13846,48366	6928,835895	9522,259083	361,592468	1047,940504	3533,692691	2949,922691	46362,53128	2334,761929	68468,56766	1639,939721	5309,641613	2236,106626
UK	6852,845194	2694,123424	25652,93751	206487,3305	1212,545291	8231,614335	1266,687924	14151,74161	1086,278384	4037,210511	8707,834935	0	61748,82609	5028,583463	21872,06084	13243,92699	8475,213606	2243,258548
USA	30874,32712	41502,92665	180971,9322	334241,6543	11308,70699	83640,15095	3061,434624	39820,02179	3178,638657	12690,81374	56530,00964	63294,16556	0	11114,5518	144880,8312	21554,49843	468678,5303	49675,41098
Rest of Africa	2124,159004	3897,520197	42794,13368	83424,99234	2795,469407	11062,30171	10011,33527	10545,07248	1036,125298	2382,589676	2206,684581	14450,3603	24921,56641	7467,369169	28293,86134	5788,16085	4439,818818	1403,296383
Rest of Asia	51964,12517	20349,42641	522904,403	290276,0415	41418,04908	118720,4045	24070,11385	68145,48726	7758,040276	18366,22989	89370,17304	34220,35478	415587,019	15180,00745	249790,9255	27884,50807	87161,02941	17290,2668
Rest of Europe	1593,594897	2128,515704	16518,25639	231680,9493	1242,009073	2810,540131	1595,7184	19264,99235	2124,529585	5956,429325	2138,930951	52009,74546	25067,69043	3865,305814	9336,505761	9319,725727	5171,586742	1816,385482
Rest of N.America	5728,050541	8115,640407	52300,3513	78883,81628	2453,890129	20889,60685	549,768262	5925,125245	598,077161	1846,407999	6585,917813	18634,67055	772763,2768	2074,800018	27745,11878	5981,963007	49186,68197	15979,2408
Rest of S.America	1859,591033	22555,4764	86470,37324	41165,83171	2518,723481	13458,66719	554,703984	5103,708519	310,34201	3698,030808	3184,126423	3607,786466	60944,17963	1992,168907	32734,54984	5497,395401	13862,93775	24259,99511

Source: Compiled by author based on data from WITS/ UN Comtrade

Annex 4 (Maritime trade value matrix)

Table 7-3: Maritime trade value matrix(in million USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	9963,001279	1329,519	178086,2246	17854,80316	10280,52954	54455,6486	658,3487338	5634,850815	338,1039189	798,791402	8346,927782	4796,300368	16851,31752	1752,523189	57333,84836	1770,834497	3056,499784	1111,838983
Brazil	862,6206184	0	108779,0975	40797,99037	2595,29628	9786,49466	1317,293647	5669,67996	1144,764692	2446,142722	3141,713164	3360,179576	32514,58012	2314,302782	16283,57742	6066,168272	15068,80224	24093,16677
China	83858,35538	52929,3766	0	635883,4631	55664,93028	183807,8319	24443,52095	76163,97104	12750,28625	51695,461	56634,097	90250,56991	557571,0883	26215,89988	333233,3579	48358,29754	173227,4036	61225,51093
EU-27	55047,90548	42439,50139	332115,4277	2332269,156	14014,09341	91810,11982	14926,70097	112306,0623	16423,41964	53449,44853	56016,76508	320625,5288	554298,1758	60836,45832	186222,7294	95700,71749	114209,6899	38219,41871
Indonesia	4727,734072	1913,77988	63247,68111	22203,47768	0	21315,58311	2252,704505	3391,479231	380,5106392	1698,164724	15434,32097	2027,118898	28663,54038	1018,070668	55766,8082	2304,049561	3593,628105	1176,892994
Japan	20180,0864	5373,6518	203468,4774	98499,23217	17796,94429	0	3095,470916	20788,56671	362,2604842	8733,72509	23723,83419	12788,6842	144443,23	3678,14667	140742,5727	6916,881716	29796,95168	6469,029272
LDC	2649,666581	735,7340514	62939,05739	55106,39699	1610,294143	6167,526107	5788,186293	27122,25309	277,2759281	1491,820338	1589,868999	6067,315003	24834,99502	5752,622523	32880,57494	2158,893426	5101,057724	1131,228301
Middle East	6695,299744	5294,094672	186952,9736	114260,7138	9585,413493	93230,91841	9081,810996	44344,70417	1831,565815	2388,461676	47626,21788	10277,98455	74206,91851	13010,92919	284391,186	21528,49548	6669,936988	3105,807755
Nigeria	437,5495199	1571,276039	3004,308224	24173,97101	2502,182463	907,8897534	685,8940196	892,2018105	0	32,85636354	594,1817957	3059,225069	5708,880194	4852,058693	16388,90602	146,0837882	1632,447438	733,5175686
Russia	446,4070687	6166,039383	78180,9049	117383,5003	1535,606611	15435,63286	1101,885148	9730,973062	2071,905888	0	5923,066069	24602,92521	30454,64878	2596,586499	31744,09172	29992,69259	4177,078447	1882,979318
SIDS	13302,70611	4739,393688	43714,29744	35121,34795	21438,76976	13708,01882	6859,547536	9427,036492	357,9765433	1037,461099	3427,68191	2920,423464	45898,90597	2311,41431	67783,88199	1623,540324	5256,545197	2213,74556
UK	6784,316742	2667,18219	25396,40813	204422,4572	1200,419838	8149,298192	1254,021045	14010,22419	1075,4156	3996,838406	8620,756586	0	61131,33783	4978,297628	21653,34023	13111,48772	8390,46147	2220,825963
USA	30565,58384	41087,89738	179162,2129	330899,2378	11195,61992	82803,74944	3030,820278	39421,82157	3146,85227	12563,9056	59964,70955	62661,2239	0	11003,40628	143432,0229	21338,95344	374942,8242	49178,65687
Rest of Africa	2102,917414	3858,544995	42366,19235	82990,74242	2767,514713	10951,67869	9911,22192	10439,62176	932,5127682	2358,763779	2184,617735	14305,85669	24672,35074	7243,348094	28010,92273	5730,279242	4395,42063	1389,263419
Rest of Asia	51444,48391	20145,93215	470613,9627	287373,2811	40175,50761	117533,2004	23829,41271	67464,03239	7680,459873	18182,5676	88476,47131	33878,15123	411431,1488	15028,20737	199832,7404	27605,66299	86289,41911	17117,36413
Rest of Europe	1577,658948	2107,230547	16353,07383	139008,5696	1229,588982	2782,43473	1579,761216	19072,34242	2103,284289	4467,321994	2117,541641	47848,96582	24817,01352	3826,652756	9243,140703	9226,52847	5119,870875	1798,221627
Rest of N.America	5670,770036	8034,484003	51777,34779	78094,97811	2429,351228	20680,71078	544,2705794	5865,873993	592,0963894	1827,943919	6520,058635	18448,32384	618210,6215	2054,052018	27467,66759	5922,143377	48694,81515	15819,44839
Rest of S.America	1840,995123	18044,38112	85605,66951	40754,17339	2493,536246	13324,08052	549,1569442	5052,671434	307,2385899	3661,0505	3152,285159	3571,708601	60334,73783	1972,247218	32407,20434	5442,421447	13724,30837	24017,39516

Source: Compiled by author based on various data sources

Annex 5 (Wet bulk trade values)

Table 7-4: Wet bulk trade value matrix(in million USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria
Aus/NZ	583,4176	0,0030789	17344,52996	90,78880635	943,4569815	15711,99279	11,15010765	76,74815313	0,10007217
Brazil	0,48863925	0	16305,6698	4389,116031	15,11696736	77,06152575	0,35123121	14,76811512	27,10068768
China	1580,684005	46,64682297	0	620,4564462	475,3812769	466,4237896	204,7720772	50,23387116	103,0037402
EU-27	655,0450008	2481,323945	6519,851562	108314,3763	487,430956	665,9619249	1393,684759	5288,329159	9395,255301
Indonesia	1213,659143	0,03160872	4641,409435	223,4811883	0	3293,763327	28,79460441	7,80201477	0,05857533
Japan	2582,910941	26,03710692	1607,564228	33,56532234	102,07435	0	17,90223039	22,73445801	0,04202055
LDC	24,38321787	450,7738614	30127,10221	5713,697384	981,274338	429,1270642	2179,429996	335,2238644	72,88136361
Middle East	4234,876449	1335,558885	146219,8579	75517,50035	6569,874439	89100,48074	5439,198571	13890,41491	579,2216621
Nigeria	436,6003643	1426,365156	2470,923923	23061,6779	2426,358794	703,8544224	553,5205979	239,1111825	0
Russia	169,400087	466,392467	45110,48606	73587,2693	44,4950055	8301,52323	554,5351439	3856,514985	1403,327591
SIDS	7603,267884	2054,185895	5872,108028	3218,994142	11520,51342	3805,210572	4046,350785	2600,441296	199,2229411
UK	155,295258	277,5125014	4442,737906	24455,94908	29,42633034	53,48916342	225,861173	464,9547603	257,9799598
USA	616,7387922	13178,02903	17392,72445	41481,27205	2601,013929	10232,35872	276,4200315	1381,853798	692,6846246
Rest of Africa	366,6582642	2,92952187	6066,459671	6966,644801	312,3307539	250,2780331	893,0385813	636,1819111	124,8948495
Rest of Asia	12564,34452	1697,556739	25079,92342	5089,235804	5332,969348	12256,25157	4113,980604	2990,953275	2435,924131
Rest of Europe	58,71346866	92,50035993	6854,848046	46311,85062	758,2964945	164,599773	124,9971179	2917,388643	1320,916218
Rest of N.America	3,33596538	154,465245	2077,991703	7573,132812	1,01321451	885,6372086	20,03383899	6,97898619	26,91287577
Rest of S.America	44,66309067	803,2057824	13645,78156	2328,851896	11,6565471	1764,167099	20,73675879	2,20063437	0

Countries	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	0,01753488	2283,074174	0,22030965	41,6163429	13,65420276	9166,425268	0,252621755	0,131851873	4,03827237
Brazil	0,00648054	777,8769689	1,64259117	5172,20108	25,78369761	2363,253096	97,37136292	4,354631345	1935,604163
China	1,1099187	6271,83076	38,53123758	522,9293731	110,4807667	6359,713904	1,187005971	224,1891982	422,3432991
EU-27	359,2896066	5219,399268	11397,72005	16000,14999	4665,11974	6189,844631	2543,288034	2530,704302	1591,896173
Indonesia	0,05355801	3899,563717	0,05492718	1205,112915	47,15214174	4894,678504	4,068648946	0,032774544	0,10052163
Japan	42,78877614	1221,854501	3,75062193	795,7583736	10,1331945	2767,133493	4,105413477	117,6990378	406,815847
LDC	0	609,1069634	188,1483605	3484,68891	2055,088624	11140,77778	4,507693562	2,032540201	660,3749401
Middle East	29,82604086	37796,60965	5740,629067	40029,17498	8208,369439	231422,4622	1726,517971	2793,033463	1388,178158
Nigeria	0	579,0330899	3012,07104	5513,966103	4624,717412	15454,16545	51,47382093	1565,060826	698,7100289
Russia	0	5623,89461	6366,233175	17879,70497	905,0236866	14558,44231	3755,495151	322,953688	370,8001074
SIDS	80,73530289	1515,287413	408,8901168	5942,144263	722,8844915	15435,72771	18,94076377	239,6180039	1402,417423
UK	6,58662048	167,0278936	0	4308,56736	402,9615167	2846,994095	752,4914103	812,6687241	223,3771373
USA	36,24058152	6329,040068	7550,047736	0	1542,791669	16536,822	1710,3574	49186,27346	15518,58211
Rest of Africa	1,64934594	346,6083397	393,030197	2324,688646	954,4432506	4863,892724	142,8276208	139,6787261	40,67225019
Rest of Asia	94,2778089	21939,02511	926,069066	7318,550936	906,6818574	19149,14846	2731,994512	522,3498159	1265,287486
Rest of Europe	18,988359	161,6038331	30073,47058	3988,137561	283,8992884	2540,31984	1236,699523	1629,735429	177,8217359
Rest of N.America	9,43007967	603,0276615	971,0456996	95969,41062	65,64405078	6995,651945	154,7295523	602,1348064	1386,199018
Rest of S.America	0	1751,271386	321,3572512	27310,11391	298,4785422	10343,55703	0,265000418	566,7363534	4342,934423

Source: Compiled by author based on data from WITS/ UN Comtrade

Annex 6 (Dry bulk trade values)

Table 7-5: Dry bulk trade value matrix(in million USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	218,7368406	927,053525	112498,277	3883,0441	4029,169701	27338,97605	218,9243994	512,2263326	80,17623306	1,25536851	111,4695787	251,1138425	9,10422216	263,3846045	24884,33209	769,8914438	54,31373145	499,2362902
Brazil	65,16384732	0	38793,73842	4727,293918	293,3700422	5699,509337	43,58957922	1551,916928	10,42009254	0,51120234	586,3957259	271,0880063	682,4505333	195,6028685	3180,095776	900,4213518	243,4959846	958,1525464
China	290,1752934	276,0441592	0	239,1613785	530,6415672	1319,492807	93,04181667	741,3071797	21,99377803	132,5365668	199,693035	34,55986743	69,08184162	328,2020359	2691,382298	187,1977536	8,65170702	11,04128487
EU-27	39,5136918	87,71766498	2040,705497	17830,88957	58,68837909	24,9704829	278,3015572	1901,16764	1006,313449	125,9023704	77,96907558	1480,424802	486,3143528	787,8361521	976,7804419	934,2459762	151,2646205	95,54106375
Indonesia	6,36560199	0,02711907	9824,969773	340,5803336	0	3131,643425	258,9794411	17,1002997	0,21592593	0	65,38094541	0,1110087	75,21765669	0,56141712	15244,0728	0,1784475	0,00868626	0
Japan	4,2873633	0,03439656	371,2292298	362,066657	46,4894793	0	13,90905747	0,61497711	0,00098307	30,12914817	7,04801394	250,7615877	33,74815653	1,2741696	503,9895505	0,19650906	0,96416694	0,00630036
LDC	150,3090597	133,3652757	2682,386644	1302,438799	15,01003449	244,6836629	200,1972723	120,0830281	10,81921797	9,08277282	7,79867352	78,36761295	4,714281	259,4188694	1396,382661	26,8290198	1,50759081	0,02858823
Middle East	22,45174965	0,11362725	1663,980481	63,13235346	84,29051169	8,96292837	121,9496335	1137,22081	4,47196563	0,19173132	67,61623176	30,78153144	104,2570188	25,50056355	1821,084967	380,2193951	1,59999048	0,00078903
Nigeria	0	0	0,14120172	0,43088067	0	0	4,57019937	0,006138	0	0,0001188	0	0,00490347	0,02433519	3,2423085	0,51553062	0,00159093	0,04203243	0
Russia	12,75037236	568,7415994	8757,316721	5650,187086	418,0640627	2609,096788	492,7213546	1358,671544	510,7771974	0	11,32528518	534,1769681	70,35340257	756,4775754	6012,108143	3740,844911	54,89148159	118,7327285
SIDS	106,0995752	6,91997487	532,3658304	112,093443	248,4173706	0	41,13630378	952,7972385	1,37182518	0	37,16722713	5,54116266	82,13116131	1,20869397	1259,607074	11,95846641	36,44976951	0,03593898
UK	6,7166748	0,00067221	236,2167631	769,6993858	0,1578357	4,27396365	2,46982131	480,4945497	8,38777599	15,92387874	0,36180243	0	27,50471559	1,41919074	187,8898725	45,90553275	9,17322516	0,53881146
USA	308,4911825	1652,140921	12553,79272	6260,557111	294,1161092	6693,494043	156,7756476	599,5981277	549,2722019	5,27836122	482,003969	550,875105	0	855,6426717	6987,140465	1017,924049	9132,149462	2415,952666
Rest of Africa	5,11068591	90,718353	7856,714305	2815,93731	46,50717456	907,1276772	203,6071947	214,0828846	23,2392807	1,19927313	100,8406852	142,3714397	30,04196877	126,939534	6701,825077	234,2309092	1,53222003	20,61863892
Rest of Asia	523,4059156	124,2473909	7127,418659	1331,119866	1301,645853	581,9513971	1369,737409	3127,400142	13,04108289	84,00696282	393,2182317	333,0705164	887,6863918	1442,276862	1945,390091	106,3074761	175,16169	33,64094052
Rest of Europe	0,44666325	0,14493303	294,4444051	343,0473408	17,14333203	0,14011965	3,18537846	57,67390035	16,63235838	53,9837835	20,71917738	92,84036848	95,70830148	4,62132198	51,01759971	59,40625284	3,97311849	0,07855056
Rest of N.America	0,77120604	280,596494	8175,472668	5503,77887	701,6825426	3035,64921	57,63150855	266,9814635	380,8865184	0,11376684	167,1749086	708,4344227	2338,061606	434,9746784	3695,275763	196,7828148	382,6777591	1259,993309
Rest of S.America	24,71846949	2775,076064	8160,460166	2709,971181	403,7024841	689,4506193	212,9631936	609,8512088	130,3232406	12,30005502	292,4299125	272,9908229	634,0735091	329,3635316	2854,835401	1964,213659	667,2584309	2160,375563

Source: Compiled by author based on data from WITS/ UN Comtrade

Annex 7 (Liner shiping trade values)

*Ta*ble 7-6: Line shipping trade value matrix*(in million USD)*

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	9160,846838	402,4623963	48243,42162	13880,97026	5307,902854	11404,67976	428,2742267	5045,876329	257,8276137	797,5184986	5952,38403	4545,166216	16800,59696	1475,484381	23283,091	1000,690431	3002,0542	608,5644206
Brazil	796,9681319	0	53679,6893	31681,58042	2286,80927	4009,923797	1273,352836	4102,994917	1107,243912	2445,625039	1777,440469	3087,448979	26659,92851	2092,916216	10740,22855	5068,375557	14820,95162	21199,41006
China	81987,49608	52606,68562	0	635023,8452	54658,90743	182021,9153	24145,70706	75372,42999	12625,68873	51561,81451	50202,5732	90177,47881	556979,0771	25777,21707	324182,2617	48169,91278	172994,5627	60792,12634
EU-27	54353,34679	39870,45978	323554,8707	2206123,89	13467,97408	91119,18741	13254,71466	105116,5655	6021,850886	52964,25655	50719,39673	307747,384	537811,7114	55383,50243	179056,1043	92223,18348	111527,721	36531,98148
Indonesia	3507,709328	1913,721152	48781,3019	21639,41615	0	14890,17636	1964,93046	3366,576917	380,2361379	1698,111166	11469,37631	2026,952962	27383,2098	970,357109	35628,05689	2299,802465	3593,586644	1176,792472
Japan	17592,8881	5347,580296	201489,6839	98103,60019	17648,38046	0	3063,659628	20765,21727	362,2174806	8660,807165	22494,93168	12534,17199	143613,7235	3666,739306	137471,4497	6912,579793	29678,28848	6062,207125
LDC	2474,974304	151,9949142	30129,56854	48090,26081	614,0097701	5493,71538	3408,559025	26666,9462	193,5753465	1482,737565	972,9633623	5800,799029	21345,59183	3438,115029	20343,4145	2127,556712	5097,517593	470,8247722
Middle East	2437,971545	3958,42216	39069,13518	38680,08113	2931,248543	4121,474743	3520,662792	29317,06718	1247,872187	2358,443904	9761,991999	4506,573949	34073,48652	4777,059186	51147,63887	19421,75811	3875,303534	1717,628808
Nigeria	0,94915557	144,9108827	533,2431001	1111,86223	75,82366836	204,0353311	127,8032224	653,08449	0	32,85624474	15,14870577	47,14912521	194,8897566	224,0989722	934,2250335	94,60837632	67,34457972	34,80753969
Russia	264,2566093	5130,905317	24313,10212	38146,04392	1073,047543	4525,012847	54,62864946	4515,786533	157,8010995	0	287,8461739	17702,51507	12504,99041	935,0852366	11173,54127	18496,35253	3799,233278	1393,446482
SIDS	5593,37865	2678,291817	37309,82359	31790,66036	9669,838971	9902,808252	2772,060447	5873,797958	157,3817771	956,7257961	1875,22727	2505,992185	39874,63054	1587,321124	51088,5472	1592,641094	4980,477423	811,2921973
UK	6622,304809	2389,669016	20717,45346	179196,8487	1170,835672	8091,535065	1025,69005	13064,77488	809,0478644	3974,327907	8453,36689	0	56795,26575	4573,916921	18618,85626	12313,09078	7568,619521	1996,910014
USA	29640,35387	26257,72743	149215,6958	283157,4086	8300,489885	65877,89668	2597,624599	37480,36965	1904,895444	12522,38666	49153,66551	54560,30106	0	8604,971942	119908,0604	18610,672	316624,4013	31244,1221
Rest of Africa	1731,148464	3764,89712	28443,01837	72808,16031	2408,676784	9794,272979	8814,576144	9589,35696	784,378638	2355,91516	1737,16871	13770,45506	22317,62013	6161,965309	16445,20493	5353,220712	4254,209684	1327,97253
Rest of Asia	38356,73348	18324,12802	438406,6206	280952,9254	33540,89241	104694,9974	18345,6947	61345,67897	5231,49466	18004,28282	66144,22797	32619,01164	403224,9115	12679,24865	178738,2018	24767,361	85591,90761	15818,43571
Rest of Europe	1518,498816	2014,585254	9203,781378	92353,67161	454,1491558	2617,694837	1451,57872	16097,27988	765,7357128	4394,349851	1935,218631	17682,65487	20733,16766	3538,132145	6651,803264	7930,462693	3486,162327	1620,321341
Rest of N.America	5666,662864	7599,422264	41523,88342	65018,06643	1726,655471	16759,42436	466,6052318	5591,913543	184,2969952	1818,400073	5749,856065	16768,84372	519903,1492	1553,433289	16776,73988	5570,63101	47710,00258	13173,25607
Rest of S.America	1771,613563	14466,09927	63799,42779	35715,35031	2078,177215	10870,4628	315,4569917	4440,619591	176,9153493	3648,750445	1108,58386	2977,360527	32390,55041	1344,405144	19208,81192	3477,942788	12490,31358	17514,08518

Source: Compiled by author based on data from WITS/ UN Comtrade

Annex 8 (Initial bilateral tariffs)

Table 7-7: Initial bilateral tariffs matrix(in million USD)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	1,0000	1,1257	1,0044	1,0415	1,0108	1,0275	1,1080	1,0581	1,1116	1,0545	1,0857	1,0380	1,0130	1,1235	1,0475	1,0595	1,0343	1,0457
Brazil	1,0313	1,0000	1,0676	1,0411	1,0744	1,0648	1,1279	1,0653	1,1186	1,0564	1,0812	1,0378	1,0359	1,1227	1,0960	1,0613	1,0478	1,0009
China	1,0000	1,1487	1,0000	1,0417	1,0092	1,0388	1,1185	1,0625	1,1214	1,0601	1,0834	1,0415	1,0351	1,1129	1,0521	1,0379	1,0494	1,0817
EU-27	1,0303	1,1422	1,0678	1,0000	1,0884	1,0137	1,1224	1,0528	1,1283	1,0581	1,0550	1,0000	1,0359	1,0900	1,0783	1,0263	1,0185	1,0478
Indonesia	1,0000	1,1672	1,0043	1,0273	1,0000	1,0087	1,1013	1,0694	1,1409	1,0594	1,0731	1,0266	1,0420	1,1575	1,0361	1,0377	1,0667	1,1059
Japan	1,0014	1,1324	1,0701	1,0020	1,0105	1,0000	1,1078	1,0527	1,1034	1,0592	1,0628	1,0019	1,0352	1,0991	1,0463	1,0359	1,0247	1,0527
LDC	1,0002	1,2278	1,0296	1,0091	1,0741	1,0059	1,0606	1,0577	1,0597	1,0404	1,0509	1,0077	1,0298	1,0818	1,0510	1,0474	1,0550	1,1481
Middle East	1,0313	1,0755	1,0638	1,0223	1,0985	1,0346	1,1389	1,0141	1,1304	1,0564	1,0427	1,0201	1,0213	1,1166	1,1060	1,0482	1,0495	1,0720
Nigeria	1,0269	1,1732	1,0639	1,0243	1,1008	1,1006	1,0611	1,0450	1,0000	1,0468	1,0940	1,0124	1,0062	1,0529	1,1474	1,1096	1,0563	1,0576
Russia	1,0292	1,1143	1,0641	1,0399	1,0920	1,0282	1,1145	1,0628	1,0000	1,0000	1,0526	1,0320	1,0327	1,1029	1,0912	1,0168	1,0458	1,0640
SIDS	1,0057	1,1297	1,0234	1,0113	1,0242	1,0164	1,0773	1,0278	1,1255	1,0494	1,0438	1,0078	1,0066	1,1163	1,0521	1,0266	1,0396	1,0613
UK	1,0275	1,1368	1,0697	1,0000	1,0921	1,0125	1,1247	1,0512	1,1246	1,0586	1,0606	1,0000	1,0356	1,0948	1,0832	1,0289	1,0139	1,0400
USA	1,0115	1,1354	1,0720	1,0407	1,0848	1,0395	1,1240	1,0428	1,1187	1,0586	1,1008	1,0398	1,0000	1,1089	1,0793	1,0428	1,0113	1,0611
Rest of Africa	1,0339	1,1587	1,0660	1,0010	1,1072	1,0507	1,0689	1,0316	1,1390	1,0566	1,0407	1,0009	1,0111	1,1012	1,1164	1,0419	1,0632	1,1052
Rest of Asia	1,0098	1,1572	1,0237	1,0196	1,0183	1,0196	1,0957	1,0663	1,1259	1,0538	1,0582	1,0188	1,0309	1,1398	1,0406	1,0378	1,0529	1,0849
Rest of Europe	1,0335	1,1567	1,0596	1,0020	1,0942	1,0398	1,1395	1,0514	1,1351	1,0489	1,0658	1,0018	1,0368	1,1032	1,0874	1,0275	1,0531	1,0803
Rest of N.America	1,0062	1,1138	1,0625	1,0010	1,0897	1,0192	1,1261	1,0475	1,1107	1,0525	1,1039	1,0007	1,0010	1,1247	1,0829	1,0356	1,0210	1,0406
Rest of S.America	1,0219	1,0006	1,0415	1,0127	1,0870	1,0615	1,1397	1,0669	1,0861	1,0576	1,1044	1,0094	1,0162	1,1327	1,0934	1,0707	1,0389	1,0014

Source: Compiled by author based on data from WITS database

Annex 9 (Bilateral distance table matrix)

Table 7-8: Bilateral distance table matrix(in nautical miles)

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	4270,0	8627,0	3307,0	9461,0	1276,0	3548,0	6000,0	4698,0	7825,0	7429,0	7300,0	9500,0	9791,0	6100,0	3702,0	7315,0	8691,0	9425,0
Brazil	8627,0	1200,0	11065,0	5430,0	8541,0	11500,0	6320,0	8611,0	7825,0	6633,0	10140,0	5300,0	5510,0	6377,0	7956,0	6519,0	6197,0	4760,0
China	3307,0	11065,0	700,0	10525,0	2523,0	933,0	7100,0	5667,0	10254,0	8493,0	4138,0	10650,0	7500,0	7164,0	4672,0	8379,0	6855,0	9304,0
EU-27	9461,0	5430,0	10525,0	2050,0	8550,0	11078,0	3400,0	6165,0	4171,0	3617,0	9700,0	250,0	5052,0	3361,0	6320,0	3503,0	6565,0	6180,0
Indonesia	1276,0	8541,0	2523,0	8550,0	862,0	3125,0	5250,0	3705,0	7739,0	6518,0	1038,0	8650,0	5500,0	5189,0	2710,0	6404,0	8937,0	10207,0
Japan	3548,0	11500,0	933,0	11078,0	3125,0	226,0	7800,0	6220,0	10809,0	9046,0	5046,0	12550,0	7450,0	7717,0	5224,0	8932,0	6118,0	8559,0
LDC	6000,0	6320,0	7100,0	3400,0	5250,0	7800,0	4000,0	2959,0	5190,0	1250,0	6100,0	3450,0	6480,0	2005,0	3200,0	1160,0	8050,0	7075,0
Middle East	4698,0	8611,0	5667,0	6165,0	3705,0	6220,0	2959,0	2198,0	7309,0	4133,0	5200,0	6250,0	9572,0	2804,0	1122,0	4019,0	12219,0	13366,0
Nigeria	7825,0	7825,0	10254,0	4171,0	7739,0	10809,0	5190,0	7309,0	283,0	5350,0	9760,0	4250,0	5952,0	5094,0	7154,0	5236,0	6797,0	6412,0
Russia	7429,0	6633,0	8493,0	3617,0	6518,0	9046,0	1250,0	4133,0	5350,0	6500,0	6317,0	4001,0	7024,0	1329,0	4288,0	362,0	8345,0	7960,0
SIDS	7300,0	10140,0	4138,0	9700,0	1038,0	5046,0	6100,0	5200,0	9760,0	6317,0	7200,0	9650,0	8970,0	6400,0	4800,0	8500,0	7400,0	8200,0
UK	9500,0	5300,0	10650,0	250,0	8650,0	12550,0	3450,0	6250,0	4250,0	4001,0	9650,0	4001,0	4900,0	3500,0	6450,0	4050,0	6500,0	6200,0
USA	9791,0	5510,0	7500,0	5052,0	5500,0	7450,0	6480,0	9572,0	5952,0	7024,0	8970,0	4900,0	4479,0	6768,0	9727,0	6910,0	3292,0	2907,0
Rest of Africa	6100,0	6377,0	7164,0	3361,0	5189,0	7717,0	2005,0	2804,0	5094,0	1329,0	6400,0	3500,0	6768,0	2024,0	2959,0	1215,0	8089,0	7704,0
Rest of Asia	3702,0	7956,0	4672,0	6320,0	2710,0	5224,0	3200,0	1122,0	7154,0	4288,0	4800,0	6450,0	9727,0	2959,0	2435,0	4174,0	11048,0	10663,0
Rest of Europe	7315,0	6519,0	8379,0	3503,0	6404,0	8932,0	1160,0	4019,0	5236,0	362,0	8500,0	4050,0	6910,0	1215,0	4174,0	615,0	8231,0	7846,0
Rest of N.America	8691,0	6197,0	6855,0	6565,0	8937,0	6118,0	8050,0	12219,0	6797,0	8345,0	7400,0	6500,0	3292,0	8089,0	11048,0	8231,0	2328,0	2475,0
Rest of S.America	9425,0	4760,0	9304,0	6180,0	10207,0	8559,0	7075,0	13366,0	6412,0	7960,0	8200,0	6200,0	2907,0	7704,0	10663,0	7846,0	2475,0	2055,0

Source: Compiled by author based on data from (Bertoli, Goujon and Santoni, 2016)

Annex 10 (Initial tariffs corrected for distance)

Table 7-9: Tariffs corrected for distance

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	1,0000	1,1762	1,0024	1,0638	1,0022	1,0159	1,1053	1,0444	1,1419	1,0658	1,1017	1,0587	1,0207	1,1224	1,0286	1,0707	1,0484	1,0700
Brazil	1,0439	1,0000	1,1215	1,0363	1,1033	1,1211	1,1313	1,0914	1,1508	1,0608	1,1338	1,0326	1,0321	1,1271	1,1241	1,0649	1,0481	1,0007
China	1,0000	1,2674	1,0000	1,0713	1,0038	1,0059	1,1367	1,0576	1,2023	1,0829	1,0561	1,0718	1,0428	1,1314	1,0396	1,0516	1,0550	1,1235
EU-27	1,0466	1,1255	1,1160	1,0000	1,1228	1,0247	1,0676	1,0529	1,0870	1,0341	1,0867	1,0000	1,0295	1,0492	1,0804	1,0150	1,0197	1,0480
Indonesia	1,0000	1,2320	1,0018	1,0379	1,0000	1,0044	1,0864	1,0418	1,1772	1,0629	1,0123	1,0374	1,0375	1,1328	1,0159	1,0392	1,0969	1,1756
Japan	1,0008	1,2474	1,0106	1,0036	1,0053	1,0000	1,1366	1,0533	1,1816	1,0870	1,0515	1,0039	1,0426	1,1243	1,0393	1,0521	1,0246	1,0733
LDC	1,0002	1,2339	1,0341	1,0050	1,0632	1,0075	1,0394	1,0277	1,0503	1,0082	1,0505	1,0043	1,0314	1,0267	1,0265	1,0089	1,0719	1,1703
Middle East	1,0239	1,1056	1,0587	1,0223	1,0593	1,0350	1,0668	1,0050	1,1549	1,0379	1,0361	1,0204	1,0331	1,0531	1,0193	1,0315	1,0983	1,1564
Nigeria	1,0342	1,2202	1,1065	1,0165	1,1268	1,1767	1,0515	1,0534	1,0000	1,0407	1,1491	1,0086	1,0060	1,0438	1,1713	1,0932	1,0622	1,0600
Russia	1,0352	1,1232	1,0885	1,0235	1,0974	1,0415	1,0233	1,0422	1,0000	1,0000	1,0540	1,0208	1,0373	1,0222	1,0635	1,0010	1,0621	1,0828
SIDS	1,0068	1,2137	1,0157	1,0178	1,0041	1,0134	1,0766	1,0235	1,1990	1,0507	1,0512	1,0122	1,0096	1,1209	1,0406	1,0367	1,0476	1,0817
UK	1,0425	1,1178	1,1206	1,0000	1,1295	1,0255	1,0699	1,0520	1,0860	1,0381	1,0950	1,0000	1,0283	1,0539	1,0872	1,0190	1,0147	1,0403
USA	1,0183	1,1212	1,0877	1,0334	1,0758	1,0478	1,1306	1,0666	1,1148	1,0669	1,1469	1,0317	1,0000	1,1198	1,1253	1,0481	1,0060	1,0289
Rest of Africa	1,0336	1,1644	1,0768	1,0005	1,0904	1,0636	1,0224	1,0144	1,1151	1,0122	1,0423	1,0005	1,0122	1,0333	1,0560	1,0083	1,0831	1,1317
Rest of Asia	1,0059	1,2032	1,0180	1,0201	1,0081	1,0166	1,0498	1,0121	1,1464	1,0375	1,0454	1,0197	1,0488	1,0672	1,0161	1,0256	1,0950	1,1471
Rest of Europe	1,0398	1,1660	1,0811	1,0011	1,0980	1,0578	1,0263	1,0336	1,1149	1,0029	1,0909	1,0012	1,0413	1,0204	1,0593	1,0027	1,0710	1,1024
Rest of N.America	1,0088	1,1146	1,0696	1,0011	1,1303	1,0191	1,1649	1,0943	1,1223	1,0712	1,1249	1,0007	1,0005	1,1639	1,1488	1,0476	1,0079	1,0163
Rest of S.America	1,0335	1,0005	1,0627	1,0128	1,1443	1,0855	1,1606	1,1453	1,0897	1,0745	1,1391	1,0095	1,0077	1,1661	1,1618	1,0901	1,0156	1,0005

Source: Compiled by author

Annex 11 (Initial NTMs corrected for freight and distance)

Table 7-10: Initial NTMs corrected for freight and distance

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	2,7007	2,3074	2,6954	2,5583	2,6957	2,6653	2,4657	2,6017	2,3840	2,5539	2,4738	2,5698	2,6546	2,4275	2,6369	2,5429	2,5926	2,5445
Brazil	2,6028	2,7007	2,4294	2,6198	2,4703	2,4305	2,4076	2,4968	2,3641	2,5650	2,4021	2,6281	2,6290	2,4169	2,4237	2,5558	2,5933	2,6992
China	2,7007	2,1040	2,7007	2,5415	2,6923	2,6876	2,3956	2,5723	2,2492	2,5156	2,5756	2,5404	2,6052	2,4074	2,6124	2,5855	2,5779	2,4250
EU-27	2,5968	2,4207	2,4419	2,7007	2,4266	2,6457	2,5498	2,5827	2,5066	2,6245	2,5072	2,7007	2,6349	2,5910	2,5212	2,6673	2,6567	2,5936
Indonesia	2,7007	2,1828	2,6968	2,6161	2,7007	2,6909	2,5078	2,6075	2,3052	2,5603	2,6732	2,6173	2,6169	2,4043	2,6652	2,6132	2,4845	2,3087
Japan	2,6989	2,1485	2,6770	2,6927	2,6888	2,7007	2,3958	2,5818	2,2954	2,5065	2,5858	2,6921	2,6056	2,4234	2,6130	2,5844	2,6459	2,5371
LDC	2,7003	2,1786	2,6245	2,6895	2,5596	2,6840	2,6128	2,6388	2,5883	2,6824	2,5881	2,6911	2,6307	2,6412	2,6415	2,6808	2,5401	2,3207
Middle East	2,6474	2,4649	2,5696	2,6509	2,5684	2,6227	2,5517	2,6895	2,3551	2,6162	2,6202	2,6552	2,6268	2,5821	2,6576	2,6305	2,4814	2,3517
Nigeria	2,6244	2,2092	2,4631	2,6640	2,4178	2,3063	2,5857	2,5814	2,7007	2,6099	2,3680	2,6816	2,6873	2,6030	2,3183	2,4926	2,5619	2,5668
Russia	2,6220	2,4258	2,5033	2,6484	2,4832	2,6082	2,6488	2,6066	2,7007	2,7007	2,5802	2,6543	2,6174	2,6511	2,5589	2,6985	2,5621	2,5160
SIDS	2,6856	2,2237	2,6656	2,6610	2,6916	2,6707	2,5297	2,6483	2,2565	2,5875	2,5863	2,6734	2,6792	2,4308	2,6100	2,6187	2,5944	2,5184
UK	2,6060	2,4378	2,4315	2,7007	2,4118	2,6438	2,5447	2,5847	2,5087	2,6157	2,4886	2,7007	2,6375	2,5804	2,5061	2,6583	2,6680	2,6108
USA	2,6599	2,4301	2,5049	2,6261	2,5316	2,5940	2,4093	2,5521	2,4445	2,5514	2,3728	2,6300	2,7007	2,4334	2,4210	2,5935	2,6872	2,6363
Rest of Africa	2,6257	2,3337	2,5292	2,6995	2,4990	2,5588	2,6506	2,6686	2,4439	2,6734	2,6062	2,6996	2,6735	2,6264	2,5758	2,6823	2,5153	2,4068
Rest of Asia	2,6876	2,2471	2,6606	2,6558	2,6827	2,6636	2,5897	2,6737	2,3741	2,6171	2,5994	2,6567	2,5917	2,5507	2,6649	2,6435	2,4888	2,3724
Rest of Europe	2,6118	2,3302	2,5196	2,6982	2,4819	2,5718	2,6420	2,6258	2,4442	2,6943	2,4979	2,6981	2,6085	2,6552	2,5684	2,6946	2,5422	2,4722
Rest of N.America	2,6812	2,4450	2,5453	2,6983	2,4100	2,6581	2,3326	2,4902	2,4278	2,5418	2,4219	2,6991	2,6995	2,3349	2,3685	2,5944	2,6830	2,6643
Rest of S.America	2,6259	2,6997	2,5607	2,6723	2,3787	2,5098	2,3423	2,3764	2,5005	2,5344	2,3902	2,6796	2,6836	2,3299	2,3395	2,4995	2,6658	2,6997

Source: Compiled by author

Annex 12 (Final NTMs calculated for Scenario 1 - $75 global carbon tax)

Table 7-11: Final NTMs for Scenario 1a

Countrie	Aus/N	Brazi	Chin	EU-	Indonesi	Japa	LDC	Middl	Nigeri	Russi	SIDS	UK	USA	Rest	Rest	Rest	Rest of	Rest of
Aus/NZ	2,7449	2,314	2,750	2,588	2,7397	2,716	2,487	2,6363	2,3982	2,584	2,498	2,601	2,694	2,445	2,681	2,5719	2,6263	2,5737
Brazil	2,6375	2,744	2,459	2,659	2,4925	2,449	2,424	2,5216	2,3765	2,596	2,418	2,665	2,669	2,434	2,443	2,5861	2,6271	2,7442
China	2,7456	2,092	2,744	2,570	2,7357	2,730	2,411	2,6041	2,2509	2,542	2,612	2,569	2,640	2,423	2,652	2,6186	2,6104	2,4434
EU-27	2,6313	2,440	2,466	2,819	2,4451	2,684	2,580	2,6191	2,5388	2,661	2,536	2,752	2,683	2,627	2,552	2,7098	2,6981	2,6285
Indonesia	2,7454	2,178	2,743	2,652	2,7445	2,736	2,533	2,6426	2,3121	2,591	2,717	2,653	2,653	2,420	2,709	2,6488	2,5081	2,3159
Japan	2,7444	2,140	2,719	2,735	2,7316	2,744	2,411	2,6146	2,3013	2,532	2,619	2,735	2,641	2,441	2,650	2,6174	2,6847	2,5659
LDC	2,7441	2,173	2,681	2,736	2,5909	2,726	2,649	2,6771	2,6217	2,724	2,621	2,734	2,670	2,680	2,687	2,7227	2,5690	2,3294
Middle	2,6891	2,487	2,701	2,742	2,6043	2,720	2,585	2,7418	2,3670	2,652	2,682	2,698	2,691	2,620	2,856	2,6689	2,5066	2,3638
Nigeria	2,6614	2,208	2,486	2,720	2,4368	2,313	2,619	2,6143	2,7445	2,645	2,381	2,725	2,733	2,640	2,337	2,5170	2,5939	2,5986
Russia	2,6586	2,444	2,559	2,738	2,5068	2,649	2,688	2,6443	2,7455	2,744	2,616	2,698	2,665	2,690	2,599	2,7447	2,5932	2,5428
SIDS	2,7333	2,224	2,710	2,703	2,7425	2,714	2,560	2,6890	2,2589	2,620	2,620	2,715	2,725	2,449	2,656	2,6549	2,6285	2,5462
UK	2,6410	2,457	2,453	2,761	2,4286	2,682	2,574	2,6180	2,5347	2,651	2,512	2,744	2,678	2,613	2,533	2,6986	2,7093	2,6463
USA	2,7003	2,457	2,542	2,691	2,5614	2,634	2,426	2,5830	2,4648	2,581	2,390	2,672	2,744	2,453	2,450	2,6284	2,7637	2,6848
Rest of	2,6628	2,343	2,561	2,748	2,5242	2,589	2,690	2,7098	2,4638	2,714	2,641	2,743	2,716	2,664	2,611	2,7245	2,5419	2,4232
Rest of	2,7388	2,249	2,717	2,698	2,7285	2,712	2,625	2,7171	2,3890	2,653	2,648	2,697	2,630	2,581	2,718	2,6839	2,5131	2,3864
Rest of	2,6474	2,339	2,551	2,773	2,5058	2,603	2,680	2,6646	2,4649	2,737	2,522	2,762	2,646	2,695	2,601	2,7387	2,5723	2,4948
Rest of	2,7232	2,465	2,576	2,747	2,4266	2,698	2,342	2,5144	2,4462	2,570	2,440	2,743	2,809	2,344	2,386	2,6284	2,7256	2,7056
Rest of	2,6627	2,744	2,600	2,715	2,3924	2,537	2,352	2,3899	2,5256	2,562	2,406	2,721	2,744	2,339	2,356	2,5246	2,7068	2,7464

Source: Compiled by author

Table 7-12: Final NTMs for Scenario 1b

Countries	Aus/N	Brazil	China	EU-27	Indonesi	Japan	LDC	Middl	Nigeri	Russia	SIDS	UK	USA	Rest of	Rest of	Rest of	Rest of	Rest of
Aus/NZ	2,7558	2,317	2,896	2,601	2,7552	2,751	2,493	2,6456	2,4019	2,591	2,502	2,609	2,704	2,450	2,716	2,5802	2,6348	2,5817
Brazil	2,6462	2,755	2,503	2,671	2,4985	2,461	2,428	2,5298	2,3796	2,604	2,422	2,674	2,676	2,438	2,450	2,5948	2,6358	2,7550
China	2,7559	2,089	2,755	2,578	2,7468	2,742	2,414	2,6130	2,2513	2,548	2,615	2,576	2,649	2,428	2,660	2,6271	2,6184	2,4476
EU-27	2,6394	2,442	2,469	2,778	2,4494	2,694	2,587	2,6261	2,5401	2,670	2,539	2,757	2,682	2,634	2,556	2,7194	2,7065	2,6360
Indonesia	2,7555	2,177	2,763	2,661	2,7555	2,748	2,540	2,6514	2,3138	2,598	2,724	2,662	2,662	2,424	2,735	2,6577	2,5140	2,3177
Japan	2,7535	2,138	2,729	2,747	2,7423	2,755	2,414	2,6227	2,3028	2,538	2,627	2,746	2,649	2,445	2,658	2,6256	2,6943	2,5728
LDC	2,7552	2,172	2,673	2,744	2,5979	2,737	2,657	2,6865	2,6300	2,735	2,629	2,744	2,677	2,689	2,691	2,7333	2,5762	2,3311
Middle	2,6960	2,492	2,611	2,699	2,6078	2,668	2,589	2,7444	2,3694	2,661	2,665	2,704	2,673	2,623	2,709	2,6775	2,5105	2,3657
Nigeria	2,6702	2,206	2,490	2,714	2,4395	2,315	2,627	2,6223	2,7555	2,654	2,383	2,734	2,740	2,646	2,328	2,5231	2,6005	2,6059
Russia	2,6677	2,449	2,546	2,704	2,5132	2,655	2,698	2,6521	2,7562	2,755	2,620	2,704	2,662	2,701	2,604	2,7579	2,6008	2,5493
SIDS	2,7388	2,222	2,717	2,711	2,7457	2,722	2,564	2,6982	2,2593	2,629	2,627	2,725	2,731	2,454	2,655	2,6639	2,6369	2,5519
UK	2,6497	2,461	2,455	2,756	2,4328	2,692	2,581	2,6265	2,5410	2,660	2,518	2,755	2,684	2,621	2,538	2,7082	2,7189	2,6551
USA	2,7103	2,455	2,553	2,680	2,5670	2,645	2,430	2,5903	2,4700	2,588	2,389	2,677	2,755	2,458	2,452	2,6370	2,7523	2,6867
Rest of	2,6718	2,345	2,574	2,757	2,5302	2,598	2,699	2,7199	2,4687	2,725	2,650	2,754	2,725	2,672	2,624	2,7352	2,5484	2,4272
Rest of	2,7415	2,249	2,719	2,707	2,7371	2,714	2,633	2,7295	2,3907	2,662	2,642	2,706	2,634	2,589	2,718	2,6917	2,5190	2,3888
Rest of	2,6562	2,341	2,553	2,753	2,5112	2,611	2,690	2,6719	2,4690	2,748	2,529	2,752	2,652	2,704	2,607	2,7487	2,5785	2,5003
Rest of	2,7337	2,470	2,592	2,760	2,4317	2,711	2,344	2,5208	2,4512	2,578	2,444	2,754	2,757	2,347	2,389	2,6371	2,7362	2,7164
Rest of	2,6719	2,758	2,609	2,727	2,3963	2,543	2,355	2,3941	2,5321	2,569	2,409	2,732	2,737	2,341	2,355	2,5334	2,7174	2,7572

Source: Compiled by author

Table 7-13: Final NTMs for Scenario 1c

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	2,7744	2,3192	2,7728	2,6105	2,7682	2,7338	2,5020	2,6596	2,4076	2,6038	2,5120	2,6226	2,7219	2,4579	2,7023	2,5911	2,6488	2,5930
Brazil	2,6603	2,7733	2,4662	2,6835	2,5074	2,4617	2,4349	2,5383	2,3847	2,6169	2,4287	2,6898	2,6935	2,4458	2,4546	2,6065	2,6510	2,7740
China	2,7827	2,0902	2,7733	2,6623	2,7699	2,7790	2,4237	2,6336	2,2534	2,5654	2,6345	2,5985	2,7270	2,4375	2,7086	2,6458	2,6513	2,4619
EU-27	2,6595	2,4545	2,5115	3,0264	2,4583	2,7202	2,6005	2,6490	2,5499	2,6914	2,5557	2,8086	2,7591	2,6530	2,5866	2,7453	2,7352	2,6538
Indonesia	2,7737	2,1754	2,7744	2,6780	2,7733	2,7636	2,5508	2,6660	2,3166	2,6113	2,7429	2,6772	2,6797	2,4311	2,7364	2,6725	2,5241	2,3207
Japan	2,7733	2,1362	2,7690	2,7753	2,7616	2,7733	2,4215	2,6384	2,3052	2,5500	2,6432	2,7648	2,6800	2,4534	2,6878	2,6398	2,7134	2,5851
LDC	2,7731	2,1703	2,6888	2,7659	2,6104	2,7547	2,6722	2,7049	2,6436	2,7523	2,6434	2,7629	2,6949	2,7050	2,7073	2,7505	2,5885	2,3345
Middle East	2,7120	2,5015	2,6264	2,7202	2,6208	2,6837	2,6016	2,7637	2,3743	2,6760	2,6814	2,7212	2,6918	2,6369	2,7294	2,6944	2,5204	2,3704
Nigeria	2,6852	2,2057	2,4989	2,7310	2,4466	2,3179	2,6405	2,6356	2,7733	2,6685	2,3890	2,7513	2,7579	2,6605	2,3317	2,5330	2,6130	2,6186
Russia	2,6825	2,4564	2,5481	2,7173	2,5223	2,6670	2,7134	2,6651	2,7733	2,7733	2,6342	2,7217	2,6786	2,7162	2,6108	2,7729	2,6137	2,5601
SIDS	2,7565	2,2228	2,7370	2,7311	2,7639	2,7398	2,5761	2,7134	2,2603	2,6427	2,6414	2,7421	2,7531	2,4617	2,6744	2,6788	2,6512	2,5629
UK	2,6647	2,4699	2,4648	2,7939	2,4398	2,7085	2,5932	2,6408	2,5516	2,6756	2,5293	2,7733	2,7068	2,6349	2,5507	2,7257	2,7363	2,6697
USA	2,7296	2,4638	2,5643	2,7197	2,5789	2,6576	2,4371	2,6060	2,4776	2,6024	2,4002	2,6979	2,7733	2,4656	2,4640	2,6516	2,7941	2,7025
Rest of Africa	2,6869	2,3499	2,5785	2,7803	2,5406	2,6106	2,7165	2,7373	2,4768	2,7421	2,6644	2,7736	2,7444	2,6882	2,6309	2,7526	2,5597	2,4340
Rest of Asia	2,7625	2,2516	2,7772	2,7537	2,7564	2,7424	2,6472	2,7492	2,3967	2,6788	2,6639	2,7263	2,6937	2,6015	2,7524	2,7101	2,5383	2,3960
Rest of Europe	2,6709	2,3457	2,5652	2,7810	2,5207	2,6247	2,7057	2,6886	2,4771	2,7664	2,5393	2,7723	2,6692	2,7212	2,6213	2,7672	2,5907	2,5096
Rest of N.America	2,7514	2,4788	2,5986	2,7780	2,4377	2,7260	2,3482	2,5309	2,4582	2,5900	2,4519	2,7733	2,8316	2,3510	2,3916	2,6512	2,7583	2,7327
Rest of S.America	2,6871	2,7738	2,6189	2,7445	2,4016	2,5541	2,3594	2,3993	2,5421	2,5817	2,4149	2,7493	2,7573	2,3453	2,3584	2,5414	2,7344	2,7741

Source: Compiled by author

Annex 13 (Final NTMs calculated for Scenario 2 - $150 global carbon tax)

Table 7-14: Final NTMs for Scenario 2a

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	2,7892	2,3215	2,8060	2,6195	2,7837	2,7680	2,5094	2,6710	2,4124	2,6141	2,5222	2,6330	2,7336	2,4641	2,7253	2,6010	2,6600	2,6029
Brazil	2,6721	2,7884	2,4888	2,6983	2,5148	2,4677	2,4404	2,5463	2,3889	2,6273	2,4350	2,7021	2,7103	2,4516	2,4628	2,6165	2,6609	2,7892
China	2,7905	2,0801	2,7884	2,6003	2,7790	2,7734	2,4264	2,6360	2,2526	2,5686	2,6484	2,5982	2,6758	2,4403	2,6923	2,6517	2,6429	2,4617
EU-27	2,6659	2,4594	2,4901	2,9375	2,4637	2,7240	2,6111	2,6555	2,5709	2,6984	2,5659	2,8041	2,7323	2,6646	2,5839	2,7522	2,7396	2,6634
Indonesia	2,7900	2,1736	2,7901	2,6882	2,7884	2,7812	2,5595	2,6777	2,3189	2,6217	2,7611	2,6893	2,6906	2,4366	2,7530	2,6844	2,5317	2,3230
Japan	2,7898	2,1329	2,7624	2,7789	2,7744	2,7884	2,4264	2,6473	2,3072	2,5579	2,6536	2,7781	2,6766	2,4592	2,6881	2,6503	2,7235	2,5947
LDC	2,7879	2,1692	2,7394	2,7829	2,6222	2,7691	2,6870	2,7153	2,6551	2,7666	2,6555	2,7772	2,7100	2,7206	2,7335	2,7647	2,5978	2,3382
Middle East	2,7309	2,5103	2,8341	2,8332	2,6403	2,8184	2,6189	2,7942	2,3789	2,6881	2,7448	2,7422	2,7557	2,6589	3,0559	2,7074	2,5318	2,3760
Nigeria	2,6984	2,2069	2,5097	2,7765	2,4559	2,3212	2,6526	2,6471	2,7884	2,6806	2,3942	2,7698	2,7801	2,6787	2,3557	2,5414	2,6258	2,6303
Russia	2,6952	2,4626	2,6161	2,8276	2,5303	2,6900	2,7275	2,6819	2,7903	2,7884	2,6531	2,7420	2,7141	2,7307	2,6401	2,7909	2,6243	2,5696
SIDS	2,7809	2,2250	2,7548	2,7456	2,7934	2,7580	2,5909	2,7297	2,2613	2,6541	2,6547	2,7565	2,7711	2,4689	2,7020	2,6911	2,6625	2,5739
UK	2,6761	2,4766	2,4749	2,8221	2,4454	2,7209	2,6035	2,6513	2,5608	2,6874	2,5368	2,7884	2,7192	2,6461	2,5613	2,7390	2,7506	2,6819
USA	2,7407	2,4853	2,5799	2,7570	2,5912	2,6758	2,4428	2,6139	2,4852	2,6112	2,4078	2,7148	2,7884	2,4732	2,4791	2,6634	2,8401	2,7333
Rest of Africa	2,6999	2,3527	2,5932	2,7965	2,5493	2,6203	2,7301	2,7511	2,4837	2,7560	2,6767	2,7876	2,7592	2,7015	2,6468	2,7667	2,5685	2,4395
Rest of Asia	2,7901	2,2523	2,7752	2,7421	2,7744	2,7612	2,6622	2,7605	2,4040	2,6892	2,6983	2,7374	2,6691	2,6115	2,7722	2,7242	2,5375	2,4004
Rest of Europe	2,6830	2,3487	2,5828	2,8491	2,5297	2,6356	2,7189	2,7035	2,4857	2,7808	2,5478	2,8266	2,6844	2,7348	2,6348	2,7828	2,6025	2,5174
Rest of N.America	2,7652	2,4850	2,6068	2,7960	2,4433	2,7390	2,3514	2,5385	2,4645	2,5998	2,4582	2,7877	2,9191	2,3542	2,4037	2,6624	2,7682	2,7470
Rest of S.America	2,6996	2,7882	2,6409	2,7578	2,4061	2,5642	2,3629	2,4034	2,5507	2,5910	2,4222	2,7637	2,8057	2,3487	2,3739	2,5496	2,7477	2,7931

Source: Compiled by author

Table 7-15: Final NTMs for Scenario 2b

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	2,8109	2,3275	3,0967	2,6447	2,8146	2,8378	2,5209	2,6895	2,4197	2,6291	2,5307	2,6494	2,7534	2,4739	2,7964	2,6176	2,6771	2,6189
Brazil	2,6896	2,8103	2,5766	2,7227	2,5267	2,4917	2,4487	2,5627	2,3951	2,6429	2,4434	2,7214	2,7236	2,4607	2,4768	2,6338	2,6784	2,8109
China	2,8111	2,0748	2,8103	2,6145	2,8013	2,7975	2,4341	2,6537	2,2533	2,5822	2,6563	2,6126	2,6927	2,4492	2,7084	2,6687	2,6588	2,4702
EU-27	2,6821	2,4650	2,4963	2,8567	2,4722	2,7425	2,6248	2,6696	2,5735	2,7166	2,5718	2,8142	2,7304	2,6770	2,5914	2,7715	2,7564	2,6784
Indonesia	2,8103	2,1713	2,8310	2,7067	2,8103	2,8063	2,5730	2,6953	2,3224	2,6371	2,7765	2,7073	2,7071	2,4446	2,8062	2,7023	2,5436	2,3266
Japan	2,8081	2,1290	2,7820	2,8013	2,7957	2,8103	2,4341	2,6636	2,3102	2,5708	2,6685	2,8003	2,6930	2,4681	2,7034	2,6668	2,7427	2,6085
LDC	2,8102	2,1664	2,7232	2,7999	2,6363	2,7904	2,7024	2,7342	2,6717	2,7877	2,6714	2,7986	2,7239	2,7376	2,7409	2,7858	2,6122	2,3414
Middle East	2,7446	2,5194	2,6529	2,7490	2,6472	2,7140	2,6267	2,7994	2,3838	2,7060	2,7111	2,7542	2,7193	2,6641	2,7618	2,7246	2,5397	2,3797
Nigeria	2,7161	2,2038	2,5171	2,7650	2,4612	2,3237	2,6684	2,6631	2,8103	2,6983	2,3998	2,7867	2,7938	2,6897	2,3384	2,5535	2,6391	2,6450
Russia	2,7133	2,4725	2,5895	2,7604	2,5431	2,7029	2,7475	2,6977	2,8116	2,8103	2,6617	2,7544	2,7077	2,7511	2,6510	2,8173	2,6394	2,5827
SIDS	2,7920	2,2218	2,7684	2,7616	2,7997	2,7733	2,5994	2,7481	2,2622	2,6707	2,6693	2,7766	2,7840	2,4772	2,7017	2,7092	2,6793	2,5854
UK	2,6934	2,4859	2,4788	2,8123	2,4538	2,7401	2,6178	2,6684	2,5734	2,7054	2,5486	2,8103	2,7323	2,6618	2,5707	2,7581	2,7699	2,6993
USA	2,7607	2,4808	2,6014	2,7346	2,6024	2,6961	2,4512	2,6284	2,4956	2,6261	2,4070	2,7245	2,8103	2,4827	2,4833	2,6806	2,8174	2,7371
Rest of Africa	2,7178	2,3577	2,6192	2,8161	2,5615	2,6376	2,7490	2,7712	2,4935	2,7767	2,6940	2,8093	2,7768	2,7190	2,6736	2,7881	2,5816	2,4477
Rest of Asia	2,7954	2,2510	2,7793	2,7583	2,7915	2,7660	2,6768	2,7852	2,4073	2,7073	2,6863	2,7569	2,6781	2,6290	2,7711	2,7400	2,5492	2,4053
Rest of Europe	2,7007	2,3532	2,5876	2,8081	2,5404	2,6512	2,7379	2,7180	2,4938	2,8025	2,5601	2,8073	2,6968	2,7542	2,6472	2,8029	2,6147	2,5284
Rest of N.America	2,7862	2,4955	2,6399	2,8217	2,4534	2,7656	2,3562	2,5513	2,4746	2,6143	2,4667	2,8101	2,8149	2,3601	2,4101	2,6797	2,7894	2,7686
Rest of S.America	2,7180	2,8163	2,6588	2,7822	2,4140	2,5766	2,3686	2,4118	2,5636	2,6052	2,4280	2,7849	2,7909	2,3537	2,3721	2,5672	2,7690	2,8146

Source: Compiled by author

Table 7-16: Final NTMs for Scenario 2c

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	2,8480	2,3309	2,8500	2,6626	2,8406	2,8022	2,5382	2,7174	2,4311	2,6537	2,5501	2,6754	2,7893	2,4884	2,7677	2,6394	2,7050	2,6414
Brazil	2,7178	2,8459	2,5029	2,7471	2,5446	2,4928	2,4622	2,5797	2,4053	2,6687	2,4552	2,7514	2,7580	2,4747	2,4856	2,6572	2,7086	2,8487
China	2,8647	2,0764	2,8459	2,7831	2,8474	2,8704	2,4518	2,6949	2,2575	2,6153	2,6935	2,6566	2,8486	2,4676	2,8046	2,7061	2,7247	2,4988
EU-27	2,7222	2,4883	2,5811	3,3519	2,4900	2,7947	2,6512	2,7154	2,5931	2,7582	2,6041	2,9165	2,8831	2,7149	2,6519	2,8233	2,8138	2,7139
Indonesia	2,8467	2,1680	2,8519	2,7400	2,8459	2,8364	2,5937	2,7245	2,3280	2,6624	2,8125	2,7371	2,7424	2,4579	2,8076	2,7317	2,5636	2,3327
Japan	2,8476	2,1239	2,8610	2,8579	2,8343	2,8459	2,4472	2,6949	2,3151	2,5935	2,7005	2,8374	2,7543	2,4835	2,7625	2,6952	2,7809	2,6330
LDC	2,8459	2,1621	2,7530	2,8422	2,6612	2,8253	2,7315	2,7709	2,6988	2,8222	2,6986	2,8346	2,7591	2,7688	2,7730	2,8203	2,6367	2,3483
Middle East	2,7766	2,5380	2,6831	2,7895	2,6732	2,7446	2,6515	2,8379	2,3934	2,7357	2,7427	2,7872	2,7569	2,6917	2,8011	2,7583	2,5595	2,3892
Nigeria	2,7459	2,2021	2,5348	2,7980	2,4754	2,3294	2,6953	2,6898	2,8459	2,7270	2,4101	2,8209	2,8284	2,7179	2,3452	2,5733	2,6641	2,6705
Russia	2,7429	2,4869	2,5929	2,7861	2,5613	2,7257	2,7779	2,7236	2,8459	2,8459	2,6881	2,7891	2,7396	2,7811	2,6627	2,8472	2,6652	2,6042
SIDS	2,8274	2,2218	2,8084	2,8011	2,8362	2,8088	2,6225	2,7786	2,2641	2,6979	2,6965	2,8107	2,8269	2,4927	2,7388	2,7388	2,7078	2,6073
UK	2,7233	2,5020	2,4980	2,8870	2,4677	2,7732	2,6418	2,6969	2,5945	2,7354	2,5700	2,8459	2,7760	2,6893	2,5952	2,7931	2,8047	2,7285
USA	2,7992	2,4975	2,6236	2,8132	2,6262	2,7212	2,4648	2,6599	2,5107	2,6532	2,4277	2,7658	2,8459	2,4978	2,5070	2,7097	2,9008	2,7687
Rest of Africa	2,7481	2,3660	2,6278	2,8610	2,5822	2,6623	2,7823	2,8060	2,5097	2,8107	2,7226	2,8475	2,8153	2,7500	2,6861	2,8229	2,6040	2,4612
Rest of Asia	2,8374	2,2560	2,8938	2,8515	2,8300	2,8213	2,7046	2,8246	2,4193	2,7404	2,7284	2,7958	2,7956	2,6523	2,8399	2,7766	2,5879	2,4195
Rest of Europe	2,7298	2,3611	2,6108	2,8637	2,5594	2,6776	2,7694	2,7515	2,5100	2,8385	2,5807	2,8465	2,7299	2,7871	2,6741	2,8397	2,6391	2,5470
Rest of N.America	2,8216	2,5126	2,6519	2,8577	2,4655	2,7939	2,3638	2,5715	2,4885	2,6382	2,4820	2,8476	2,9636	2,3671	2,4147	2,7080	2,8336	2,8012
Rest of S.America	2,7482	2,8478	2,6771	2,8168	2,4246	2,5983	2,3765	2,4222	2,5837	2,6289	2,4395	2,8189	2,8309	2,3606	2,3772	2,5832	2,8030	2,8485

Source: Compiled by author

Annex 14 (Final NTMs calculated for Scenario 3 - $100 global carbon tax)

Table 7-17: Final NTMs for Scenario 3a

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	2,7597	2,3168	2,7692	2,5991	2,7544	2,7338	2,4949	2,6479	2,4030	2,5940	2,5061	2,6119	2,7073	2,4519	2,6959	2,5816	2,6376	2,5835
Brazil	2,6490	2,7592	2,4690	2,6722	2,5000	2,4553	2,4294	2,5298	2,3806	2,6066	2,4240	2,6775	2,6832	2,4400	2,4498	2,5963	2,6383	2,7592
China	2,7606	2,0881	2,7592	2,5807	2,7501	2,7448	2,4162	2,6147	2,2515	2,5510	2,6242	2,5789	2,6523	2,4293	2,6657	2,6296	2,6212	2,4495
EU-27	2,6428	2,4465	2,4741	2,8586	2,4513	2,6979	2,5907	2,6312	2,5495	2,6738	2,5463	2,7696	2,6999	2,6401	2,5630	2,7239	2,7120	2,6401
Indonesia	2,7603	2,1767	2,7590	2,6642	2,7592	2,7511	2,5423	2,6543	2,3144	2,6012	2,7318	2,6653	2,6660	2,4258	2,7238	2,6607	2,5160	2,3183
Japan	2,7595	2,1381	2,7340	2,7502	2,7459	2,7592	2,4162	2,6255	2,3033	2,5408	2,6310	2,7494	2,6529	2,4472	2,6630	2,6284	2,6976	2,5756
LDC	2,7587	2,1723	2,7011	2,7518	2,6014	2,7408	2,6623	2,6898	2,6328	2,7386	2,6331	2,7485	2,6836	2,6942	2,7028	2,7367	2,5786	2,3324
Middle East	2,7031	2,4952	2,7460	2,7724	2,6163	2,7532	2,5965	2,7593	2,3709	2,6641	2,7033	2,7132	2,7128	2,6333	2,9232	2,6817	2,5150	2,3679
Nigeria	2,6737	2,2076	2,4942	2,7390	2,4432	2,3163	2,6303	2,6252	2,7592	2,6570	2,3855	2,7404	2,7492	2,6535	2,3432	2,5251	2,6045	2,6092
Russia	2,6708	2,4503	2,5785	2,7679	2,5146	2,6627	2,7013	2,6568	2,7605	2,7592	2,6288	2,7128	2,6819	2,7042	2,6130	2,7601	2,6036	2,5517
SIDS	2,7492	2,2246	2,7251	2,7174	2,7595	2,7289	2,5705	2,7026	2,2597	2,6320	2,6319	2,7288	2,7405	2,4562	2,6713	2,6670	2,6399	2,5554
UK	2,6527	2,4637	2,4605	2,7816	2,4342	2,6952	2,5839	2,6291	2,5434	2,6635	2,5208	2,7592	2,6920	2,6242	2,5429	2,7121	2,7231	2,6582
USA	2,7138	2,4670	2,5549	2,7134	2,5713	2,6485	2,4317	2,5933	2,4716	2,5913	2,3962	2,6866	2,7592	2,4599	2,4597	2,6401	2,7892	2,7010
Rest of Africa	2,6752	2,3464	2,5719	2,7642	2,5326	2,5998	2,7036	2,7236	2,4705	2,7285	2,6532	2,7582	2,7307	2,6765	2,6231	2,7385	2,5508	2,4286
Rest of Asia	2,7559	2,2506	2,7370	2,7133	2,7438	2,7287	2,6380	2,7316	2,3940	2,6652	2,6654	2,7106	2,6433	2,5913	2,7364	2,6973	2,5213	2,3911
Rest of Europe	2,6593	2,3426	2,5618	2,7988	2,5138	2,6143	2,6933	2,6776	2,4718	2,7520	2,5312	2,7838	2,6591	2,7083	2,6127	2,7534	2,5824	2,5023
Rest of N.America	2,7372	2,4716	2,5863	2,7634	2,4322	2,7121	2,3451	2,5224	2,4523	2,5805	2,4461	2,7582	2,8460	2,3478	2,3920	2,6398	2,7398	2,7195
Rest of S.America	2,6750	2,7587	2,6142	2,7293	2,3970	2,5461	2,3560	2,3944	2,5340	2,5721	2,4116	2,7357	2,7650	2,3424	2,3624	2,5329	2,7204	2,7620

Source: Compiled by author

Table 7-18: Final NTMs for Scenario 3b

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	2,7741	2,3208	2,9628	2,6159	2,7750	2,7803	2,5025	2,6602	2,4078	2,6040	2,5117	2,6229	2,7204	2,4584	2,7432	2,5926	2,6489	2,5941
Brazil	2,6607	2,7737	2,5275	2,6884	2,5079	2,4713	2,4350	2,5407	2,3847	2,6169	2,4296	2,6902	2,6920	2,4461	2,4591	2,6078	2,6500	2,7736
China	2,7743	2,0845	2,7737	2,5902	2,7649	2,7609	2,4212	2,6266	2,2520	2,5600	2,6294	2,5885	2,6635	2,4353	2,6764	2,6410	2,6318	2,4551
EU-27	2,6536	2,4502	2,4782	2,8047	2,4570	2,7102	2,5998	2,6406	2,5512	2,6859	2,5502	2,7763	2,6986	2,6483	2,5680	2,7367	2,7231	2,6501
Indonesia	2,7738	2,1751	2,7862	2,6765	2,7737	2,7678	2,5513	2,6660	2,3167	2,6115	2,7421	2,6773	2,6770	2,4312	2,7592	2,6725	2,5239	2,3206
Japan	2,7717	2,1355	2,7470	2,7651	2,7601	2,7737	2,4213	2,6363	2,3052	2,5493	2,6409	2,7642	2,6639	2,4532	2,6732	2,6393	2,7104	2,5847
LDC	2,7735	2,1705	2,6903	2,7630	2,6107	2,7549	2,6725	2,7024	2,6439	2,7526	2,6436	2,7627	2,6928	2,7054	2,7078	2,7507	2,5882	2,3345
Middle East	2,7121	2,5012	2,6251	2,7162	2,6209	2,6835	2,6017	2,7627	2,3742	2,6760	2,6808	2,7211	2,6885	2,6367	2,7271	2,6932	2,5202	2,3703
Nigeria	2,6855	2,2056	2,4991	2,7313	2,4467	2,3179	2,6408	2,6359	2,7737	2,6688	2,3892	2,7517	2,7583	2,6608	2,3317	2,5332	2,6133	2,6189
Russia	2,6828	2,4569	2,5607	2,7231	2,5231	2,6713	2,7146	2,6673	2,7746	2,7737	2,6345	2,7210	2,6776	2,7177	2,6202	2,7777	2,6136	2,5604
SIDS	2,7565	2,2225	2,7341	2,7280	2,7636	2,7391	2,5762	2,7148	2,2603	2,6429	2,6416	2,7422	2,7491	2,4617	2,6711	2,6790	2,6510	2,5630
UK	2,6642	2,4698	2,4630	2,7751	2,4398	2,7080	2,5934	2,6404	2,5518	2,6755	2,5286	2,7737	2,7007	2,6347	2,5491	2,7248	2,7359	2,6698
USA	2,7271	2,4639	2,5692	2,6984	2,5787	2,6620	2,4372	2,6030	2,4785	2,6012	2,3956	2,6930	2,7737	2,4663	2,4625	2,6515	2,7740	2,7035
Rest of Africa	2,6871	2,3497	2,5892	2,7772	2,5407	2,6113	2,7162	2,7370	2,4770	2,7422	2,6647	2,7727	2,7423	2,6881	2,6410	2,7528	2,5595	2,4340
Rest of Asia	2,7594	2,2497	2,7397	2,7241	2,7552	2,7318	2,6478	2,7480	2,3962	2,6772	2,6573	2,7235	2,6493	2,6028	2,7357	2,7078	2,5291	2,3943
Rest of Europe	2,6710	2,3455	2,5649	2,7714	2,5209	2,6247	2,7059	2,6873	2,4772	2,7664	2,5393	2,7709	2,6673	2,7212	2,6209	2,7668	2,5905	2,5096
Rest of N.America	2,7512	2,4786	2,6083	2,7805	2,4389	2,7298	2,3483	2,5309	2,4590	2,5901	2,4517	2,7731	2,7764	2,3517	2,3962	2,6513	2,7539	2,7338
Rest of S.America	2,6873	2,7774	2,6260	2,7455	2,4022	2,5543	2,3598	2,4000	2,5426	2,5816	2,4154	2,7498	2,7551	2,3458	2,3612	2,5446	2,7345	2,7763

Source: Compiled by author

Table 7-19: Final NTMs for Scenario 3c

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	2,7989	2,3231	2,7985	2,6278	2,7923	2,7566	2,5140	2,6788	2,4154	2,6205	2,5247	2,6402	2,7444	2,4681	2,7241	2,6072	2,6675	2,6091
Brazil	2,6795	2,7975	2,4784	2,7047	2,5198	2,4720	2,4440	2,5521	2,3916	2,6342	2,4375	2,7103	2,7150	2,4554	2,4649	2,6234	2,6702	2,7989
China	2,8100	2,0856	2,7975	2,7026	2,7957	2,8095	2,4331	2,6541	2,2547	2,5820	2,6542	2,6179	2,7675	2,4475	2,7406	2,6659	2,6758	2,4742
EU-27	2,6804	2,4657	2,5347	3,1349	2,4688	2,7450	2,6174	2,6712	2,5643	2,7137	2,5718	2,8446	2,8004	2,6736	2,6084	2,7713	2,7614	2,6738
Indonesia	2,7980	2,1729	2,8002	2,6987	2,7975	2,7879	2,5651	2,6855	2,3204	2,6284	2,7661	2,6971	2,7006	2,4400	2,7602	2,6922	2,5372	2,3247
Japan	2,7980	2,1321	2,7997	2,8028	2,7859	2,7975	2,4300	2,6573	2,3085	2,5645	2,6623	2,7890	2,7047	2,4634	2,7127	2,6583	2,7359	2,6011
LDC	2,7974	2,1676	2,7102	2,7913	2,6274	2,7782	2,6920	2,7269	2,6620	2,7756	2,6618	2,7868	2,7163	2,7263	2,7292	2,7738	2,6046	2,3391
Middle East	2,7335	2,5136	2,6453	2,7433	2,6383	2,7040	2,6182	2,7884	2,3807	2,6959	2,7018	2,7432	2,7135	2,6552	2,7533	2,7157	2,5334	2,3767
Nigeria	2,7054	2,2045	2,5109	2,7533	2,4562	2,3217	2,6588	2,6537	2,7975	2,6880	2,3961	2,7745	2,7814	2,6796	2,3362	2,5464	2,6301	2,6359
Russia	2,7026	2,4665	2,5630	2,7402	2,5353	2,6866	2,7349	2,6846	2,7975	2,7975	2,6522	2,7442	2,6989	2,7378	2,6281	2,7977	2,6309	2,5748
SIDS	2,7802	2,2224	2,7608	2,7544	2,7880	2,7628	2,5916	2,7352	2,2616	2,6611	2,6598	2,7650	2,7777	2,4721	2,6959	2,6988	2,6700	2,5777
UK	2,6842	2,4806	2,4759	2,8249	2,4491	2,7301	2,6094	2,6595	2,5659	2,6955	2,5429	2,7975	2,7299	2,6530	2,5655	2,7482	2,7591	2,6893
USA	2,7528	2,4751	2,5840	2,7508	2,5947	2,6788	2,4463	2,6240	2,4887	2,6193	2,4094	2,7205	2,7975	2,4763	2,4783	2,6709	2,8297	2,7246
Rest of Africa	2,7073	2,3552	2,5950	2,8072	2,5545	2,6278	2,7384	2,7602	2,4878	2,7650	2,6838	2,7982	2,7681	2,7088	2,6493	2,7761	2,5745	2,4431
Rest of Asia	2,7875	2,2530	2,8161	2,7863	2,7809	2,7687	2,6663	2,7743	2,4042	2,6993	2,6854	2,7494	2,7277	2,6184	2,7816	2,7323	2,5549	2,4038
Rest of Europe	2,6905	2,3508	2,5804	2,8086	2,5336	2,6424	2,7269	2,7096	2,4881	2,7904	2,5531	2,7970	2,6894	2,7432	2,6389	2,7913	2,6068	2,5221
Rest of N.America	2,7748	2,4901	2,6164	2,8046	2,4470	2,7487	2,3534	2,5444	2,4683	2,6061	2,4620	2,7981	2,8756	2,3564	2,3993	2,6701	2,7834	2,7556
Rest of S.America	2,7075	2,7985	2,6383	2,7686	2,4093	2,5688	2,3651	2,4069	2,5560	2,5974	2,4231	2,7725	2,7819	2,3504	2,3647	2,5553	2,7573	2,7989

Source: Compiled by author

Annex 15 (Change in trade values in billion USD)

Table 7-20: Change in trade values for Wet bulk Scenario 1

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,370	0,000	-10,970	-0,054	-0,603	-10,003	-0,007	-0,048	0,000	0,000	-1,368	0,000	-0,026	-0,008	-5,473	0,000	0,000	-0,002
Brazil	0,000	0,000	-9,584	-2,719	-0,009	-0,046	0,000	-0,009	-0,016	0,000	-0,462	-0,001	-3,260	-0,016	-1,314	-0,061	-0,003	-1,252
China	-1,014	-0,023	0,000	-0,370	-0,307	-0,299	-0,121	-0,032	-0,057	-0,001	-3,950	-0,024	-0,324	-0,066	-3,800	-0,001	-0,135	-0,247
EU-27	-0,386	-1,398	-3,556	-70,232	-0,271	-0,401	-0,828	-3,203	-5,535	-0,219	-3,045	-7,044	-9,630	-2,829	-3,357	-1,562	-1,494	-0,941
Indonesia	-0,774	0,000	-2,924	-0,136	0,000	-2,104	-0,018	-0,005	0,000	0,000	-2,512	0,000	-0,745	-0,028	-2,958	-0,003	0,000	0,000
Japan	-1,659	-0,014	-1,011	-0,021	-0,066	0,000	-0,011	-0,014	0,000	-0,026	-0,770	-0,002	-0,493	-0,006	-1,651	-0,003	-0,073	-0,248
LDC	-0,016	-0,235	-18,882	-3,566	-0,603	-0,272	-1,380	-0,214	-0,046	0,000	-0,380	-0,120	-2,162	-1,315	-6,694	-0,003	-0,001	-0,364
Middle East	-2,428	-0,725	-90,841	-45,144	-3,702	-54,727	-3,086	-8,394	-0,297	-0,017	-22,566	-3,315	-23,379	-4,742	-151,513	-0,997	-1,443	-0,688
Nigeria	-0,275	-0,776	-1,452	-14,683	-1,439	-0,393	-0,352	-0,152	0,000	0,000	-0,339	-1,940	-3,537	-2,974	-8,277	-0,031	-0,949	-0,434
Russia	-0,103	-0,270	-26,960	-46,847	-0,026	-5,080	-0,348	-2,404	-0,896	0,000	-3,452	-3,946	-10,958	-0,570	-8,324	-2,381	-0,188	-0,218
SIDS	-4,840	-1,105	-3,659	-1,987	-7,433	-2,412	-2,498	-1,670	-0,109	-0,051	-0,947	-0,259	-3,750	-0,430	-9,208	-0,012	-0,144	-0,842
UK	-0,096	-0,165	-2,543	-15,563	-0,017	-0,034	-0,140	-0,293	-0,158	-0,004	-0,101	0,000	-2,687	-0,253	-1,616	-0,480	-0,503	-0,139
USA	-0,385	-7,839	-10,273	-25,910	-1,573	-6,318	-0,161	-0,854	-0,410	-0,022	-3,633	-4,703	0,000	-0,912	-9,053	-1,060	-31,466	-9,742
Rest of Africa	-0,230	-0,002	-3,653	-4,414	-0,190	-0,154	-0,577	-0,415	-0,075	-0,001	-0,220	-0,253	-1,476	-0,614	-2,875	-0,092	-0,083	-0,024
Rest of Asia	-7,965	-0,913	-15,697	-3,113	-3,390	-7,735	-2,568	-1,920	-1,399	-0,059	-13,864	-0,578	-4,455	-0,559	-11,566	-1,719	-0,299	-0,707
Rest of Europe	-0,036	-0,051	-3,980	-29,336	-0,444	-0,099	-0,078	-1,829	-0,772	-0,012	-0,096	-19,232	-2,411	-0,179	-1,442	-0,782	-0,944	-0,103
Rest of N.America	-0,002	-0,086	-1,164	-4,493	-0,001	-0,529	-0,011	-0,004	-0,015	-0,005	-0,332	-0,587	-61,812	-0,035	-3,431	-0,091	-0,353	-0,829
Rest of S.America	-0,028	-0,523	-8,301	-1,448	-0,007	-1,063	-0,012	-0,001	0,000	0,000	-1,022	-0,204	-17,588	-0,171	-5,478	0,000	-0,351	-2,785

Source: Compiled by author

Table 7-21: Change in trade values for Wet bulk Scenario 2

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,373	0,000	-11,028	-0,052	-0,613	-10,166	-0,007	-0,049	0,000	0,000	-1,374	0,000	-0,026	-0,008	-5,279	0,000	0,000	-0,002
Brazil	0,000	0,000	-9,575	-2,724	-0,009	-0,046	0,000	-0,009	-0,016	0,000	-0,468	-0,001	-3,311	-0,016	-1,244	-0,062	-0,003	-1,284
China	-1,031	-0,022	0,000	-0,363	-0,314	-0,303	-0,122	-0,033	-0,056	-0,001	-4,051	-0,024	-0,325	-0,067	-3,690	-0,001	-0,134	-0,245
EU-27	-0,371	-1,344	-3,255	-72,146	-0,256	-0,388	-0,812	-3,172	-5,438	-0,215	-2,959	-6,931	-9,351	-2,802	-2,972	-1,539	-1,413	-0,906
Indonesia	-0,784	0,000	-2,928	-0,134	0,000	-2,134	-0,018	-0,005	0,000	0,000	-2,576	0,000	-0,745	-0,028	-2,869	-0,003	0,000	0,000
Japan	-1,690	-0,013	-1,014	-0,021	-0,067	0,000	-0,011	-0,015	0,000	-0,027	-0,788	-0,002	-0,495	-0,006	-1,600	-0,003	-0,073	-0,250
LDC	-0,016	-0,227	-19,096	-3,543	-0,608	-0,275	-1,412	-0,220	-0,047	0,000	-0,386	-0,121	-2,161	-1,350	-6,491	-0,003	-0,001	-0,351
Middle East	-2,221	-0,656	-92,424	-43,427	-3,397	-54,465	-2,872	-8,090	-0,259	-0,016	-21,852	-3,052	-22,015	-4,470	-157,979	-0,926	-1,200	-0,569
Nigeria	-0,280	-0,772	-1,437	-14,948	-1,457	-0,387	-0,364	-0,158	0,000	0,000	-0,342	-1,988	-3,605	-3,087	-7,800	-0,032	-0,945	-0,441
Russia	-0,102	-0,266	-26,851	-47,828	-0,025	-5,039	-0,351	-2,429	-0,908	0,000	-3,459	-3,928	-10,872	-0,577	-7,803	-2,399	-0,180	-0,212
SIDS	-4,906	-1,078	-3,648	-1,965	-7,615	-2,438	-2,545	-1,715	-0,107	-0,051	-0,962	-0,261	-3,771	-0,434	-8,930	-0,012	-0,142	-0,840
UK	-0,097	-0,167	-2,469	-15,722	-0,017	-0,034	-0,143	-0,300	-0,161	-0,004	-0,102	0,000	-2,697	-0,260	-1,526	-0,490	-0,500	-0,140
USA	-0,385	-7,922	-10,098	-26,126	-1,573	-6,338	-0,161	-0,867	-0,410	-0,022	-3,601	-4,726	0,000	-0,915	-8,420	-1,068	-32,040	-9,854
Rest of Africa	-0,234	-0,002	-3,638	-4,440	-0,193	-0,156	-0,597	-0,429	-0,077	-0,001	-0,226	-0,258	-1,495	-0,635	-2,786	-0,095	-0,081	-0,024
Rest of Asia	-8,043	-0,884	-15,738	-3,054	-3,435	-7,802	-2,609	-1,963	-1,388	-0,060	-14,194	-0,578	-4,414	-0,565	-11,217	-1,738	-0,286	-0,683
Rest of Europe	-0,035	-0,050	-3,824	-29,527	-0,435	-0,097	-0,079	-1,850	-0,764	-0,012	-0,095	-19,527	-2,362	-0,181	-1,334	-0,787	-0,900	-0,099
Rest of N.America	-0,002	-0,082	-1,064	-4,226	-0,001	-0,506	-0,010	-0,004	-0,014	-0,005	-0,311	-0,565	-63,212	-0,032	-2,777	-0,088	-0,330	-0,795
Rest of S.America	-0,028	-0,539	-8,293	-1,440	-0,007	-1,063	-0,012	-0,001	0,000	0,000	-1,025	-0,207	-18,013	-0,171	-5,049	0,000	-0,349	-2,837

Source: Compiled by author

Table 7-22: Change in trade values for Wet bulk Scenario 3

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,371	0,000	-10,989	-0,053	-0,607	-10,060	-0,007	-0,049	0,000	0,000	-1,370	0,000	-0,026	-0,008	-5,406	0,000	0,000	-0,002
Brazil	0,000	0,000	-9,581	-2,720	-0,009	-0,046	0,000	-0,009	-0,016	0,000	-0,464	-0,001	-3,278	-0,016	-1,290	-0,061	-0,003	-1,263
China	-1,020	-0,023	0,000	-0,368	-0,309	-0,300	-0,121	-0,032	-0,057	-0,001	-3,985	-0,024	-0,324	-0,066	-3,762	-0,001	-0,135	-0,246
EU-27	-0,381	-1,380	-3,457	-70,883	-0,266	-0,397	-0,822	-3,192	-5,501	-0,217	-3,016	-7,004	-9,535	-2,819	-3,229	-1,554	-1,467	-0,929
Indonesia	-0,778	0,000	-2,926	-0,135	0,000	-2,115	-0,018	-0,005	0,000	0,000	-2,534	0,000	-0,745	-0,028	-2,927	-0,003	0,000	0,000
Japan	-1,669	-0,013	-1,012	-0,021	-0,066	0,000	-0,011	-0,015	0,000	-0,026	-0,776	-0,002	-0,494	-0,006	-1,633	-0,003	-0,073	-0,249
LDC	-0,016	-0,233	-18,956	-3,558	-0,605	-0,273	-1,391	-0,216	-0,046	0,000	-0,383	-0,120	-2,162	-1,327	-6,623	-0,003	-0,001	-0,360
Middle East	-2,359	-0,702	-91,364	-44,552	-3,600	-54,626	-3,014	-8,289	-0,284	-0,017	-22,318	-3,227	-22,918	-4,650	- 153,745	-0,973	-1,364	-0,649
Nigeria	-0,277	-0,775	-1,447	-14,773	-1,445	-0,391	-0,356	-0,154	0,000	0,000	-0,340	-1,956	-3,560	-3,013	-8,114	-0,032	-0,947	-0,436
Russia	-0,103	-0,268	-26,922	-47,182	-0,026	-5,067	-0,349	-2,412	-0,900	0,000	-3,454	-3,939	-10,929	-0,572	-8,147	-2,387	-0,185	-0,216
SIDS	-4,862	-1,096	-3,656	-1,980	-7,495	-2,421	-2,514	-1,686	-0,108	-0,051	-0,952	-0,259	-3,757	-0,431	-9,111	-0,012	-0,143	-0,841
UK	-0,096	-0,166	-2,518	-15,617	-0,017	-0,034	-0,141	-0,296	-0,159	-0,004	-0,101	0,000	-2,690	-0,256	-1,585	-0,483	-0,502	-0,139
USA	-0,385	-7,867	-10,214	-25,983	-1,573	-6,326	-0,161	-0,859	-0,410	-0,022	-3,623	-4,711	0,000	-0,913	-8,840	-1,063	-31,659	-9,779
Rest of Africa	-0,232	-0,002	-3,648	-4,423	-0,191	-0,155	-0,584	-0,420	-0,076	-0,001	-0,222	-0,255	-1,483	-0,621	-2,844	-0,093	-0,082	-0,024
Rest of Asia	-7,991	-0,903	-15,711	-3,093	-3,405	-7,759	-2,582	-1,935	-1,396	-0,059	-13,978	-0,578	-4,442	-0,561	-11,444	-1,726	-0,295	-0,699
Rest of Europe	-0,035	-0,051	-3,928	-29,399	-0,441	-0,098	-0,079	-1,837	-0,770	-0,012	-0,096	-19,332	-2,394	-0,180	-1,406	-0,784	-0,929	-0,102
Rest of N.America	-0,002	-0,085	-1,131	-4,403	-0,001	-0,521	-0,010	-0,004	-0,015	-0,005	-0,325	-0,580	-62,279	-0,034	-3,217	-0,090	-0,345	-0,817
Rest of S.America	-0,028	-0,528	-8,297	-1,445	-0,007	-1,063	-0,012	-0,001	0,000	0,000	-1,023	-0,205	-17,733	-0,171	-5,333	0,000	-0,351	-2,802

Source: Compiled by author

Table 7-23: Change in trade values for Dry bulk Scenario 1

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,125	-0,424	-75,727	-2,022	-2,429	-16,788	-0,111	-0,279	-0,039	-0,001	-0,058	-0,133	-0,005	-0,130	-14,909	-0,402	-0,028	-0,257
Brazil	-0,041	0,000	-22,736	-2,961	-0,181	-3,402	-0,025	-0,933	-0,006	0,000	-0,343	-0,171	-0,427	-0,114	-1,864	-0,552	-0,147	-0,617
China	-0,185	-0,124	0,000	-0,140	-0,350	-0,852	-0,052	-0,451	-0,011	-0,079	-0,099	-0,021	-0,042	-0,186	-1,683	-0,114	-0,005	-0,006
EU-27	-0,024	-0,051	-1,022	-11,555	-0,034	-0,016	-0,168	-1,158	-0,602	-0,078	-0,047	-0,940	-0,297	-0,488	-0,580	-0,585	-0,091	-0,057
Indonesia	-0,004	0,000	-5,839	-0,205	0,000	-2,022	-0,153	-0,010	0,000	0,000	-0,042	0,000	-0,046	0,000	-9,944	0,000	0,000	0,000
Japan	-0,003	0,000	-0,219	-0,230	-0,031	0,000	-0,008	0,000	0,000	-0,018	-0,004	-0,161	-0,021	-0,001	-0,319	0,000	-0,001	0,000
LDC	-0,098	-0,068	-1,573	-0,838	-0,010	-0,161	-0,128	-0,077	-0,007	-0,006	-0,005	-0,051	-0,003	-0,169	-0,904	-0,017	-0,001	0,000
Middle East	-0,014	0,000	-0,937	-0,040	-0,054	-0,006	-0,076	-0,739	-0,003	0,000	-0,044	-0,020	-0,065	-0,016	-1,179	-0,240	-0,001	0,000
Nigeria	0,000	0,000	0,000	0,000	0,000	0,000	-0,003	0,000	0,000	0,000	0,000	0,000	0,000	-0,002	0,000	0,000	0,000	0,000
Russia	-0,008	-0,339	-4,857	-3,584	-0,259	-1,670	-0,318	-0,856	-0,338	0,000	-0,007	-0,341	-0,044	-0,491	-3,780	-2,440	-0,033	-0,071
SIDS	-0,068	-0,004	-0,309	-0,070	-0,165	0,000	-0,025	-0,603	-0,001	0,000	-0,023	-0,004	-0,052	-0,001	-0,790	-0,007	-0,022	0,000
UK	-0,004	0,000	-0,122	-0,494	0,000	-0,003	-0,002	-0,300	-0,005	-0,010	0,000	0,000	-0,017	-0,001	-0,114	-0,029	-0,006	0,000
USA	-0,198	-0,991	-7,065	-3,947	-0,186	-4,304	-0,091	-0,344	-0,328	-0,003	-0,277	-0,348	0,000	-0,506	-4,138	-0,635	-5,846	-1,526
Rest of Africa	-0,003	-0,052	-4,455	-1,823	-0,029	-0,572	-0,132	-0,139	-0,014	-0,001	-0,065	-0,093	-0,019	-0,082	-4,282	-0,152	-0,001	-0,012
Rest of Asia	-0,338	-0,066	-4,238	-0,835	-0,869	-0,377	-0,862	-2,022	-0,007	-0,053	-0,251	-0,212	-0,544	-0,898	-1,258	-0,067	-0,100	-0,018
Rest of Europe	0,000	0,000	-0,162	-0,221	-0,011	0,000	-0,002	-0,037	-0,010	-0,035	-0,013	-0,061	-0,060	-0,003	-0,032	-0,039	-0,002	0,000
Rest of N.America	-0,001	-0,170	-4,667	-3,574	-0,422	-1,991	-0,032	-0,160	-0,226	0,000	-0,099	-0,462	-1,514	-0,244	-2,117	-0,123	-0,241	-0,806
Rest of S.America	-0,016	-1,872	-4,717	-1,739	-0,240	-0,426	-0,120	-0,346	-0,080	-0,008	-0,171	-0,177	-0,408	-0,185	-1,610	-1,189	-0,419	-1,407

Source: Compiled by author

Table 7-24: Change in trade values for Dry bulk Scenario 2

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,113	-0,315	-80,080	-1,654	-2,340	-16,584	-0,090	-0,241	-0,030	-0,001	-0,048	-0,111	-0,004	-0,104	-14,471	-0,332	-0,022	-0,207
Brazil	-0,041	0,000	-22,733	-2,993	-0,185	-3,427	-0,025	-0,933	-0,006	0,000	-0,342	-0,174	-0,429	-0,114	-1,850	-0,555	-0,144	-0,630
China	-0,188	-0,103	0,000	-0,135	-0,365	-0,873	-0,050	-0,449	-0,010	-0,078	-0,101	-0,020	-0,041	-0,181	-1,705	-0,113	-0,005	-0,006
EU-27	-0,024	-0,050	-0,823	-11,879	-0,034	-0,016	-0,168	-1,153	-0,600	-0,078	-0,047	-0,949	-0,292	-0,493	-0,572	-0,587	-0,088	-0,056
Indonesia	-0,004	0,000	-5,536	-0,201	0,000	-2,071	-0,151	-0,010	0,000	0,000	-0,043	0,000	-0,045	0,000	-10,321	0,000	0,000	0,000
Japan	-0,003	0,000	-0,206	-0,233	-0,033	0,000	-0,008	0,000	0,000	-0,018	-0,005	-0,165	-0,021	-0,001	-0,325	0,000	-0,001	0,000
LDC	-0,102	-0,064	-1,494	-0,857	-0,010	-0,168	-0,133	-0,079	-0,007	-0,006	-0,005	-0,053	-0,003	-0,176	-0,936	-0,018	-0,001	0,000
Middle East	-0,015	0,000	-0,862	-0,040	-0,056	-0,006	-0,077	-0,764	-0,002	0,000	-0,045	-0,020	-0,066	-0,017	-1,218	-0,245	-0,001	0,000
Nigeria	0,000	0,000	0,000	0,000	0,000	0,000	-0,003	0,000	0,000	0,000	0,000	0,000	0,000	-0,002	0,000	0,000	0,000	0,000
Russia	-0,008	-0,345	-4,478	-3,654	-0,267	-1,723	-0,329	-0,875	-0,353	0,000	-0,007	-0,348	-0,044	-0,510	-3,886	-2,522	-0,032	-0,070
SIDS	-0,069	-0,003	-0,286	-0,070	-0,172	0,000	-0,025	-0,612	-0,001	0,000	-0,024	-0,004	-0,052	-0,001	-0,802	-0,007	-0,021	0,000
UK	-0,004	0,000	-0,104	-0,503	0,000	-0,003	-0,002	-0,306	-0,005	-0,010	0,000	0,000	-0,017	-0,001	-0,115	-0,030	-0,006	0,000
USA	-0,203	-1,014	-6,630	-4,019	-0,193	-4,467	-0,090	-0,348	-0,331	-0,003	-0,276	-0,355	0,000	-0,509	-4,167	-0,645	-5,952	-1,553
Rest of Africa	-0,003	-0,052	-4,189	-1,872	-0,030	-0,588	-0,138	-0,143	-0,014	-0,001	-0,068	-0,096	-0,020	-0,085	-4,444	-0,157	-0,001	-0,011
Rest of Asia	-0,346	-0,063	-4,053	-0,841	-0,913	-0,389	-0,883	-2,081	-0,007	-0,054	-0,259	-0,215	-0,543	-0,919	-1,295	-0,068	-0,094	-0,017
Rest of Europe	0,000	0,000	-0,148	-0,226	-0,011	0,000	-0,002	-0,038	-0,010	-0,037	-0,013	-0,063	-0,061	-0,003	-0,033	-0,040	-0,002	0,000
Rest of N.America	-0,001	-0,174	-4,399	-3,679	-0,433	-2,074	-0,031	-0,161	-0,229	0,000	-0,100	-0,476	-1,554	-0,240	-2,095	-0,125	-0,242	-0,825
Rest of S.America	-0,016	-1,985	-4,489	-1,781	-0,245	-0,435	-0,118	-0,339	-0,083	-0,008	-0,173	-0,183	-0,418	-0,182	-1,582	-1,200	-0,422	-1,452

Source: Compiled by author

Table 7-25: Change in trade values for Dry bulk Scenario 3

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,121	-0,388	-77,239	-1,902	-2,398	-16,711	-0,104	-0,266	-0,036	-0,001	-0,055	-0,126	-0,005	-0,122	-14,752	-0,379	-0,026	-0,241
Brazil	-0,041	0,000	-22,726	-2,972	-0,182	-3,413	-0,025	-0,933	-0,006	0,000	-0,343	-0,172	-0,428	-0,114	-1,860	-0,553	-0,146	-0,622
China	-0,186	-0,117	0,000	-0,138	-0,355	-0,859	-0,051	-0,450	-0,011	-0,078	-0,100	-0,020	-0,042	-0,185	-1,691	-0,113	-0,005	-0,006
EU-27	-0,024	-0,050	-0,957	-11,663	-0,034	-0,016	-0,168	-1,156	-0,601	-0,078	-0,047	-0,943	-0,295	-0,489	-0,578	-0,586	-0,090	-0,057
Indonesia	-0,004	0,000	-5,734	-0,204	0,000	-2,039	-0,153	-0,010	0,000	0,000	-0,042	0,000	-0,045	0,000	-10,074	0,000	0,000	0,000
Japan	-0,003	0,000	-0,214	-0,231	-0,032	0,000	-0,008	0,000	0,000	-0,018	-0,005	-0,163	-0,021	-0,001	-0,321	0,000	-0,001	0,000
LDC	-0,100	-0,067	-1,546	-0,844	-0,010	-0,164	-0,130	-0,078	-0,007	-0,006	-0,005	-0,052	-0,003	-0,171	-0,915	-0,018	-0,001	0,000
Middle East	-0,014	0,000	-0,912	-0,040	-0,055	-0,006	-0,076	-0,748	-0,003	0,000	-0,044	-0,020	-0,065	-0,016	-1,193	-0,242	-0,001	0,000
Nigeria	0,000	0,000	0,000	0,000	0,000	0,000	-0,003	0,000	0,000	0,000	0,000	0,000	0,000	-0,002	0,000	0,000	0,000	0,000
Russia	-0,008	-0,341	-4,728	-3,607	-0,262	-1,689	-0,322	-0,862	-0,343	0,000	-0,007	-0,343	-0,044	-0,497	-3,816	-2,468	-0,032	-0,070
SIDS	-0,068	-0,003	-0,301	-0,070	-0,167	0,000	-0,025	-0,606	-0,001	0,000	-0,024	-0,004	-0,052	-0,001	-0,794	-0,007	-0,021	0,000
UK	-0,004	0,000	-0,116	-0,497	0,000	-0,003	-0,002	-0,302	-0,005	-0,010	0,000	0,000	-0,017	-0,001	-0,114	-0,030	-0,006	0,000
USA	-0,200	-0,998	-6,916	-3,971	-0,189	-4,362	-0,091	-0,346	-0,329	-0,003	-0,277	-0,351	0,000	-0,507	-4,148	-0,638	-5,882	-1,535
Rest of Africa	-0,003	-0,052	-4,364	-1,840	-0,030	-0,577	-0,134	-0,140	-0,014	-0,001	-0,066	-0,094	-0,019	-0,083	-4,338	-0,154	-0,001	-0,012
Rest of Asia	-0,341	-0,065	-4,174	-0,837	-0,884	-0,381	-0,870	-2,042	-0,007	-0,053	-0,253	-0,213	-0,544	-0,905	-1,271	-0,068	-0,098	-0,018
Rest of Europe	0,000	0,000	-0,157	-0,223	-0,011	0,000	-0,002	-0,037	-0,010	-0,036	-0,013	-0,061	-0,060	-0,003	-0,032	-0,039	-0,002	0,000
Rest of N.America	-0,001	-0,171	-4,575	-3,609	-0,426	-2,020	-0,032	-0,161	-0,227	0,000	-0,100	-0,467	-1,528	-0,243	-2,110	-0,124	-0,241	-0,812
Rest of S.America	-0,016	-1,911	-4,638	-1,753	-0,242	-0,429	-0,119	-0,344	-0,081	-0,008	-0,172	-0,179	-0,412	-0,184	-1,601	-1,192	-0,420	-1,422

Source: Compiled by author

Table 7-26: Change in trade values for Containers Scenario 1

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-5,825	-0,223	-30,711	-8,517	-3,371	-7,187	-0,253	-3,119	-0,147	-0,485	-3,528	-2,782	-10,571	-0,859	-14,565	-0,607	-1,852	-0,369
Brazil	-0,495	0,000	-31,605	-19,900	-1,361	-2,353	-0,740	-2,463	-0,631	-1,500	-1,031	-1,931	-16,730	-1,219	-6,291	-3,102	-9,192	-13,528
China	-51,815	-25,767	0,000	-396,723	-34,426	-115,225	-13,741	-45,862	-6,703	-30,734	-30,525	-54,355	-351,621	-14,729	-202,461	-29,382	-106,143	-35,104
EU-27	-32,121	-21,950	-184,159	-1487,298	-7,445	-54,844	-7,679	-61,993	-3,426	-31,551	-29,005	-190,283	-330,957	-32,612	-103,936	-55,832	-67,465	-21,530
Indonesia	-2,229	-0,994	-31,055	-13,511	0,000	-9,447	-1,177	-2,084	-0,210	-1,035	-7,234	-1,258	-17,049	-0,559	-22,471	-1,425	-2,140	-0,653
Japan	-11,147	-2,708	-128,121	-62,587	-11,154	0,000	-1,755	-12,720	-0,198	-5,170	-13,793	-7,922	-89,358	-2,122	-85,593	-4,234	-18,558	-3,657
LDC	-1,572	-0,078	-18,772	-30,660	-0,374	-3,475	-2,110	-16,664	-0,119	-0,936	-0,598	-3,674	-13,330	-2,145	-12,728	-1,343	-3,091	-0,262
Middle East	-1,528	-2,335	-23,991	-24,425	-1,795	-2,566	-2,142	-18,605	-0,705	-1,463	-6,069	-2,830	-21,296	-2,933	-32,237	-12,118	-2,307	-0,971
Nigeria	-0,001	-0,077	-0,318	-0,708	-0,044	-0,114	-0,079	-0,404	0,000	-0,020	-0,009	-0,030	-0,124	-0,139	-0,526	-0,057	-0,041	-0,021
Russia	-0,165	-2,986	-14,618	-24,094	-0,639	-2,808	-0,034	-2,799	-0,100	0,000	-0,177	-11,130	-7,794	-0,586	-6,834	-11,770	-2,326	-0,839
SIDS	-3,540	-1,421	-23,536	-20,106	-6,132	-6,245	-1,673	-3,678	-0,085	-0,588	-1,152	-1,580	-25,273	-0,924	-31,739	-0,988	-3,074	-0,488
UK	-4,083	-1,388	-12,064	-114,949	-0,675	-5,047	-0,620	-8,003	-0,482	-2,455	-5,014	0,000	-35,491	-2,793	-11,131	-7,707	-4,755	-1,232
USA	-18,592	-15,238	-89,930	-179,046	-5,003	-40,631	-1,496	-22,767	-1,110	-7,589	-27,994	-33,963	0,000	-5,000	-70,021	-11,437	-202,983	-19,458
Rest of Africa	-1,077	-2,105	-17,216	-46,611	-1,440	-5,977	-5,521	-6,040	-0,459	-1,484	-1,074	-8,747	-14,110	-3,830	-10,093	-3,383	-2,560	-0,767
Rest of Asia	-24,137	-9,739	-279,382	-178,209	-21,077	-65,686	-11,199	-38,488	-2,947	-11,081	-40,611	-20,337	-252,005	-7,636	-112,599	-15,376	-50,835	-8,930
Rest of Europe	-0,939	-1,122	-5,536	-59,057	-0,269	-1,600	-0,905	-10,002	-0,447	-2,780	-1,153	-11,210	-12,845	-2,213	-4,063	-5,020	-2,112	-0,957
Rest of N.America	-3,537	-4,377	-24,931	-41,089	-0,984	-10,401	-0,257	-3,283	-0,105	-1,086	-3,289	-10,520	-334,619	-0,855	-9,409	-3,387	-29,879	-8,181
Rest of S.America	-1,105	-9,195	-39,191	-22,718	-1,192	-6,548	-0,178	-2,544	-0,106	-2,212	-0,638	-1,885	-20,597	-0,754	-10,858	-2,085	-7,891	-11,154

Source: Compiled by author

Table 7-27: Change in trade values for Containers Scenario 2

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-5,880	-0,217	-31,059	-8,576	-3,401	-7,245	-0,251	-3,132	-0,145	-0,486	-3,512	-2,788	-10,666	-0,850	-14,674	-0,607	-1,861	-0,369
Brazil	-0,499	0,000	-31,633	-20,189	-1,361	-2,347	-0,735	-2,468	-0,624	-1,508	-1,024	-1,949	-16,932	-1,212	-6,275	-3,119	-9,275	-13,703
China	-52,031	- 23,877	0,000	-407,228	-34,516	- 116,179	- 13,433	- 45,705	-6,396	- 30,444	- 30,373	-54,101	- 359,448	- 14,409	- 204,805	-29,260	-106,471	-34,530
EU-27	-31,038	- 20,637	- 178,684	- 1566,926	-7,018	-53,380	-7,353	- 60,000	-3,255	- 30,532	- 27,716	- 188,008	- 330,181	- 31,439	- 100,583	-54,392	-65,834	-20,757
Indonesia	-2,249	-0,949	-31,402	-13,645	0,000	-9,534	-1,174	-2,092	-0,205	-1,036	-7,287	-1,264	-17,176	-0,553	-22,675	-1,431	-2,134	-0,638
Japan	-11,219	-2,553	- 129,913	-63,439	-11,222	0,000	-1,726	- 12,722	-0,192	-5,137	- 13,795	-7,967	-90,195	-2,091	-86,307	-4,232	-18,654	-3,643
LDC	-1,585	-0,075	-18,894	-31,078	-0,375	-3,503	-2,117	- 16,767	-0,119	-0,942	-0,599	-3,702	-13,426	-2,154	-12,812	-1,353	-3,093	-0,257
Middle East	-1,538	-2,318	-24,117	-24,739	-1,800	-2,581	-2,144	- 18,787	-0,693	-1,470	-6,101	-2,850	-21,485	-2,939	-32,559	-12,197	-2,302	-0,956
Nigeria	-0,001	-0,075	-0,319	-0,721	-0,044	-0,113	-0,080	-0,408	0,000	-0,021	-0,009	-0,030	-0,127	-0,141	-0,521	-0,057	-0,042	-0,022
Russia	-0,166	-2,959	-14,638	-24,422	-0,638	-2,826	-0,034	-2,815	-0,101	0,000	-0,178	-11,227	-7,858	-0,590	-6,861	-11,893	-2,335	-0,839
SIDS	-3,569	-1,368	-23,751	-20,351	-6,185	-6,295	-1,670	-3,701	-0,082	-0,589	-1,155	-1,591	-25,543	-0,915	-31,960	-0,993	-3,086	-0,487
UK	-4,087	-1,368	-11,940	-116,901	-0,666	-5,064	-0,617	-8,001	-0,478	-2,456	-4,976	0,000	-35,724	-2,787	-11,081	-7,735	-4,779	-1,233
USA	-18,691	- 15,037	-90,248	-182,476	-4,987	-40,794	-1,473	- 22,753	-1,095	-7,569	- 27,573	-34,126	0,000	-4,935	-69,714	-11,447	-206,873	-19,530
Rest of Africa	-1,083	-2,060	-17,240	-47,330	-1,436	-5,988	-5,553	-6,084	-0,454	-1,494	-1,078	-8,825	-14,247	-3,845	-10,127	-3,409	-2,558	-0,758
Rest of Asia	-24,198	-9,307	- 284,707	-181,037	-21,123	-65,998	- 11,144	- 38,590	-2,869	- 11,046	- 40,549	-20,346	- 256,116	-7,572	- 113,521	-15,363	-50,510	-8,717
Rest of Europe	-0,942	-1,095	-5,524	-59,923	-0,268	-1,601	-0,908	- 10,039	-0,441	-2,797	-1,147	-11,293	-12,906	-2,221	-4,066	-5,054	-2,110	-0,950
Rest of N.America	-3,524	-4,268	-24,683	-41,265	-0,958	-10,358	-0,247	-3,225	-0,103	-1,070	-3,206	-10,495	- 341,374	-0,823	-9,134	-3,354	-29,854	-8,141
Rest of S.America	-1,114	-9,280	-39,494	-23,060	-1,180	-6,558	-0,175	-2,517	-0,106	-2,215	-0,632	-1,903	-20,860	-0,741	-10,724	-2,084	-7,974	-11,277

Source: Compiled by author

Table 7-28: Change in trade values for Containers Scenario 3

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-5,844	-0,221	-30,829	-8,537	-3,381	-7,206	-0,252	-3,123	-0,147	-0,485	-3,522	-2,784	-10,603	-0,856	-14,602	-0,607	-1,855	-0,369
Brazil	-0,496	0,000	-31,613	-19,998	-1,361	-2,351	-0,738	-2,465	-0,629	-1,503	-1,028	-1,937	-16,798	-1,217	-6,285	-3,107	-9,220	-13,588
China	-51,884	- 25,143	0,000	-400,333	-34,454	- 115,541	- 13,636	-45,804	-6,601	- 30,633	- 30,471	-54,263	- 354,293	- 14,620	- 203,246	-29,338	-106,245	-34,908
EU-27	-31,738	- 21,498	- 182,191	- 1515,634	-7,298	-54,319	-7,565	-61,285	-3,367	- 31,189	- 28,555	- 189,404	- 330,511	- 32,198	- 102,742	-55,314	-66,876	-21,257
Indonesia	-2,236	-0,979	-31,172	-13,556	0,000	-9,476	-1,176	-2,086	-0,208	-1,035	-7,251	-1,260	-17,092	-0,557	-22,540	-1,427	-2,138	-0,648
Japan	-11,171	-2,657	- 128,730	-62,878	-11,176	0,000	-1,745	-12,720	-0,196	-5,159	- 13,793	-7,937	-89,639	-2,111	-85,833	-4,233	-18,590	-3,652
LDC	-1,576	-0,077	-18,813	-30,803	-0,374	-3,484	-2,112	-16,698	-0,119	-0,938	-0,598	-3,683	-13,362	-2,148	-12,756	-1,346	-3,092	-0,260
Middle East	-1,531	-2,329	-24,033	-24,532	-1,796	-2,571	-2,143	-18,667	-0,701	-1,466	-6,079	-2,836	-21,360	-2,935	-32,346	-12,144	-2,306	-0,966
Nigeria	-0,001	-0,076	-0,318	-0,712	-0,044	-0,114	-0,079	-0,406	0,000	-0,021	-0,009	-0,030	-0,125	-0,140	-0,525	-0,057	-0,042	-0,022
Russia	-0,165	-2,977	-14,624	-24,206	-0,639	-2,814	-0,034	-2,804	-0,101	0,000	-0,177	-11,163	-7,815	-0,588	-6,842	-11,811	-2,329	-0,839
SIDS	-3,550	-1,403	-23,608	-20,190	-6,150	-6,262	-1,672	-3,686	-0,084	-0,588	-1,153	-1,584	-25,364	-0,921	-31,813	-0,990	-3,078	-0,488
UK	-4,084	-1,381	-12,021	-115,615	-0,672	-5,052	-0,619	-8,002	-0,481	-2,455	-5,001	0,000	-35,568	-2,791	-11,114	-7,716	-4,763	-1,232
USA	-18,625	- 15,170	-90,032	-180,219	-4,997	-40,684	-1,488	-22,761	-1,105	-7,582	- 27,851	-34,015	0,000	-4,978	-69,913	-11,440	-204,311	-19,481
Rest of Africa	-1,079	-2,090	-17,223	-46,857	-1,439	-5,980	-5,532	-6,054	-0,457	-1,488	-1,075	-8,773	-14,156	-3,835	-10,104	-3,392	-2,559	-0,764
Rest of Asia	-24,156	-9,595	- 281,202	-179,174	-21,091	-65,789	- 11,179	-38,521	-2,921	- 11,068	- 40,588	-20,338	- 253,402	-7,614	- 112,908	-15,370	-50,722	-8,858
Rest of Europe	-0,940	-1,113	-5,531	-59,352	-0,269	-1,600	-0,906	-10,014	-0,445	-2,785	-1,151	-11,238	-12,865	-2,216	-4,064	-5,031	-2,111	-0,955
Rest of N.America	-3,532	-4,340	-24,845	-41,147	-0,975	-10,386	-0,254	-3,263	-0,104	-1,081	-3,261	-10,510	- 336,929	-0,844	-9,317	-3,375	-29,868	-8,167
Rest of S.America	-1,108	-9,224	-39,292	-22,835	-1,188	-6,551	-0,177	-2,535	-0,106	-2,213	-0,636	-1,891	-20,686	-0,750	-10,813	-2,084	-7,919	-11,195

Source: Compiled by author

Annex 16 (Change in CO2 emission, in million tonnes, due to reduction of trade)

Table 7-29: Absolute change in CO2 emissions for Wet bulk in Scenario 1

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,043	0,000	-1,288	-0,006	-0,071	-1,174	-0,001	-0,006	0,000	0,000	-0,161	0,000	-0,003	-0,001	-0,642	0,000	0,000	0,000
Brazil	0,000	0,000	-1,125	-0,319	-0,001	-0,005	0,000	-0,001	-0,002	0,000	-0,054	0,000	-0,383	-0,002	-0,154	-0,007	0,000	-0,147
China	-0,119	-0,003	0,000	-0,043	-0,036	-0,035	-0,014	-0,004	-0,007	0,000	-0,464	-0,003	-0,038	-0,008	-0,446	0,000	-0,016	-0,029
EU-27	-0,045	-0,164	-0,418	-8,245	-0,032	-0,047	-0,097	-0,376	-0,650	-0,026	-0,358	-0,827	-1,131	-0,332	-0,394	-0,183	-0,175	-0,110
Indonesia	-0,091	0,000	-0,343	-0,016	0,000	-0,247	-0,002	-0,001	0,000	0,000	-0,295	0,000	-0,087	-0,003	-0,347	0,000	0,000	0,000
Japan	-0,195	-0,002	-0,119	-0,002	-0,008	0,000	-0,001	-0,002	0,000	-0,003	-0,090	0,000	-0,058	-0,001	-0,194	0,000	-0,009	-0,029
LDC	-0,002	-0,028	-2,217	-0,419	-0,071	-0,032	-0,162	-0,025	-0,005	0,000	-0,045	-0,014	-0,254	-0,154	-0,786	0,000	0,000	-0,043
Middle East	-0,285	-0,085	-10,664	-5,300	-0,435	-6,425	-0,362	-0,985	-0,035	-0,002	-2,649	-0,389	-2,745	-0,557	-17,787	-0,117	-0,169	-0,081
Nigeria	-0,032	-0,091	-0,170	-1,724	-0,169	-0,046	-0,041	-0,018	0,000	0,000	-0,040	-0,228	-0,415	-0,349	-0,972	-0,004	-0,111	-0,051
Russia	-0,012	-0,032	-3,165	-5,500	-0,003	-0,596	-0,041	-0,282	-0,105	0,000	-0,405	-0,463	-1,286	-0,067	-0,977	-0,280	-0,022	-0,026
SIDS	-0,568	-0,130	-0,430	-0,233	-0,873	-0,283	-0,293	-0,196	-0,013	-0,006	-0,111	-0,030	-0,440	-0,050	-1,081	-0,001	-0,017	-0,099
UK	-0,011	-0,019	-0,298	-1,827	-0,002	-0,004	-0,016	-0,034	-0,019	0,000	-0,012	0,000	-0,315	-0,030	-0,190	-0,056	-0,059	-0,016
USA	-0,045	-0,920	-1,206	-3,042	-0,185	-0,742	-0,019	-0,100	-0,048	-0,003	-0,427	-0,552	0,000	-0,107	-1,063	-0,124	-3,694	-1,144
Rest of Africa	-0,027	0,000	-0,429	-0,518	-0,022	-0,018	-0,068	-0,049	-0,009	0,000	-0,026	-0,030	-0,173	-0,072	-0,337	-0,011	-0,010	-0,003
Rest of Asia	-0,935	-0,107	-1,843	-0,365	-0,398	-0,908	-0,301	-0,225	-0,164	-0,007	-1,628	-0,068	-0,523	-0,066	-1,358	-0,202	-0,035	-0,083
Rest of Europe	-0,004	-0,006	-0,467	-3,444	-0,052	-0,012	-0,009	-0,215	-0,091	-0,001	-0,011	-2,258	-0,283	-0,021	-0,169	-0,092	-0,111	-0,012
Rest of N.America	0,000	-0,010	-0,137	-0,527	0,000	-0,062	-0,001	0,000	-0,002	-0,001	-0,039	-0,069	-7,256	-0,004	-0,403	-0,011	-0,041	-0,097
Rest of S.America	-0,003	-0,061	-0,974	-0,170	-0,001	-0,125	-0,001	0,000	0,000	0,000	-0,120	-0,024	-2,065	-0,020	-0,643	0,000	-0,041	-0,327

Source: Compiled by author

Table 7-30: Absolute change in CO_2 emissions for Wet bulk in Scenario 2

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,044	0,000	-1,295	-0,006	-0,072	-1,193	-0,001	-0,006	0,000	0,000	-0,161	0,000	-0,003	-0,001	-0,620	0,000	0,000	0,000
Brazil	0,000	0,000	-1,124	-0,320	-0,001	-0,005	0,000	-0,001	-0,002	0,000	-0,055	0,000	-0,389	-0,002	-0,146	-0,007	0,000	-0,151
China	-0,121	-0,003	0,000	-0,043	-0,037	-0,036	-0,014	-0,004	-0,007	0,000	-0,476	-0,003	-0,038	-0,008	-0,433	0,000	-0,016	-0,029
EU-27	-0,044	-0,158	-0,382	-8,470	-0,030	-0,046	-0,095	-0,372	-0,638	-0,025	-0,347	-0,814	-1,098	-0,329	-0,349	-0,181	-0,166	-0,106
Indonesia	-0,092	0,000	-0,344	-0,016	0,000	-0,251	-0,002	-0,001	0,000	0,000	-0,302	0,000	-0,087	-0,003	-0,337	0,000	0,000	0,000
Japan	-0,198	-0,002	-0,119	-0,002	-0,008	0,000	-0,001	-0,002	0,000	-0,003	-0,093	0,000	-0,058	-0,001	-0,188	0,000	-0,009	-0,029
LDC	-0,002	-0,027	-2,242	-0,416	-0,071	-0,032	-0,166	-0,026	-0,005	0,000	-0,045	-0,014	-0,254	-0,158	-0,762	0,000	0,000	-0,041
Middle East	-0,261	-0,077	-10,850	-5,098	-0,399	-6,394	-0,337	-0,950	-0,030	-0,002	-2,565	-0,358	-2,584	-0,525	-18,546	-0,109	-0,141	-0,067
Nigeria	-0,033	-0,091	-0,169	-1,755	-0,171	-0,045	-0,043	-0,019	0,000	0,000	-0,040	-0,233	-0,423	-0,362	-0,916	-0,004	-0,111	-0,052
Russia	-0,012	-0,031	-3,152	-5,615	-0,003	-0,592	-0,041	-0,285	-0,107	0,000	-0,406	-0,461	-1,276	-0,068	-0,916	-0,282	-0,021	-0,025
SIDS	-0,576	-0,127	-0,428	-0,231	-0,894	-0,286	-0,299	-0,201	-0,013	-0,006	-0,113	-0,031	-0,443	-0,051	-1,048	-0,001	-0,017	-0,099
UK	-0,011	-0,020	-0,290	-1,846	-0,002	-0,004	-0,017	-0,035	-0,019	-0,001	-0,012	0,000	-0,317	-0,030	-0,179	-0,058	-0,059	-0,016
USA	-0,045	-0,930	-1,185	-3,067	-0,185	-0,744	-0,019	-0,102	-0,048	-0,003	-0,423	-0,555	0,000	-0,107	-0,988	-0,125	-3,761	-1,157
Rest of Africa	-0,027	0,000	-0,427	-0,521	-0,023	-0,018	-0,070	-0,050	-0,009	0,000	-0,027	-0,030	-0,176	-0,075	-0,327	-0,011	-0,010	-0,003
Rest of Asia	-0,944	-0,104	-1,848	-0,359	-0,403	-0,916	-0,306	-0,230	-0,163	-0,007	-1,666	-0,068	-0,518	-0,066	-1,317	-0,204	-0,034	-0,080
Rest of Europe	-0,004	-0,006	-0,449	-3,466	-0,051	-0,011	-0,009	-0,217	-0,090	-0,001	-0,011	-2,292	-0,277	-0,021	-0,157	-0,092	-0,106	-0,012
Rest of N.America	0,000	-0,010	-0,125	-0,496	0,000	-0,059	-0,001	0,000	-0,002	-0,001	-0,036	-0,066	-7,421	-0,004	-0,326	-0,010	-0,039	-0,093
Rest of S.America	-0,003	-0,063	-0,973	-0,169	-0,001	-0,125	-0,001	0,000	0,000	0,000	-0,120	-0,024	-2,115	-0,020	-0,593	0,000	-0,041	-0,333

Source: Compiled by author

Table 7-31: Absolute change in CO2 emissions for Wet bulk in Scenario 3

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,044	0,000	-1,290	-0,006	-0,071	-1,181	-0,001	-0,006	0,000	0,000	-0,161	0,000	-0,003	-0,001	-0,635	0,000	0,000	0,000
Brazil	0,000	0,000	-1,125	-0,319	-0,001	-0,005	0,000	-0,001	-0,002	0,000	-0,054	0,000	-0,385	-0,002	-0,151	-0,007	0,000	-0,148
China	-0,120	-0,003	0,000	-0,043	-0,036	-0,035	-0,014	-0,004	-0,007	0,000	-0,468	-0,003	-0,038	-0,008	-0,442	0,000	-0,016	-0,029
EU-27	-0,045	-0,162	-0,406	-8,321	-0,031	-0,047	-0,097	-0,375	-0,646	-0,026	-0,354	-0,822	-1,119	-0,331	-0,379	-0,182	-0,172	-0,109
Indonesia	-0,091	0,000	-0,343	-0,016	0,000	-0,248	-0,002	-0,001	0,000	0,000	-0,297	0,000	-0,087	-0,003	-0,344	0,000	0,000	0,000
Japan	-0,196	-0,002	-0,119	-0,002	-0,008	0,000	-0,001	-0,002	0,000	-0,003	-0,091	0,000	-0,058	-0,001	-0,192	0,000	-0,009	-0,029
LDC	-0,002	-0,027	-2,225	-0,418	-0,071	-0,032	-0,163	-0,025	-0,005	0,000	-0,045	-0,014	-0,254	-0,156	-0,778	0,000	0,000	-0,042
Middle East	-0,277	-0,082	-10,726	-5,230	-0,423	-6,413	-0,354	-0,973	-0,033	-0,002	-2,620	-0,379	-2,690	-0,546	-18,049	-0,114	-0,160	-0,076
Nigeria	-0,033	-0,091	-0,170	-1,734	-0,170	-0,046	-0,042	-0,018	0,000	0,000	-0,040	-0,230	-0,418	-0,354	-0,953	-0,004	-0,111	-0,051
Russia	-0,012	-0,032	-3,160	-5,539	-0,003	-0,595	-0,041	-0,283	-0,106	0,000	-0,405	-0,462	-1,283	-0,067	-0,956	-0,280	-0,022	-0,025
SIDS	-0,571	-0,129	-0,429	-0,232	-0,880	-0,284	-0,295	-0,198	-0,013	-0,006	-0,112	-0,030	-0,441	-0,051	-1,070	-0,001	-0,017	-0,099
UK	-0,011	-0,019	-0,296	-1,833	-0,002	-0,004	-0,017	-0,035	-0,019	0,000	-0,012	0,000	-0,316	-0,030	-0,186	-0,057	-0,059	-0,016
USA	-0,045	-0,923	-1,199	-3,050	-0,185	-0,743	-0,019	-0,101	-0,048	-0,003	-0,425	-0,553	0,000	-0,107	-1,038	-0,125	-3,717	-1,148
Rest of Africa	-0,027	0,000	-0,428	-0,519	-0,022	-0,018	-0,069	-0,049	-0,009	0,000	-0,026	-0,030	-0,174	-0,073	-0,334	-0,011	-0,010	-0,003
Rest of Asia	-0,938	-0,106	-1,844	-0,363	-0,400	-0,911	-0,303	-0,227	-0,164	-0,007	-1,641	-0,068	-0,521	-0,066	-1,343	-0,203	-0,035	-0,082
Rest of Europe	-0,004	-0,006	-0,461	-3,451	-0,052	-0,012	-0,009	-0,216	-0,090	-0,001	-0,011	-2,269	-0,281	-0,021	-0,165	-0,092	-0,109	-0,012
Rest of N.America	0,000	-0,010	-0,133	-0,517	0,000	-0,061	-0,001	0,000	-0,002	-0,001	-0,038	-0,068	-7,311	-0,004	-0,378	-0,011	-0,041	-0,096
Rest of S.America	-0,003	-0,062	-0,974	-0,170	-0,001	-0,125	-0,001	0,000	0,000	0,000	-0,120	-0,024	-2,082	-0,020	-0,626	0,000	-0,041	-0,329

Source: Compiled by author

Table 7-32: Absolute change in CO2 emissions for Dry bulk in Scenario 1

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,038	-0,130	-23,130	-0,618	-0,742	-5,128	-0,034	-0,085	-0,012	0,000	-0,018	-0,041	-0,002	-0,040	-4,554	-0,123	-0,009	-0,079
Brazil	-0,012	0,000	-6,944	-0,904	-0,055	-1,039	-0,008	-0,285	-0,002	0,000	-0,105	-0,052	-0,130	-0,035	-0,569	-0,169	-0,045	-0,189
China	-0,057	-0,038	0,000	-0,043	-0,107	-0,260	-0,016	-0,138	-0,003	-0,024	-0,030	-0,006	-0,013	-0,057	-0,514	-0,035	-0,002	-0,002
EU-27	-0,007	-0,015	-0,312	-3,529	-0,010	-0,005	-0,051	-0,354	-0,184	-0,024	-0,014	-0,287	-0,091	-0,149	-0,177	-0,179	-0,028	-0,018
Indonesia	-0,001	0,000	-1,784	-0,063	0,000	-0,618	-0,047	-0,003	0,000	0,000	-0,013	0,000	-0,014	0,000	-3,037	0,000	0,000	0,000
Japan	-0,001	0,000	-0,067	-0,070	-0,009	0,000	-0,002	0,000	0,000	-0,006	-0,001	-0,049	-0,006	0,000	-0,097	0,000	0,000	0,000
LDC	-0,030	-0,021	-0,480	-0,256	-0,003	-0,049	-0,039	-0,024	-0,002	-0,002	-0,002	-0,016	-0,001	-0,052	-0,276	-0,005	0,000	0,000
Middle East	-0,004	0,000	-0,286	-0,012	-0,017	-0,002	-0,023	-0,226	-0,001	0,000	-0,013	-0,006	-0,020	-0,005	-0,360	-0,073	0,000	0,000
Nigeria	0,000	0,000	0,000	0,000	0,000	0,000	-0,001	0,000	0,000	0,000	0,000	0,000	0,000	-0,001	0,000	0,000	0,000	0,000
Russia	-0,002	-0,103	-1,483	-1,095	-0,079	-0,510	-0,097	-0,261	-0,103	0,000	-0,002	-0,104	-0,013	-0,150	-1,154	-0,745	-0,010	-0,022
SIDS	-0,021	-0,001	-0,094	-0,021	-0,050	0,000	-0,008	-0,184	0,000	0,000	-0,007	-0,001	-0,016	0,000	-0,241	-0,002	-0,007	0,000
UK	-0,001	0,000	-0,037	-0,151	0,000	-0,001	0,000	-0,092	-0,002	-0,003	0,000	0,000	-0,005	0,000	-0,035	-0,009	-0,002	0,000
USA	-0,060	-0,303	-2,158	-1,206	-0,057	-1,315	-0,028	-0,105	-0,100	-0,001	-0,085	-0,106	0,000	-0,155	-1,264	-0,194	-1,785	-0,466
Rest of Africa	-0,001	-0,016	-1,361	-0,557	-0,009	-0,175	-0,040	-0,042	-0,004	0,000	-0,020	-0,028	-0,006	-0,025	-1,308	-0,046	0,000	-0,004
Rest of Asia	-0,103	-0,020	-1,295	-0,255	-0,265	-0,115	-0,263	-0,618	-0,002	-0,016	-0,077	-0,065	-0,166	-0,274	-0,384	-0,021	-0,030	-0,006
Rest of Europe	0,000	0,000	-0,050	-0,068	-0,003	0,000	-0,001	-0,011	-0,003	-0,011	-0,004	-0,019	-0,018	-0,001	-0,010	-0,012	-0,001	0,000
Rest of N.America	0,000	-0,052	-1,425	-1,092	-0,129	-0,608	-0,010	-0,049	-0,069	0,000	-0,030	-0,141	-0,463	-0,075	-0,647	-0,038	-0,074	-0,246
Rest of S.America	-0,005	-0,572	-1,441	-0,531	-0,073	-0,130	-0,037	-0,106	-0,025	-0,002	-0,052	-0,054	-0,125	-0,057	-0,492	-0,363	-0,128	-0,430

Source: Compiled by author

Table 7-33: Absolute change in CO2 emissions for Dry bulk in Scenario 2

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,034	-0,096	-24,460	-0,505	-0,715	-5,065	-0,027	-0,074	-0,009	0,000	-0,015	-0,034	-0,001	-0,032	-4,420	-0,101	-0,007	-0,063
Brazil	-0,013	0,000	-6,944	-0,914	-0,057	-1,047	-0,008	-0,285	-0,002	0,000	-0,105	-0,053	-0,131	-0,035	-0,565	-0,170	-0,044	-0,192
China	-0,058	-0,031	0,000	-0,041	-0,111	-0,267	-0,015	-0,137	-0,003	-0,024	-0,031	-0,006	-0,013	-0,055	-0,521	-0,035	-0,001	-0,002
EU-27	-0,007	-0,015	-0,251	-3,628	-0,010	-0,005	-0,051	-0,352	-0,183	-0,024	-0,014	-0,290	-0,089	-0,151	-0,175	-0,179	-0,027	-0,017
Indonesia	-0,001	0,000	-1,691	-0,061	0,000	-0,633	-0,046	-0,003	0,000	0,000	-0,013	0,000	-0,014	0,000	-3,152	0,000	0,000	0,000
Japan	-0,001	0,000	-0,063	-0,071	-0,010	0,000	-0,002	0,000	0,000	-0,006	-0,001	-0,050	-0,006	0,000	-0,099	0,000	0,000	0,000
LDC	-0,031	-0,020	-0,456	-0,262	-0,003	-0,051	-0,041	-0,024	-0,002	-0,002	-0,002	-0,016	-0,001	-0,054	-0,286	-0,005	0,000	0,000
Middle East	-0,004	0,000	-0,263	-0,012	-0,017	-0,002	-0,024	-0,233	-0,001	0,000	-0,014	-0,006	-0,020	-0,005	-0,372	-0,075	0,000	0,000
Nigeria	0,000	0,000	0,000	0,000	0,000	0,000	-0,001	0,000	0,000	0,000	0,000	0,000	0,000	-0,001	0,000	0,000	0,000	0,000
Russia	-0,003	-0,105	-1,368	-1,116	-0,082	-0,526	-0,100	-0,267	-0,108	0,000	-0,002	-0,106	-0,013	-0,156	-1,187	-0,770	-0,010	-0,021
SIDS	-0,021	-0,001	-0,087	-0,021	-0,053	0,000	-0,008	-0,187	0,000	0,000	-0,007	-0,001	-0,016	0,000	-0,245	-0,002	-0,006	0,000
UK	-0,001	0,000	-0,032	-0,154	0,000	-0,001	0,000	-0,093	-0,002	-0,003	0,000	0,000	-0,005	0,000	-0,035	-0,009	-0,002	0,000
USA	-0,062	-0,310	-2,025	-1,228	-0,059	-1,364	-0,027	-0,106	-0,101	-0,001	-0,084	-0,108	0,000	-0,155	-1,273	-0,197	-1,818	-0,474
Rest of Africa	-0,001	-0,016	-1,279	-0,572	-0,009	-0,180	-0,042	-0,044	-0,004	0,000	-0,021	-0,029	-0,006	-0,026	-1,357	-0,048	0,000	-0,003
Rest of Asia	-0,106	-0,019	-1,238	-0,257	-0,279	-0,119	-0,270	-0,636	-0,002	-0,017	-0,079	-0,066	-0,166	-0,281	-0,395	-0,021	-0,029	-0,005
Rest of Europe	0,000	0,000	-0,045	-0,069	-0,003	0,000	-0,001	-0,012	-0,003	-0,011	-0,004	-0,019	-0,018	-0,001	-0,010	-0,012	-0,001	0,000
Rest of N.America	0,000	-0,053	-1,344	-1,124	-0,132	-0,634	-0,010	-0,049	-0,070	0,000	-0,031	-0,146	-0,475	-0,073	-0,640	-0,038	-0,074	-0,252
Rest of S.America	-0,005	-0,606	-1,371	-0,544	-0,075	-0,133	-0,036	-0,104	-0,025	-0,002	-0,053	-0,056	-0,128	-0,056	-0,483	-0,367	-0,129	-0,443

Source: Compiled by author

Table 7-34: Absolute change in CO2 emissions for Dry bulk in Scenario 3

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,037	-0,119	-23,592	-0,581	-0,732	-5,104	-0,032	-0,081	-0,011	0,000	-0,017	-0,038	-0,001	-0,037	-4,506	-0,116	-0,008	-0,074
Brazil	-0,013	0,000	-6,941	-0,908	-0,056	-1,042	-0,008	-0,285	-0,002	0,000	-0,105	-0,053	-0,131	-0,035	-0,568	-0,169	-0,045	-0,190
China	-0,057	-0,036	0,000	-0,042	-0,109	-0,262	-0,016	-0,137	-0,003	-0,024	-0,030	-0,006	-0,013	-0,056	-0,516	-0,035	-0,002	-0,002
EU-27	-0,007	-0,015	-0,292	-3,562	-0,010	-0,005	-0,051	-0,353	-0,184	-0,024	-0,014	-0,288	-0,090	-0,149	-0,176	-0,179	-0,028	-0,017
Indonesia	-0,001	0,000	-1,751	-0,062	0,000	-0,623	-0,047	-0,003	0,000	0,000	-0,013	0,000	-0,014	0,000	-3,077	0,000	0,000	0,000
Japan	-0,001	0,000	-0,065	-0,071	-0,010	0,000	-0,002	0,000	0,000	-0,006	-0,001	-0,050	-0,006	0,000	-0,098	0,000	0,000	0,000
LDC	-0,030	-0,020	-0,472	-0,258	-0,003	-0,050	-0,040	-0,024	-0,002	-0,002	-0,002	-0,016	-0,001	-0,052	-0,280	-0,005	0,000	0,000
Middle East	-0,004	0,000	-0,278	-0,012	-0,017	-0,002	-0,023	-0,228	-0,001	0,000	-0,013	-0,006	-0,020	-0,005	-0,364	-0,074	0,000	0,000
Nigeria	0,000	0,000	0,000	0,000	0,000	0,000	-0,001	0,000	0,000	0,000	0,000	0,000	0,000	-0,001	0,000	0,000	0,000	0,000
Russia	-0,002	-0,104	-1,444	-1,102	-0,080	-0,516	-0,098	-0,263	-0,105	0,000	-0,002	-0,105	-0,013	-0,152	-1,166	-0,754	-0,010	-0,021
SIDS	-0,021	-0,001	-0,092	-0,021	-0,051	0,000	-0,008	-0,185	0,000	0,000	-0,007	-0,001	-0,016	0,000	-0,243	-0,002	-0,007	0,000
UK	-0,001	0,000	-0,035	-0,152	0,000	-0,001	0,000	-0,092	-0,002	-0,003	0,000	0,000	-0,005	0,000	-0,035	-0,009	-0,002	0,000
USA	-0,061	-0,305	-2,112	-1,213	-0,058	-1,332	-0,028	-0,106	-0,100	-0,001	-0,085	-0,107	0,000	-0,155	-1,267	-0,195	-1,797	-0,469
Rest of Africa	-0,001	-0,016	-1,333	-0,562	-0,009	-0,176	-0,041	-0,043	-0,004	0,000	-0,020	-0,029	-0,006	-0,025	-1,325	-0,047	0,000	-0,004
Rest of Asia	-0,104	-0,020	-1,275	-0,256	-0,270	-0,116	-0,266	-0,624	-0,002	-0,016	-0,077	-0,065	-0,166	-0,276	-0,388	-0,021	-0,030	-0,005
Rest of Europe	0,000	0,000	-0,048	-0,068	-0,003	0,000	-0,001	-0,011	-0,003	-0,011	-0,004	-0,019	-0,018	-0,001	-0,010	-0,012	-0,001	0,000
Rest of N.America	0,000	-0,052	-1,397	-1,102	-0,130	-0,617	-0,010	-0,049	-0,069	0,000	-0,030	-0,143	-0,467	-0,074	-0,644	-0,038	-0,074	-0,248
Rest of S.America	-0,005	-0,584	-1,417	-0,536	-0,074	-0,131	-0,036	-0,105	-0,025	-0,002	-0,053	-0,055	-0,126	-0,056	-0,489	-0,364	-0,128	-0,434

Source: Compiled by author

Table 7-35: Absolute change in CO2 emissions for Containers in Scenario 1

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,178	-0,007	-0,939	-0,260	-0,103	-0,220	-0,008	-0,095	-0,005	-0,015	-0,108	-0,085	-0,323	-0,026	-0,445	-0,019	-0,057	-0,011
Brazil	-0,015	0,000	-0,967	-0,609	-0,042	-0,072	-0,023	-0,075	-0,019	-0,046	-0,032	-0,059	-0,512	-0,037	-0,192	-0,095	-0,281	-0,414
China	-1,585	-0,788	0,000	-12,132	-1,053	-3,524	-0,420	-1,403	-0,205	-0,940	-0,933	-1,662	-10,753	-0,450	-6,192	-0,899	-3,246	-1,074
EU-27	-0,982	-0,671	-5,632	-45,484	-0,228	-1,677	-0,235	-1,896	-0,105	-0,965	-0,887	-5,819	-10,121	-0,997	-3,178	-1,707	-2,063	-0,658
Indonesia	-0,068	-0,030	-0,950	-0,413	0,000	-0,289	-0,036	-0,064	-0,006	-0,032	-0,221	-0,038	-0,521	-0,017	-0,687	-0,044	-0,065	-0,020
Japan	-0,341	-0,083	-3,918	-1,914	-0,341	0,000	-0,054	-0,389	-0,006	-0,158	-0,422	-0,242	-2,733	-0,065	-2,618	-0,129	-0,568	-0,112
LDC	-0,048	-0,002	-0,574	-0,938	-0,011	-0,106	-0,065	-0,510	-0,004	-0,029	-0,018	-0,112	-0,408	-0,066	-0,389	-0,041	-0,095	-0,008
Middle East	-0,047	-0,071	-0,734	-0,747	-0,055	-0,078	-0,066	-0,569	-0,022	-0,045	-0,186	-0,087	-0,651	-0,090	-0,986	-0,371	-0,071	-0,030
Nigeria	0,000	-0,002	-0,010	-0,022	-0,001	-0,003	-0,002	-0,012	0,000	-0,001	0,000	-0,001	-0,004	-0,004	-0,016	-0,002	-0,001	-0,001
Russia	-0,005	-0,091	-0,447	-0,737	-0,020	-0,086	-0,001	-0,086	-0,003	0,000	-0,005	-0,340	-0,238	-0,018	-0,209	-0,360	-0,071	-0,026
SIDS	-0,108	-0,043	-0,720	-0,615	-0,188	-0,191	-0,051	-0,112	-0,003	-0,018	-0,035	-0,048	-0,773	-0,028	-0,971	-0,030	-0,094	-0,015
UK	-0,125	-0,042	-0,369	-3,515	-0,021	-0,154	-0,019	-0,245	-0,015	-0,075	-0,153	0,000	-1,085	-0,085	-0,340	-0,236	-0,145	-0,038
USA	-0,569	-0,466	-2,750	-5,475	-0,153	-1,243	-0,046	-0,696	-0,034	-0,232	-0,856	-1,039	0,000	-0,153	-2,141	-0,350	-6,208	-0,595
Rest of Africa	-0,033	-0,064	-0,526	-1,425	-0,044	-0,183	-0,169	-0,185	-0,014	-0,045	-0,033	-0,268	-0,432	-0,117	-0,309	-0,103	-0,078	-0,023
Rest of Asia	-0,738	-0,298	-8,544	-5,450	-0,645	-2,009	-0,342	-1,177	-0,090	-0,339	-1,242	-0,622	-7,707	-0,234	-3,443	-0,470	-1,555	-0,273
Rest of Europe	-0,029	-0,034	-0,169	-1,806	-0,008	-0,049	-0,028	-0,306	-0,014	-0,085	-0,035	-0,343	-0,393	-0,068	-0,124	-0,154	-0,065	-0,029
Rest of N.America	-0,108	-0,134	-0,762	-1,257	-0,030	-0,318	-0,008	-0,100	-0,003	-0,033	-0,101	-0,322	-10,233	-0,026	-0,288	-0,104	-0,914	-0,250
Rest of S.America	-0,034	-0,281	-1,199	-0,695	-0,036	-0,200	-0,005	-0,078	-0,003	-0,068	-0,020	-0,058	-0,630	-0,023	-0,332	-0,064	-0,241	-0,341

Source: Compiled by author

Table 7-36: Absolute change in CO_2 emissions for Containers in Scenario 2

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,180	-0,007	-0,950	-0,262	-0,104	-0,222	-0,008	-0,096	-0,004	-0,015	-0,107	-0,085	-0,326	-0,026	-0,449	-0,019	-0,057	-0,011
Brazil	-0,015	0,000	-0,967	-0,617	-0,042	-0,072	-0,022	-0,075	-0,019	-0,046	-0,031	-0,060	-0,518	-0,037	-0,192	-0,095	-0,284	-0,419
China	-1,591	-0,730	0,000	-12,454	-1,056	-3,553	-0,411	-1,398	-0,196	-0,931	-0,929	-1,654	-10,992	-0,441	-6,263	-0,895	-3,256	-1,056
EU-27	-0,949	-0,631	-5,464	-47,919	-0,215	-1,632	-0,225	-1,835	-0,100	-0,934	-0,848	-5,750	-10,097	-0,961	-3,076	-1,663	-2,013	-0,635
Indonesia	-0,069	-0,029	-0,960	-0,417	0,000	-0,292	-0,036	-0,064	-0,006	-0,032	-0,223	-0,039	-0,525	-0,017	-0,693	-0,044	-0,065	-0,020
Japan	-0,343	-0,078	-3,973	-1,940	-0,343	0,000	-0,053	-0,389	-0,006	-0,157	-0,422	-0,244	-2,758	-0,064	-2,639	-0,129	-0,570	-0,111
LDC	-0,048	-0,002	-0,578	-0,950	-0,011	-0,107	-0,065	-0,513	-0,004	-0,029	-0,018	-0,113	-0,411	-0,066	-0,392	-0,041	-0,095	-0,008
Middle East	-0,047	-0,071	-0,738	-0,757	-0,055	-0,079	-0,066	-0,575	-0,021	-0,045	-0,187	-0,087	-0,657	-0,090	-0,996	-0,373	-0,070	-0,029
Nigeria	0,000	-0,002	-0,010	-0,022	-0,001	-0,003	-0,002	-0,012	0,000	-0,001	0,000	-0,001	-0,004	-0,004	-0,016	-0,002	-0,001	-0,001
Russia	-0,005	-0,090	-0,448	-0,747	-0,020	-0,086	-0,001	-0,086	-0,003	0,000	-0,005	-0,343	-0,240	-0,018	-0,210	-0,364	-0,071	-0,026
SIDS	-0,109	-0,042	-0,726	-0,622	-0,189	-0,193	-0,051	-0,113	-0,003	-0,018	-0,035	-0,049	-0,781	-0,028	-0,977	-0,030	-0,094	-0,015
UK	-0,125	-0,042	-0,365	-3,575	-0,020	-0,155	-0,019	-0,245	-0,015	-0,075	-0,152	0,000	-1,092	-0,085	-0,339	-0,237	-0,146	-0,038
USA	-0,572	-0,460	-2,760	-5,580	-0,152	-1,248	-0,045	-0,696	-0,033	-0,231	-0,843	-1,044	0,000	-0,151	-2,132	-0,350	-6,326	-0,597
Rest of Africa	-0,033	-0,063	-0,527	-1,447	-0,044	-0,183	-0,170	-0,186	-0,014	-0,046	-0,033	-0,270	-0,436	-0,118	-0,310	-0,104	-0,078	-0,023
Rest of Asia	-0,740	-0,285	-8,707	-5,536	-0,646	-2,018	-0,341	-1,180	-0,088	-0,338	-1,240	-0,622	-7,832	-0,232	-3,472	-0,470	-1,545	-0,267
Rest of Europe	-0,029	-0,033	-0,169	-1,833	-0,008	-0,049	-0,028	-0,307	-0,014	-0,086	-0,035	-0,345	-0,395	-0,068	-0,124	-0,155	-0,065	-0,029
Rest of N.America	-0,108	-0,131	-0,755	-1,262	-0,029	-0,317	-0,008	-0,099	-0,003	-0,033	-0,098	-0,321	-10,440	-0,025	-0,279	-0,103	-0,913	-0,249
Rest of S.America	-0,034	-0,284	-1,208	-0,705	-0,036	-0,201	-0,005	-0,077	-0,003	-0,068	-0,019	-0,058	-0,638	-0,023	-0,328	-0,064	-0,244	-0,345

Source: Compiled by author

Table 7-37: Absolute change in CO2 emissions for Containers in Scenario 3

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	Middle East	Nigeria	Russia	SIDS	UK	USA	Rest of Africa	Rest of Asia	Rest of Europe	Rest of N.America	Rest of S.America
Aus/NZ	-0,179	-0,007	-0,943	-0,261	-0,103	-0,220	-0,008	-0,096	-0,004	-0,015	-0,108	-0,085	-0,324	-0,026	-0,447	-0,019	-0,057	-0,011
Brazil	-0,015	0,000	-0,967	-0,612	-0,042	-0,072	-0,023	-0,075	-0,019	-0,046	-0,031	-0,059	-0,514	-0,037	-0,192	-0,095	-0,282	-0,416
China	-1,587	-0,769	0,000	-12,243	-1,054	-3,533	-0,417	-1,401	-0,202	-0,937	-0,932	-1,659	-10,835	-0,447	-6,216	-0,897	-3,249	-1,068
EU-27	-0,971	-0,657	-5,572	-46,350	-0,223	-1,661	-0,231	-1,874	-0,103	-0,954	-0,873	-5,792	-10,107	-0,985	-3,142	-1,692	-2,045	-0,650
Indonesia	-0,068	-0,030	-0,953	-0,415	0,000	-0,290	-0,036	-0,064	-0,006	-0,032	-0,222	-0,039	-0,523	-0,017	-0,689	-0,044	-0,065	-0,020
Japan	-0,342	-0,081	-3,937	-1,923	-0,342	0,000	-0,053	-0,389	-0,006	-0,158	-0,422	-0,243	-2,741	-0,065	-2,625	-0,129	-0,568	-0,112
LDC	-0,048	-0,002	-0,575	-0,942	-0,011	-0,107	-0,065	-0,511	-0,004	-0,029	-0,018	-0,113	-0,409	-0,066	-0,390	-0,041	-0,095	-0,008
Middle East	-0,047	-0,071	-0,735	-0,750	-0,055	-0,079	-0,066	-0,571	-0,021	-0,045	-0,186	-0,087	-0,653	-0,090	-0,989	-0,371	-0,071	-0,030
Nigeria	0,000	-0,002	-0,010	-0,022	-0,001	-0,003	-0,002	-0,012	0,000	-0,001	0,000	-0,001	-0,004	-0,004	-0,016	-0,002	-0,001	-0,001
Russia	-0,005	-0,091	-0,447	-0,740	-0,020	-0,086	-0,001	-0,086	-0,003	0,000	-0,005	-0,341	-0,239	-0,018	-0,209	-0,361	-0,071	-0,026
SIDS	-0,109	-0,043	-0,722	-0,617	-0,188	-0,192	-0,051	-0,113	-0,003	-0,018	-0,035	-0,048	-0,776	-0,028	-0,973	-0,030	-0,094	-0,015
UK	-0,125	-0,042	-0,368	-3,536	-0,021	-0,155	-0,019	-0,245	-0,015	-0,075	-0,153	0,000	-1,088	-0,085	-0,340	-0,236	-0,146	-0,038
USA	-0,570	-0,464	-2,753	-5,511	-0,153	-1,244	-0,046	-0,696	-0,034	-0,232	-0,852	-1,040	0,000	-0,152	-2,138	-0,350	-6,248	-0,596
Rest of Africa	-0,033	-0,064	-0,527	-1,433	-0,044	-0,183	-0,169	-0,185	-0,014	-0,045	-0,033	-0,268	-0,433	-0,117	-0,309	-0,104	-0,078	-0,023
Rest of Asia	-0,739	-0,293	-8,600	-5,479	-0,645	-2,012	-0,342	-1,178	-0,089	-0,338	-1,241	-0,622	-7,749	-0,233	-3,453	-0,470	-1,551	-0,271
Rest of Europe	-0,029	-0,034	-0,169	-1,815	-0,008	-0,049	-0,028	-0,306	-0,014	-0,085	-0,035	-0,344	-0,393	-0,068	-0,124	-0,154	-0,065	-0,029
Rest of N.America	-0,108	-0,133	-0,760	-1,258	-0,030	-0,318	-0,008	-0,100	-0,003	-0,033	-0,100	-0,321	-10,304	-0,026	-0,285	-0,103	-0,913	-0,250
Rest of S.America	-0,034	-0,282	-1,202	-0,698	-0,036	-0,200	-0,005	-0,078	-0,003	-0,068	-0,019	-0,058	-0,633	-0,023	-0,331	-0,064	-0,242	-0,342

Source: Compiled by author

Annex 17 (Sensitivity analysis – Substitution elasticity)

Figure 7-5: Dry bulk producer surplus in billion USD (Sensitivity to SE)

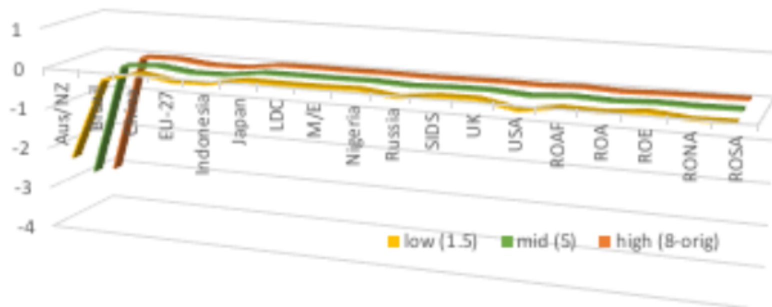


Figure 7-4: Dry bulk consumer surplus in billion USD (Sensitivity to SE)

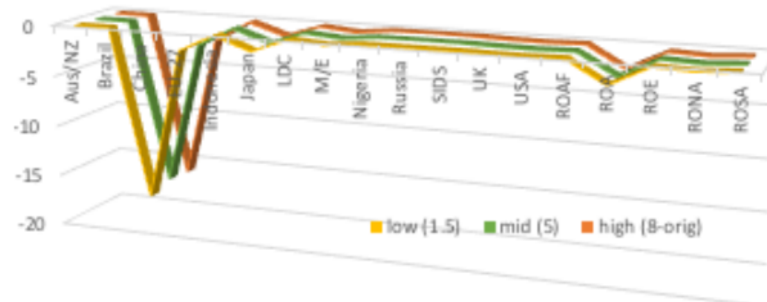
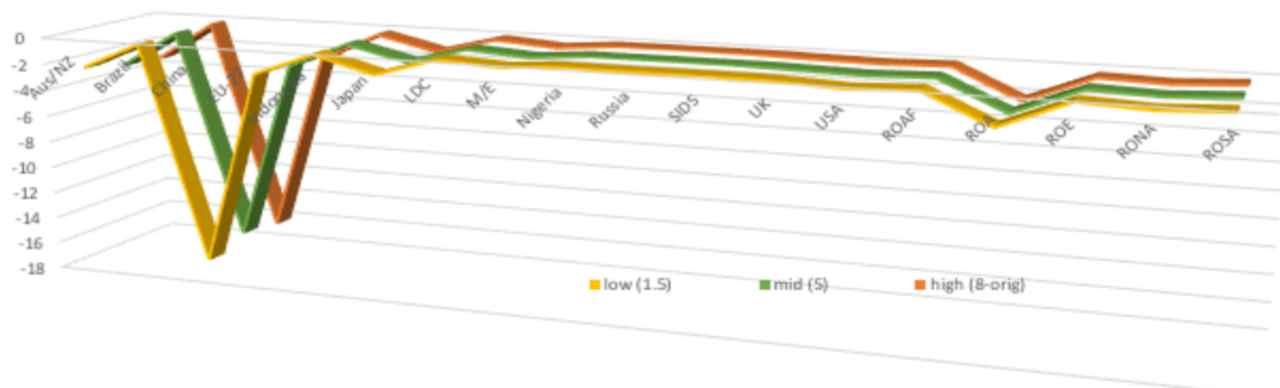


Figure 7-3: Dry bulk welfare in billion USD (Sensitivity to SE)



Source: Author's compilation of model results

Figure 7-6: Liner producer surplus in billion USD (Sensitivity to SE)

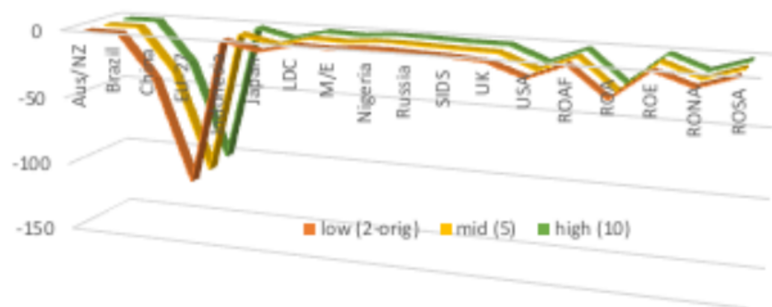


Figure 7-7: Liner consumer surplus in billion USD (Sensitivity to SE)

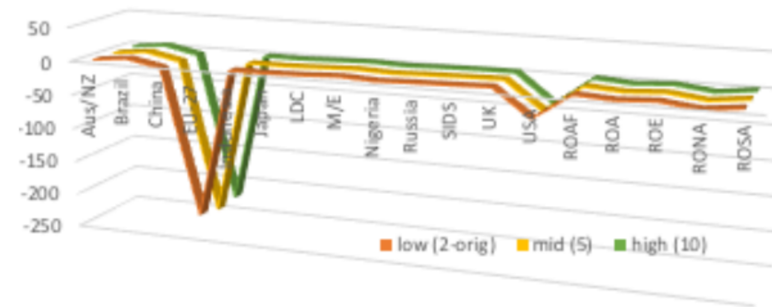
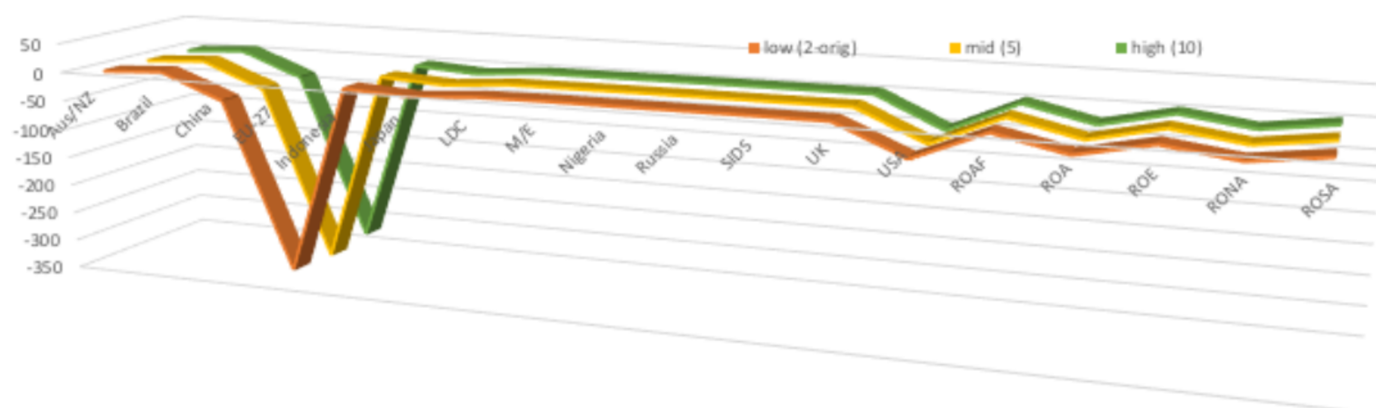


Figure 7-8: Liner welfare in billion USD (Sensitivity to SE)



Source: Author's compilation of model results

Annex 18 (Sensitivity analysis – Demand & Supply elasticity)

Figure 7-10: Dry bulk producer surplus in billion USD (Sensitivity to D&S elasticity)

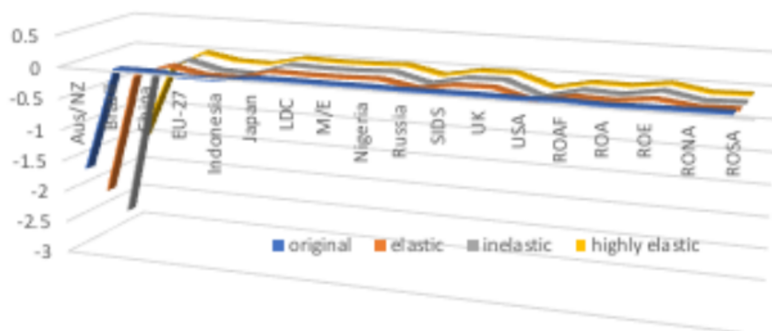


Figure 7-11: Dry bulk consumer surplus in billion USD (Sensitivity to D&S elasticity)

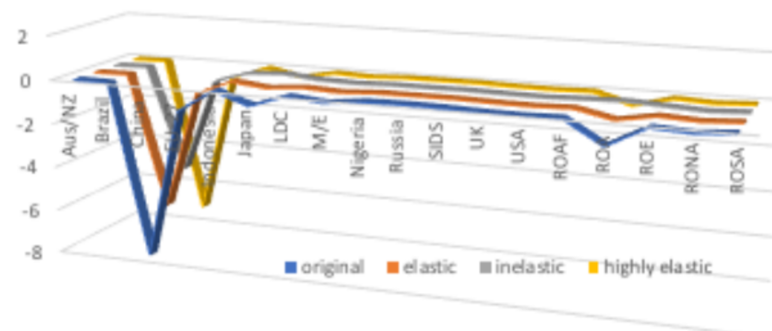
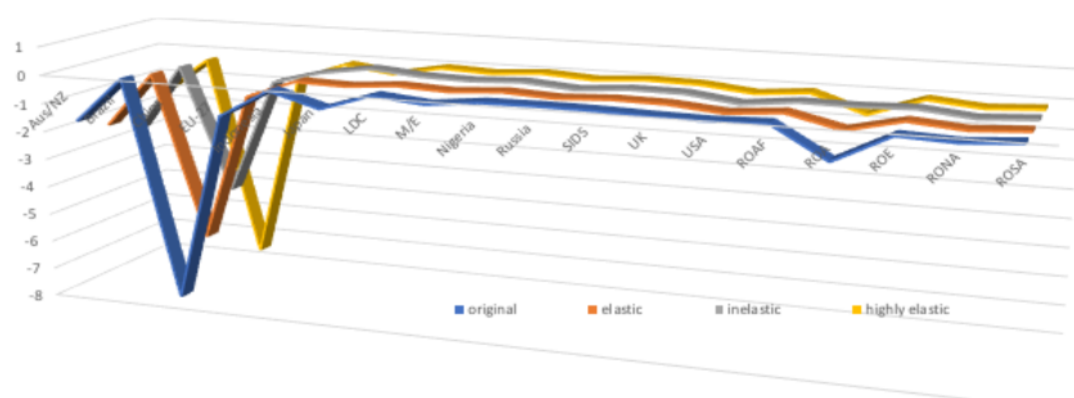


Figure 7-9: Dry bulk welfare in billion USD (Sensitivity to D&S elasticity)



Source: Author's compilation of model results

Figure 7-13: Liner producer surplus in billion USD (Sensitivity to D&S elasticity)

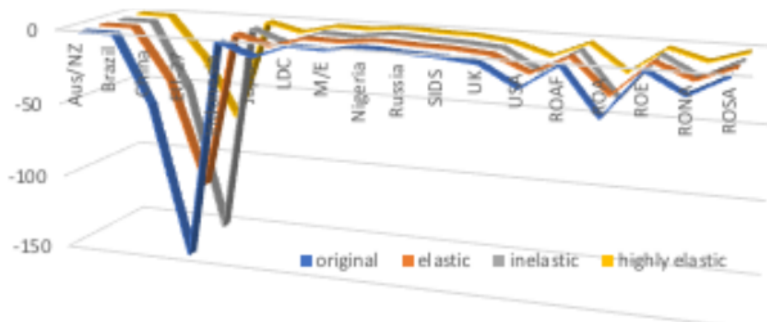


Figure 7-14: Liner consumer surplus in billion USD (Sensitivity to D&S elasticity)

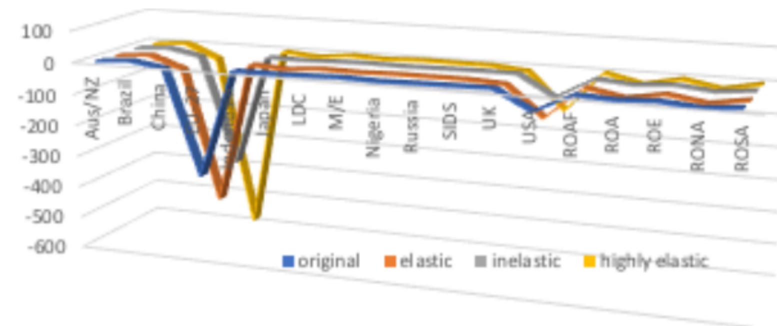
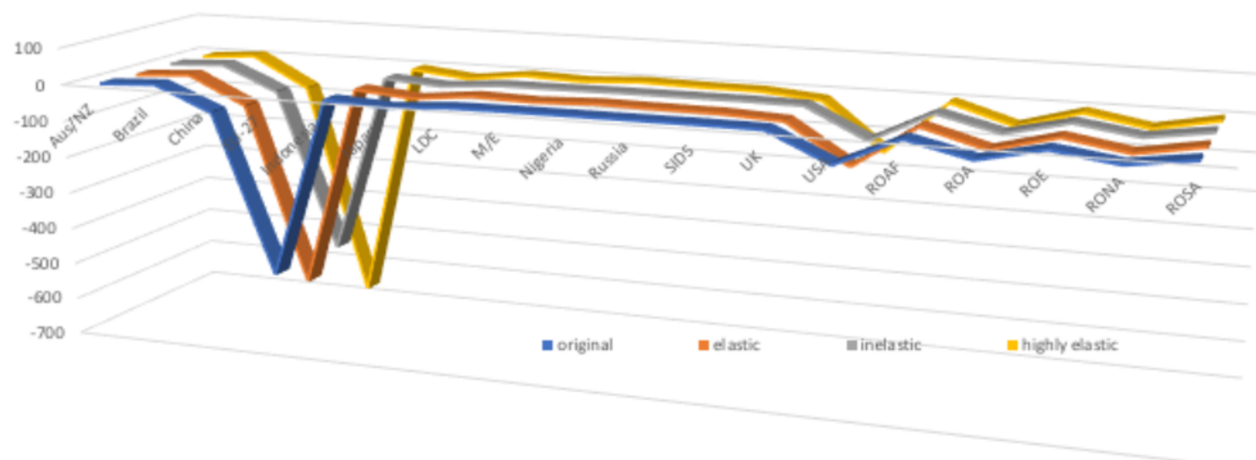


Figure 7-12: Liner welfare in billion USD (Sensitivity to D&S elasticity)



Source: Author's compilation of model results

Annex 19(Change in bilateral trade volumes in all three scenarios for each segment)

Table 7-38: Change in bilateral trade volume(million tons) for wet bulk in Scenario 1

Countries	AUS/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
EU-27	-0,6	-2,0	-5,1	-100,3	-0,4	-0,6	-1,2	-4,6	-7,9	-0,3	-4,4	-10,1	-13,8	-4,0	-4,8	-2,2	-2,1	-1,3
LDC	0,0	-0,3	-27,0	-5,1	-0,9	-0,4	-2,0	-0,3	-0,1	0,0	-0,5	-0,2	-3,1	-1,9	-9,6	0,0	0,0	-0,5
ME	-3,5	-1,0	-129,8	-64,5	-5,3	-78,2	-4,4	-12,0	-0,4	0,0	-32,2	-4,7	-33,4	-6,8	-216,4	-1,4	-2,1	-1,0
Nigeria	-0,4	-1,1	-2,1	-21,0	-2,1	-0,6	-0,5	-0,2	0,0	0,0	-0,5	-2,8	-5,1	-4,2	-11,8	0,0	-1,4	-0,6
Russia	-0,1	-0,4	-38,5	-66,9	0,0	-7,3	-0,5	-3,4	-1,3	0,0	-4,9	-5,6	-15,7	-0,8	-11,9	-3,4	-0,3	-0,3
SIDS	-6,9	-1,6	-5,2	-2,8	-10,6	-3,4	-3,6	-2,4	-0,2	-0,1	-1,4	-0,4	-5,4	-0,6	-13,2	0,0	-0,2	-1,2
USA	-0,5	-11,2	-14,7	-37,0	-2,2	-9,0	-0,2	-1,2	-0,6	0,0	-5,2	-6,7	0,0	-1,3	-12,9	-1,5	-45,0	-13,9
ROA	-11,4	-1,3	-22,4	-4,4	-4,8	-11,1	-3,7	-2,7	-2,0	-0,1	-19,8	-0,8	-6,4	-0,8	-16,5	-2,5	-0,4	-1,0
ROE	-0,1	-0,1	-5,7	-41,9	-0,6	-0,1	-0,1	-2,6	-1,1	0,0	-0,1	-27,5	-3,4	-0,3	-2,1	-1,1	-1,3	-0,1
RONA	0,0	-0,1	-1,7	-6,4	0,0	-0,8	0,0	0,0	0,0	0,0	-0,5	-0,8	-88,3	0,0	-4,9	-0,1	-0,5	-1,2

Source: Calculated by author based on data from model and World Bank

Table 7-39: Change in bilateral trade volume(million tons) for wet bulk in Scenario 2

Countries	AUS/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
EU-27	-0,5	-1,9	-4,6	-103,1	-0,4	-0,6	-1,2	-4,5	-7,8	-0,3	-4,2	-9,9	-13,4	-4,0	-4,2	-2,2	-2,0	-1,3
LDC	0,0	-0,3	-27,3	-5,1	-0,9	-0,4	-2,0	-0,3	-0,1	0,0	-0,6	-0,2	-3,1	-1,9	-9,3	0,0	0,0	-0,5
ME	-3,2	-0,9	-132,0	-62,0	-4,9	-77,8	-4,1	-11,6	-0,4	0,0	-31,2	-4,4	-31,5	-6,4	-225,7	-1,3	-1,7	-0,8
Nigeria	-0,4	-1,1	-2,1	-21,4	-2,1	-0,6	-0,5	-0,2	0,0	0,0	-0,5	-2,8	-5,2	-4,4	-11,1	0,0	-1,3	-0,6
Russia	-0,1	-0,4	-38,4	-68,3	0,0	-7,2	-0,5	-3,5	-1,3	0,0	-4,9	-5,6	-15,5	-0,8	-11,1	-3,4	-0,3	-0,3
SIDS	-7,0	-1,5	-5,2	-2,8	-10,9	-3,5	-3,6	-2,5	-0,2	-0,1	-1,4	-0,4	-5,4	-0,6	-12,8	0,0	-0,2	-1,2
USA	-0,6	-11,3	-14,4	-37,3	-2,2	-9,1	-0,2	-1,2	-0,6	0,0	-5,1	-6,8	0,0	-1,3	-12,0	-1,5	-45,8	-14,1
ROA	-11,5	-1,3	-22,5	-4,4	-4,9	-11,1	-3,7	-2,8	-2,0	-0,1	-20,3	-0,8	-6,3	-0,8	-16,0	-2,5	-0,4	-1,0

Countries	AUS/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
ROE	-0,1	-0,1	-5,5	-42,2	-0,6	-0,1	-0,1	-2,6	-1,1	0,0	-0,1	-27,9	-3,4	-0,3	-1,9	-1,1	-1,3	-0,1
RONA	0,0	-0,1	-1,5	-6,0	0,0	-0,7	0,0	0,0	0,0	0,0	-0,4	-0,8	-90,3	0,0	-4,0	-0,1	-0,5	-1,1

Source: Calculated by author based on data from model and World Bank

Table 7-40: Change in bilateral trade volume(million tons) for wet bulk in Scenario 3

Countries	AUS/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
EU-27	-0,5	-2,0	-4,9	-101,3	-0,4	-0,6	-1,2	-4,6	-7,9	-0,3	-4,3	-10,0	-13,6	-4,0	-4,6	-2,2	-2,1	-1,3
LDC	0,0	-0,3	-27,1	-5,1	-0,9	-0,4	-2,0	-0,3	-0,1	0,0	-0,5	-0,2	-3,1	-1,9	-9,5	0,0	0,0	-0,5
ME	-3,4	-1,0	-130,5	-63,6	-5,1	-78,0	-4,3	-11,8	-0,4	0,0	-31,9	-4,6	-32,7	-6,6	-219,6	-1,4	-1,9	-0,9
Nigeria	-0,4	-1,1	-2,1	-21,1	-2,1	-0,6	-0,5	-0,2	0,0	0,0	-0,5	-2,8	-5,1	-4,3	-11,6	0,0	-1,4	-0,6
Russia	-0,1	-0,4	-38,5	-67,4	0,0	-7,2	-0,5	-3,4	-1,3	0,0	-4,9	-5,6	-15,6	-0,8	-11,6	-3,4	-0,3	-0,3
SIDS	-6,9	-1,6	-5,2	-2,8	-10,7	-3,5	-3,6	-2,4	-0,2	-0,1	-1,4	-0,4	-5,4	-0,6	-13,0	0,0	-0,2	-1,2
USA	-0,5	-11,2	-14,6	-37,1	-2,2	-9,0	-0,2	-1,2	-0,6	0,0	-5,2	-6,7	0,0	-1,3	-12,6	-1,5	-45,2	-14,0
ROA	-11,4	-1,3	-22,4	-4,4	-4,9	-11,1	-3,7	-2,8	-2,0	-0,1	-20,0	-0,8	-6,3	-0,8	-16,3	-2,5	-0,4	-1,0
ROE	-0,1	-0,1	-5,6	-42,0	-0,6	-0,1	-0,1	-2,6	-1,1	0,0	-0,1	-27,6	-3,4	-0,3	-2,0	-1,1	-1,3	-0,1
RONA	0,0	-0,1	-1,6	-6,3	0,0	-0,7	0,0	0,0	0,0	0,0	-0,5	-0,8	-89,0	0,0	-4,6	-0,1	-0,5	-1,2

Source: Calculated by author based on data from model and World Bank

Table 7-41: Change in bilateral trade volume(million tons) for dry bulk in Scenario 1

Countries	AUS/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
AUS/NZ	-0,8	-2,7	-480,1	-12,8	-15,4	-106,4	-0,7	-1,8	-0,2	0,0	-0,4	-0,8	0,0	-0,8	-94,5	-2,5	-0,2	-1,6
Brazil	-0,2	0,0	-138,7	-18,1	-1,1	-20,8	-0,2	-5,7	0,0	0,0	-2,1	-1,0	-2,6	-0,7	-11,4	-3,4	-0,9	-3,8
EU-27	-0,1	-0,2	-4,4	-49,2	-0,1	-0,1	-0,7	-4,9	-2,6	-0,3	-0,2	-4,0	-1,3	-2,1	-2,5	-2,5	-0,4	-0,2
Indonesia	0,0	0,0	-17,1	-0,6	0,0	-5,9	-0,4	0,0	0,0	0,0	-0,1	0,0	-0,1	0,0	-29,2	0,0	0,0	0,0

Countries	AUS/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
Russia	0,0	-1,8	-26,3	-19,4	-1,4	-9,1	-1,7	-4,6	-1,8	0,0	0,0	-1,8	-0,2	-2,7	-20,5	-13,2	-0,2	-0,4
USA	-1,3	-6,4	-45,3	-25,3	-1,2	-27,6	-0,6	-2,2	-2,1	0,0	-1,8	-2,2	0,0	-3,2	-26,5	-4,1	-37,5	-9,8
ROAF	0,0	-0,2	-18,8	-7,7	-0,1	-2,4	-0,6	-0,6	-0,1	0,0	-0,3	-0,4	-0,1	-0,3	-18,1	-0,6	0,0	0,0
ROA	-1,6	-0,3	-20,0	-3,9	-4,1	-1,8	-4,1	-9,5	0,0	-0,3	-1,2	-1,0	-2,6	-4,2	-5,9	-0,3	-0,5	-0,1
RONA	0,0	-0,8	-22,2	-17,0	-2,0	-9,5	-0,2	-0,8	-1,1	0,0	-0,5	-2,2	-7,2	-1,2	-10,0	-0,6	-1,1	-3,8
ROSA	0,0	-5,6	-14,1	-5,2	-0,7	-1,3	-0,4	-1,0	-0,2	0,0	-0,5	-0,5	-1,2	-0,6	-4,8	-3,6	-1,3	-4,2

Source: Calculated by author based on data from model and World Bank

Table 7-42: Change in bilateral trade volume(million tons) for dry bulk in Scenario 2

Countries	AUS/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
AUS/NZ	-0,7	-2,0	-507,7	-10,5	-14,8	-105,1	-0,6	-1,5	-0,2	0,0	-0,3	-0,7	0,0	-0,7	-91,7	-2,1	-0,1	-1,3
Brazil	-0,3	0,0	-138,7	-18,3	-1,1	-20,9	-0,2	-5,7	0,0	0,0	-2,1	-1,1	-2,6	-0,7	-11,3	-3,4	-0,9	-3,8
EU-27	-0,1	-0,2	-3,5	-50,6	-0,1	-0,1	-0,7	-4,9	-2,6	-0,3	-0,2	-4,0	-1,2	-2,1	-2,4	-2,5	-0,4	-0,2
Indonesia	0,0	0,0	-16,2	-0,6	0,0	-6,1	-0,4	0,0	0,0	0,0	-0,1	0,0	-0,1	0,0	-30,3	0,0	0,0	0,0
Russia	0,0	-1,9	-24,3	-19,8	-1,4	-9,3	-1,8	-4,7	-1,9	0,0	0,0	-1,9	-0,2	-2,8	-21,1	-13,7	-0,2	-0,4
USA	-1,3	-6,5	-42,5	-25,8	-1,2	-28,7	-0,6	-2,2	-2,1	0,0	-1,8	-2,3	0,0	-3,3	-26,7	-4,1	-38,2	-10,0
ROAF	0,0	-0,2	-17,7	-7,9	-0,1	-2,5	-0,6	-0,6	-0,1	0,0	-0,3	-0,4	-0,1	-0,4	-18,8	-0,7	0,0	0,0
ROA	-1,6	-0,3	-19,1	-4,0	-4,3	-1,8	-4,2	-9,8	0,0	-0,3	-1,2	-1,0	-2,6	-4,3	-6,1	-0,3	-0,4	-0,1
RONA	0,0	-0,8	-20,9	-17,5	-2,1	-9,8	-0,1	-0,8	-1,1	0,0	-0,5	-2,3	-7,4	-1,1	-9,9	-0,6	-1,1	-3,9
ROSA	0,0	-5,9	-13,4	-5,3	-0,7	-1,3	-0,4	-1,0	-0,2	0,0	-0,5	-0,5	-1,3	-0,5	-4,7	-3,6	-1,3	-4,3

Source: Calculated by author based on data from model and World Bank

Table 7-43: Change in bilateral trade volume(million tons) for dry bulk in Scenario 3

Countries	AUS/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
AUS/NZ	-0,8	-2,5	-489,7	-12,1	-15,2	-105,9	-0,7	-1,7	-0,2	0,0	-0,3	-0,8	0,0	-0,8	-93,5	-2,4	-0,2	-1,5

Countries	AUS/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
Brazil	-0,3	0,0	-138,6	-18,1	-1,1	-20,8	-0,2	-5,7	0,0	0,0	-2,1	-1,0	-2,6	-0,7	-11,3	-3,4	-0,9	-3,8
EU-27	-0,1	-0,2	-4,1	-49,7	-0,1	-0,1	-0,7	-4,9	-2,6	-0,3	-0,2	-4,0	-1,3	-2,1	-2,5	-2,5	-0,4	-0,2
Indonesia	0,0	0,0	-16,8	-0,6	0,0	-6,0	-0,4	0,0	0,0	0,0	-0,1	0,0	-0,1	0,0	-29,5	0,0	0,0	0,0
Russia	0,0	-1,8	-25,6	-19,6	-1,4	-9,2	-1,7	-4,7	-1,9	0,0	0,0	-1,9	-0,2	-2,7	-20,7	-13,4	-0,2	-0,4
USA	-1,3	-6,4	-44,4	-25,5	-1,2	-28,0	-0,6	-2,2	-2,1	0,0	-1,8	-2,2	0,0	-3,3	-26,6	-4,1	-37,7	-9,8
ROAF	0,0	-0,2	-18,4	-7,8	-0,1	-2,4	-0,6	-0,6	-0,1	0,0	-0,3	-0,4	-0,1	-0,4	-18,3	-0,6	0,0	0,0
ROA	-1,6	-0,3	-19,7	-4,0	-4,2	-1,8	-4,1	-9,6	0,0	-0,3	-1,2	-1,0	-2,6	-4,3	-6,0	-0,3	-0,5	-0,1
RONA	0,0	-0,8	-21,7	-17,1	-2,0	-9,6	-0,2	-0,8	-1,1	0,0	-0,5	-2,2	-7,3	-1,2	-10,0	-0,6	-1,1	-3,9
ROSA	0,0	-5,7	-13,9	-5,3	-0,7	-1,3	-0,4	-1,0	-0,2	0,0	-0,5	-0,5	-1,2	-0,6	-4,8	-3,6	-1,3	-4,3

Source: Calculated by author based on data from model and World Bank

Table 7-44: Change in bilateral trade volume('000 TEU) for containers in Scenario 1

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
EU-27	-61,7	-42,2	-354,0	-2858,6	-14,3	-105,4	-14,8	-119,2	-6,6	-60,6	-55,7	-365,7	-636,1	-62,7	-199,8	-107,3	-129,7	-41,4
China	-99,6	-49,5	0,0	-762,5	-66,2	-221,5	-26,4	-88,1	-12,9	-59,1	-58,7	-104,5	-675,8	-28,3	-389,1	-56,5	-204,0	-67,5
ROA	-46,4	-18,7	-537,0	-342,5	-40,5	-126,3	-21,5	-74,0	-5,7	-21,3	-78,1	-39,1	-484,4	-14,7	-216,4	-29,6	-97,7	-17,2
USA	-35,7	-29,3	-172,8	-344,1	-9,6	-78,1	-2,9	-43,8	-2,1	-14,6	-53,8	-65,3	0,0	-9,6	-134,6	-22,0	-390,1	-37,4
RONA	-6,8	-8,4	-47,9	-79,0	-1,9	-20,0	-0,5	-6,3	-0,2	-2,1	-6,3	-20,2	-643,1	-1,6	-18,1	-6,5	-57,4	-15,7
Japan	-21,4	-5,2	-246,3	-120,3	-21,4	0,0	-3,4	-24,4	-0,4	-9,9	-26,5	-15,2	-171,7	-4,1	-164,5	-8,1	-35,7	-7,0
UK	-7,8	-2,7	-23,2	-220,9	-1,3	-9,7	-1,2	-15,4	-0,9	-4,7	-9,6	0,0	-68,2	-5,4	-21,4	-14,8	-9,1	-2,4
ME	-2,9	-4,5	-46,1	-46,9	-3,4	-4,9	-4,1	-35,8	-1,4	-2,8	-11,7	-5,4	-40,9	-5,6	-62,0	-23,3	-4,4	-1,9
ROSA	-2,1	-17,7	-75,3	-43,7	-2,3	-12,6	-0,3	-4,9	-0,2	-4,3	-1,2	-3,6	-39,6	-1,4	-20,9	-4,0	-15,2	-21,4

Calculated by author based on data from model and Clarkson's research

Table 7-45: Change in bilateral trade volume('000 TEU) for containers in Scenario 2

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
EU-27	-59,7	-39,7	-343,4	-3011,7	-13,5	-102,6	-14,1	-115,3	-6,3	-58,7	-53,3	-361,4	-634,6	-60,4	-193,3	-104,5	-126,5	-39,9
China	-100,0	-45,9	0,0	-782,7	-66,3	-223,3	-25,8	-87,8	-12,3	-58,5	-58,4	-104,0	-690,9	-27,7	-393,6	-56,2	-204,6	-66,4
ROA	-46,5	-17,9	-547,2	-348,0	-40,6	-126,9	-21,4	-74,2	-5,5	-21,2	-77,9	-39,1	-492,3	-14,6	-218,2	-29,5	-97,1	-16,8
USA	-35,9	-28,9	-173,5	-350,7	-9,6	-78,4	-2,8	-43,7	-2,1	-14,5	-53,0	-65,6	0,0	-9,5	-134,0	-22,0	-397,6	-37,5
RONA	-6,8	-8,2	-47,4	-79,3	-1,8	-19,9	-0,5	-6,2	-0,2	-2,1	-6,2	-20,2	-656,1	-1,6	-17,6	-6,4	-57,4	-15,6
Japan	-21,6	-4,9	-249,7	-121,9	-21,6	0,0	-3,3	-24,5	-0,4	-9,9	-26,5	-15,3	-173,4	-4,0	-165,9	-8,1	-35,9	-7,0
UK	-7,9	-2,6	-22,9	-224,7	-1,3	-9,7	-1,2	-15,4	-0,9	-4,7	-9,6	0,0	-68,7	-5,4	-21,3	-14,9	-9,2	-2,4
ME	-3,0	-4,5	-46,4	-47,5	-3,5	-5,0	-4,1	-36,1	-1,3	-2,8	-11,7	-5,5	-41,3	-5,6	-62,6	-23,4	-4,4	-1,8
ROSA	-2,1	-17,8	-75,9	-44,3	-2,3	-12,6	-0,3	-4,8	-0,2	-4,3	-1,2	-3,7	-40,1	-1,4	-20,6	-4,0	-15,3	-21,7

Calculated by author based on data from model and Clarkson's research

Table 7-46: Change in bilateral trade volume('000 TEU) for containers in Scenario 3

Countries	Aus/NZ	Brazil	China	EU-27	Indonesia	Japan	LDC	ME	Nigeria	Russia	SIDS	UK	USA	ROAF	ROA	ROE	RONA	ROSA
EU-27	-61,0	-41,3	-350,2	-2913,1	-14,0	-104,4	-14,5	-117,8	-6,5	-59,9	-54,9	-364,0	-635,2	-61,9	-197,5	-106,3	-128,5	-40,9
China	-99,7	-48,3	0,0	-769,4	-66,2	-222,1	-26,2	-88,0	-12,7	-58,9	-58,6	-104,3	-681,0	-28,1	-390,6	-56,4	-204,2	-67,1
ROA	-46,4	-18,4	-540,5	-344,4	-40,5	-126,4	-21,5	-74,0	-5,6	-21,3	-78,0	-39,1	-487,0	-14,6	-217,0	-29,5	-97,5	-17,0
USA	-35,8	-29,2	-173,0	-346,4	-9,6	-78,2	-2,9	-43,7	-2,1	-14,6	-53,5	-65,4	0,0	-9,6	-134,4	-22,0	-392,7	-37,4
RONA	-6,8	-8,3	-47,8	-79,1	-1,9	-20,0	-0,5	-6,3	-0,2	-2,1	-6,3	-20,2	-647,6	-1,6	-17,9	-6,5	-57,4	-15,7
Japan	-21,5	-5,1	-247,4	-120,9	-21,5	0,0	-3,4	-24,4	-0,4	-9,9	-26,5	-15,3	-172,3	-4,1	-165,0	-8,1	-35,7	-7,0
UK	-7,8	-2,7	-23,1	-222,2	-1,3	-9,7	-1,2	-15,4	-0,9	-4,7	-9,6	0,0	-68,4	-5,4	-21,4	-14,8	-9,2	-2,4
ME	-2,9	-4,5	-46,2	-47,2	-3,5	-4,9	-4,1	-35,9	-1,3	-2,8	-11,7	-5,5	-41,1	-5,6	-62,2	-23,3	-4,4	-1,9
ROSA	-2,1	-17,7	-75,5	-43,9	-2,3	-12,6	-0,3	-4,9	-0,2	-4,3	-1,2	-3,6	-39,8	-1,4	-20,8	-4,0	-15,2	-21,5

Calculated by author based on data from model and Clarkson's research