UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT
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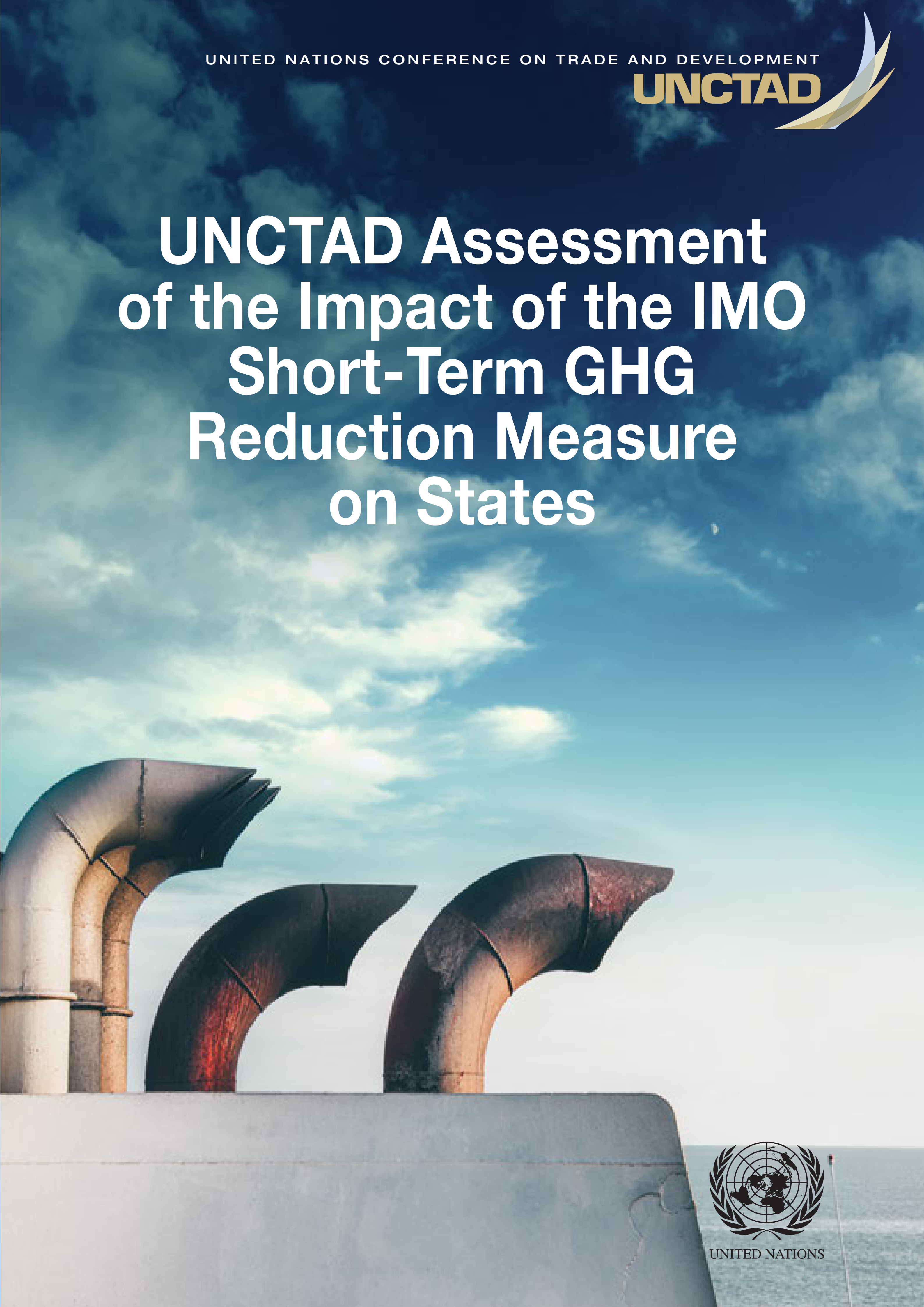
# UNCTAD Assessment of the Impact of the IMO Short-Term GHG Reduction Measure on States



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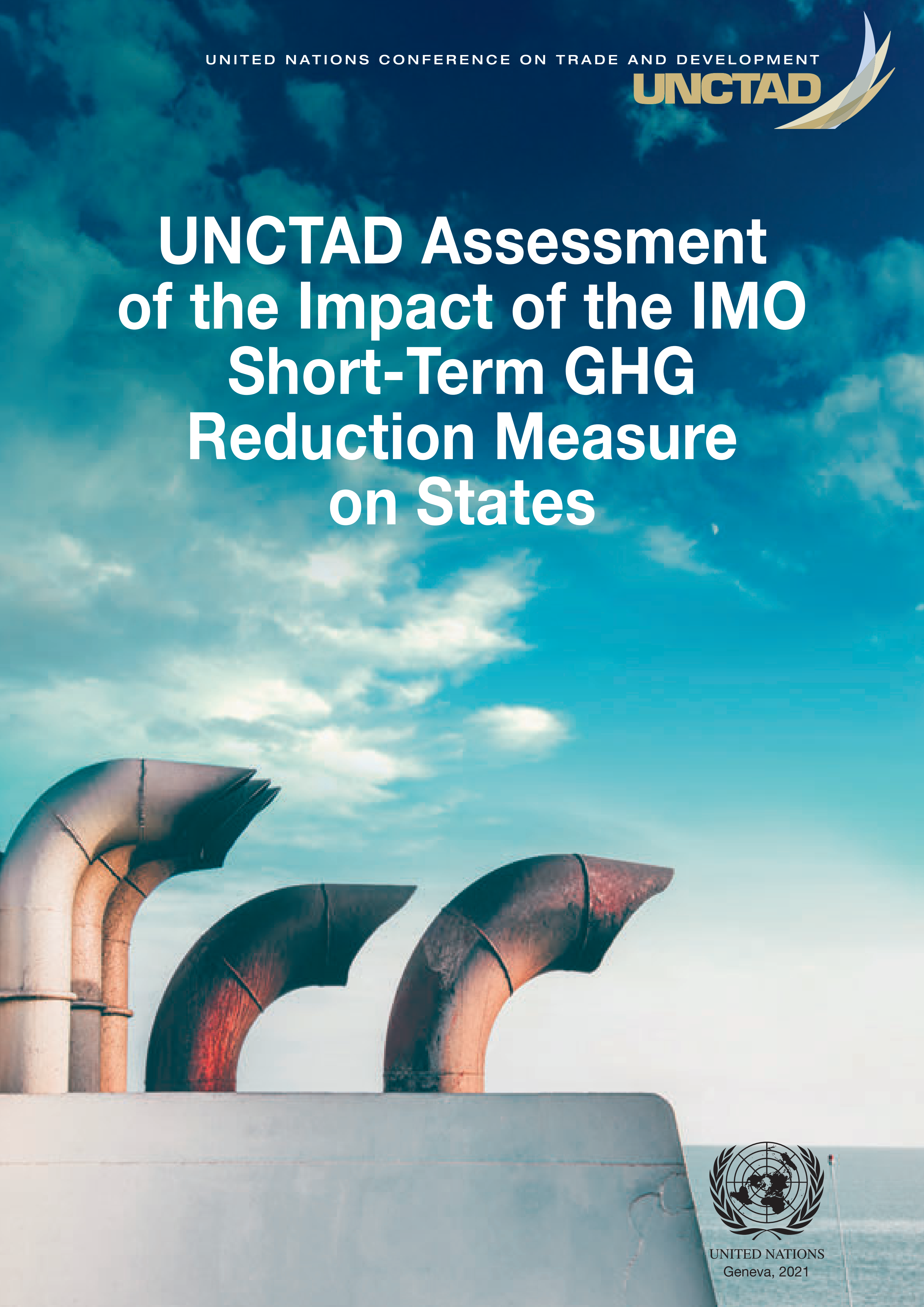

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## Preface

In an ever interdependent and globalized world, countries share not only in growth and prosperity but also in crises and challenges. One such challenge is the global warming effect of climate change, and its implications for economies and societies developed and developing alike.

Like other economic sectors, maritime transport is at the forefront of the climate change challenge. A strategic industry handling over 80% of world merchandise trade by volume and more than 70% of its value being maritime transport, shipping and ports face the dual challenge of cutting their carbon footprint and building their resilience to withstand unavoidable climate change impacts better. Both climate change mitigation and resilience building are crucial to future-proofing the maritime transport sector.

UNCTAD commends and supports efforts under the International Maritime Organization (IMO) framework that aim to set clear goals, milestones, and regulations with a view to reducing Green-House-Gas emissions in shipping. With climate change being a global challenge and maritime transport an inherently international industry, the importance of collaborative global efforts and partnerships among key players from industry, government, and relevant international organizations cannot be overemphasized. Accordingly, and in line with the long-standing collaboration between the two UN-sister agencies, UNCTAD has worked closely, over the past year, with the IMO and contributed expert advice and substantive input into IMO's mandated assessment of the potential impact on States of the proposed short-term IMO GHG reduction measure.

In addition to reviewing the comprehensiveness of relevant impact assessments prepared by proponents of various concrete proposals setting approaches to carbon intensity reduction measures, UNCTAD has also carried out a thorough evaluation of the potential impact on States of the proposed IMO short-term measure before the adoption of relevant amendments to MARPOL Annex VI by the IMO Marine Environment Protection Committee (MEPC) in June 2021. This measure contains mandatory provisions addressing the technical efficiency of ships (the Energy Efficiency Existing Ship Index: EEXI) and their operational carbon intensity (the Carbon Intensity Indicator rating mechanism: CII).

The present report presents the main findings of the UNCTAD impact assessment as submitted to the IMO Secretariat and Membership, which constitutes an essential element of the broader Comprehensive impact assessment of the short-term measure approved by MEPC 76. Funding from the IMO GHG-TC Trust Fund has enabled this work and the completion of the UNCTAD Impact Assessment.

The aggregate global impacts of the proposed IMO short-term measure assessed in the UNCTAD report can be considered small compared to typical market variability of freight rates. Also, the global effect on GDP and trade flows can be regarded as minor compared to the long-term impact of other disruptions such as pandemics or climate change factors.

However, for some countries, the negative impacts of the IMO measure assessed in this report are relatively higher than for others. Aware of the resource constraints of some developing countries, including SIDS and LDCs, UNCTAD expects that some countries will likely require support to mitigate the increased maritime logistics costs and alleviate the consequent negative impact on their respective real income and trade flows.

The impact assessment reveals that countries most affected by climate change, are also those potentially most negatively affected by higher transport costs and lower maritime connectivity that may result from increased maritime logistics costs. UNCTAD’s existing work has already shown that SIDS pay, on average, twice as much for the transport of their foreign trade than the world average. SIDS are confronted with remoteness and lower maritime transport connectivity which undermine the resilience and reliability of their transportation systems and increase their transport and trade costs. Providing technical and financial support to these countries is paramount to ensure that they can effectively contribute to climate mitigation action in maritime transport while also alleviating and adapting to any potential negative impact of new regulatory measures on their transport, connectivity, and sustainable development aspirations.

The conduct of an assessment of possible impacts on States before the adoption and implementation of the IMO short-term measure on GHG reduction in shipping constitutes an example of good practice in the field of regulatory governance. Insights gained will help anticipate and understand the potential negative impacts or unintended effects that may arise. It can also help ensure that the IMO measure achieves its set goals while, at the same time, taking into account relevant implementation and compliance costs that may arise.

Achieving the targets of the Initial IMO Strategy on reduction of GHG emissions from ships is crucial for sustainable development in an increasingly fragile, inter-linked, and complex global eco-system. Yet, navigating through the energy transition away from fossil-fuel-dependent combustion systems is still a significant challenge for the maritime transport industry. In this respect, the 2015 global Sustainable Development Goals (SDGs) and the 2030 Agenda for Sustainable Development have emphasized that achieving economic progress and development need not be at the expense of environmental protection and societal well-being.

In the interest of developing countries highly affected by climate change factors, UNCTAD considers it essential that policymakers aim at high ambition reductions of GHG emissions from shipping. Developing countries that may be disproportionally affected will require support, including through technical and financial assistance. Such assistance can include, among other things, measures to reduce transport costs and to provide support to trade facilitation reforms, modernization of ports, and climate adaptation action in maritime transport. In accordance with its mandate and within its resources, UNCTAD stands ready to support its members in this endeavour.

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# UNCTAD Assessment of the Impact of the IMO Short-Term GHG Reduction Measure on States

## Assessment of Impacts on Maritime Logistics Costs, Trade, and GDP

United Nations Conference on Trade and Development – UNCTAD. Geneva, 13 April 2021

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## Acknowledgements

The Impact Assessment contained in this report was prepared by the United Nations Conference on Trade and Development, UNCTAD, in response to a request by the International Maritime Organization, IMO. UNCTAD's project team were Jan Hoffmann, Frida Youssef, Hassiba Benamara and Hidenobu Tokuda from the Trade Logistics Branch, Division on Technology and Logistics, and Alessandro Nicita from the Trade Analysis Branch, Division on International Trade and Commodities. Report writing was managed by Khalid Bichou, with contributions from the UNCTAD project team, as well as Ronald Halim and Sisangile Nduna.

Substantive contributions were received from MDS Transmodal (MDST), led by Michael Garratt and Antonella Teodoro who consolidated data relating to changes in ship costs and transit times as computed by DNV, with data on trade and fleet deployment; Developing Trade Consultants (DTC), led by Ben Shepherd who simulated the impact of changes in maritime logistics costs on trade and real gross domestic product (income/output) by running a global trade model and contributing key analysis and quantitative assessment; MarineTraffic who provided detailed data on ship movement, including fleet deployment and journeys; DNV who provided, for various vessel types, data on expected changes in ship costs and speed resulting from the IMO short-term measure; Equitable Maritime Consulting (EMC), led by Ronald Halim who provided estimates on the value of time (VoT) and potential modal shifts; and Drewry Shipping Consultants Ltd. who contributed insights about freight market patterns. The report had further benefited from data and reports prepared by Clarksons Research, Dynamar, and Drewry Maritime Research. More sources are mentioned in the report.

## Notes

The report has not been formally edited.

For a list of economies and groups of economies, see UNCTAD Statistics under
https://unctadstat.unctad.org/EN/Documentation.html

## Executive Summary

UNCTAD has been requested by the IMO Secretariat to carry out Task 3 of the Workplan approved by the Steering Committee established under ISWG-GHG 7, for the conduct of the Comprehensive Impact Assessment of the short-term GHG (greenhouse gas) measure approved at MEPC 75. The short-term measure combines both technical (Energy Efficiency Existing Ship Index- EEXI) and operational requirements (Carbon Intensity Indicator- CII). Together with six other tasks, Task 3has been identified by the Steering Committee as necessary to fulfilling the requirements under the approved Terms of Reference (TORs) by MEPC 75 and key to the conduct of a comprehensive impact assessment of the IMO short-term measure.

Building up on the output of Task 2 carried out by DNV and assessing possible impacts on the global shipping fleet, Task 3 sets out a quantitative and qualitative assessment of the impacts of the IMO short-term measure on States, including developing countries, Small Island Developing States (SIDS) and Least Developed Countries (LDCs). A key element of UNCTAD's analysis was to quantify the changes in maritime logistics costs and assess their impact on countries' trade and GDP (real income). Task 3 further includes selected case studies that illustrate more granular and specific impacts of the IMO short-term measure.

For the purposes of the UNCTAD impact assessment, a negative impact of the IMO short-term measure on States is understood to mean higher maritime logistics costs (including transport costs and time costs). lower trade flows (imports or exports), lower GDP, or a combination of any of these three outcomes.

To effectively deliver on Task 3, UNCTAD aligned its working approach with the requirements set out under MEPC.1/Circ855, including the emphasis on the needs of developing countries, especially SIDS and LDCs, and the use of robust methods and analytical tools such as maritime transport cost models, trade flows models, and general equilibrium models, which can provide a detailed and evidence-based impact assessment.

In line with Task 2, the assessment in Task 3 covers three GHG reduction scenarios under the IMO short-term measure, namely, the EEXI-Only scenario, HIGH-GHG reduction scenario, and LOW-GHG reduction scenario, each compared to the baseline 2030 scenario (Current Regulations). Each scenario is defined as follows:

- "EEXI-Only": Regulatory scenario including EEXI requirements only.
- "HIGH": Regulatory scenario including both EEXI and CII requirements. For CII, a supply-based metric (emission per transport capacity: g CO2/dwt-nm) has been used to determine the reduction from 2008 to 2019, giving an average reduction requirement of 21.5% between 2019 and 2030.

- “LOW”: Regulatory scenario including both EEXI and CII requirements. For CII, a demand-based metric (emission per actual transport work: g CO2/tonne-nm) has been used to determine the reduction from 2008 to 2019, giving an average reduction requirement of 10.2 per cent between 2019 and 2030.
- “BASELINE”: Current Regulatory scenario with only adopted EEDI requirements, including those entering into force in 2022.

Under Task 2, DNV assessed the impact of the IMO short-term measure on ships’ costs and transit speed across the three 2030 scenarios (EEXI-Only, HIGH-GHG reduction scenario and LOW-GHG reduction scenario) compared with the baseline 2030 scenario under Current Regulations. DNV’s analysis covered 41 ship segments, albeit with no information about the laden status of these ships, geographical distribution, movement or journeys between ports and countries.

To be able to use the results of DNV’s analysis as input data into UNCTAD’s transport costs and trade models, UNCTAD first mapped out and matched the various categories of DNV ships against the 2019 trade flows derived from MDS Transmodal’s (MDST) World Cargo Database (WCD). The various vessel types were also matched against the AIS 2019 global ship and traffic data obtained from MarineTraffic. This work resulted in a detailed dataset about ships, their sizes, types, journeys between ports, and distances travelled. The dataset did not consider ship journeys that were in ballast or involving unknown conditions.

The next step for UNCTAD was to assign the matched ships and journeys to Origin/Destination (O/D) bilateral trade pairs for 185 economies across 11 trade sectors representing the Eora global sector classification. The main 11 sectors are as follows: Agriculture, Fishing, Mining and Quarrying, Food and Beverages, Textiles and Wearing Apparels, Wood and Paper, Petroleum, Chemical and Non-Metallic Mineral Products, Metal Products, Electrical and Machinery, Transport Equipment, Other Manufacturing.

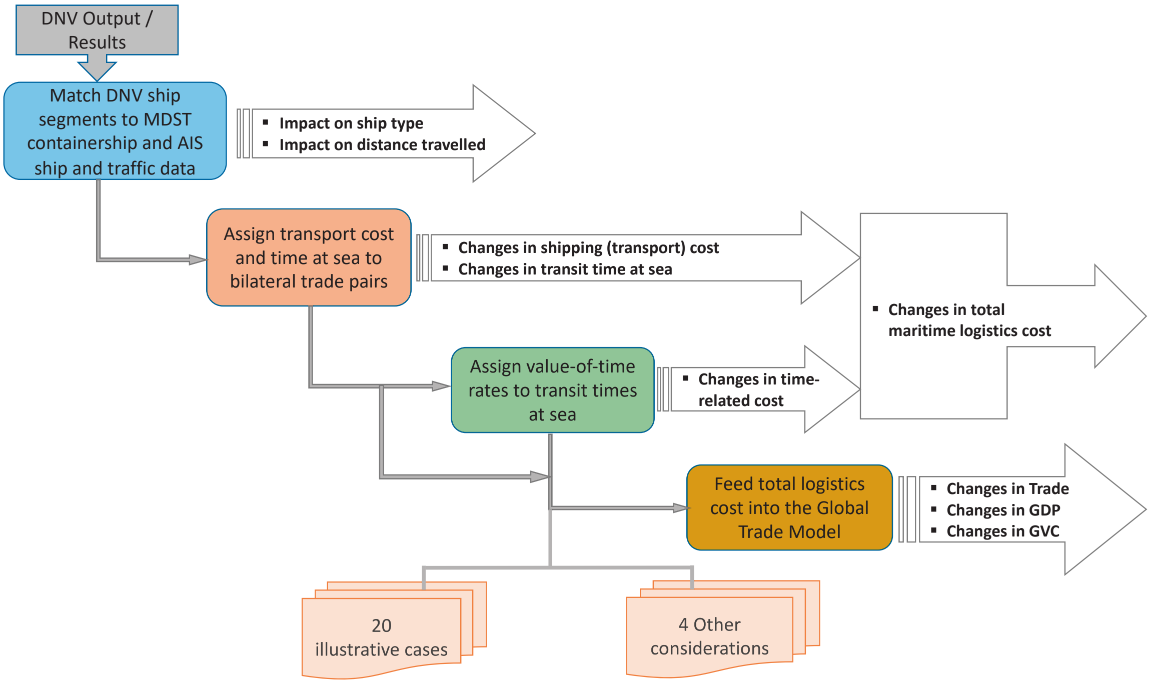
To better reflect the perspective of shippers and trade, DNV ship costs and speed reduction estimates were converted into shipping (transport) costs and time at sea (transit time) costs, respectively. Together the computed shipping (transport) costs and time costs were combined to quantify changes in total maritime logistics costs across the three GHG reduction scenarios. This step enabled UNCTAD to consider the perspective of shippers/ cargo interests and their supply chains. This helped to avoid adopting a narrow view which only considers costs from the perspective of ships, carriers, and ship operators. Improving the understanding of how changes in ship costs affect maritime logistics costs, and how the latter affect trade flows and GDP levels, is key to understanding the impact on States of the IMO short-term measure.

To ensure that the impact assessment carried out by UNCTAD is as comprehensive as possible, the methodological approach that had been adopted favoured wide country coverage and did not rely exclusively on a sample of representative cases. Additionally, the scope of coverage extends to all ships and trades for which data is available. Two main interlinked steps underpinned UNCTAD's analysis. In step 1, UNCTAD assessed the impact of the IMO short-term measure on the maritime logistics costs, including shipping (transport) and time-related costs. In step 2, the impact of changes in maritime logistics costs across the three GHG reduction scenarios was assessed for the trade and GDP of 184 economies. The computed changes in maritime logistics costs across the three GHG scenarios were fed as input data into a global trade model that assessed the impact of the IMO short-term measure on countries' trade, economic output (GDP), and participation in Global Value Chain trade (GVC).

In addition to the comprehensive assessment of impacts at the global level, which relied on modelling the impact on 184 economies across 11 trade sectors, a more granular analysis was carried out through selected illustrative case studies. The aim was to clarify how the IMO short-term measure affect specific countries, their trade and supply chains. This analysis was further supplemented by a qualitative assessment of other impacts and cross-cutting considerations that could not be covered by the global trade model.

Figure 1 describes UNCTAD's methodological approach and interlinked analytical steps.

Figure 1: UNCTAD's methodological approach to Task 3



*Source: UNCTAD, 2021.*

## Global Model Assessment

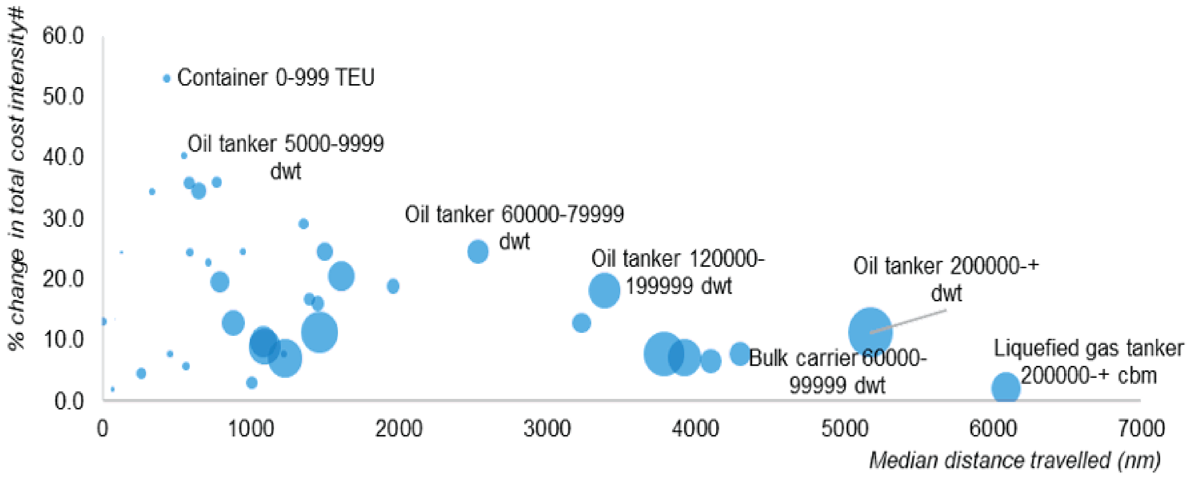
As noted above, to assess the impact of the IMO short-term measure on States, the first step was to convert changes in ship costs and speed, as estimated by DNV, into changes in maritime logistics costs i.e., costs to shippers and cargo interests. The second step was to assess how the computed changes in maritime logistics costs will impact on trade flows (Imports and Exports) and GDP at both the aggregate and the country specific levels and across the three GHG reduction scenarios (EEXI-Only, HIGH-GHG reduction scenario, and LOW-GHG reduction scenario), as compared to the 2030 baseline Current Regulations scenario. The impact on supply chain costs, ship journeys, and routing patterns were also examined across country-trade sector as well as ship types and routes, respectively.

### *Impacts on Ships and Journeys*

By matching DNV ship segments and sailing speeds with the global AIS-based ship traffic data, it was possible to identify the ship types and categories expected to be affected by the IMO short-term measure. As regards shipping costs, small-sized vessels plying short-sea shipping routes have been found to be more negatively affected as compared to larger ships travelling longer distances (Figure 2). Some substitution between ship sizes may also occur when a deep-sea liner is required to go slower, potentially skipping a port and leading to more transhipment, adding to the use of smaller ships, and thereby leading to increased costs.

To sum up, the IMO short-term measure does not only translate into potential changes in ship costs, but also changes in ship travel distance, fleet distribution, routing patterns, as well as market and regional connectivity levels.

Figure 2: Percentage change in cost intensity by ship segment, average size* and median distance travelled



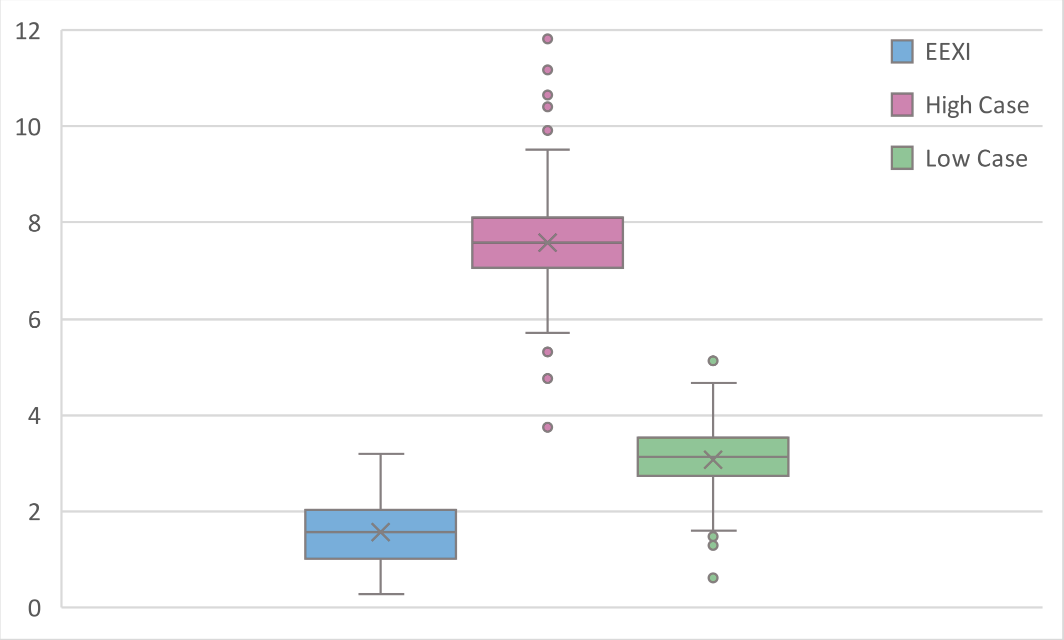
*Source: UNCTAD compiled from DNV and MarineTraffic data.*
*: *Size of the bubbles* stands for the average ship size per DWT.
#: *% change in total cost intensity in* HIGH-GHG reduction scenario compared to the 2030 Current Regulations scenario.

The impact of sailing speed reduction and the potential for service-reconfiguration is more apparent in the case of the Pacific and Caribbean SIDS where short-sea shipping and the use of general cargo ships are more prevalent. Network analysis of regional shipping services within the Pacific and the Caribbean SIDS confirms that smaller economies in these two regions are heavily challenged by shipping (dis)connectivity and service (in)frequency; and could therefore be expected to be more adversely impacted by the IMO short-term measure.

### *Impact on Maritime Logistics Costs*

At the aggregate level, UNCTAD's analysis shows an upward average increase in maritime logistics costs across all three GHG reduction scenarios. These stand at 1.6%, 3.1% and 7.6% for the EEXI-Only scenario, the LOW-GHG reduction scenario and the HIGH-GHG reduction scenario, respectively. However, wide variations prevail across the three GHG reduction scenarios, particularly the HIGH-GHG reduction scenario. These variations imply that some countries and trade pairs would be more impacted than the global average. Conversely, moving from an EEXI-Only scenario to a LOW-GHG reduction scenario generates the smallest maritime logistics cost increases as compared to a shift from a LOW-GHG reduction scenario to a HIGH-GHG reduction scenario. This suggests that much of the cost burden will take place at a later or more advanced stage of the implementation process where operational carbon intensity reduction requirements become more stringent.

Figure 3: Percentage changes in total maritime logistics costs by regulatory scenario, relative to the 2030 baseline scenario



*Source: UNCTAD, based on data provided MDS Transmodal (MDST).*

Estimated changes in shipping (transport) costs have followed a pattern like the one observed in the case of changes in total maritime logistics costs. A small difference is seen, however when comparing the EEXI-Only scenario and the LOW-GHG reduction scenario. For some trades, especially under the EEXI-Only scenario, a reduction in shipping (transport) costs is expected, assuming cost savings are passed on by carriers and ship operators to their clients, the shippers.

Time at sea – the second component of the total maritime logistics costs – is expected to experience a small to a moderate increase across all three GHG reduction scenarios as compared to the 2030 baseline Current Regulations scenario. A reduction in sailing speed will induce different impacts on transit times and costs across the three scenarios.

For all cost components, namely, time at sea and transport costs, and the combined total maritime logistics costs, the highest impacts are expected to occur under the HIGH-GHG reduction scenario. The next highest impact will be seen under the LOW-GHG reduction scenario, followed by the EEXI-Only GHG reduction scenario, respectively (Table 1).

Table 1: Global average changes in logistics costs under the three 2030 GHG reduction scenarios as compared to the baseline 2030 Current Regulations scenario

| **Changes in maritime logistics costs** | **EEXI-Only** | **HIGH** | **LOW** |
|---|---|---|---|
| Change in time at sea, % | **2.2** | **7.8** | **2.8** |
| Change in transport costs, % | **0.4** | **5.6** | **1.5** |
| Change in total maritime logistics costs, % | **1.7** | **7.2** | **2.7** |

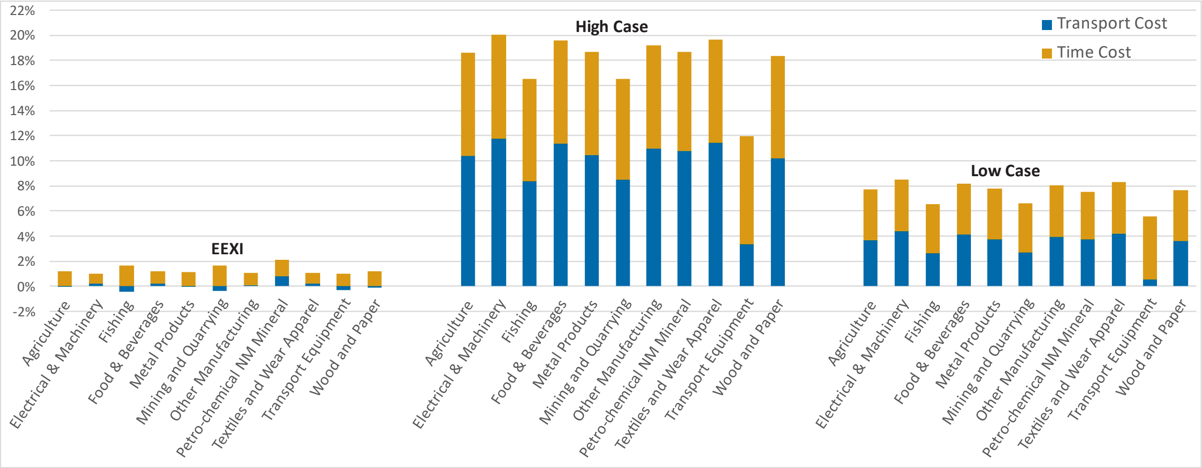
*Source: UNCTAD, based on data provided MDS Transmodal (MDST).*

A similar analysis was undertaken to show impacts per country trade flow, i.e., import or export, the full results of which are presented in Chapter 3 of this Report. The results show that smaller economies, including small island economies, can be expected to be affected more by the IMO short-term measure as compared to the world average, especially under the HIGH-GHG and LOW-GHG reduction scenarios. The effect on some countries will be felt more by their exporters, while for other countries the impact will be felt more by importers.

Further analysis was undertaken to assess impacts on specific sectors or supply chains to highlight the extent to which these trades could be affected when considered independently as compared to the aggregate and country-level results presented above. The analysis revealed that for a small number of supply chain trade pairs, there will be positive impacts across the three GHG reduction scenarios whereby they experience a reduction in maritime logistics costs. On the other hand, some supply chain trades, especially some outliers, were shown to experience a steep increase in their maritime logistics costs by as much as 58%. This entails implications for these supply chains ranging from modal shifts to supply chain reconfiguration.

The analysis of impacts on supply chain trades provides interesting insights into the interplay between shipping (transport) costs and time-related costs. Across all three GHG reduction scenarios, time-related costs account for a larger share of total maritime logistics costs. This is clearer in the case of sectors and supply chains where time-related costs far outweigh transport costs under each of the three GHG reduction scenarios. Nonetheless, the weight of changes in time-costs compared to changes in shipping (transport) costs is more visible in the EEXI-Only scenario, reflecting the impact of speed reduction. Conversely, for the HIGH-GHG reduction scenario, all sectors, but one, are showing a balanced weight in the change in transport costs, on the one hand, and the change in time-related costs, on the other.

Figure 4: Percentage changes in transport and time costs by sector and regulatory scenario, compared to the baseline 2030 Current Regulations scenario



*Source: UNCTAD, based on data provided by MDS Transmodal (MDST).*

To put the above results into perspective, it is worth illustrating how freight rates change over time, and how the changes that may result from the IMO short-term measure compare to freight rate levels and volatility. The blue line in Figure 5 shows the historical data of the spot freight rate (transports costs) for a 20-foot container from Shanghai to Santos, while the green dotted line shows the hypothetical freight rate if the transport costs had been 0.4% higher, in line with the EEXI-Only scenario in 2030. In Figure 6, the blue line is the historical data, while the red dotted line shows an increase in transport costs of 7.1%, in line with the estimated increase in transport costs of Brazilian imports in 2030.

Figure 5: Containerized freight rates, Shanghai – Santos, EEXI-Only scenario 2009 - 2021

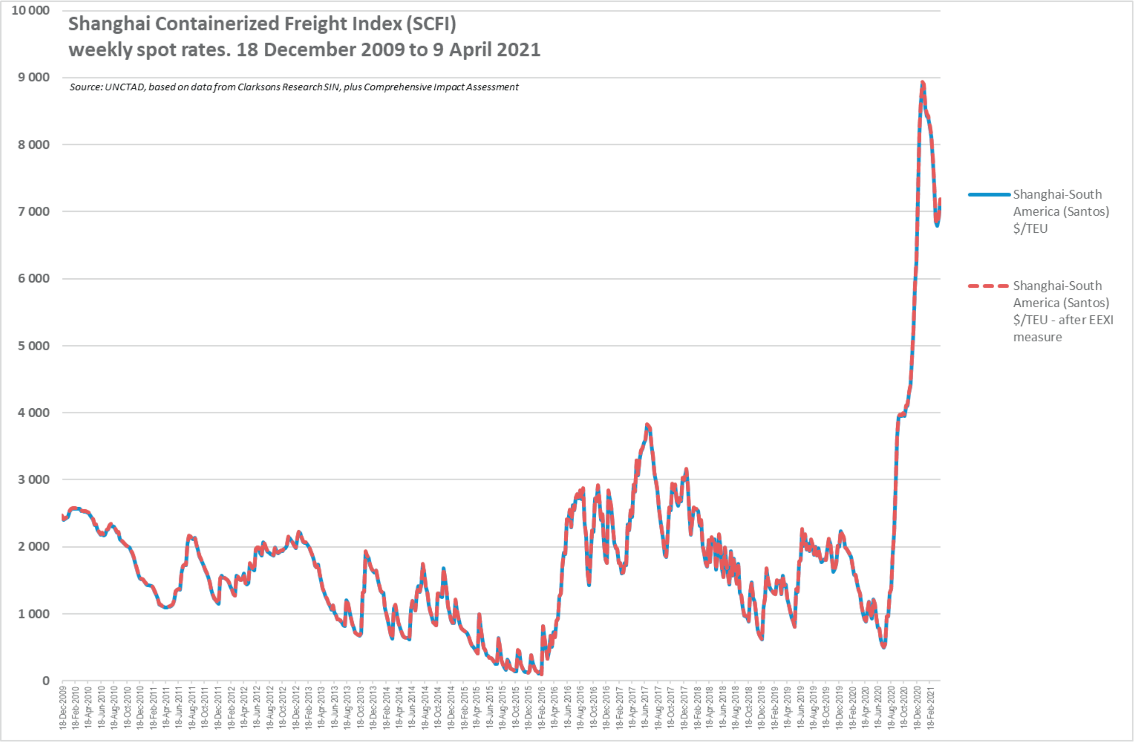
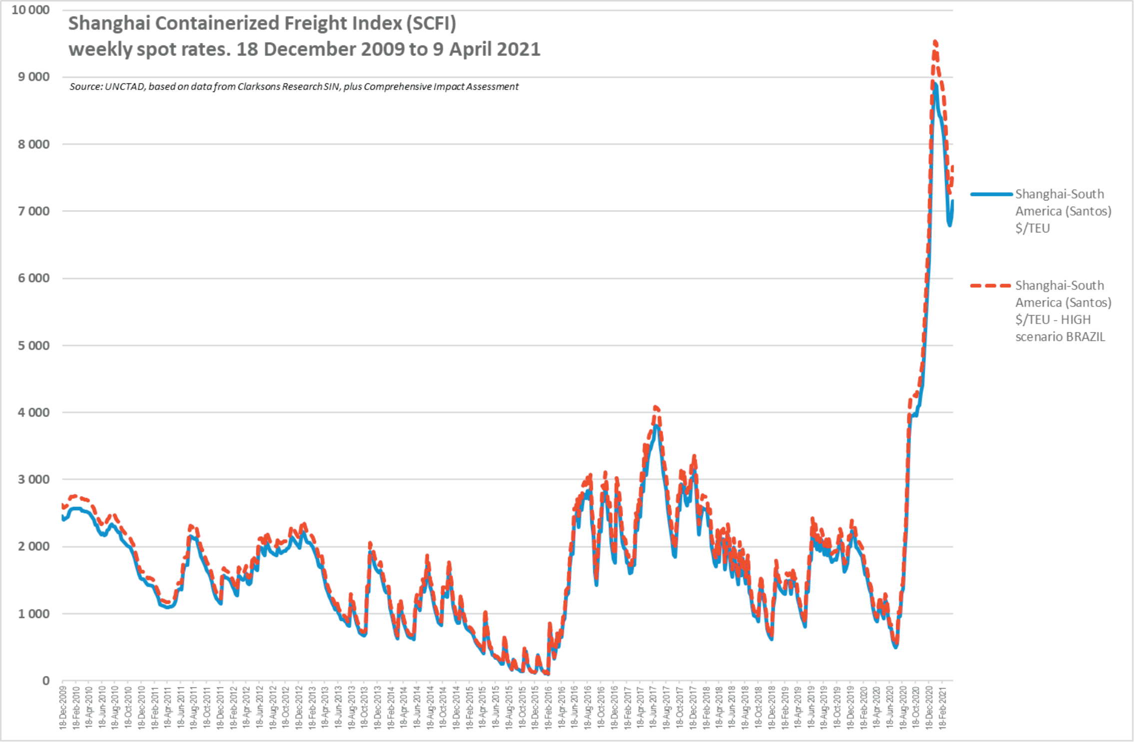


Figure 6: Containerized freight rates, Shanghai – Santos, HIGH-GHG reduction scenario for Brazilian imports, 2009 -2021



*Source: UNCTAD, based on data provided by Clarksons Research 2021 and estimates of higher transport costs resulting from IMO short-term measure.*

### *Impact on States: Trade and Income/Economic Output (GDP)*

At the country level, the impact of the EEXI-Only scenario is found to be small for both developing and developed countries, though the impact is larger in relative terms (percentage) for developing countries. These differences are magnified when considering both the Low-GHG reduction and HIGH-GHG reduction scenarios. In both cases, the distribution is shifted downwards for developing countries compared to developed countries, which means that developing countries will see larger drops in their export flows.

These downward shifts become clearer when countries are grouped by specific sector or trade flow. For example, while both the agricultural product exporting countries and net-food importing countries experience a negative impact in all three GHG reduction scenarios, such negative impact is larger for the net-food importers than for the agricultural product exporters. A similar, yet more dispersed pattern is seen for manufacturing product exporters and mining commodity exporting countries. The same general trend is seen among SIDS and LDCs groupings, albeit with a wider scattering of negative impacts, with exports in some cases falling by close to 2 per cent as compared with the 2030 baseline Current Regulations scenario. Figure 7, Figure 8, and Figure 9 present the simulated change in trade (imports plus exports) resulting for the IMO short-term measure across the three GHG reduction scenarios.

Results reported in Chapter 3 on impacts on trade and GDP, point towards minor changes across the three GHG reduction scenarios. GDP reduction at the global level will range between -0.01%, -0.04% and -0.02% under the EEXI-Only scenario, the HIGH-GHG reduction scenario and LOW-GHG reduction, respectively. Trade (imports plus exports) reduction at the global level will range between -0.10%, -0.49% and -0.21% under the EEXI-Only scenario, the HIGH-GHG reduction scenario and LOW-GHG reduction, respectively.

Countries with higher GDP and trade values tend to be slightly less negatively affected than countries with lower GDP and trade levels, although the correlation is not strong and not applicable in all cases and scenarios. Nevertheless, many economies which may be considered as outliers or outside normal ranges, show larger changes in their GDP, with these changes being larger in absolute value. Changes in GDP for these economies range from -0.1% under the LOW-GHG reduction scenario to -0.2% under the HIGH-GHG reduction scenario.

When disaggregated by import and export trade flows, changes in exports tend to be larger than changes in imports. This is particularly true under the HIGH-GHG reduction scenario where most affected countries are expected to see a drop in total merchandise exports of up to –4%.

Figure 7: Map with simulated impact on decline in trade (imports plus exports), compared to the 2030 baseline Current Regulations scenario, EEXI-Only scenario

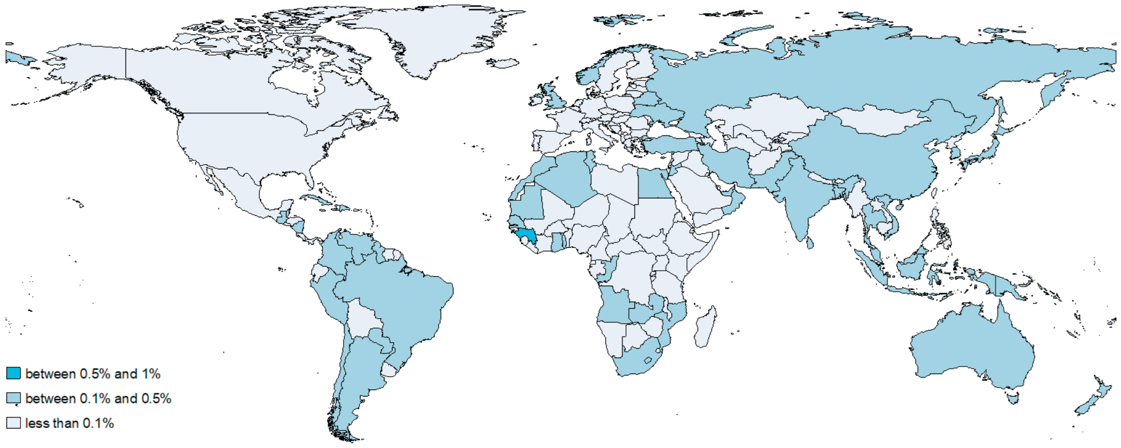


Figure 8: Map with simulated impact on decline in trade (imports plus exports), compared to the 2030 baseline Current Regulations scenario, HIGH-GHG scenario

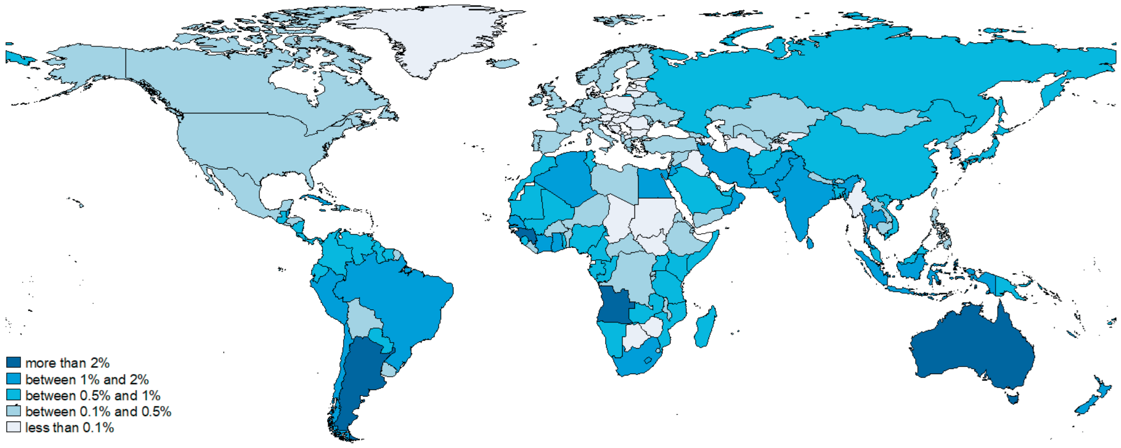
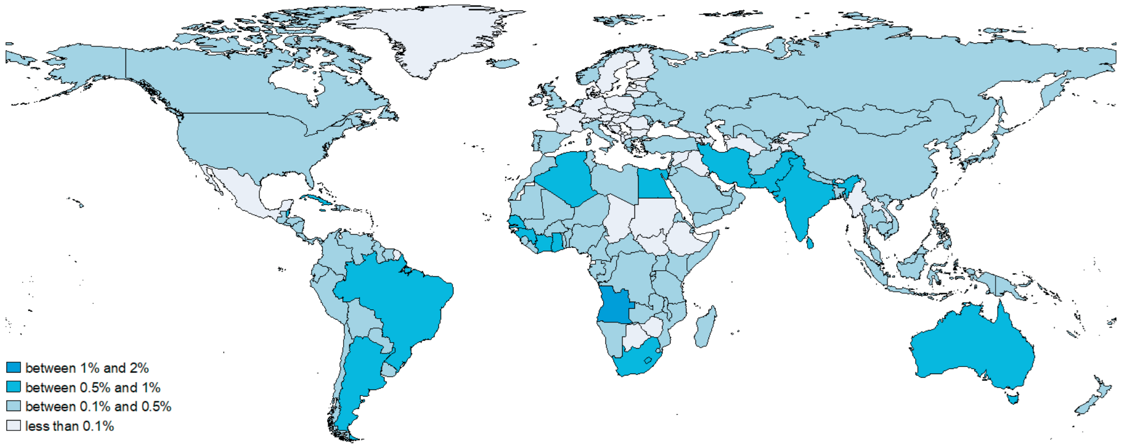


Figure 9: Map with simulated impact on decline in trade (imports plus exports), compared to the 2030 baseline Current Regulations scenario- LOW-GHG scenario



*Source: UNCTAD, based on results of the global trade model used for the impact assessment.*

Disaggregated results are more revealing as small losses at the aggregate level could conceal large losses at a more granular level. In some cases, results show large drops in export flows, implying that exporters in some countries would suffer economic losses resulting from the IMO short-term measure.

A further interesting insight is provided when land-locked countries are compared with coastal countries. Developing coastal countries, including SIDS and LDCs, are shown to experience a bigger decline in their GDP as well as import and export flows, when compared with developed coastal countries. The decline is more moderate in the case of land-locked countries. Several reasons may explain why the trade and GDP of land-locked countries can be less impacted by increases in maritime logistics costs as compared to coastal countries. Land-locked countries' trade tends to rely less on maritime transport, resulting in a reduced sensitivity to direct changes in maritime logistics costs. Another factor would be the potential benefits that could be gained by land-locked countries from changing trade patterns. Some coastal neighbouring countries may decide to trade more with neighbouring land-locked countries to mitigate the incidence of for the increased maritime logistics costs (Figure 10, Figure 11 and Figure 12).

Figure 10: Simulated percentage change in income (GDP), by country grouping, compared to 2030 baseline scenario

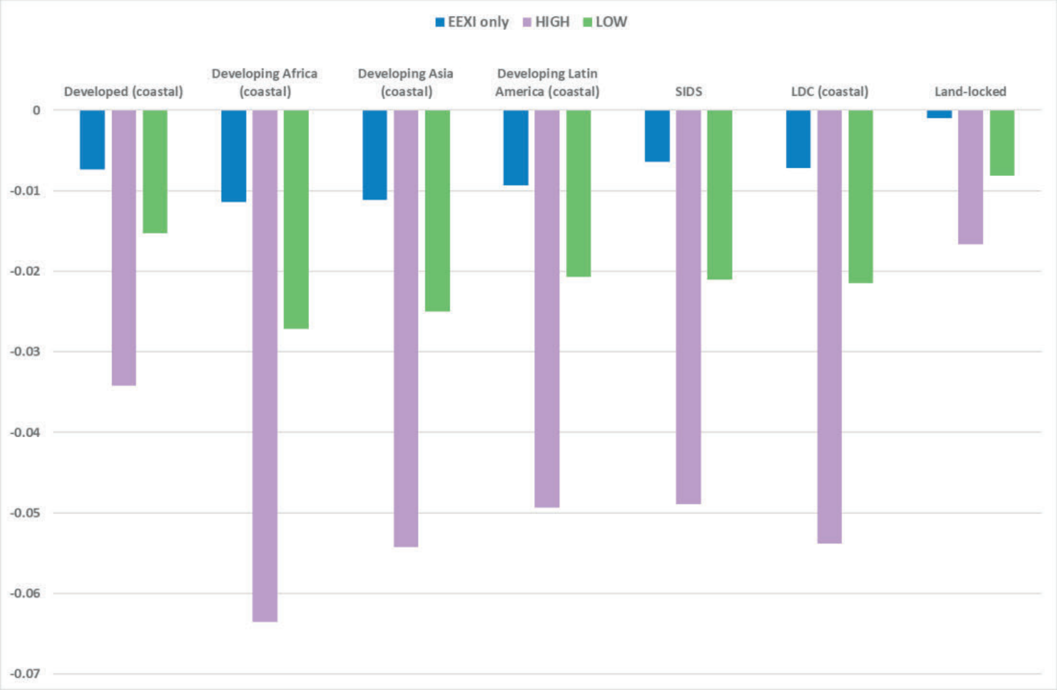


Figure 11: Simulated percentage change in exports, by country grouping, compared to 2030 baseline scenario

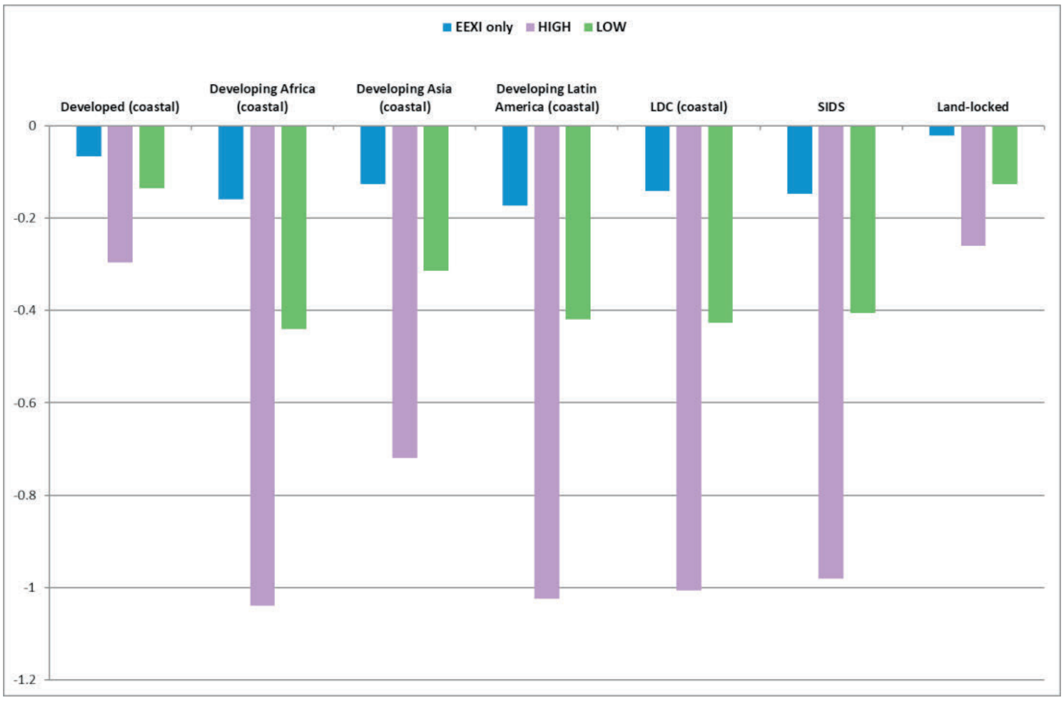
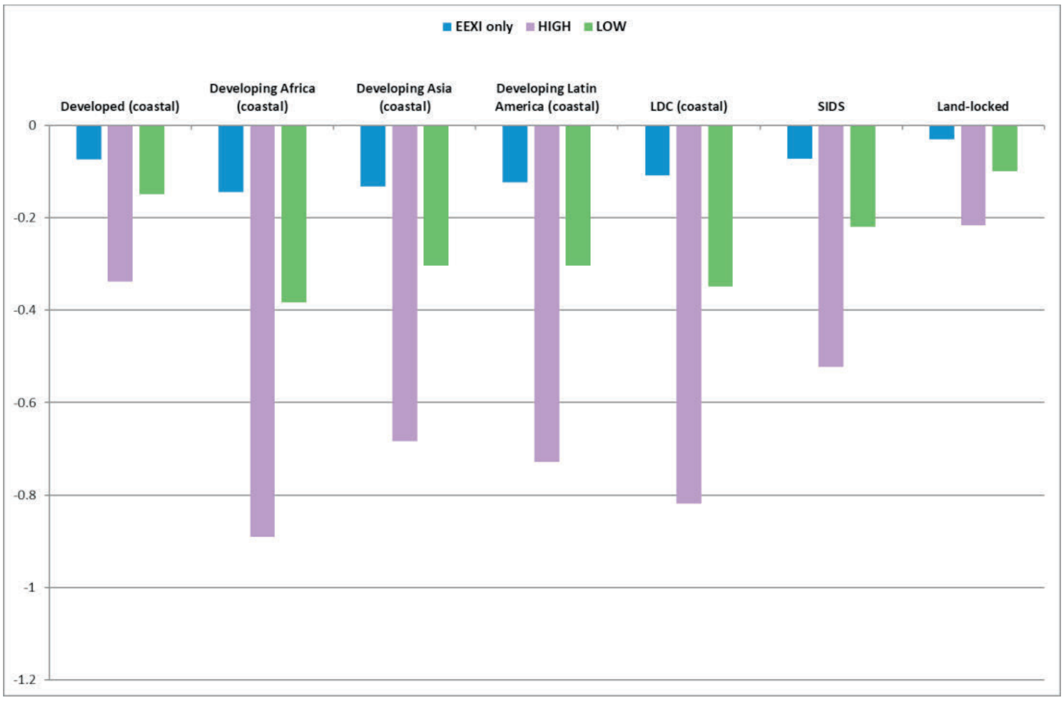


Figure 12: Simulated percentage change in imports, by country grouping, compared to 2030 baseline scenario



*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

## Illustrative Case Studies

The transport cost model applied for the purposes of this impact assessment includes 230 countries and territories. For each of those countries and territories, both the shipping (transport) costs and the time-related costs were computed. The global trade model which covers 184 economies was used to assess the impact of changes in maritime logistics costs on countries' bilateral trade flows and GDP, across 11 trade sectors. When combined, the various variables represent over 130,000 importer-exporter-commodity data points, each with information on various aspects of the maritime logistics costs, shipping routes, and trade.

It is not possible to cover each country-sector trade pair in full detail and with enough granularity. To illustrate potential impacts at a more granular level, while complementing the results obtained under the global trade model, UNCTAD prepared several cases that had been selected based on objective criteria to illustrate the impacts that the IMO short term measure could have on specific countries and country-trade pairs.

A total of 21 illustrative case studies have been completed, thereby providing a snapshot summary of the changes in shipping (transport) costs, time at sea and total maritime logistics costs. Seventeen short illustrative cases were selected to cover both import and export trade flows of countries and sectors but with specific emphasis on developing countries, namely SIDS and LDCs. Three more detailed illustrative cases were selected and covered iron ore, cherries, and grain trades. A fourth detailed case study was carried out to offer a regional perspective focusing on the liner shipping connectivity in the Pacific and Caribbean SIDS. The illustrative case studies confirm that impacts vary by commodity-type, route, and country with trades expected to be affected at varying degrees, in line with the results assessed at the global level. In this regard, the Stakeholder Analysis for individual countries (Task 4) are a complement, presenting qualitative data, to the present assessment.

## Conclusions

Conducting an impact assessment prior to the adoption and implementation of the IMO short-term measure on GHG reduction in shipping is an example of good practice in the field of regulatory governance. Insights gained will help to better predict and understand the potential negative impacts or unintended effects that may arise for countries and supply chains across the three IMO GHG reduction scenarios. Insights gained can also help ensure that the IMO measure achieves its set goal while, at the same time, being better informed with a view to addressing potential implementation and compliance costs that may arise.

Achieving the IMO Initial Strategy for maritime decarbonization targets is crucial for sustainable development, in an increasingly fragile, inter-linked and complex global eco-system. Yet, navigating through the energy transition away from fossil-fuel dependent combustion systems is still a major challenge for the maritime transport industry. In this respect, the global Sustainable Development Goals (SDGs) and the 2030 Agenda for Sustainable Development adopted in 2015, have emphasized that achieving economic progress and development need not be at the expense of environmental protection and societal well-being.

Achieving environmental protection through an effective energy transition can generate economic co-benefits. In the longer term, it can be expected that increased energy efficiency coupled with the use of cleaner and renewable energy sources will bring about dividends to all stakeholders. Initial investments in fleet renewals, innovative ship designs, fuel technologies, including in ports and across the energy supply chain, will bear fruit in the longer term and can, over time, be expected to be matched with lower costs and higher returns on investment.

Countries that are affected the most by climate change impacts, in particular economies in SIDS and LDCs, are already facing high shipping and trade costs with their trade depending almost exclusively on maritime transport to access regional and global markets. The results of this Impact Assessment, which is based on an impact simulation model, have shown that – on average – developing coastal countries will be affected more by the proposed IMO short-term measure, compared to coastal countries in developed regions. Results show an average small increase in maritime logistics costs which translates into a slight decline in global trade flows and GDP. These changes will lead to potential shift in logistics and trade patterns, including potentially trading more with less-distant markets and some regionalization.

Impacts affecting countries' trade and GDP depend on several factors, including trade openness, i.e., the share of imports and exports in countries' GDP, modal share of trade flows, the price and value of time of traded products and commodities, and the types of ships and distances travelled. Changes in maritime logistics costs as computed by UNCTAD in this Impact Assessment will lead to changes in countries' trade flows (imports and exports) and GDP that vary across countries.

At the aggerate level, the distinction between developed and developing economies becomes blurry when assessing the impact of the IMO short-term measure. Both developed and developing economies will feature among the countries that are affected the most by the IMO short-term measure. There will also be both developed and developing economies that feature among the least affected economies. However, at disaggregated trade flow and sector levels, some aspects are likely to affect developing countries more, including distance to markets, dis-economies of scale, the extent to which countries are dependent on commodity exports, as well as the type, size, age, and other characteristics of the ships that serve their markets. The Stakeholder Analysis for individual countries (Task 4) presents additional qualitative data to complement these aspects.

While any such comparison should be handled with care given the differences pertaining to the various shocks, their duration, and their root causes, it is worth noting that the decline in global GDP or country level GDP as featured in the UNCTAD Impact assessment are dwarfed by the contraction in world GDP resulting from the COVID-19 disruption (-3.9 per cent in 2020 at the global level) and, below the contractions in GDP seen during the 2008-2009 financial crisis (-1.7 per cent at the global level). Simulated impacts on trade flows are also marginal when compared to impacts seen in the wake of the financial crisis and the COVID-19 disruption, or those projected to result from unchecked GHG emissions and further climate change. The impact on global GDP and trade flows of earlier shocks such as the COVID-19 pandemic and the Global Financial Crisis, provide a useful point of comparison. The analysis focusing on country, country-pair and supply chain levels, allows for a more nuanced assessment and results. Although the average impact of the IMO short-term measure is negative (i.e., higher maritime logistics costs associated with lower trade flows and GDP levels), for some supply chains and bilateral trades, a positive impact will also occur. At the other end of the spectrum, some supply chain trades which may be considered unusual or outliers, may experience a steep increase in maritime logistics costs of more than 50 per cent in the case of some trades. Such increases are likely to have implications for modal and nodal shifts to wider supply chain reconfigurations, e.g., regionalization of trade flows and loss of trade.

The distribution of the impacts is skewed, with lower median values as compared to average values as the average value is influenced by large impacts for a small number of observations. Put differently, more than 50 per cent of the countries included in the impact assessment, will be affected at a lesser rate than the average, while a small number will be particularly strongly affected.

For specific trades, the ultimate net impact of the IMO short-term measure could be lower or higher than what the average results of the transport and trade models used in the UNCTAD Impact Assessment may have shown. The UNCTAD Impact Assessment presents the most likely impacts that can be expected, given the current state of knowledge, available information, and data, as well as the assumptions underpinning DNV’s output data.

Aggregate global impacts of the proposed IMO short-term measure on maritime logistics costs can be considered small when compared to typical market variability of freight rates. Also, the global impact on GDP and trade flows can be considered small when compared to the long-term impact of other disruptions such as a pandemic or climate change factors.

However, for some countries, the negative impacts of the IMO measure assessed in this report are relatively higher than for others. Aware of the resource constraints of some developing countries, including SIDS and LDCs, UNCTAD expects that some countries will likely require support to mitigate the increased maritime logistics costs and alleviate the consequent negative impact on their respective real income and trade flows.

# 1 Introduction

## 1.1 Background

The International Maritime Organization (IMO) has over recent years accelerated its work on regulating air emissions from ships, including air pollutants and greenhouse gas emissions (GHG) with the 72nd session of IMO's Marine Environment Protection Committee (MEPC) held in April 2018, adopting resolution MEPC.304(72) on the Initial IMO Strategy on reduction of GHG emissions from ships (the Initial Strategy). The Strategy sets out a series of candidate short-, mid-and long-term measures aimed at reducing the carbon footprint of international shipping.

The Initial Strategy provides that the impacts on States of a measure should be assessed and considered, as appropriate, before the adoption of the measure. In assessing the impacts, particular attention should be paid to the needs of developing countries, especially small island developing States (SIDS) and least developed countries (LDCs). Disproportionately negative impacts should also be assessed and addressed, as appropriate. The procedure for assessing impacts on States of candidate measures is set out in MEPC.1/Circ.885, approved by MEPC 74 in May 2019. MEPC.1/Circ.885 which identifies steps in the procedure and specifies what should be included as well as the respective roles of the proponent of a measure and of the MEPC, without prejudging the substance of any future impact assessment. It further provides for a review of the impact assessment procedure by 2023, together with the adoption of the Revised Strategy in the same year. The first step of the procedure involves the submission of an Initial Impact Assessment as part of the initial proposal to the MEPC for candidate measures. A more detailed impact assessment could also be submitted in the first instance, taking into consideration the elements listed in paragraph 15 of MEPC.1/Circ.885. Bearing in mind two additional steps that may involve providing comments on the Initial Impact Assessment and revising the Initial Assessment, the modalities in MEPC.1/Circ. 885, stipulate that a Comprehensive Impact Assessment may be conducted if required by the MEPC.

Against this background and drawing upon a long-standing and fruitful cooperation between the two agencies, an *expert review of the comprehensiveness of the impact assessments submitted at ISWG-GHG 7,* was conducted by UNCTAD in 2020, at the request of the IMO Secretariat.[1]

Accordingly, and taking into account the Terms of Reference (TORs) established by the IMO secretariat and the procedure for assessing the impacts of candidate measures on States as

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[1] The impacts assessments (initial and detailed) covered by the UNCTAD expert review were contained in documents ISWG-GHG 7/2/8, ISWG-GHG 6/2, ISWG-GHG 7/2/12, ISWG-GHG 7/2/20, ISWG-GHG 7/2/21.

set out in MEPC.1/Circ.885, UNCTAD examined whether the impact assessments reviewed paid particular attention to the needs of developing countries, especially SIDS and LDCs. UNCTAD also ascertained whether (i) the assumptions and methods used in the analysis were robust, (ii) the specific negative impacts on States were qualitatively and/or quantitatively assessed and (iii) the measure could result in disproportionately negative impacts. Given some of the challenges and limitations identified, it was concluded that the impact assessments submitted at ISWG-GHG 7 did not fully address all parameters described in step 1 of the Procedure for Assessing Impacts on States of Candidate Measures contained in MEPC.1/Circ.885. It was deemed that the attention paid to the needs of developing countries, especially SIDS and LDCs, was not at the scale or level of detail that may result in comprehensive findings or reach conclusions that could be generalized for all member countries. UNCTAD recognized that while some improvement to the impact assessments may be possible, it would not be realistic to comprehensively assess all possible impacts as set out in MEPC.1/Circ.885 and that an element of uncertainty may have to be accepted.[2]

## 1.2 MEPC 75 and Comprehensive Impact Assessment

In September 2020, the IMO received a new proposal for a goal-based approach combining various elements of the individual proposals for technical and operational measures that had been submitted earlier. The MEPC at its 75th session approved a consolidated short-term measure that combines technical (Energy Efficiency Existing Ship Index, EEXI) and operational requirements (Carbon Intensity Indicator, CII). Whereas the impact assessments submitted along with the individually proposed measures addressed those different elements, it was considered advisable to carry out, ahead of the adoption of the measure, an additional impact assessment that can both assess the combined approach as well as tackle some of the limitations that may have constrained the previous impact assessments that had been submitted and reviewed by UNCTAD. The final comprehensive impact assessment of the short-term measure should be submitted to the 76th session of the MEPC for its consideration and analysis of measures to be implemented to address, as appropriate, any identified disproportionate impacts on developing States. Based on the comprehensive impact assessment and, as appropriate, a framework should be considered with a view to reviewing the impact of the measure on States including developing countries, and more specifically LDCs and SIDS, and countries remote from their export markets. Such a framework should also be considered in order to address disproportionately negative impacts on States.

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[2] The main findings and conclusions of UNCTAD’s expert review are set out in the document titled “Review of the comprehensiveness of the impact assessments submitted to the 7th Session of the International Maritime Organization’s Intersessional Working Group on the Reduction of GHG Emissions from Ships (ISWG-GHG 7)”.

Consequently, a Steering Committee of IMO Member States was established following an agreement by MEPC at its 75th session. Terms of Reference (TORs) defining the scope of work and mandate of the Steering Committee were developed. The Steering Committee was structured to ensure geographically balanced country coverage (e.g., with reference to the five United Nations regions) and appropriate representation of both developing and developed countries. In addition, a Workplan for *the Conduct of the Comprehensive Impact Assessment of the Short-term Measure Approved at MEPC 75* was also formulated to organize the work.

The Workplan identified seven Tasks to be carried out to fulfil the requirements under the TORs and complete the comprehensive impact assessment. Task 1 focuses on a review of peer-reviewed literature, including ex-post analysis, and other relevant information as agreed by the Steering Committee; Task 2 provides an assessment of possible impacts of the IMO short-term measure on the global fleet to serve as input for the quantitative and qualitative impact assessment; Task 3 sets out a qualitative and quantitative assessment of specific negative impacts on States, including statistically relevant number of case studies, to be possibly complemented by a number of illustrative case studies representative of broader trade conditions that might be shared across developing countries, including SIDS, LDCs and countries remote from their import/export markets; Task 4 involves a basic stakeholder analysis (SHA) by Member States to understand the amount of speed reduction-based delay acceptable to various commodities to avoid any disproportionately negative impacts; Task 5 identifies areas of missing data; Task 6 focuses on disproportionate impacts of the measure on States, including developing countries, in particular SIDS and LDCs, in the context of the COVID-19 pandemic, and of the potential additional impacts of the measure on projected economic scenarios; Task 7 aims to assess whether the measure is likely to result in disproportionately negative impacts on States, including developing countries, in particular LDCs and SIDS.

To further guide the conduct of this work, the IMO secretariat prepared an "*Explanatory note on the approved short-term measure as contained in the draft amendments to MARPOL Annex VI"*. The Note clarified the scope of the analysis and emphasized that the comprehensive impact assessment should focus solely on evaluating the possible impacts on States of the approved short-term measure, as set out in draft amendments to MARPOL Annex VI.

## 1.3 Task 3 and Scope of Work

In accordance with paragraph 10 of the Terms of Reference and Arrangements for the Conduct of a Comprehensive Impact Assessment of the Short-Term Measure Before MEPC 76, the IMO secretariat asked UNCTAD to carry out **Task 3** of the Workplan. Task 3 required the conduct of a qualitative and quantitative assessment of specific negative impacts on

States. It also required that selected illustrative case studies representative of broader trade conditions that might be shared across developing countries, including SIDS, LDCs and countries remote from their import/export markets be carried out.

UNCTAD responded favourably to IMO’s request emphasizing that the conduct of an impact assessments prior to the adoption and implementation of the IMO regulatory measure was an important good practice in regulatory governance. Insights gained from such an assessment can help to foresee potential implementation challenges that may arise, including negative impacts or unintended effects on relevant stakeholders directly or indirectly subjected to the measure covered by the impact assessment. In UNCTAD’s view, an impact assessment carried out pre-regulation, will ultimately help ensure that the IMO measure achieves its goal while, at the same time, ensuring that potential implementation and compliance costs that may arise are effectively addressed.

Bearing these considerations in mind and recalling some of the limitations and complexities associated with the conduct of impact assessments, especially in the short time available before MEPC 76, UNCTAD carried out Task 3 of the Workplan in collaboration with External Experts while taking into consideration inputs and feedback received from the Steering Committee members and interacting with the task leader and experts responsible for carrying out of Task 1 (World Maritime University, WMU), Task 2 (DNV) and Task 4 (Starcrest) of the Workplan.

Results of the modelling exercise under Task 2 have underpinned the quantitative assessment and modelling work under Task 3. Key findings of the WMU’s literature review under Task 1, have further informed UNCTAD's overall approach to the impact assessment and confirmed that no comprehensive impact assessment evaluating the impact on States of regulatory measures in shipping exists. In this respect, it can be argued that UNCTAD’s contribution to Task 3 will help fill an important research gap. Another main message emerging from the literature review, and which moved into sharp focus the need to assess both ship/carrier costs as well as shippers' costs, is uncertainty about carriers’ response to changes in ship costs. The degree to which cost savings due to slow steaming and reduced fuel consumption may be passed on to shippers and States is not certain and depends on many factors. The literature review by WMU highlighted in several instances that the economic benefit gained by the ship-owner was not necessarily found to be equally distributed among the different actors of the global supply chain. In some cases, it was reported that indirect economic impacts could potentially exceed the cost savings.

## 1.4 Structure of the Report

Against this background, the present report, which sets out the main approach and results of the work carried out under Task 3, is structured as follows:

- Chapter 2 describes UNCTAD's approach, the methodology and analytical models used.
- Chapter 3 presents the results of the global logistics costs and trade models assessing the impact of the IMO short-term measure on countries' total maritime logistics costs, trade (export and import), and gross domestic product (GDP).
- Chapter 4 presents selected illustrative case studies showcasing, by way of example, more granular impacts of the IMO short-term measure on specific States, routes, and commodities.
- Chapter 5 sets out several cross-cutting considerations and a qualitative assessment of other potential impacts.
- Chapter 6 summarizes the key findings and puts forward some main conclusions.

# 2 Approach and Methodology

## 2.1 UNCTAD's Approach

UNCTAD's approach to Task 3 was informed by the requirements set out under MEPC.1/Circ855, which specifies that the **Comprehensive Impact Assessment** should consider the issues identified in the previous steps (i.e., in the Initial Impact Assessment and, if applicable, the comments received). Other requirements provide that the Comprehensive Impact Assessment should pay particular attention to the needs of developing countries, especially SIDS and LDCs and include, inter alia, 1) a description of the assumptions and methods used in the analysis; 2) a detailed qualitative and/or quantitative assessment of specific negative impacts on States; and 3) ensuring that the analytical tools and models used to support the Impact Assessment are evidence-based and consider analytical tools such as maritime transport cost models, trade models, and impact on GDP. In line with IMO's guidelines, UNCTAD's approach takes into account the need for the impact assessment to be simple, inclusive, transparent, flexible, evidence-based, and measure-specific while, at the same time, being commensurate to the complexity and nature of the proposed IMO measure.

UNCTAD focused on assessing the impact of the IMO short-term measure on **total maritime logistics costs**; that is the shipping costs incurred by trade parties (cargo owners and shippers) for physically transporting the goods by sea, as well as the time-related costs resulting from additional transit times due to speed reduction. This approach is in line with UNCTAD's recommendations submitted as part of its expert review to the ISWG-GHG7 (ISWG-GHG 7/2/36). In addition to being aligned with UNCTAD's earlier recommendations, emphasizing total maritime logistics costs was considered important to assessing the impact on countries' trade and GDP, while keeping all other factors constant.

For the purposes of this impact assessment, maritime logistics costs are defined as the sum of maritime transport costs (or the costs of goods transport by sea) and time-related costs (including waiting costs, inventory carrying costs and depreciation costs). Established transport cost models were relied upon to quantify changes in maritime logistics costs resulting from the IMO short-term measure. Computed changes in these costs were subsequently fed as input data into an established global trade model. The aim was to assess ways in which changes in maritime logistics costs, resulting from the IMO short-term measure, would impact on countries' trade, GDP (economic output and income), and participation in Global Value Chains (GVC) trade. The global trade model used covers 184 economies, various trades and economic sectors and enables country-pair analysis and comparisons.

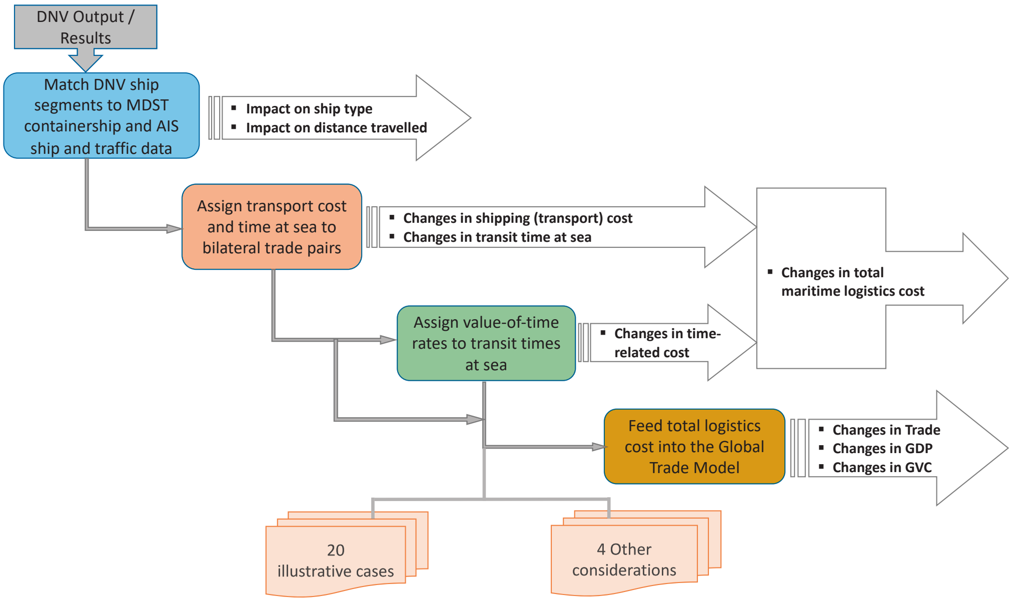
UNCTAD's impact assessment is considered comprehensive to the extent that it simulates how the IMO short-term measure will affect total maritime logistics costs and how changes in these costs will impact on the trade of a total of 184 economies, including by commodity sector. In addition, the assessment covers practically all ships, all trades, and all countries for which data is available. Furthermore, it considers not only costs to carriers and operators, but also the shipping (transport) and time costs which are of great relevance to shippers and cargo owners.

To complement the results obtained through the global trade model, which as previously noted, aims at being as comprehensive as possible, a more granular assessment was carried out focusing on selected short but more elaborated **illustrative cases**. In line with the request from the IMO Steering Committee, a closer look at these cases is considered useful in clarifying the impact of the IMO short-term measure on specific countries, trades and maritime supply chains. The selection of the case studies was undertaken in consultation with the IMO Secretariat and with due consideration of the needs expressly identified by the Steering Committee members.

Additionally, UNCTAD undertook a qualitative assessment of **other cross-cutting impacts and considerations** that might have been difficult to quantify as part of global models used for the Impact Assessment. Such considerations include the impacts of energy transition and technological change, demand and supply (im)balance, industrial structure, and competitive behaviour, as well as freight logistics and modal shifts.

## 2.2 Methodological Framework and Modelling Stages

Figure 13: UNCTAD's methodological approach for Task 3



*Source: UNCTAD.*

To deliver on Task 3, a structured approach comprised of four key steps was adopted. The ultimate objective was to generate a balanced impact assessment that would be as comprehensive as possible, while, at the same time, offering granularity and detailed analysis as appropriate (Figure 13).

### *2.2.1 Step 1: Understanding and Using DNV Study Results as Key Data Inputs*

UNCTAD's analysis relied to a large extent on the results produced under Task 2 of the Workplan carried out by DNV. DNV assessed the impact of the IMO short-term measure on ships' costs, transit speed and emissions under the three 2030 GHG reduction scenarios (**EEXI-Only**, **HIGH-GHG reduction Case** New Policies and **LOW-GHG reduction Case** New Policies) as compared to the 2030 **baseline scenario under Current Regulations**.

DNV examined the global deployment of ships based on annual data from IHS for 2019. These vessels were divided into 41 ship segments, following a breakdown by 13 ship types with each type being further categorized by size (generally dwt). DNV's output data on vessel ship costs and speed did not take into account the geographical distribution of ships.

In its report on Task 2, DNV outlined its methodological approach and modelling tools , including some of the underlying constraints and limitations. In addition to its report, DNV has made available to UNCTAD detailed data matching ships according to their IMO numbers and relevant ship category as well as detailed estimates of expected changes in ships' costs and speed.

### *2.2.2 Step 2: Assigning DNV Ship Segments to AIS Operating Ships and Journeys*

DNV's results covered 41 ship segments with no information about their laden status, movement or journey between ports and countries. However, for UNCTAD to be able to quantify changes in countries' maritime logistics costs as per the objectives of the comprehensive impact assessment, there was a need to assign the cost and speed changes by ship segment identified by DNV, to each operating ship by route and journey between countries and regions. Therefore, a key step for UNCTAD was to assign assigning the various ship segments identified by DNV, to the global shipping fleet and its movements recorded in 2019. To do so, UNCTAD relied on two datasets. For container ships, MDST's 2019 data providing information on individual ship deployment by operator, service, distance per round-trip, and ports, was used to capture the complexity of multi-porting itineraries. For ships other than containerships, UNCTAD relied on the 2019 Automatic Identification System (AIS) vessel movement and traffic data provided by MarineTraffic. This ship dataset is the largest and most up to date as it uses AIS tracking data to map out detailed ship and traffic information (e.g., ship type, size, laden status, journey, arrival and departure times, and distance travelled).

According to MarineTraffic data, there were 29,342 operating ships on the sea in 2019, making 1,072,771 journeys.[3] However, 54% of the journeys made were in ballast or were recorded under unknown loading condition.[4] When journeys involving ballast or unknown loading conditions are filtered out, the dataset counts a total of 27,420 ships and 489,241 journeys in 2019. These make up the population of ships and journeys considered in this impact assessment.

### *2.2.3 Step 3: Assigning Transport Costs and Transit Times to Maritime Trade Routes*

UNCTAD mapped DNV's ship cost estimates – as calibrated by UNCTAD with (AIS) ship traffic data – against bilateral trade flows by vessel type, O/D (Origin-Destination) trade route and product/commodity type, while allowing for countries, including land-locked countries, to be grouped by regions and 'clustered' through main ports.

The World Cargo Database (WCD) maintained by MDST, which describes total international trade by volume (tonnes), value, SITC 5 digit (Standard International Trade Classification) and estimated mode of transport, was used to gauge total maritime trade in volume and value terms for each country-sector pair. These estimates were calibrated to 2019 levels to ensure their alignment with DNV's data on expected changes in ship costs and sailing speeds.

To re-map countries to regions, DNV's ship costs and speed data that had been matched with ships and their journeys, have been assigned to Origin/Destination (O/D) trade pairs for 230 economies and territories and across 11 sectors as per Eora commodity classification. To this end, WCD SITC codes were converted into Eora heading codes.[5] This has generated over 130,00 country-sector bilateral datapoints, i.e., 11 sectors * 230 territories * 229 bilateral country-pairs *minus* no-maritime-trade pairs.

Across all country-sector pairs, changes in shipping (transport) costs and speed reduction computed by DNV, , were applied to each of 2030 scenarios (EEXI-Only, LOW-GHG Reduction and HIGH-GHG Reduction) as compared to the 2030 baseline Current Regulations scenario. This work resulted in estimates of **maritime transport costs** for country-sector pairs and **travel times at sea** for port-to-port trade pairs, under the three GHG reduction 2030 scenarios. Appendix 1 describes in more detail this methodology that has been applied.

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[3] For departures and arrivals made in 2019, excluding domestic journeys and ships not covered by DNV's study.

[4] Unknown load condition is recorded mainly in cruise ship and ferry-RoPax.

[5] See https://www.worldmrio.com/ for further information about the Eora commodity classification.

### *2.2.4 Step 4: Assigning Value of Time Rates to Estimate Time-related Costs*

Sector-based **Value of Time (VoT)** rates were applied to port-to-port travel times at sea to estimate time-related costs (in both percentage change and absolute value), resulting from reduced ship sailing speeds and extended transit times under the three 2030 GHG reduction scenarios.

The VoT captures additional inventory carrying and holding costs as well as the cost of interest and depreciation. VoT is often expressed as the proportion of the value of a product or commodity, aggregated in our analysis into 11 VoT estimates for each sector. The VoT rates used for the present assessment relate to shippers' (cargo interests; exporters/importers) VoT rather than carriers' VoT. Appendix 2 provides a detailed description of the VoT methodology and estimates used for the purpose of this impact assessment.

### *2.2.5 Step 5: Estimating Total Maritime Logistics Costs*

Estimated changes in shipping (transport) costs and time-related costs derived from the previous steps, were combined to generate the changes in **total maritime logistics costs** resulting from the IMO short-term measure. Changes in costs were initially calculated for each of the 230,000 country-sector trade pairs, in both absolute values and percentage change, then converted into pivot tables for exporting and importing countries.

### *2.2.6 Step 6: Feeding Maritime Logistics Costs into the Global Trade Model*

The last step of this analytical process was to incorporate the above results into an established global trade model (DTC Global Trade Model) to simulate the impact of the IMO short-term measure on countries' merchandise trade, GDP as well as GVC related trade flows (including backward and forward linkages). For each of the three 2030 GHG reduction scenarios UNCTAD calculated the ad valorem percentage changes in trade costs associated with the difference over the 2030 baseline Current Regulation scenario.

An innovative feature of the modelling approach used by UNCTAD is that it makes it possible to isolate the impact that changes in maritime logistics costs could have for GVC related trade at both detailed and aggregated levels. Therefore, it provides a comprehensive picture of the economic changes that could take place due to the IMO short-term measure, based on standard behavioural assumptions and in line with current best practice in the academic literature on international trade. Appendix 3 provides a detailed description of the Global Trade Model used in this impact assessment and its technical features.

### *2.2.7 Illustrative Case Studies*

A total of 21 case studies were carried out in response to the Steering Committee's request for some representative analyses focusing on specific trades, routes and commodities to further illustrate — at a more granular level and taking into specific context and conditions — the potential negative impact of the IMO short-term measure on selected States, commodities, routes, with a specific focus on developing countries, in particular SIDS and LDCs.

A total of **17 short cases** were completed, thereby providing a snapshot summary of the changes in shipping (transport) costs and time at sea as well changes in trade flows and GDP that could result from the IMO short-term measure.

In parallel, UNCTAD also carried out **4 more detailed case studies** assessing the s of changes in the maritime logistics costs across specific supply chains, routes, commodities and countries. These include (i) Brazilian exports of iron ore to China, (ii) Chilean exports of cherries to China, (iii) Egypt's imports of wheat from the United States; and (iv) trade and maritime connectivity of the Pacific and Caribbean SIDS.

Cases expressly identified by the Steering Committee members were considered as a matter of priority. As to the selection of other cases, UNCTAD relied on the results of the global trade model used, to identify the countries that were simulated to see relatively higher negative impacts on their respective trade and GDP. Once these had been identified, UNCTAD examined their most important traded commodities and their main trading partners. The selected illustrative cases include SIDS and LDCs and cover the perspective of importers and exporters from different geographical regions.

## 2.3 Key Limitations and Caveats

UNCTAD's methodology and models used for the purposes of the present Impact Assessment as well as input data obtained from DNV, MDS Transmodal (MDST) and MarineTraffic, all entail some inherent limitations that need to be highlighted. Taking note of consideration these limitations is important when interpreting the results of the modelling work carried out or deriving conclusions and recommendations for the way forward.

### *2.3.1 Limitations Related to Input Data*

UNCTAD has made use of input data received from DNV as well as data derived from MarineTraffic's AIS records. Both have their respective methodological and data limitations which are outlined further below. To mitigate some of the identified constraints and limitations, UNCTAD used complementary data sources (e.g., MDST's containership database) as well as cross-mapped some initial input data (e.g., DNV's fleet segments against AIS traffic data).

In many cases, assumptions used to derive input data for further modelling work, may be too static and deterministic for a multi-faceted and dynamic global shipping market. Where possible, UNCTAD has sought to nuance its results by acknowledging the constraints and limitations associated with input data received. Chapter 5 specifically addresses some of these issues.

### *2.3.2 Limitations Related to the Models Used*

Some caveats are also worth mentioning in connection with the models used by UNCTAD to derive the impacts of the IMO short-term measure on maritime logistics costs, countries' trade flows and GDP. Some of the underlying limitations can be summarized as follows:

- No time dimension: The trade model is comparative static, not dynamic. As such, its output should be understood as a counterfactual, not a projection or forecast. The model answers the following questions: "What would trade patterns in the baseline year have looked like if bilateral trade costs had changed (resulting from changes in maritime logistics costs), but all other factors had remained constant?" In this case, the counterfactual scenarios are defined using projections for maritime logistics costs for 2030, but by comparing the baseline projection with the three GHG reduction scenarios, it is possible to express each scenario as a percentage deviation from 2030 baseline costs. This deviation is the input for the global trade model, I.e., in the maritime logistics costs.
- Assumption of ad valorem equivalence: The model assumes that the time costs can be converted into ad valorem equivalents, assigning a Value of Time to the changes in delivery times.
- Absence of modal choice: The model does not allow for modal shift as a possible outcome resulting from changes in maritime logistics costs. A separate consideration of modal shift in Chapter 4 has shown that the shift from maritime transport to faster modes because of changes in total maritime logistics costs can be expected, although this shift is estimated to be very small at less than 0.1% in terms of volume.

# 3 Global Model Assessment

## 3.1 Impact on Ship Types and Journeys

By assigning the various ship segments and changes in ship speed and costs computed by DNV to the global AIS-based ship traffic data, it possible to convert DNV results to fit the configuration of sector-country trade data pairs required for the global trade model. It was also possible to further analyse the distribution of ship journeys and derive some conclusions on the impact of the IMO short-term measure on ship travel distance, routing patterns and connectivity by vessel type and region.

### *3.1.1 Impact by Ship Type and Distance Travelled*

The output data received from DNV in connections with the 2030 HIGH-GHG reduction scenario, shows that ships most affected by the IMO short-term measure in terms of cost intensity are containerships and tanker vessels operating in shortsea shipping. Total cost intensity increases by 41.1% and 37.6% for containers and tankers deployed in short-sea shipping, respectively, under the HIGH-GHG reduction scenario. For deep-sea bulkers and gas carriers, this increases by 9.3% and 10.3%, respectively.

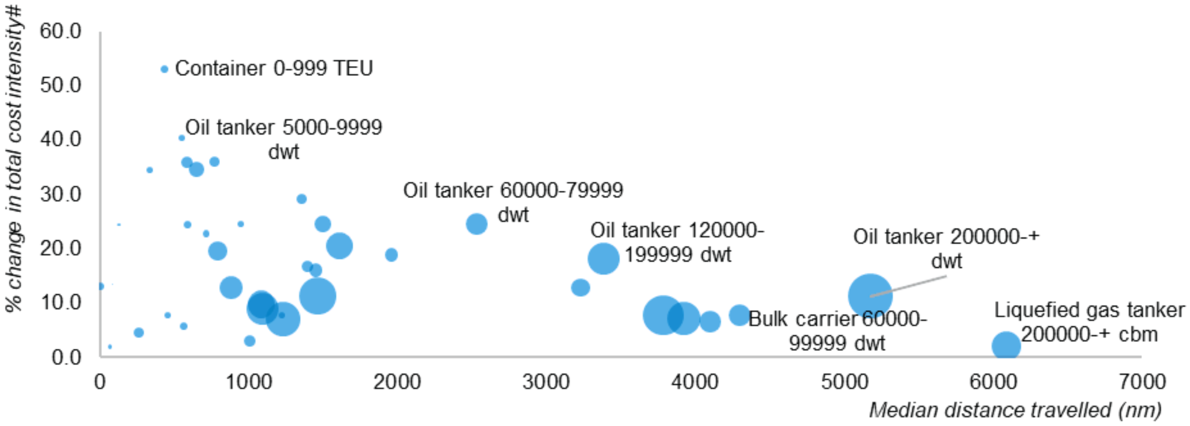
Table 2: DNV typical ship categories for the HIGH-GHG reduction scenario and results converted to AIS data

| DNV ship category | DNV study | | AIS data (only laden or partially laden journeys) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | % Increase in CII | Nº of ships in 2019 | Nº of ships deployed in 2019 | Nº of direct journeys | Median distance travelled (nm) | Median duration of journey (days) | Median speed (knot) | Average DWT | Average age |
| **Deep sea – bulk carrier** | 9.3 | 8,895 | 7,938 | 46,082 | 3,833 | 17.5 | 9.7 | 85,639 | 9.7 |
| **Short sea – bulk carrier** | 16.0 | 1,968 | 1,614 | 15,082 | 1,450 | 8.9 | 9.5 | 27,383 | 17.7 |
| **Deep sea – tanker** | 19.9 | 5,648 | 4,722 | 38,237 | 1,649 | 9.9 | 9.7 | 79,934 | 10.3 |
| **Short sea – tanker** | 37.6 | 3,104 | 1,992 | 38,003 | 631 | 3.4 | 9.4 | 10,772 | 11.5 |
| **Deep sea – container** | 14.9 | 3,086 | 2,898 | 111,560 | 827 | 3.1 | 13.8 | 75,393 | 11.4 |
| **Short sea – container** | 41.1 | 2,212 | 1,717 | 97,225 | 516 | 1.9 | 12.6 | 15,255 | 14.1 |
| **Liquified Gas** | 10.3 | 1,924 | 1,496 | 22,620 | 1,050 | 5.5 | 10.6 | 31,171 | 11.6 |
| **Other** | 16.2 | 9,880 | 5,043 | 120,432 | 586 | 2.5 | 11.8 | 12,218 | 15.6 |
| **Total** | **16.0** | **36,717** | **27,420** | **489,241** | **762** | **3.2** | **11.3** | **40,740** | **12.9** |

*Source: UNCTAD compiled from DNV and MarineTraffic data.*

Table 2 and Figure 14 show similar patterns, whereby smaller ships trading across short distances experience larger increases in total cost intensity as compared to large ships travelling longer distances.

Figure 14: Percentage change in cost intensity by ship segment, average size* and median distance travelled



*Source: UNCTAD compiled from DNV and MarineTraffic data.*
**: Size of the bubbles stands for the average ship size per DWT.*
*#: % change in total cost intensity in HIGH-GHG reduction scenario compared to the Current Regulations scenario in 2030.*

### 3.1.2 Impact by Journeys and Region

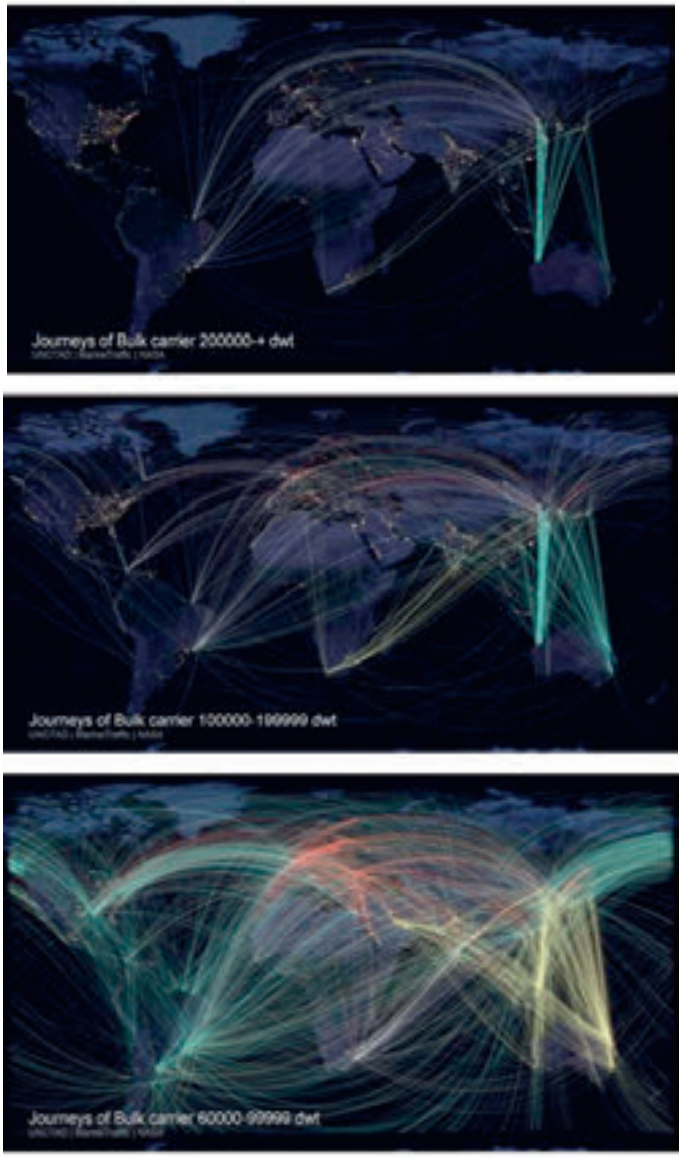
Figure 15 shows the 2019 laden and partially laden journeys made by containerships and tankers involved in regional shortsea shipping, with the Pacific SIDS and African coastal regions showing a relatively lower concentration

Figure 15: Journeys made by containers and tankers involved in shortsea shipping in 2019

*Source: UNCTAD, based on MarineTraffic and NASA.*

Figure 16 shows the 2019 journeys made by deep-sea bulk carriers. Very large bulk carriers (>200,000 dwt) are mostly deployed on export routes from Brazil or Australia to East Asia. Capsize bulk carriers (100,000-200,000 dwt) are shown to trade across more routes with shorter distances, including from North America to Europe and East Asia. In the case of Panamax (60,000-99,999 dwt) and post-Panamax (35,000-59,999 dwt) vessels, a more dispersed travel pattern emerges with both size segments sailing long distances and serving regional trades in North Europe, the Middle East, and East Asia.

Figure 16: Journeys made by deep-sea bulk carriers in 2019, by ship segment



*Source: UNCTAD, based on MarineTraffic and NASA.*

Table 3 highlights the most frequently travelled routes for additional ship segments. Variations between inter-regional and intra-regional routes can be observed.

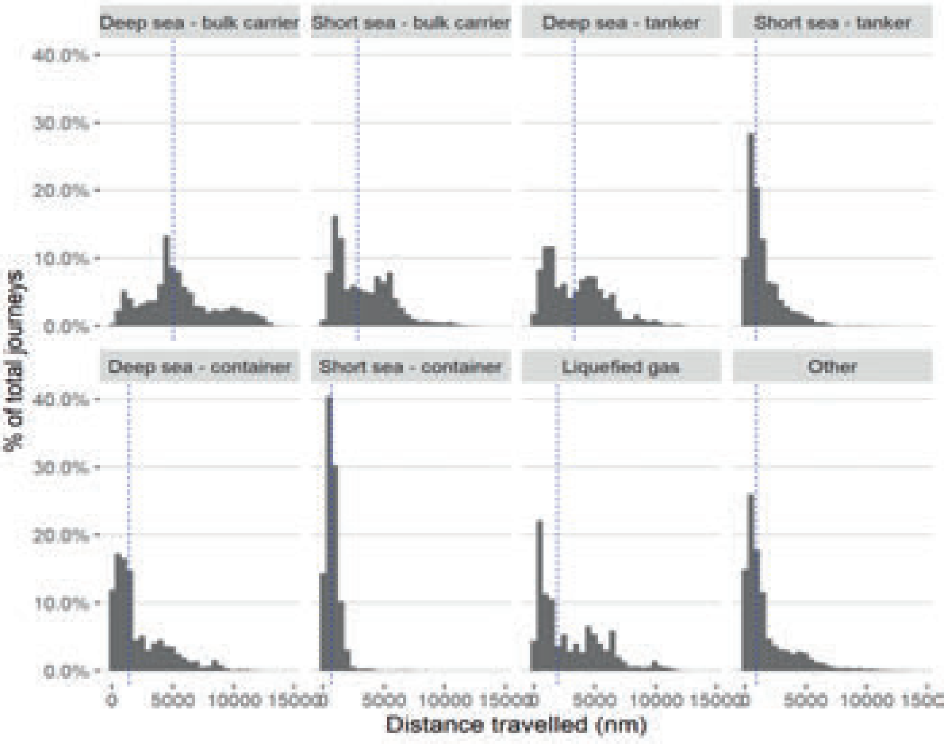
There exist also variations within each vessel category (Figure 17). Some substitution effects are likely to emerge between longer and shorter routes served by ships of the same type, with implications for service routing and network configuration.

Table 3: Frequent travel routes for selected ship segments in 2019

| DNV ship type | Route | | | | |
|---|---|---|---|---|---|
| | 1st frequent | 2nd frequent | 3rd frequent | 4th frequent | 5th frequent |
| **Bulk carrier 200,000-+ dwt** | Australia to China | Brazil to China | Australia to Japan | Australia to Republic of Korea | China to Australia |
| **Gas carrier 200,000-+ cbm** | Qatar to China | Qatar to UK | Qatar to Republic of Korea | Qatar to India | Qatar to Japan<br>Qatar to Pakistan |
| **Container 0-999 TEU** | Republic of Korea to Japan | Japan to Republic of Korea | Netherlands to UK | China to Japan | China to Republic of Korea |
| **Oil tanker 5,000-9,999 dwt** | Republic of Korea to China | Singapore to Malaysia | Netherlands to UK | Japan to Republic of Korea | Republic of Korea to Japan |
| **Ferry- RoPax 0-1,999 GT** | Sint Maarten (Dutch part) to British Virgin Islands | British Virgin Islands to Sint Maarten (Dutch part) | Sint Maarten (Dutch part) to Bonaire, St Eustatius & Saba | Saint Martin (French part) to Sint Maarten | Bonaire, St Eustatius and Saba to Montserrat |
| **Ferry-RoPax 2,000-+ GT** | UK to France | France to UK | Argentina to Uruguay<br>Uruguay to Argentina | Italy to Albania | Albania to Italy |
| **Ro-ro 0-4,999 dwt** | UAE to Iran (Islamic Republic of) | Iran (Islamic Republic of) to UAE | St Barthélemy to Saint Martin (French part) | Saint Martin (French part) to St Barthélemy | Turkey to Russian Federation |
| **Ro-ro 5,000-+ dwt** | Netherlands to UK | Belgium to UK | UK to Netherlands | UK to Belgium | UK to Ireland |

*Source: UNCTAD, based on data from DNV on ship sizes and types and MarineTraffic data on ship deployment and journeys.*

Figure 17: Distribution[*] and median[#] of distance travelled per journey by ship category



*Source: UNCTAD based on MarineTraffic and CERDI-sea distance database.*

** If recorded distance travelled is larger than 120% or smaller than 80% of true distance of the bilateral country pair, these journeys are considered as outliers and excluded from the histograms.*

*#: Median of distance travelled for each ship category is indicated as a blue dotted line.*

## 3.2 Impact on Maritime Logistics Costs

An assessment of expected changes in maritime logistics costs has been carried out for three GHG reduction scenarios in 2030 relative to the 2030 baseline Current Regulations scenario. Changes in maritime logistics costs have been computed based on input data on changes in ship costs and speed computed by DNV. The DNV's referenced central estimates of ship cost and speed changes assuming 'full-compliance' by 2030, across the three GHG reduction scenarios, were used as the basis for UNCTAD's assessment of expected changes in maritime logistics costs across the three 2030 GHG reduction scenarios.

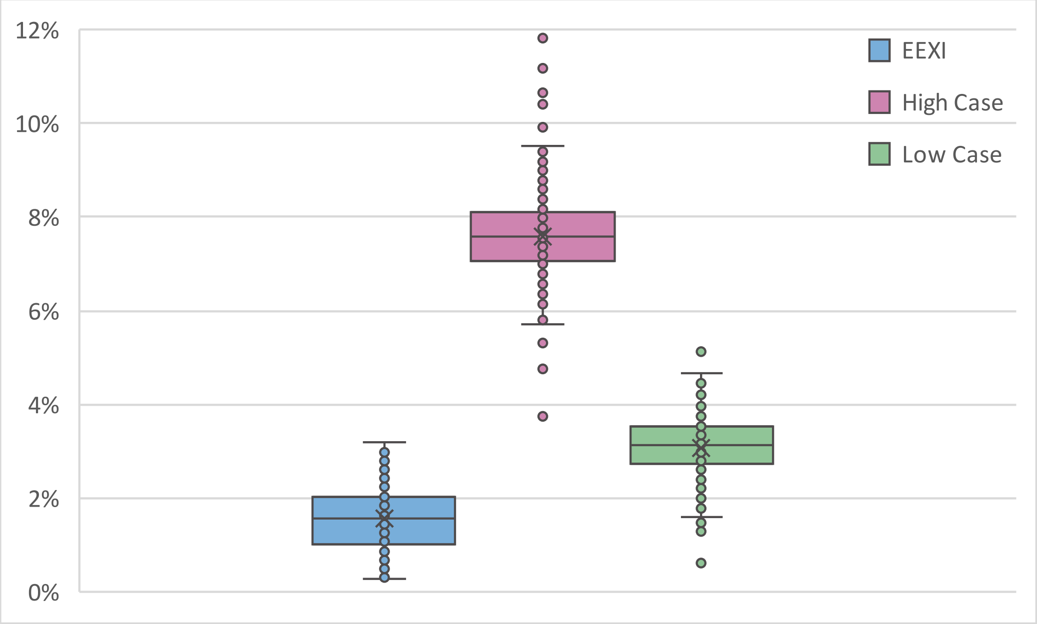
### *3.2.1 Aggregate Impact*

Given the large set of country-sector trade pairs, aggregated results cannot provide an itemized assessment of the specific impacts per country, sector/commodity, journey or direction of trade. However, they provide meaningful indication of how the three GHG reduction scenarios broadly compare in terms of the average and range of changes in costs and their impact on GDP and trade flows across country trade pairs.

Figure 18 provides a snapshot boxplot summary of aggregate changes in total maritime logistics costs for country trade pairs under each scenario relative to the baseline Current Regulations scenario in 2030. In the boxplot, the shaded box indicates the 25th to 75th percentiles of the data series, the central line indicates the median, the two end lines indicate the minimum and maximum, and the points indicate outliers. The results indicate an increase in total maritime logistics costs across all three GHG reduction scenarios, although at with the magnitude of impacts varying in degrees Average increases in total maritime logistics costs stand at 1.6%, 3.1% and 7.6% for the EEXI-Only, LOW-GHG reduction and HIGH-GHG reduction scenarios, respectively. However, while the EEXI-Only scenario shows a smooth inter-quartile distribution with no outliers, wider variations are triggered as the transition to LOW-GHG reduction then HIGH-GHG reduction scenarios takes place. This is evident in the HIGH-GHG reduction scenario where total maritime logistics costs can be 12% higher than the 2030 baseline Current Regulations scenario. This implies that some countries and trade pairs would be far more impacted than the global average.

At the same time, the transition from EEXI-Only to LOW-GHG reduction scenarios is shown to trigger smaller cost increases as compared to the situation when moving from a LOW-GHG reduction scenario to a HIGH-GHG reduction scenario.

Figure 18: Percentage changes in total maritime logistics costs by regulatory scenario, relative to the 2030 baseline Current Regulations scenario



*Source: UNCTAD, based on data provided MDS Transmodal (MDST).*

Looking at the individual components of maritime logistics costs, i.e., the transport cost and the time-related cost, some interesting insights emerge. Table 4 shows the percentage change in shipping (transport) costs for each of the three scenarios as compared to the 2030 baseline Current Regulations scenario. The results follow the same pattern observed for total maritime logistics costs, i.e., a small variation in range of impact between EEXI-Only and LOW-GHG reduction scenarios against a greater cost change under the HIGH-GHG reduction scenario. For some countries and trades, the cost of shipping (transport) may decrease. This may result, for example, from fuel cost savings per ton transported resulting from speed reduction being larger than the extra cost of employing more ships.

Table 4: Aggregate percentage change in maritime transport cost for each scenario, relative to the 2030 baseline scenario

| | EEXI | High Case | Low Case |
|---|---|---|---|
| **Min** | -2.14 | -0.88 | -1.21 |
| **Max** | 5.38 | 15.21 | 6.08 |
| **Average** | 0.29 | 6.91 | 2.02 |
| **Median** | 0.07 | 6.93 | 1.97 |
| **St Deviation** | 1.27 | 2.92 | 1.29 |

*Source: UNCTAD, based on data provided by MDS Transmodal (MDST).*

As to the impact of (extra) transit time at sea resulting from speed reduction, the analysis shows that mean time at sea is averaging 749 hours or just over 31 sailing days per trade pair across scenarios. When translated into changes across the three 2030 GHG reduction scenarios vis-à-vis the 2030 baseline Current Regulations scenario, results show that mean time at sea would increase by an average of 1.1%, 8.2% and 4.1% for EEXI-Only, HIGH-GHG reduction and LOW-GHG reduction scenarios, respectively.

Table 5: Aggregate percentage change of mean time at sea for each scenario, relative to 2030 baseline scenario

| | EEXI | High Case | Low Case |
|---|---|---|---|
| **Min** | -1.41 | 2.72 | -1.39 |
| **Max** | 5.16 | 10.06 | 7.61 |
| **Average** | 1.11 | 8.19 | 4.10 |
| **Median** | 0.86 | 8.40 | 4.07 |
| **St Deviation** | 0.83 | 0.72 | 0.62 |

*Source: UNCTAD, based on data provided by MDS Transmodal (MDST).*

However, when the additional transit time is calibrated against the Value of Time (VoT) to reflect changes in time-related costs, a different pattern emerges with a higher cost increase for EEXI-Only scenario against lower cost increases for LOW-GHG and HIGH-GHG reduction scenarios. This suggests that a reduction in sailing speed will trigger more than a proportional increase in time costs under the EEXI-Only scenario, while translating into less than a proportional increase in time cost under the LOW-GHG and HIGH-GHG reduction scenarios. This is most probably due to the technical nature of EEXI requirements; but can also be seen as an offset to the small increase or in some cases drop in shipping (transport) costs under the EEXI-Only scenario.

Table 6: Aggregate percentage change in time-related cost for each scenario, relative to 2030 baseline scenario

| | EEXI | High Case | Low Case |
|---|---|---|---|
| **Min** | -0.46 | 4.94 | -0.12 |
| **Max** | 3.48 | 8.84 | 4.65 |
| **Average** | 2.02 | 7.78 | 3.44 |
| **Median** | 2.09 | 7.83 | 3.64 |
| **St Deviation** | 0.71 | 0.64 | 0.70 |

*Source: UNCTAD, based on data provided by MDS Transmodal (MDST).*

The above results underline the particular dynamics between transport costs and time related costs across countries, trades and regulations, which further substantiate UNCTAD's approach in advocating a total maritime logistics cost analysis for assessing the impacts of the IMO short-term measure.

### *3.2.2 Impact by Country and Territory*

The impact of the IMO short-term measure on the costs incurred by importer and exporter countries/territories is summarized in Table 8 and Table 9. The consolidated impacts are summarized in Table 7.

Table 7: Global average changes in total maritime logistics costs under the three 2030 GHG scenarios

| Changes in maritime logistics costs | EEXI-Only | HIGH | LOW |
|---|---|---|---|
| Change in time at sea, % | **2.2** | **7.8** | **2.8** |
| Change in transport costs, % | **0.4** | **5.6** | **1.5** |
| Change in total maritime logistics costs, % | **1.7** | **7.2** | **2.7** |

*Source: UNCTAD, based on data provided by MDS Transmodal (MDST).*

Table 8: Changes in costs for importers in 2030 compared to the 2030 baseline Current Regulations scenario

| | Change in time at sea, % | | | Change in transport costs, % | | | Change in total maritime logistics costs, % | | |
|---|---|---|---|---|---|---|---|---|---|
| **IMPORTING ECONOMY** | **EEXI-Only** | **High case** | **Low case** | **EEXI-Only** | **High case** | **Low case** | **EEXI-Only** | **High case** | **Low case** |
| **Afghanistan** | 1.5 | 7.4 | 3.8 | 0.9 | 6.7 | 2.0 | 1.2 | 7.2 | 3.4 |
| **Albania** | 2.2 | 7.3 | 3.6 | 0.5 | 7.7 | 2.6 | 1.8 | 7.5 | 3.6 |
| **Algeria** | 2.9 | 7.6 | 3.5 | -0.1 | 5.7 | 1.3 | 2.3 | 7.2 | 3.2 |
| **Andorra** | 2.4 | 7.9 | 4.0 | -0.7 | 8.0 | 2.4 | 1.0 | 7.8 | 3.5 |
| **Angola** | 2.1 | 8.1 | 4.0 | -0.1 | 9.8 | 3.1 | 1.6 | 8.5 | 3.8 |
| **Anguilla** | 2.7 | 7.5 | 4.1 | 1.2 | 10.5 | 2.7 | 1.7 | 9.0 | 3.5 |
| **Antigua and Barbuda** | 3.0 | 7.0 | 3.9 | 2.3 | 10.6 | 2.6 | 2.3 | 8.8 | 3.4 |
| **Argentina** | 2.6 | 7.7 | 3.7 | 1.0 | 6.6 | 2.0 | 1.6 | 7.6 | 3.2 |
| **Armenia** | 1.2 | 7.8 | 3.8 | 0.2 | 8.1 | 2.6 | 0.8 | 7.9 | 3.6 |
| **Aruba** | 2.4 | 7.4 | 3.8 | 1.2 | 10.0 | 2.7 | 1.5 | 8.7 | 3.5 |
| **Australia** | 2.6 | 7.4 | 3.7 | 1.5 | 11.1 | 3.1 | 1.9 | 9.1 | 3.6 |
| **Austria** | 2.2 | 7.3 | 3.3 | 1.0 | 8.6 | 2.5 | 1.8 | 7.9 | 3.3 |
| **Azerbaijan** | 2.1 | 7.7 | 3.6 | 0.5 | 5.8 | 1.6 | 2.1 | 7.5 | 3.3 |
| **Bahamas** | 3.0 | 6.8 | 3.4 | 2.9 | 11.7 | 3.1 | 2.8 | 8.9 | 3.3 |
| **Bahrain** | 3.0 | 7.7 | 3.3 | 0.8 | 5.5 | 1.2 | 2.3 | 7.0 | 2.9 |
| **Bangladesh** | 3.0 | 7.8 | 3.6 | 0.1 | 6.4 | 1.5 | 2.3 | 7.6 | 3.1 |
| **Barbados** | 2.1 | 7.7 | 3.9 | 1.2 | 8.6 | 2.2 | 1.4 | 8.3 | 3.3 |
| **Belarus** | 1.8 | 7.8 | 4.0 | 0.1 | 8.6 | 2.8 | 1.6 | 8.0 | 3.5 |
| **Belgium** | 2.2 | 6.8 | 2.9 | 0.9 | 7.4 | 2.4 | 1.9 | 7.2 | 3.0 |
| **Belize** | 2.1 | 7.7 | 3.8 | 1.0 | 8.4 | 2.2 | 1.5 | 8.1 | 3.4 |
| **Benin** | 2.7 | 7.9 | 3.7 | -0.6 | 6.4 | 1.6 | 2.3 | 7.6 | 3.3 |
| **Bermuda** | 3.1 | 7.0 | 3.5 | 1.6 | 8.9 | 2.3 | 2.4 | 7.7 | 3.3 |
| **Bhutan** | 1.0 | 8.4 | 3.9 | 0.1 | 8.0 | 2.4 | 0.7 | 8.3 | 3.5 |
| **Bolivia (Plurinational State of)** | 1.1 | 8.6 | 4.3 | -0.1 | 2.4 | -0.4 | 0.7 | 5.9 | 2.2 |
| **Bosnia and Herzegovina** | 2.2 | 7.6 | 3.5 | -0.1 | 6.9 | 2.0 | 2.1 | 7.6 | 3.3 |
| **Botswana** | 0.6 | 8.8 | 4.4 | -0.2 | 4.6 | 0.8 | 0.4 | 7.2 | 2.9 |
| **Bouvet Island** | 0.7 | 8.7 | 4.2 | 0.1 | 11.9 | 4.0 | 0.5 | 9.6 | 4.1 |
| **Brazil** | 3.1 | 7.6 | 3.8 | 0.6 | 7.1 | 1.6 | 2.1 | 7.6 | 3.1 |
| **British Indian Ocean Territory** | 0.7 | 8.6 | 4.0 | 0.0 | 9.8 | 3.0 | 0.4 | 9.0 | 3.6 |
| **British Virgin Islands** | 2.0 | 7.5 | 3.5 | 1.9 | 10.5 | 2.8 | 1.7 | 8.9 | 3.3 |
| **Brunei Darussalam** | 3.1 | 7.3 | 3.7 | 0.2 | 5.8 | 1.3 | 2.1 | 7.0 | 3.2 |
| **Bulgaria** | 2.4 | 6.9 | 3.2 | 1.4 | 8.9 | 2.7 | 1.9 | 7.5 | 3.3 |
| **Burkina Faso** | 2.1 | 8.2 | 3.7 | -0.4 | 6.2 | 1.6 | 1.5 | 7.9 | 3.1 |
| **Burundi** | 2.3 | 7.7 | 3.7 | 0.7 | 7.7 | 1.8 | 1.2 | 8.0 | 3.0 |
| **Cabo Verde** | 2.7 | 7.2 | 3.7 | 0.8 | 9.5 | 2.8 | 2.1 | 8.1 | 3.6 |

| | Change in time at sea, % | | | Change in transport costs, % | | | Change in total maritime logistics costs, % | | |
|---|---|---|---|---|---|---|---|---|---|
| IMPORTING ECONOMY | EEXI-Only | High case | Low case | EEXI-Only | High case | Low case | EEXI-Only | High case | Low case |
| **Cambodia** | 2.4 | 6.9 | 3.4 | 1.4 | 7.4 | 2.3 | 2.3 | 7.3 | 3.4 |
| **Cameroon** | 2.6 | 7.7 | 3.7 | 0.0 | 7.9 | 2.2 | 2.0 | 7.9 | 3.4 |
| **Canada** | 2.0 | 8.0 | 3.7 | 0.2 | 8.0 | 2.2 | 1.1 | 8.1 | 3.3 |
| **Cayman Islands** | 3.0 | 7.6 | 3.7 | 0.1 | 6.5 | 1.1 | 1.9 | 7.4 | 3.0 |
| **Central African Republic** | 1.3 | 7.6 | 3.3 | 1.1 | 6.2 | 2.6 | 1.1 | 7.5 | 3.4 |
| **Chad** | 1.5 | 8.4 | 4.1 | 0.0 | 9.4 | 3.0 | 1.2 | 8.6 | 3.7 |
| **Chile** | 2.7 | 7.5 | 3.7 | 0.8 | 6.8 | 1.7 | 1.9 | 7.5 | 3.1 |
| **China** | 1.9 | 8.3 | 2.2 | -0.6 | 2.2 | 0.3 | 1.2 | 6.2 | 1.8 |
| **China, Hong Kong SAR** | 2.2 | 7.9 | 3.6 | -1.1 | 2.8 | 0.1 | 1.1 | 6.6 | 2.8 |
| **China, Macao SAR** | 3.0 | 7.8 | 3.7 | -0.7 | 3.3 | 0.4 | 2.2 | 7.0 | 3.2 |
| **China, Taiwan Province of** | 1.9 | 7.9 | 3.3 | -0.2 | 5.4 | 1.5 | 1.2 | 7.1 | 2.9 |
| **Christmas Island** | 1.9 | 7.4 | 3.5 | 1.0 | 10.9 | 3.1 | 1.6 | 9.0 | 3.3 |
| **Cocos (Keeling) Islands** | 0.8 | 8.9 | 4.1 | 0.2 | 9.8 | 3.0 | 0.5 | 9.3 | 3.6 |
| **Colombia** | 2.5 | 7.8 | 3.9 | 0.0 | 7.2 | 1.6 | 1.5 | 7.7 | 3.1 |
| **Comoros** | 2.1 | 8.1 | 3.9 | -0.3 | 7.7 | 2.0 | 1.4 | 8.0 | 3.3 |
| **Congo** | 2.1 | 8.1 | 4.0 | -0.4 | 8.4 | 2.5 | 1.5 | 8.2 | 3.7 |
| **Congo, Democratic Rep. of the** | 1.6 | 8.1 | 4.0 | 0.5 | 9.7 | 2.9 | 1.2 | 8.8 | 3.7 |
| **Cook Islands** | 2.2 | 8.1 | 3.7 | 0.1 | 8.7 | 2.4 | 1.6 | 8.3 | 3.5 |
| **Costa Rica** | 2.3 | 7.8 | 3.9 | 0.5 | 8.4 | 2.1 | 1.6 | 8.1 | 3.3 |
| **Côte d'Ivoire** | 2.6 | 7.5 | 3.6 | 0.4 | 8.5 | 2.4 | 2.2 | 7.9 | 3.4 |
| **Croatia** | 2.2 | 7.2 | 3.2 | 0.9 | 7.8 | 2.4 | 1.8 | 7.4 | 3.3 |
| **Cuba** | 2.9 | 7.4 | 3.6 | 0.5 | 8.4 | 2.3 | 2.5 | 7.8 | 3.6 |
| **Curaçao** | 2.9 | 7.3 | 3.6 | 0.7 | 7.8 | 1.6 | 1.8 | 7.6 | 2.9 |
| **Cyprus** | 2.5 | 6.6 | 3.2 | 2.8 | 10.8 | 3.4 | 2.6 | 7.8 | 3.5 |
| **Czechia** | 2.3 | 7.6 | 3.9 | 0.3 | 7.4 | 2.1 | 1.5 | 7.6 | 3.5 |
| **Denmark** | 2.4 | 7.3 | 3.5 | 0.7 | 8.3 | 2.2 | 1.8 | 7.7 | 3.3 |
| **Djibouti** | 2.3 | 7.3 | 3.6 | 0.5 | 6.0 | 1.6 | 1.9 | 7.0 | 3.1 |
| **Dominica** | 2.5 | 6.6 | 3.4 | 2.5 | 8.7 | 2.7 | 2.2 | 7.9 | 3.1 |
| **Dominican Republic** | 2.3 | 7.4 | 3.6 | 1.0 | 7.9 | 2.3 | 1.7 | 7.8 | 3.2 |
| **Ecuador** | 2.7 | 7.6 | 3.8 | 0.9 | 7.6 | 1.8 | 2.1 | 7.7 | 3.2 |
| **Egypt** | 2.7 | 7.4 | 3.4 | 0.5 | 5.6 | 1.5 | 2.0 | 7.0 | 3.0 |
| **El Salvador** | 2.3 | 7.8 | 3.8 | 0.4 | 7.5 | 1.8 | 1.6 | 7.8 | 3.2 |
| **Equatorial Guinea** | 1.3 | 8.4 | 4.3 | 0.0 | 10.0 | 3.3 | 1.0 | 8.7 | 4.1 |
| **Eritrea** | 1.1 | 7.3 | 3.8 | 0.6 | 7.0 | 2.4 | 0.8 | 7.1 | 3.1 |
| **Estonia** | 2.3 | 7.6 | 4.2 | 0.1 | 6.8 | 1.9 | 1.6 | 7.4 | 3.6 |
| **Eswatini** | 1.4 | 8.2 | 4.0 | 0.4 | 8.7 | 2.7 | 0.9 | 8.5 | 3.3 |
| **Ethiopia** | 2.2 | 7.4 | 3.7 | 0.4 | 5.7 | 1.5 | 1.6 | 6.8 | 3.0 |
| **Falkland Islands (Malvinas)[6]** | 2.1 | 7.2 | 3.6 | 2.4 | 12.1 | 3.2 | 1.8 | 9.0 | 3.5 |
| **Faroe Islands** | 2.7 | 6.2 | 3.1 | 2.6 | 12.5 | 3.9 | 2.4 | 7.7 | 3.1 |
| **Fiji** | 2.7 | 7.4 | 3.7 | 1.7 | 11.3 | 3.2 | 2.1 | 9.0 | 3.6 |
| **Finland** | 2.5 | 7.2 | 3.6 | 0.5 | 7.8 | 2.2 | 1.8 | 7.5 | 3.3 |
| **France** | 2.4 | 7.4 | 3.0 | 1.2 | 8.5 | 2.5 | 1.9 | 7.8 | 3.0 |
| **French Polynesia** | 1.4 | 8.2 | 3.9 | 0.7 | 9.5 | 2.9 | 1.0 | 8.8 | 3.7 |
| **French Southern Territories** | 0.8 | 9.0 | 2.9 | 0.1 | 8.7 | 2.6 | 0.2 | 8.7 | 2.8 |

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[6] A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

| | Change in time at sea, % | | | Change in transport costs, % | | | Change in total maritime logistics costs, % | | |
|---|---|---|---|---|---|---|---|---|---|
| IMPORTING ECONOMY | EEXI-Only | High case | Low case | EEXI-Only | High case | Low case | EEXI-Only | High case | Low case |
| **Gabon** | 2.4 | 8.0 | 3.9 | -0.5 | 8.1 | 2.4 | 1.6 | 8.1 | 3.6 |
| **Gambia** | 2.1 | 8.2 | 3.9 | -0.3 | 8.4 | 2.4 | 1.4 | 8.2 | 3.5 |
| **Georgia** | 2.2 | 7.9 | 3.7 | -0.4 | 4.0 | 0.8 | 1.3 | 6.7 | 3.0 |
| **Germany** | 2.3 | 7.4 | 3.5 | 0.6 | 7.9 | 2.2 | 1.6 | 7.7 | 3.2 |
| **Ghana** | 2.4 | 8.0 | 3.9 | -0.2 | 8.4 | 2.4 | 1.7 | 8.1 | 3.5 |
| **Gibraltar** | 2.5 | 6.1 | 2.6 | 3.9 | 13.2 | 4.0 | 3.0 | 8.6 | 3.1 |
| **Greece** | 2.0 | 6.9 | 2.9 | 2.3 | 8.9 | 3.1 | 2.2 | 7.6 | 3.3 |
| **Greenland** | 2.7 | 7.2 | 3.8 | 2.5 | 13.0 | 3.5 | 2.2 | 9.2 | 3.8 |
| **Grenada** | 1.8 | 7.9 | 3.8 | 0.2 | 5.9 | 1.6 | 1.2 | 7.6 | 3.4 |
| **Guam** | 3.3 | 6.6 | 3.8 | 3.1 | 14.9 | 4.1 | 3.0 | 10.7 | 4.0 |
| **Guatemala** | 2.5 | 7.7 | 3.9 | 0.4 | 7.6 | 1.8 | 1.8 | 7.8 | 3.2 |
| **Guinea** | 2.6 | 8.0 | 3.8 | -0.4 | 7.2 | 1.9 | 1.8 | 7.8 | 3.3 |
| **Guinea-Bissau** | 2.6 | 8.0 | 3.6 | -0.5 | 7.1 | 1.7 | 2.2 | 7.9 | 3.3 |
| **Guyana** | 2.1 | 7.8 | 3.8 | 0.0 | 6.4 | 1.6 | 1.4 | 7.6 | 3.3 |
| **Haiti** | 2.6 | 7.5 | 3.6 | 0.7 | 9.2 | 2.4 | 2.1 | 7.8 | 3.3 |
| **Heard Island and McDonald Islands** | 0.7 | 8.7 | 4.4 | -0.1 | 8.8 | 2.7 | 0.4 | 8.8 | 3.7 |
| **Holy See** | 1.3 | 7.3 | 4.0 | 0.5 | 7.5 | 2.5 | 0.9 | 7.4 | 3.3 |
| **Honduras** | 2.4 | 7.7 | 3.8 | 0.6 | 8.2 | 2.1 | 1.8 | 8.0 | 3.3 |
| **Hungary** | 2.5 | 7.4 | 3.8 | 0.6 | 7.4 | 2.0 | 1.7 | 7.5 | 3.5 |
| **Iceland** | 2.2 | 7.6 | 2.7 | 1.1 | 8.1 | 2.2 | 1.9 | 7.5 | 2.8 |
| **India** | 2.8 | 7.9 | 3.2 | 0.6 | 5.4 | 1.5 | 2.1 | 7.1 | 2.7 |
| **Indonesia** | 2.4 | 7.2 | 3.3 | 0.9 | 6.1 | 1.8 | 2.0 | 7.1 | 3.1 |
| **Iran, Islamic Republic of** | 2.6 | 7.9 | 3.2 | -0.6 | 3.9 | 0.7 | 2.0 | 7.0 | 2.9 |
| **Iraq** | 2.9 | 7.6 | 3.8 | 0.2 | 4.4 | 1.1 | 2.0 | 7.0 | 3.2 |
| **Ireland** | 2.2 | 6.2 | 2.7 | 2.4 | 8.9 | 3.4 | 2.3 | 7.3 | 3.2 |
| **Israel** | 2.6 | 7.4 | 3.7 | 0.8 | 8.1 | 2.2 | 2.2 | 7.6 | 3.5 |
| **Italy** | 2.2 | 6.9 | 2.9 | 1.6 | 7.3 | 2.8 | 2.2 | 7.2 | 3.1 |
| **Jamaica** | 2.7 | 7.1 | 3.6 | 1.9 | 8.7 | 2.3 | 2.2 | 7.9 | 3.2 |
| **Japan** | 2.0 | 8.1 | 2.2 | 0.0 | 3.0 | 0.9 | 1.4 | 6.7 | 2.0 |
| **Jordan** | 2.2 | 7.3 | 3.4 | 0.7 | 4.4 | 1.5 | 1.8 | 6.6 | 3.1 |
| **Kazakhstan** | 1.4 | 7.8 | 3.5 | 0.3 | 4.5 | 1.0 | 1.1 | 7.3 | 3.0 |
| **Kenya** | 2.4 | 7.7 | 3.6 | 0.6 | 7.4 | 1.8 | 1.7 | 7.8 | 3.1 |
| **Kiribati** | 1.6 | 8.4 | 4.0 | 0.0 | 9.3 | 2.9 | 1.0 | 8.8 | 3.6 |
| **Korea, Dem. People's Rep. of** | 2.3 | 7.9 | 3.2 | 1.1 | 8.8 | 2.6 | 1.6 | 8.2 | 3.1 |
| **Korea, Republic of** | 2.2 | 8.1 | 2.4 | 0.1 | 3.8 | 1.1 | 1.6 | 6.9 | 2.3 |
| **Kosovo** | 1.4 | 7.6 | 3.5 | 0.3 | 8.4 | 3.0 | 1.2 | 7.5 | 3.7 |
| **Kuwait** | 3.3 | 7.7 | 3.9 | -0.4 | 3.2 | 0.5 | 2.3 | 6.8 | 3.2 |
| **Kyrgyzstan** | 1.7 | 8.0 | 3.8 | -0.4 | -2.4 | -1.9 | 1.2 | 4.6 | 1.7 |
| **Lao People's Dem. Rep.** | 1.6 | 6.2 | 2.6 | 4.7 | 10.4 | 5.0 | 2.6 | 8.0 | 3.7 |
| **Latvia** | 2.1 | 7.8 | 3.9 | 0.0 | 7.3 | 2.1 | 1.3 | 7.6 | 3.3 |
| **Lebanon** | 2.1 | 7.1 | 3.4 | 1.0 | 7.7 | 2.3 | 1.7 | 7.3 | 3.3 |
| **Lesotho** | 0.6 | 8.8 | 4.3 | 0.0 | 7.5 | 2.1 | 0.2 | 8.1 | 3.1 |
| **Liberia** | 3.0 | 7.3 | 3.5 | 2.7 | 13.0 | 3.8 | 2.8 | 9.0 | 3.6 |
| **Libya** | 2.6 | 7.2 | 3.5 | 0.7 | 4.5 | 0.8 | 1.8 | 6.5 | 2.9 |
| **Liechtenstein** | 2.2 | 7.5 | 2.7 | 1.5 | 5.7 | 2.0 | 1.8 | 6.8 | 2.8 |
| **Lithuania** | 2.3 | 7.5 | 3.4 | 0.5 | 6.5 | 1.8 | 1.7 | 7.2 | 3.2 |
| **Luxembourg** | 1.8 | 7.8 | 4.1 | 0.2 | 8.2 | 2.6 | 1.6 | 7.9 | 3.7 |

| | Change in time at sea, % | | | Change in transport costs, % | | | Change in total maritime logistics costs, % | | |
|---|---|---|---|---|---|---|---|---|---|
| IMPORTING ECONOMY | EEXI-Only | High case | Low case | EEXI-Only | High case | Low case | EEXI-Only | High case | Low case |
| **Madagascar** | 2.7 | 7.9 | 3.7 | 0.2 | 8.6 | 2.4 | 1.6 | 8.3 | 3.1 |
| **Malawi** | 2.2 | 8.1 | 4.0 | -0.2 | 8.4 | 2.4 | 0.9 | 8.3 | 3.3 |
| **Malaysia** | 2.6 | 7.6 | 3.2 | 0.3 | 5.7 | 1.3 | 1.9 | 7.1 | 2.9 |
| **Maldives** | 2.7 | 8.0 | 3.5 | -0.3 | 5.2 | 1.1 | 1.5 | 7.3 | 2.9 |
| **Mali** | 2.3 | 8.1 | 4.1 | -0.5 | 6.9 | 1.9 | 1.5 | 7.9 | 3.5 |
| **Malta** | 2.7 | 6.7 | 3.2 | 2.4 | 10.1 | 3.3 | 2.6 | 7.8 | 3.4 |
| **Marshall Islands** | 2.9 | 7.2 | 3.1 | 1.1 | 9.1 | 2.2 | 2.4 | 7.9 | 3.0 |
| **Mauritania** | 2.4 | 8.0 | 3.9 | -0.5 | 8.2 | 2.5 | 1.6 | 8.1 | 3.7 |
| **Mauritius** | 1.8 | 7.8 | 3.5 | 0.6 | 8.9 | 2.6 | 1.2 | 8.4 | 3.2 |
| **Mayotte** | 2.0 | 8.2 | 3.6 | -0.4 | 7.5 | 1.9 | 1.4 | 8.0 | 3.2 |
| **Mexico** | 2.5 | 7.6 | 3.6 | 0.3 | 5.8 | 1.6 | 1.8 | 7.3 | 3.1 |
| **Micronesia (Federated States of)** | 2.1 | 8.1 | 3.8 | -0.2 | 7.8 | 2.3 | 1.5 | 8.1 | 3.5 |
| **Moldova, Republic of** | 1.2 | 7.8 | 3.7 | 0.2 | 9.1 | 3.3 | 0.8 | 8.0 | 3.8 |
| **Mongolia** | 2.9 | 7.7 | 4.4 | -0.2 | 0.2 | -0.8 | 2.0 | 5.7 | 3.1 |
| **Montenegro** | 1.1 | 7.8 | 3.7 | 0.1 | 8.8 | 2.8 | 0.9 | 7.9 | 3.6 |
| **Montserrat** | 2.5 | 7.3 | 3.8 | 1.7 | 8.8 | 2.3 | 1.9 | 8.1 | 3.3 |
| **Morocco** | 2.7 | 7.2 | 3.3 | 1.7 | 8.2 | 2.6 | 2.3 | 7.6 | 3.3 |
| **Mozambique** | 3.3 | 7.7 | 3.9 | -0.3 | 6.6 | 1.3 | 2.0 | 7.4 | 3.1 |
| **Myanmar** | 2.0 | 6.0 | 2.9 | 1.9 | 9.7 | 2.8 | 2.1 | 7.4 | 3.1 |
| **Namibia** | 3.0 | 7.5 | 3.9 | 0.7 | 9.6 | 2.4 | 1.5 | 8.7 | 3.2 |
| **Nauru** | 1.1 | 8.4 | 3.8 | 0.3 | 9.4 | 2.9 | 0.7 | 9.0 | 3.6 |
| **Nepal** | 2.1 | 8.0 | 3.8 | -0.1 | 6.9 | 1.9 | 1.2 | 7.7 | 3.2 |
| **Netherlands** | 2.4 | 6.7 | 2.9 | 1.7 | 9.5 | 2.9 | 2.2 | 7.7 | 3.1 |
| **New Caledonia** | 2.8 | 7.7 | 3.7 | 0.3 | 7.8 | 1.8 | 1.6 | 8.0 | 3.2 |
| **New Zealand** | 2.4 | 7.8 | 3.8 | 0.6 | 9.6 | 2.6 | 1.7 | 8.5 | 3.5 |
| **Nicaragua** | 2.6 | 7.4 | 3.6 | 1.3 | 8.4 | 2.2 | 1.9 | 7.9 | 3.2 |
| **Niger** | 2.3 | 8.1 | 3.7 | -0.5 | 6.5 | 1.6 | 2.0 | 7.7 | 3.3 |
| **Nigeria** | 2.6 | 7.7 | 4.0 | 0.5 | 8.9 | 2.5 | 1.6 | 8.4 | 3.4 |
| **Niue** | 2.2 | 8.1 | 3.7 | 0.1 | 8.7 | 2.4 | 1.6 | 8.3 | 3.5 |
| **Norfolk Island** | 2.1 | 8.2 | 3.8 | -0.5 | 8.6 | 2.2 | 0.3 | 8.7 | 3.3 |
| **North Macedonia** | 2.1 | 8.3 | 2.4 | -1.2 | 3.3 | 0.6 | 1.4 | 6.9 | 2.4 |
| **Northern Mariana Islands** | 2.6 | 7.3 | 3.9 | 1.8 | 13.0 | 3.8 | 1.8 | 10.3 | 4.0 |
| **Norway** | 2.6 | 7.5 | 3.4 | 0.4 | 6.8 | 1.8 | 1.8 | 7.2 | 3.0 |
| **Oman** | 2.7 | 7.9 | 3.2 | -0.3 | 2.6 | 0.2 | 2.3 | 6.8 | 3.0 |
| **Pakistan** | 2.4 | 7.8 | 3.0 | 1.0 | 5.8 | 1.9 | 1.9 | 7.1 | 2.8 |
| **Palau** | 0.9 | 7.1 | 2.3 | 2.0 | 9.0 | 3.7 | 1.3 | 8.2 | 3.3 |
| **Panama** | 2.7 | 7.3 | 3.6 | 1.9 | 9.4 | 2.6 | 2.1 | 8.4 | 3.2 |
| **Papua New Guinea** | 2.1 | 8.0 | 3.8 | 0.3 | 9.0 | 2.7 | 1.4 | 8.5 | 3.6 |
| **Paraguay** | 2.0 | 8.1 | 3.9 | 0.4 | 5.3 | 0.7 | 1.4 | 7.5 | 3.0 |
| **Peru** | 2.8 | 7.8 | 3.8 | 0.2 | 7.2 | 1.5 | 1.8 | 7.7 | 3.1 |
| **Philippines** | 2.7 | 7.3 | 3.5 | 0.8 | 6.5 | 1.6 | 2.2 | 7.2 | 3.2 |
| **Pitcairn** | 1.4 | 6.2 | 1.4 | 2.8 | 10.4 | 3.0 | 1.8 | 7.4 | 1.9 |
| **Poland** | 2.3 | 7.8 | 3.4 | 0.1 | 6.9 | 1.9 | 1.5 | 7.5 | 3.2 |
| **Portugal** | 2.0 | 7.0 | 2.6 | 1.0 | 5.9 | 2.1 | 1.8 | 6.7 | 2.7 |
| **Qatar** | 3.4 | 7.8 | 3.8 | -0.6 | 3.0 | 0.4 | 2.1 | 6.7 | 3.1 |
| **Romania** | 2.5 | 7.6 | 3.6 | -0.3 | 5.2 | 1.2 | 1.6 | 7.1 | 3.2 |
| **Russian Federation** | 2.2 | 7.8 | 4.0 | 0.0 | 6.4 | 1.7 | 1.6 | 7.2 | 3.4 |

| | Change in time at sea, % | | | Change in transport costs, % | | | Change in total maritime logistics costs, % | | |
|---|---|---|---|---|---|---|---|---|---|
| IMPORTING ECONOMY | EEXI-Only | High case | Low case | EEXI-Only | High case | Low case | EEXI-Only | High case | Low case |
| Rwanda | 1.7 | 8.4 | 4.0 | -0.2 | 7.2 | 1.9 | 0.8 | 8.1 | 3.3 |
| Samoa | 1.9 | 8.0 | 3.9 | 0.5 | 10.2 | 3.1 | 1.3 | 8.9 | 3.8 |
| San Marino | 1.4 | 7.6 | 4.2 | 0.3 | 13.2 | 5.3 | 1.0 | 9.3 | 4.5 |
| Sao Tome and Principe | 1.1 | 8.5 | 4.3 | -0.1 | 10.3 | 3.6 | 0.9 | 8.9 | 4.2 |
| Saudi Arabia | 2.4 | 7.5 | 3.6 | 0.1 | 4.7 | 1.0 | 1.8 | 6.8 | 3.0 |
| Senegal | 2.7 | 7.5 | 3.8 | 0.7 | 9.0 | 2.5 | 2.1 | 8.1 | 3.4 |
| Serbia | 2.7 | 7.6 | 3.7 | -0.5 | 4.5 | 1.1 | 1.6 | 6.9 | 3.2 |
| Seychelles | 1.6 | 8.3 | 3.8 | 0.1 | 8.7 | 2.5 | 0.9 | 8.5 | 3.3 |
| Sierra Leone | 2.5 | 8.0 | 3.7 | -0.5 | 7.5 | 2.0 | 2.0 | 7.9 | 3.3 |
| Singapore | 2.5 | 7.0 | 2.9 | 2.5 | 8.7 | 2.9 | 2.4 | 7.6 | 3.0 |
| Slovakia | 2.7 | 7.8 | 3.7 | -0.2 | 6.0 | 1.5 | 1.6 | 7.2 | 3.4 |
| Slovenia | 2.5 | 7.5 | 3.7 | 0.0 | 6.0 | 1.6 | 2.1 | 7.3 | 3.3 |
| Solomon Islands | 2.5 | 7.7 | 3.9 | 1.3 | 11.2 | 3.2 | 2.0 | 8.9 | 3.8 |
| Somalia | 1.9 | 8.0 | 3.8 | 0.3 | 8.3 | 2.1 | 1.6 | 8.2 | 3.5 |
| South Africa | 3.3 | 7.6 | 4.0 | -0.6 | 5.9 | 1.3 | 1.1 | 7.2 | 2.9 |
| Spain | 2.3 | 7.0 | 3.0 | 1.9 | 7.9 | 2.8 | 2.2 | 7.4 | 3.1 |
| Sri Lanka | 2.6 | 7.8 | 3.4 | 1.0 | 8.0 | 2.3 | 2.2 | 7.9 | 3.2 |
| Saint Helena | 1.8 | 7.9 | 3.7 | 0.7 | 9.1 | 2.5 | 1.2 | 8.7 | 3.5 |
| Saint Kitts and Nevis | 2.5 | 7.7 | 3.9 | 0.6 | 7.2 | 1.6 | 1.6 | 7.7 | 3.2 |
| Saint Lucia | 3.0 | 6.7 | 3.1 | 3.5 | 12.3 | 3.6 | 3.1 | 9.0 | 3.4 |
| Saint Pierre and Miquelon | 1.7 | 8.5 | 4.2 | -0.2 | 8.9 | 2.7 | 0.8 | 8.7 | 4.0 |
| Saint Vincent and the Grenadines | 2.1 | 7.7 | 3.7 | 0.3 | 7.3 | 2.0 | 1.2 | 7.8 | 3.3 |
| State of Palestine | 3.3 | 7.2 | 3.7 | 0.4 | 4.2 | 1.6 | 3.0 | 6.9 | 3.5 |
| Sudan | 2.5 | 7.4 | 3.9 | 0.0 | 4.8 | 1.3 | 1.3 | 6.6 | 3.0 |
| Suriname | 1.6 | 8.2 | 4.0 | -0.1 | 6.8 | 1.7 | 1.1 | 7.9 | 3.3 |
| Sweden | 2.3 | 7.3 | 3.3 | 1.0 | 8.2 | 2.4 | 1.9 | 7.7 | 3.3 |
| Switzerland | 1.9 | 7.5 | 3.9 | 0.4 | 7.7 | 2.2 | 1.3 | 7.6 | 3.3 |
| Syrian Arab Republic | 1.6 | 7.2 | 3.6 | 0.5 | 7.3 | 2.6 | 1.4 | 7.3 | 3.5 |
| Tajikistan | 2.7 | 7.1 | 3.4 | 1.3 | 6.8 | 1.3 | 2.2 | 7.2 | 2.7 |
| Tanzania, United Republic of | 2.2 | 7.8 | 3.6 | 0.7 | 7.5 | 1.8 | 1.7 | 7.8 | 3.1 |
| Thailand | 2.4 | 7.2 | 3.4 | 0.7 | 6.6 | 1.8 | 2.0 | 7.3 | 3.2 |
| Timor-Leste | 2.9 | 7.4 | 3.8 | -0.3 | 4.6 | 0.8 | 2.5 | 7.1 | 3.5 |
| Togo | 2.8 | 6.9 | 3.5 | 2.0 | 10.5 | 3.3 | 2.4 | 8.4 | 3.5 |
| Tokelau | 0.8 | 9.0 | 4.0 | 0.2 | 9.6 | 2.9 | 0.5 | 9.2 | 3.7 |
| Tonga | 2.9 | 7.9 | 3.6 | -1.2 | 5.6 | 1.2 | 2.2 | 7.6 | 3.3 |
| Trinidad and Tobago | 2.8 | 7.6 | 3.9 | 0.2 | 7.2 | 1.4 | 1.5 | 7.7 | 3.0 |
| Tunisia | 2.6 | 6.9 | 3.2 | 2.2 | 9.4 | 2.9 | 2.5 | 7.6 | 3.4 |
| Turkey | 2.5 | 7.5 | 3.4 | 0.3 | 6.5 | 1.9 | 1.9 | 7.3 | 3.2 |
| Turkmenistan | 1.4 | 7.5 | 4.1 | 0.1 | 3.8 | 1.0 | 1.3 | 6.8 | 3.4 |
| Turks and Caicos Islands | 2.1 | 7.9 | 3.9 | 0.2 | 6.1 | 1.4 | 1.2 | 7.6 | 3.3 |
| Tuvalu | 1.7 | 7.3 | 2.9 | 2.4 | 13.0 | 4.2 | 1.8 | 9.7 | 3.7 |
| Uganda | 2.4 | 7.7 | 3.7 | 0.4 | 7.2 | 1.7 | 1.7 | 7.7 | 3.1 |
| Ukraine | 2.8 | 7.8 | 3.4 | -1.0 | 3.5 | 0.3 | 1.6 | 6.6 | 2.8 |
| United Arab Emirates | 2.4 | 7.5 | 3.6 | 0.7 | 5.9 | 1.5 | 1.8 | 7.0 | 3.1 |
| United Kingdom | 2.0 | 6.3 | 2.7 | 1.8 | 8.2 | 2.9 | 2.0 | 7.2 | 3.1 |
| United States of America | 2.1 | 7.8 | 3.6 | 0.5 | 8.4 | 2.3 | 1.3 | 8.1 | 3.2 |
| Uruguay | 2.7 | 7.7 | 4.0 | 1.0 | 8.0 | 1.7 | 1.7 | 8.0 | 3.2 |

| | Change in time at sea, % | | | Change in transport costs, % | | | Change in total maritime logistics costs, % | | |
|---|---|---|---|---|---|---|---|---|---|
| IMPORTING ECONOMY | EEXI-Only | High case | ow case | EEXI-Only | High case | Low case | EEXI-Only | High case | Low case |
| **United States Minor Outlying Islands** | 2.5 | 8.1 | 3.7 | -0.4 | 8.0 | 2.0 | 1.3 | 8.1 | 3.1 |
| **United States Virgin Islands** | 1.8 | 6.8 | 2.7 | 2.8 | 12.2 | 3.6 | 2.0 | 9.7 | 3.4 |
| **Uzbekistan** | 1.5 | 7.3 | 4.0 | 0.2 | 2.5 | 0.5 | 1.3 | 6.1 | 3.0 |
| **Vanuatu** | 2.0 | 7.8 | 3.7 | 0.9 | 10.2 | 3.0 | 1.6 | 8.8 | 3.5 |
| **Venezuela (Bolivarian Rep. of)** | 2.6 | 7.6 | 3.8 | 0.6 | 9.0 | 2.2 | 1.7 | 8.2 | 3.4 |
| **Viet Nam** | 2.4 | 7.5 | 3.4 | 0.2 | 6.2 | 1.5 | 1.8 | 7.3 | 3.1 |
| **Wallis and Futuna Islands** | 1.5 | 8.4 | 3.8 | -0.1 | 9.8 | 3.1 | 1.1 | 8.8 | 3.8 |
| **Yemen** | 2.8 | 7.5 | 3.8 | -0.4 | 4.5 | 0.9 | 1.7 | 6.7 | 3.0 |
| **Zambia** | 2.2 | 8.0 | 4.2 | 0.4 | 8.9 | 2.4 | 1.2 | 8.5 | 3.4 |
| **Zimbabwe** | 1.7 | 8.3 | 4.2 | -0.2 | 7.1 | 1.9 | 0.8 | 7.9 | 3.2 |
| **World total** | **2.2** | **7.8** | **2.8** | **0.4** | **5.6** | **1.5** | **1.7** | **7.2** | **2.7** |

*Source: UNCTAD, based on data provided MDS Transmodal (MDST).*

Table 9: Changes in costs for exporters by 2030 compared to baseline current regulations scenario

| | Change in time at sea, % | | | Change in transport costs, % | | | Change in total maritime logistics costs, % | | |
|---|---|---|---|---|---|---|---|---|---|
| EXPORTING ECONOMY | EEXI-Onl | High cas | Low case | EEXI-Only | High case | ow case | EEXI-Only | High case | Low case |
| **Afghanistan** | 1.5 | 7.7 | 4.1 | -0.9 | 4.5 | 1.0 | 1.1 | 6.4 | 3.1 |
| **Albania** | 2.3 | 7.7 | 3.1 | 0.1 | 5.6 | 1.7 | 1.9 | 7.1 | 3.2 |
| **Algeria** | 1.7 | 5.9 | 1.8 | 4.3 | 9.8 | 4.3 | 2.9 | 7.6 | 2.9 |
| **Andorra** | 1.5 | 6.8 | 2.1 | 2.8 | 11.3 | 3.6 | 1.9 | 8.7 | 3.1 |
| **Angola** | 1.8 | 6.8 | 2.0 | 2.2 | 4.6 | 2.3 | 2.0 | 5.7 | 2.2 |
| **Anguilla** | 1.2 | 7.4 | 2.6 | 1.5 | 10.4 | 3.0 | 1.3 | 8.1 | 2.8 |
| **Antigua and Barbuda** | 2.8 | 7.8 | 3.8 | -0.5 | 7.1 | 1.8 | 1.9 | 7.7 | 3.3 |
| **Argentina** | 2.4 | 8.1 | 2.8 | -0.8 | 3.6 | 0.5 | 1.9 | 7.2 | 2.5 |
| **Armenia** | 1.7 | 8.5 | 2.1 | -1.0 | 3.4 | 0.6 | 0.8 | 7.1 | 2.1 |
| **Aruba** | 3.0 | 7.7 | 3.7 | -0.1 | 3.3 | 0.9 | 1.8 | 6.4 | 2.8 |
| **Australia** | 1.5 | 8.4 | 1.6 | -0.7 | 1.1 | 0.3 | 1.1 | 6.9 | 1.4 |
| **Austria** | 2.0 | 8.0 | 4.0 | -0.2 | 6.0 | 1.6 | 1.4 | 7.7 | 3.6 |
| **Azerbaijan** | 2.8 | 8.1 | 2.8 | 2.3 | 7.5 | 2.4 | 2.6 | 7.9 | 2.7 |
| **Bahamas** | 3.6 | 7.6 | 3.9 | -1.0 | 4.6 | 0.6 | 2.1 | 6.7 | 2.8 |
| **Bahrain** | 3.2 | 7.6 | 3.5 | 1.0 | 6.1 | 1.5 | 2.9 | 7.4 | 3.3 |
| **Bangladesh** | 1.1 | 8.2 | 3.7 | 0.1 | 7.9 | 2.3 | 0.3 | 7.9 | 2.5 |
| **Barbados** | 2.5 | 7.3 | 3.2 | 0.5 | 7.8 | 2.1 | 2.1 | 7.7 | 3.2 |
| **Belarus** | 3.4 | 7.7 | 3.9 | -1.5 | 3.4 | 0.0 | 2.4 | 6.8 | 3.1 |
| **Belgium** | 2.6 | 7.3 | 3.9 | 1.0 | 7.5 | 1.9 | 2.0 | 7.5 | 3.4 |
| **Belize** | 2.3 | 8.0 | 3.0 | -0.4 | 7.9 | 2.1 | 1.7 | 8.0 | 2.7 |
| **Benin** | 1.5 | 8.4 | 4.0 | -0.0 | 10.2 | 3.7 | 1.1 | 8.8 | 3.7 |
| **Bermuda** | 0.6 | 6.1 | 0.8 | 2.0 | 1.7 | 2.0 | 1.3 | 3.9 | 1.4 |
| **Bhutan** | 2.7 | 7.9 | 3.8 | -0.3 | 7.1 | 1.9 | 0.7 | 7.5 | 2.7 |
| **Bolivia (Plurinational State of)** | 2.4 | 8.2 | 3.0 | -0.7 | 6.1 | 1.6 | 1.9 | 7.4 | 2.9 |
| **Bosnia and Herzegovina** | 2.0 | 7.8 | 3.5 | 0.0 | 7.7 | 2.4 | 2.1 | 7.7 | 3.5 |
| **Botswana** | 1.2 | 8.6 | 3.8 | -0.3 | 5.2 | 1.1 | 0.6 | 8.0 | 3.3 |
| **Bouvet Island** | 0.7 | 8.9 | 4.1 | 0.2 | 9.8 | 3.0 | 0.5 | 9.3 | 3.6 |
| **Brazil** | 2.1 | 8.3 | 2.3 | -1.2 | 2.2 | 0.1 | 1.5 | 6.9 | 2.1 |
| **British Indian Ocean Territory** | 0.4 | 8.5 | 3.9 | 0.0 | 10.1 | 3.1 | 0.3 | 8.8 | 3.7 |
| **British Virgin Islands** | 2.6 | 7.7 | 3.3 | 1.2 | 9.3 | 2.8 | 1.9 | 8.3 | 3.4 |
| **Brunei Darussalam** | 1.6 | 4.9 | 1.6 | 4.8 | 11.3 | 4.8 | 3.2 | 8.0 | 3.2 |
| **Bulgaria** | 2.9 | 7.3 | 3.4 | 0.4 | 7.1 | 1.7 | 1.9 | 7.3 | 2.8 |
| **Burkina Faso** | 1.7 | 8.4 | 4.1 | -0.5 | 9.3 | 2.9 | 0.7 | 8.8 | 3.7 |
| **Burundi** | 0.7 | 8.8 | 4.1 | 0.0 | 9.6 | 2.9 | 0.5 | 8.9 | 3.6 |

| | Change in time at sea, % | | | Change in transport costs, % | | | Change in total maritime logistics costs, % | | |
|---|---|---|---|---|---|---|---|---|---|
| EXPORTING ECONOMY | EEXI-Onl | High cas | Low case | EEXI-Only | High case | ow case | EEXI-Only | High case | Low case |
| **Cabo Verde** | 1.2 | 8.4 | 4.3 | -0.2 | 13.8 | 5.3 | 1.0 | 9.1 | 4.5 |
| **Cambodia** | 2.6 | 7.6 | 3.7 | -0.4 | 6.1 | 1.5 | 1.2 | 7.0 | 2.8 |
| **Cameroon** | 1.9 | 8.0 | 3.8 | 1.1 | 11.6 | 4.5 | 1.5 | 9.5 | 4.1 |
| **Canada** | 2.8 | 8.0 | 3.2 | -0.9 | 3.9 | 0.5 | 1.5 | 6.7 | 2.3 |
| **Cayman Islands** | 2.0 | 6.7 | 2.2 | -0.3 | 5.2 | 0.6 | 0.9 | 6.1 | 1.6 |
| **Central African Republic** | 1.0 | 8.7 | 4.2 | 0.0 | 13.3 | 5.0 | 0.5 | 11.2 | 4.7 |
| **Chad** | 1.8 | 7.8 | 3.7 | 2.0 | 13.2 | 4.4 | 1.8 | 10.0 | 4.0 |
| **Chile** | 2.0 | 8.4 | 2.5 | -0.9 | 5.9 | 1.5 | 1.0 | 7.6 | 2.3 |
| **China** | 2.0 | 7.7 | 3.9 | -0.1 | 6.8 | 1.8 | 1.2 | 7.6 | 3.4 |
| **China, Hong Kong SAR** | 1.6 | 7.8 | 3.9 | 0.1 | 8.3 | 2.5 | 1.0 | 7.9 | 3.6 |
| **China, Macao SAR** | 2.9 | 7.8 | 3.8 | -0.5 | 5.8 | 1.3 | 1.6 | 7.3 | 3.2 |
| **China, Taiwan Province of** | 1.6 | 7.8 | 3.8 | 0.4 | 8.3 | 2.6 | 1.1 | 7.9 | 3.5 |
| **Christmas Island** | 2.7 | 8.1 | 3.4 | -1.1 | 4.9 | 0.8 | 1.2 | 7.4 | 2.7 |
| **Cocos (Keeling) Islands** | 0.8 | 8.9 | 3.8 | 0.2 | 9.8 | 2.9 | 0.6 | 9.2 | 3.4 |
| **Colombia** | 3.3 | 7.8 | 3.5 | -0.4 | 5.5 | 0.9 | 2.1 | 7.0 | 2.7 |
| **Comoros** | 0.9 | 8.7 | 4.1 | -0.0 | 9.8 | 3.0 | 0.8 | 9.0 | 3.8 |
| **Congo** | 2.5 | 7.7 | 3.9 | 1.8 | 11.4 | 3.3 | 2.8 | 8.6 | 3.8 |
| **Congo, Democratic. Rep. of the** | 1.5 | 8.5 | 3.0 | -0.2 | 9.7 | 3.4 | 1.2 | 8.7 | 3.1 |
| **Cook Islands** | 2.9 | 7.8 | 3.7 | 0.1 | 10.0 | 2.4 | 2.4 | 8.2 | 3.5 |
| **Costa Rica** | 2.0 | 8.2 | 3.7 | -0.3 | 10.0 | 3.1 | 1.1 | 8.9 | 3.5 |
| **Côte d’Ivoire** | 1.5 | 8.3 | 3.2 | 0.1 | 13.7 | 5.3 | 0.9 | 10.4 | 4.2 |
| **Croatia** | 2.8 | 7.3 | 3.6 | 0.3 | 7.0 | 2.0 | 1.7 | 7.3 | 3.2 |
| **Cuba** | 3.1 | 7.9 | 3.4 | -1.3 | 4.4 | 0.5 | 2.4 | 7.6 | 2.9 |
| **Curaçao** | 2.7 | 7.4 | 3.1 | 2.1 | 9.2 | 3.0 | 2.4 | 8.0 | 3.1 |
| **Cyprus** | 2.6 | 6.7 | 3.1 | 2.4 | 10.2 | 3.1 | 2.3 | 7.7 | 3.1 |
| **Czechia** | 2.4 | 7.9 | 4.2 | -0.3 | 4.8 | 1.1 | 1.3 | 7.3 | 3.5 |
| **Denmark** | 2.5 | 7.1 | 3.7 | 1.1 | 8.7 | 2.6 | 1.8 | 7.7 | 3.7 |
| **Djibouti** | 0.9 | 7.2 | 3.6 | 0.8 | 7.4 | 2.8 | 0.9 | 7.1 | 3.3 |
| **Dominica** | 2.8 | 7.9 | 3.4 | -1.5 | 6.5 | 1.5 | 1.3 | 7.4 | 3.0 |
| **Dominican Republic** | 1.8 | 8.1 | 3.6 | 0.0 | 8.9 | 2.8 | 1.2 | 8.4 | 3.5 |
| **Ecuador** | 2.2 | 8.0 | 2.8 | 0.8 | 9.0 | 3.1 | 1.6 | 8.4 | 3.1 |
| **Egypt** | 2.5 | 7.1 | 3.3 | 1.5 | 8.4 | 2.6 | 2.2 | 7.6 | 3.1 |
| **El Salvador** | 2.2 | 7.8 | 3.6 | 0.8 | 8.9 | 2.9 | 2.4 | 8.0 | 3.6 |
| **Equatorial Guinea** | 0.9 | 6.5 | 1.7 | 2.6 | 3.6 | 2.8 | 1.9 | 4.6 | 2.2 |
| **Eritrea** | 3.3 | 7.7 | 3.5 | -2.1 | 1.4 | -1.2 | 1.2 | 5.4 | 1.8 |
| **Estonia** | 3.1 | 7.4 | 3.6 | 0.5 | 5.8 | 1.6 | 1.9 | 6.7 | 2.9 |
| **Eswatini** | 2.2 | 8.2 | 3.1 | -1.0 | 4.8 | 0.9 | 2.0 | 7.9 | 2.7 |
| **Ethiopia** | 1.2 | 7.5 | 3.6 | 0.2 | 6.7 | 2.1 | 0.8 | 7.1 | 2.9 |
| **Falkland Islands (Malvinas)[7]** | 2.4 | 8.1 | 3.4 | -0.8 | 9.1 | 3.0 | 1.2 | 8.5 | 3.3 |
| **Faroe Islands** | 2.7 | 7.9 | 4.1 | -1.2 | 7.6 | 2.2 | 2.1 | 7.8 | 3.8 |
| **Fiji** | 1.5 | 8.3 | 3.2 | 0.4 | 12.4 | 3.8 | 1.3 | 8.8 | 3.7 |
| **Finland** | 2.8 | 7.2 | 3.7 | 0.9 | 8.3 | 2.2 | 2.2 | 7.5 | 3.3 |
| **France** | 2.5 | 7.6 | 3.9 | 0.3 | 7.0 | 1.9 | 1.5 | 7.6 | 3.5 |
| **French Polynesia** | 0.9 | 8.8 | 4.0 | 0.1 | 10.3 | 3.2 | 0.6 | 9.2 | 3.9 |
| **French Southern Territories** | 0.8 | 7.1 | 1.8 | 0.1 | 9.4 | 2.8 | 0.6 | 8.3 | 2.6 |
| **Gabon** | 2.1 | 8.3 | 2.2 | 0.5 | 7.1 | 1.3 | 1.8 | 7.8 | 2.1 |
| **Gambia** | 0.9 | 8.7 | 4.0 | 0.0 | 11.0 | 3.7 | 0.4 | 9.9 | 3.8 |
| **Georgia** | 2.5 | 7.6 | 3.2 | 0.5 | 7.1 | 1.8 | 2.3 | 7.5 | 3.2 |
| **Germany** | 2.2 | 7.9 | 4.2 | -0.3 | 3.7 | 0.6 | 1.5 | 7.0 | 3.5 |
| **Ghana** | 1.5 | 8.5 | 2.0 | -0.3 | 7.4 | 2.4 | 1.0 | 8.1 | 2.4 |

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[7] A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

| | Change in time at sea, % | | | Change in transport costs, % | | | Change in total maritime logistics costs, % | | |
|---|---|---|---|---|---|---|---|---|---|
| EXPORTING ECONOMY | EEXI-Onl | High cas | Low case | EEXI-Only | High case | ow case | EEXI-Only | High case | Low case |
| **Gibraltar** | 2.3 | 6.9 | 3.2 | 1.6 | 8.4 | 2.6 | 1.8 | 7.4 | 3.2 |
| **Greece** | 2.6 | 6.9 | 3.2 | 1.8 | 9.7 | 2.8 | 2.5 | 7.8 | 3.3 |
| **Greenland** | 1.7 | 8.3 | 3.7 | -0.2 | 10.2 | 3.4 | 1.1 | 8.8 | 3.7 |
| **Grenada** | 2.0 | 8.2 | 3.8 | -0.4 | 9.0 | 2.8 | 1.1 | 8.4 | 3.4 |
| **Guam** | 1.1 | 8.5 | 4.0 | 0.5 | 12.4 | 4.1 | 0.8 | 10.1 | 4.1 |
| **Guatemala** | 2.3 | 8.1 | 3.3 | -0.1 | 8.0 | 2.1 | 1.7 | 7.9 | 3.1 |
| **Guinea** | 1.8 | 8.5 | 1.9 | -1.7 | 0.6 | -0.6 | 1.0 | 6.6 | 1.3 |
| **Guinea-Bissau** | 2.1 | 8.3 | 3.7 | -0.5 | 9.5 | 3.1 | 1.5 | 8.5 | 3.0 |
| **Guyana** | 2.7 | 8.0 | 3.2 | -1.2 | 5.3 | 0.9 | 1.8 | 7.3 | 2.7 |
| **Haiti** | 0.8 | 8.5 | 3.9 | 0.0 | 10.4 | 3.3 | 0.5 | 9.1 | 3.8 |
| **Heard Island and McDonald Islands** | 0.8 | 8.5 | 4.3 | 0.1 | 12.6 | 4.4 | 0.6 | 9.4 | 4.3 |
| **Holy See** | 0.9 | 8.0 | 3.7 | 0.2 | 9.0 | 2.8 | 0.6 | 8.5 | 3.4 |
| **Honduras** | 2.2 | 7.8 | 3.7 | 0.6 | 10.4 | 3.4 | 1.6 | 8.6 | 3.5 |
| **Hungary** | 1.4 | 8.1 | 4.4 | 0.1 | 4.4 | 1.0 | 1.1 | 7.2 | 3.5 |
| **Iceland** | 2.9 | 7.6 | 4.0 | 0.1 | 6.9 | 2.0 | 3.0 | 7.5 | 3.8 |
| **India** | 2.6 | 7.8 | 3.7 | 0.4 | 7.9 | 2.2 | 1.3 | 7.9 | 2.9 |
| **Indonesia** | 3.0 | 7.6 | 3.3 | -1.0 | 2.8 | 0.0 | 1.3 | 5.4 | 1.9 |
| **Iran, Islamic Republic of** | 3.1 | 8.0 | 3.3 | 0.7 | 4.7 | 1.2 | 2.6 | 7.2 | 3.0 |
| **Iraq** | 2.9 | 8.3 | 2.9 | 2.2 | 6.8 | 2.3 | 2.7 | 7.8 | 2.7 |
| **Ireland** | 2.6 | 7.4 | 3.9 | 0.4 | 7.9 | 2.3 | 1.7 | 7.7 | 3.7 |
| **Israel** | 2.5 | 7.4 | 3.5 | 0.6 | 8.6 | 2.6 | 2.0 | 7.8 | 3.3 |
| **Italy** | 1.9 | 7.3 | 3.6 | 0.8 | 9.6 | 3.1 | 1.6 | 8.2 | 3.6 |
| **Jamaica** | 3.6 | 7.7 | 3.8 | -2.1 | 2.9 | -0.3 | 1.9 | 6.4 | 2.7 |
| **Japan** | 2.4 | 7.7 | 3.9 | -0.1 | 2.5 | -0.1 | 1.8 | 6.4 | 2.8 |
| **Jordan** | 2.8 | 7.7 | 3.6 | -0.6 | 5.0 | 1.0 | 1.4 | 6.7 | 2.7 |
| **Kazakhstan** | 3.0 | 8.2 | 3.1 | 0.9 | 5.0 | 1.4 | 2.6 | 7.4 | 3.0 |
| **Kenya** | 2.0 | 8.2 | 4.0 | 0.3 | 8.3 | 2.4 | 1.3 | 8.1 | 3.4 |
| **Kiribati** | 1.1 | 8.8 | 4.0 | -0.1 | 10.0 | 3.2 | 0.8 | 9.0 | 3.9 |
| **Korea, Dem. People's Rep. of** | 1.8 | 7.9 | 3.9 | -0.2 | 4.6 | 0.9 | 1.3 | 7.1 | 3.2 |
| **Korea, Republic of** | 2.4 | 7.3 | 3.6 | 1.1 | 7.2 | 1.7 | 2.1 | 7.5 | 3.2 |
| **Kosovo** | 1.9 | 8.5 | 2.0 | -1.4 | 1.0 | -0.4 | 1.1 | 6.7 | 1.5 |
| **Kuwait** | 2.9 | 8.2 | 3.0 | 1.8 | 5.4 | 1.9 | 2.5 | 7.2 | 2.6 |
| **Kyrgyzstan** | 0.8 | 7.9 | 4.0 | 0.5 | 7.8 | 2.6 | 0.7 | 7.7 | 3.7 |
| **Lao People's Dem. Rep.** | 3.0 | 7.7 | 3.7 | -1.0 | 5.3 | 1.0 | 2.0 | 7.1 | 3.1 |
| **Latvia** | 3.3 | 7.7 | 3.8 | -1.2 | 3.6 | 0.3 | 1.5 | 6.4 | 2.7 |
| **Lebanon** | 1.8 | 7.5 | 3.9 | 0.2 | 7.3 | 2.3 | 1.4 | 7.5 | 3.4 |
| **Lesotho** | 2.4 | 7.9 | 3.9 | -1.7 | 6.3 | 1.1 | 2.0 | 7.6 | 3.5 |
| **Liberia** | 2.8 | 8.1 | 3.0 | -1.9 | 2.2 | -0.3 | 1.3 | 6.3 | 2.0 |
| **Libya** | 2.1 | 6.1 | 2.1 | 4.1 | 12.1 | 4.1 | 2.8 | 8.4 | 2.9 |
| **Liechtenstein** | 2.0 | 7.6 | 4.5 | 0.5 | 6.4 | 2.0 | 1.8 | 7.4 | 4.2 |
| **Lithuania** | 3.1 | 7.3 | 3.6 | 1.0 | 7.9 | 1.8 | 2.0 | 7.4 | 2.9 |
| **Luxembourg** | 2.9 | 7.8 | 3.9 | -1.2 | 5.0 | 0.8 | 2.8 | 7.5 | 3.7 |
| **Madagascar** | 2.5 | 8.1 | 3.9 | -0.9 | 6.5 | 1.4 | 0.9 | 7.7 | 3.1 |
| **Malawi** | 1.0 | 8.8 | 4.2 | 0.0 | 10.4 | 3.3 | 0.9 | 9.0 | 4.1 |
| **Malaysia** | 2.3 | 6.8 | 3.1 | 1.7 | 9.2 | 2.7 | 2.0 | 7.8 | 3.1 |
| **Maldives** | 1.0 | 5.8 | 1.6 | 2.5 | 5.7 | 3.3 | 2.0 | 6.0 | 2.9 |
| **Mali** | 0.9 | 8.8 | 4.3 | 0.1 | 12.6 | 4.6 | 0.5 | 10.7 | 4.4 |
| **Malta** | 2.3 | 6.7 | 3.0 | 2.9 | 11.6 | 3.6 | 2.3 | 8.2 | 3.4 |
| **Marshall Islands** | 1.9 | 8.4 | 2.6 | -0.4 | 7.4 | 2.0 | 1.4 | 8.1 | 2.5 |
| **Mauritania** | 2.0 | 8.4 | 2.1 | -1.8 | 1.0 | -0.6 | 1.0 | 6.5 | 1.5 |
| **Mauritius** | 1.4 | 8.4 | 4.0 | -0.3 | 8.5 | 2.5 | 0.8 | 8.5 | 3.7 |
| **Mayotte** | 1.1 | 8.2 | 4.2 | -0.4 | 6.8 | 2.0 | 0.6 | 8.0 | 3.8 |
| **Mexico** | 2.4 | 7.8 | 3.6 | 1.1 | 8.8 | 2.3 | 1.6 | 8.2 | 3.3 |
| **Micronesia (Federated States** | 1.0 | 8.8 | 3.9 | 0.1 | 10.2 | 3.2 | 0.6 | 9.4 | 3.7 |

| | Change in time at sea, % | | | Change in transport costs, % | | | Change in total maritime logistics costs, % | | |
|---|---|---|---|---|---|---|---|---|---|
| EXPORTING ECONOMY | EEXI-Onl | High cas | Low case | EEXI-Only | High case | .ow case | EEXI-Only | High case | Low case |
| **of)** | | | | | | | | | |
| **Moldova, Republic of** | 3.2 | 7.6 | 3.9 | -0.8 | 5.0 | 0.9 | 1.0 | 6.7 | 3.0 |
| **Mongolia** | 3.4 | 7.6 | 3.9 | -1.2 | 4.1 | 0.3 | 1.7 | 6.8 | 3.2 |
| **Montenegro** | 1.2 | 8.1 | 4.2 | 0.2 | 10.3 | 3.4 | 0.9 | 8.8 | 3.9 |
| **Montserrat** | 2.8 | 7.9 | 3.3 | -2.4 | 3.7 | -0.0 | 0.6 | 6.9 | 2.5 |
| **Morocco** | 3.1 | 7.7 | 3.9 | -1.0 | 4.7 | 0.7 | 1.8 | 6.8 | 2.9 |
| **Mozambique** | 2.1 | 8.1 | 2.5 | -0.2 | 4.0 | 1.1 | 1.6 | 7.2 | 2.2 |
| **Myanmar** | 2.2 | 7.5 | 3.2 | -0.0 | 2.5 | 0.8 | 1.5 | 5.3 | 2.2 |
| **Namibia** | 1.4 | 8.5 | 3.6 | -0.6 | 6.2 | 1.5 | 1.0 | 8.1 | 3.2 |
| **Nauru** | 2.1 | 8.3 | 2.4 | -1.2 | 4.7 | 0.8 | 1.1 | 7.4 | 2.2 |
| **Nepal** | 1.8 | 8.1 | 3.7 | 0.1 | 8.1 | 2.4 | 0.4 | 8.1 | 2.7 |
| **Netherlands** | 2.7 | 7.0 | 3.6 | 1.7 | 9.7 | 2.7 | 2.2 | 7.9 | 3.5 |
| **New Caledonia** | 1.5 | 8.5 | 1.7 | -1.1 | 2.4 | 0.4 | 1.0 | 7.5 | 1.8 |
| **New Zealand** | 1.4 | 8.5 | 2.2 | 0.1 | 8.4 | 2.5 | 0.8 | 8.5 | 3.0 |
| **Nicaragua** | 1.9 | 8.1 | 3.8 | 0.1 | 9.7 | 2.9 | 1.8 | 8.3 | 3.6 |
| **Niger** | 1.2 | 7.8 | 3.9 | 3.8 | 8.3 | 5.0 | 2.2 | 8.1 | 4.4 |
| **Nigeria** | 1.6 | 6.3 | 1.8 | 2.2 | 5.3 | 2.5 | 1.9 | 5.8 | 2.2 |
| **Niue** | 2.9 | 7.8 | 3.7 | 0.1 | 10.0 | 2.4 | 2.4 | 8.2 | 3.5 |
| **Norfolk Island** | 0.7 | 8.9 | 4.1 | 0.2 | 12.0 | 4.3 | 0.5 | 10.1 | 4.2 |
| **North Macedonia** | 1.4 | 7.5 | 3.8 | 0.3 | 8.3 | 2.7 | 1.2 | 7.8 | 3.6 |
| **Northern Mariana Islands** | 0.7 | 9.0 | 4.0 | 0.2 | 9.8 | 3.0 | 0.5 | 9.4 | 3.6 |
| **Norway** | 1.9 | 4.9 | 1.9 | 5.4 | 11.3 | 5.5 | 3.0 | 7.0 | 3.1 |
| **Oman** | 2.9 | 7.7 | 3.1 | 0.6 | 2.8 | 1.0 | 2.1 | 6.2 | 2.4 |
| **Pakistan** | 2.3 | 8.0 | 3.6 | 0.0 | 7.6 | 2.1 | 1.2 | 7.7 | 2.8 |
| **Palau** | 0.8 | 8.9 | 4.1 | 0.2 | 9.7 | 2.9 | 0.5 | 9.2 | 3.7 |
| **Panama** | 2.5 | 7.7 | 3.1 | 0.7 | 6.7 | 2.2 | 1.7 | 7.3 | 2.7 |
| **Papua New Guinea** | 1.1 | 7.0 | 2.0 | 1.6 | 6.1 | 2.4 | 1.6 | 6.5 | 2.2 |
| **Paraguay** | 2.6 | 8.0 | 3.1 | -0.9 | 5.5 | 1.1 | 2.0 | 7.7 | 2.9 |
| **Peru** | 1.8 | 8.1 | 2.1 | 0.2 | 4.8 | 1.7 | 1.2 | 6.8 | 2.0 |
| **Philippines** | 2.5 | 7.5 | 3.4 | -0.9 | 3.9 | 0.4 | 0.7 | 5.9 | 2.2 |
| **Pitcairn** | 1.2 | 8.6 | 4.1 | 0.0 | 9.7 | 2.9 | 0.8 | 8.9 | 3.8 |
| **Poland** | 2.5 | 7.8 | 4.1 | -0.2 | 6.2 | 1.6 | 1.5 | 7.5 | 3.6 |
| **Portugal** | 2.5 | 7.4 | 3.9 | 1.0 | 8.6 | 2.4 | 2.1 | 7.8 | 3.6 |
| **Qatar** | 1.0 | 6.6 | 1.1 | 1.6 | 2.4 | 1.7 | 1.4 | 4.9 | 1.5 |
| **Romania** | 3.1 | 7.6 | 3.6 | -0.4 | 5.2 | 1.1 | 1.5 | 6.8 | 2.8 |
| **Russian Federation** | 3.2 | 7.3 | 3.4 | 0.4 | 6.1 | 1.3 | 2.6 | 7.1 | 3.0 |
| **Rwanda** | 0.7 | 8.7 | 4.1 | -0.0 | 10.0 | 3.1 | 0.6 | 8.9 | 3.8 |
| **Samoa** | 0.8 | 8.8 | 4.1 | 0.2 | 10.3 | 3.2 | 0.5 | 9.4 | 3.8 |
| **San Marino** | 1.0 | 7.8 | 3.9 | 0.4 | 8.0 | 2.6 | 1.0 | 7.8 | 3.7 |
| **Sao Tome and Principe** | 1.5 | 8.5 | 4.3 | -0.0 | 15.2 | 6.1 | 0.5 | 11.8 | 5.1 |
| **Saudi Arabia** | 3.0 | 8.4 | 3.2 | 1.3 | 4.6 | 1.6 | 2.5 | 7.2 | 2.7 |
| **Senegal** | 2.3 | 8.2 | 2.9 | -1.2 | 6.6 | 1.9 | 1.2 | 7.7 | 2.9 |
| **Serbia** | 3.1 | 7.8 | 3.6 | -0.8 | 5.1 | 1.1 | 1.0 | 6.9 | 2.7 |
| **Seychelles** | 1.3 | 8.5 | 4.0 | -0.8 | 8.7 | 2.0 | 0.7 | 8.7 | 3.5 |
| **Sierra Leone** | 2.7 | 8.1 | 3.5 | -1.1 | 6.5 | 1.5 | 0.8 | 7.4 | 2.6 |
| **Singapore** | 2.3 | 5.7 | 2.8 | 3.7 | 13.8 | 4.2 | 2.7 | 9.0 | 3.5 |
| **Slovakia** | 1.7 | 8.2 | 4.8 | -0.4 | -0.9 | -1.2 | 0.7 | 4.8 | 2.4 |
| **Slovenia** | 2.2 | 7.7 | 3.8 | -0.0 | 6.9 | 2.1 | 1.0 | 7.5 | 3.2 |
| **Solomon Islands** | 1.2 | 8.7 | 3.0 | -0.1 | 8.9 | 2.8 | 0.8 | 8.7 | 3.0 |
| **Somalia** | 0.9 | 8.5 | 4.0 | -0.3 | 8.4 | 2.4 | 0.3 | 8.5 | 3.4 |
| **South Africa** | 2.2 | 8.3 | 2.5 | -1.4 | 1.1 | -0.5 | 1.4 | 6.7 | 2.0 |
| **Spain** | 2.2 | 7.5 | 3.8 | 0.6 | 8.6 | 2.6 | 1.7 | 7.9 | 3.5 |
| **Sri Lanka** | 1.1 | 8.2 | 3.7 | 0.2 | 8.1 | 2.4 | 0.4 | 8.2 | 2.7 |
| **Saint Helena** | 2.9 | 7.3 | 4.2 | 2.6 | 14.9 | 3.8 | 2.1 | 9.9 | 4.1 |
| **Saint Kitts & Nevis** | 0.9 | 8.5 | 3.5 | -0.1 | 8.9 | 2.7 | 0.7 | 8.6 | 3.7 |

| | Change in time at sea, % | | | Change in transport costs, % | | | Change in total maritime logistics costs, % | | |
|---|---|---|---|---|---|---|---|---|---|
| EXPORTING ECONOMY | EEXI-Onl | High cas | Low case | EEXI-Only | High case | ow case | EEXI-Only | High case | Low case |
| **Saint Lucia** | 3.5 | 7.5 | 3.9 | -1.3 | 5.1 | 0.8 | 1.1 | 6.4 | 2.4 |
| **Saint Pierre and Miquelon** | 0.5 | 7.9 | 4.3 | -0.1 | 14.4 | 5.3 | 0.4 | 8.5 | 4.1 |
| **Saint Vincent and the Grenadines** | 1.8 | 8.3 | 2.8 | -0.6 | 6.9 | 1.8 | 0.6 | 7.8 | 2.7 |
| **State of Palestine** | 1.0 | 7.1 | 4.0 | 0.7 | 6.8 | 2.4 | 0.9 | 7.0 | 3.6 |
| **Sudan** | 2.0 | 7.9 | 3.3 | 1.0 | 5.7 | 1.8 | 1.8 | 7.0 | 2.8 |
| **Suriname** | 1.4 | 8.4 | 2.7 | -0.0 | 8.4 | 2.4 | 0.7 | 8.4 | 2.8 |
| **Sweden** | 2.9 | 7.6 | 3.6 | -0.0 | 5.4 | 1.1 | 1.9 | 7.0 | 3.0 |
| **Switzerland** | 1.7 | 7.8 | 3.8 | 0.5 | 6.6 | 1.9 | 1.3 | 7.7 | 3.6 |
| **Syrian Arab Republic** | 1.3 | 7.4 | 3.9 | 0.4 | 7.0 | 2.3 | 0.9 | 7.2 | 3.5 |
| **Tajikistan** | 3.2 | 7.7 | 3.9 | -0.5 | 3.5 | 0.6 | 2.0 | 7.2 | 3.4 |
| **Tanzania, United Republic of** | 1.1 | 8.5 | 4.0 | -0.4 | 8.4 | 2.4 | 1.2 | 8.3 | 3.6 |
| **Thailand** | 2.2 | 7.5 | 3.6 | -0.2 | 6.0 | 1.4 | 1.6 | 7.2 | 3.1 |
| **Timor-Leste** | 1.7 | 4.4 | 1.9 | 4.8 | 14.1 | 5.2 | 3.0 | 8.5 | 3.4 |
| **Togo** | 1.8 | 7.8 | 2.7 | 1.0 | 8.0 | 2.7 | 1.6 | 7.8 | 2.8 |
| **Tokelau** | 1.0 | 8.8 | 4.0 | 0.1 | 9.6 | 2.9 | 0.8 | 9.0 | 3.6 |
| **Tonga** | 0.8 | 8.8 | 4.1 | 0.1 | 11.3 | 3.8 | 0.4 | 10.0 | 3.9 |
| **Trinidad and Tobago** | 2.5 | 6.5 | 2.6 | 3.4 | 8.1 | 3.6 | 3.1 | 7.4 | 3.2 |
| **Tunisia** | 2.8 | 7.3 | 3.7 | 1.0 | 8.7 | 2.6 | 2.4 | 7.7 | 3.5 |
| **Turkey** | 2.5 | 7.6 | 3.8 | 0.1 | 7.1 | 1.9 | 2.2 | 7.6 | 3.5 |
| **Turkmenistan** | -0.4 | 5.8 | -0.2 | 1.3 | 1.5 | 1.4 | 0.4 | 3.7 | 0.6 |
| **Turks and Caicos Islands** | 0.6 | 7.9 | 4.3 | -0.4 | 21.0 | 8.6 | 0.5 | 8.6 | 4.6 |
| **Tuvalu** | 1.0 | 8.9 | 4.1 | 0.1 | 10.0 | 3.1 | 0.7 | 9.2 | 3.8 |
| **Uganda** | 0.8 | 8.7 | 4.1 | -0.3 | 8.9 | 2.6 | 0.7 | 8.6 | 3.5 |
| **Ukraine** | 2.6 | 8.0 | 2.8 | -0.6 | 3.7 | 0.4 | 2.1 | 6.9 | 2.7 |
| **United Arab Emirates** | 3.0 | 7.9 | 3.2 | 1.0 | 4.7 | 1.4 | 2.3 | 7.0 | 2.8 |
| **United Kingdom** | 2.3 | 6.3 | 3.0 | 2.7 | 9.6 | 3.3 | 2.4 | 7.5 | 3.3 |
| **United States of America** | 2.5 | 7.5 | 3.2 | 1.0 | 6.9 | 2.0 | 1.7 | 7.3 | 2.8 |
| **Uruguay** | 2.0 | 8.3 | 2.6 | -1.0 | 5.9 | 1.7 | 1.4 | 7.7 | 2.9 |
| **United States Minor Outlying Islands** | 2.6 | 7.8 | 3.6 | 0.4 | 8.8 | 2.5 | 1.6 | 8.4 | 3.4 |
| **United States Virgin Islands** | 0.7 | 8.4 | 3.9 | 0.1 | 10.2 | 3.3 | 0.3 | 9.5 | 3.7 |
| **Uzbekistan** | 0.5 | 6.8 | 2.7 | 0.9 | 4.6 | 2.0 | 0.8 | 6.0 | 2.5 |
| **Vanuatu** | 1.6 | 8.5 | 2.6 | -0.6 | 6.5 | 1.5 | 1.2 | 8.2 | 2.3 |
| **Venezuela (Bolivarian Rep. of)** | 2.9 | 8.0 | 2.9 | 2.2 | 8.3 | 2.5 | 2.6 | 8.1 | 2.9 |
| **Viet Nam** | 2.4 | 7.6 | 3.5 | -0.7 | 5.0 | 1.0 | 1.6 | 6.9 | 2.8 |
| **Wallis and Futuna Islands** | 0.8 | 8.7 | 4.0 | 0.3 | 9.9 | 3.0 | 0.5 | 9.4 | 3.5 |
| **Yemen** | 2.7 | 8.3 | 3.1 | 1.2 | 4.3 | 1.7 | 2.1 | 7.0 | 2.8 |
| **Zambia** | 1.9 | 8.4 | 2.6 | -0.7 | 4.8 | 1.1 | 1.8 | 8.1 | 2.6 |
| **Zimbabwe** | 2.1 | 8.3 | 3.0 | -1.3 | 3.1 | 0.3 | 1.3 | 7.3 | 2.6 |
| **World total** | **2.2** | **7.8** | **2.8** | **0.4** | **5.6** | **1.5** | **1.7** | **7.2** | **2.7** |

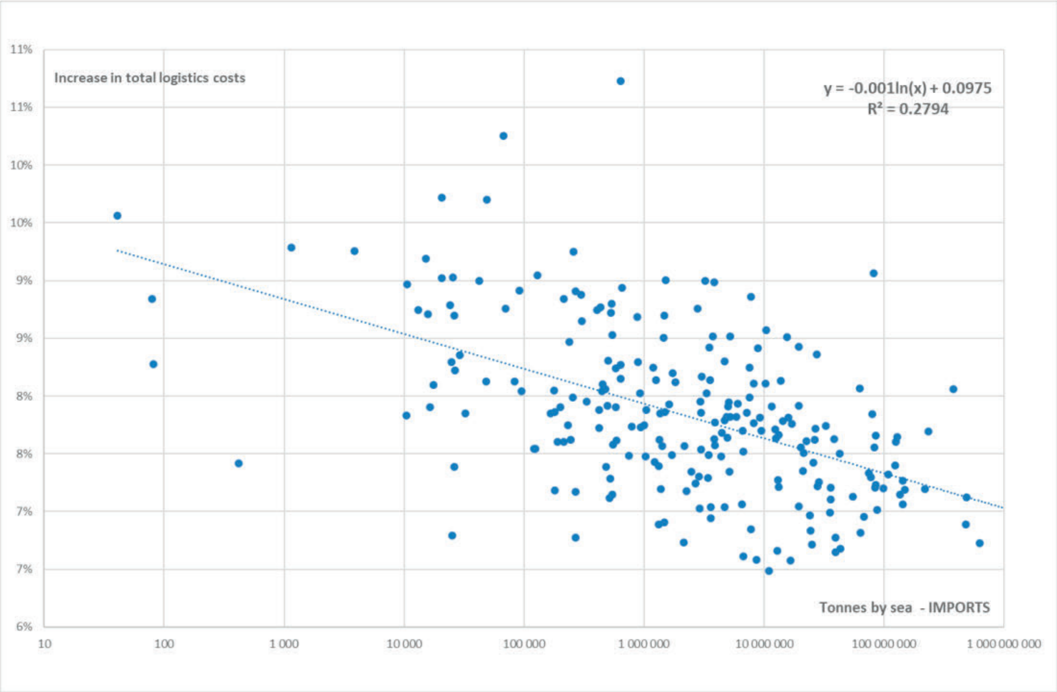
*Source: UNCTAD, based on data provided MDS Transmodal (MDST).*

The highest impact on time at sea, transport costs, and total maritime logistics costs is expected to occur in the HIGH-GHG reduction scenario. Next highest impacts will be seen under the LOW-GHG reduction scenario and the EEXI-Only scenario, respectively. Under the EEXI-Only scenario, total global time at sea will increase by 2.2%, transport costs will go up by 0.4%, and total maritime logistics costs by 1.7%. Under the HIGH-GHG reduction scenario the respective values are +7.8% (time), +5.6% (transport costs) and +7.2% (total maritime logistics costs). Under the LOW-GHG reduction scenario, we record +2.8% (time), +1.5% (transport costs) and +2.7% (total maritime logistics costs). As can be seen, several countries/territories, notably small island economies, appear among the most strongly affected under all three scenarios.

Under the EEXI-Only scenario, the economies that would see the highest increase in maritime logistics costs in terms of imports (Table 8) are St. Lucia, State of Palestine, Gibraltar, Guam, the Bahamas, Liberia, Lao People's Dem. Rep., Cyprus, and Malta. As regards maritime logistics costs in terms of exports (Table 9), the most affected economies would be Brunei Darussalam, Trinidad & Tobago, Timor-Leste, Iceland, Norway, Bahrain, Algeria, Libya, the Republic of Congo, and Luxembourg.

Under the HIGH-GHG reduction scenario, the economies that would see the highest increase in maritime logistics costs in terms of imports (Table 8) are Guam, Northern Mariana Islands, Tuvalu, US Virgin-islands, Bouvet Island, San Marino, Cocos (Keeling) Islands, Greenland, Tokelau, and Australia. As regards maritime logistics costs in terms of exports, (Table 9) most affected economies would be Sao Tome & Principe, Central African Republic, Mali, Côte d'Ivoire, Guam, Norfolk Island, Tonga, Chad, Australian Oceania, and St Helena.

Figure 19: Correlation between volume of imports (2019) and estimated change in total maritime logistics costs (HIGH-GHG reduction scenario)



*Source: UNCTAD, based on data provided by MDS Transmodal (MDST). Note: Tonnes by sea are indicative, 2019 data.*

Under the LOW-GHG reduction scenario, the economies that would see the highest increase in maritime logistics costs in terms of imports (Table 8) are San Marino, Sao Tome & Principe, Bouvet Island, Equatorial Guinea, Guam, Northern Mariana Islands, St Pierre & Miquelon, Greenland, and Solomon Islands. As regards maritime logistics costs in terms of exports (Table 9) most affected economies would be Sao Tome & Principe, Central African Republic, Turks & Caicos Islands, Cabo Verde, Niger, Mali, Heard Island & McDonald Islands, and Côte d'Ivoire.

Under the HIGH- and LOW-GHG reduction scenarios, small island economies and, in general, smaller economies are more strongly affected than the world average. Under the scenario EEXI-Only, such a generalized trend cannot be identified. By way of example, the correlation between import volumes and the expected changes in total maritime logistics costs for the HIGH-GHG reduction scenario are illustrated in Figure 19 .

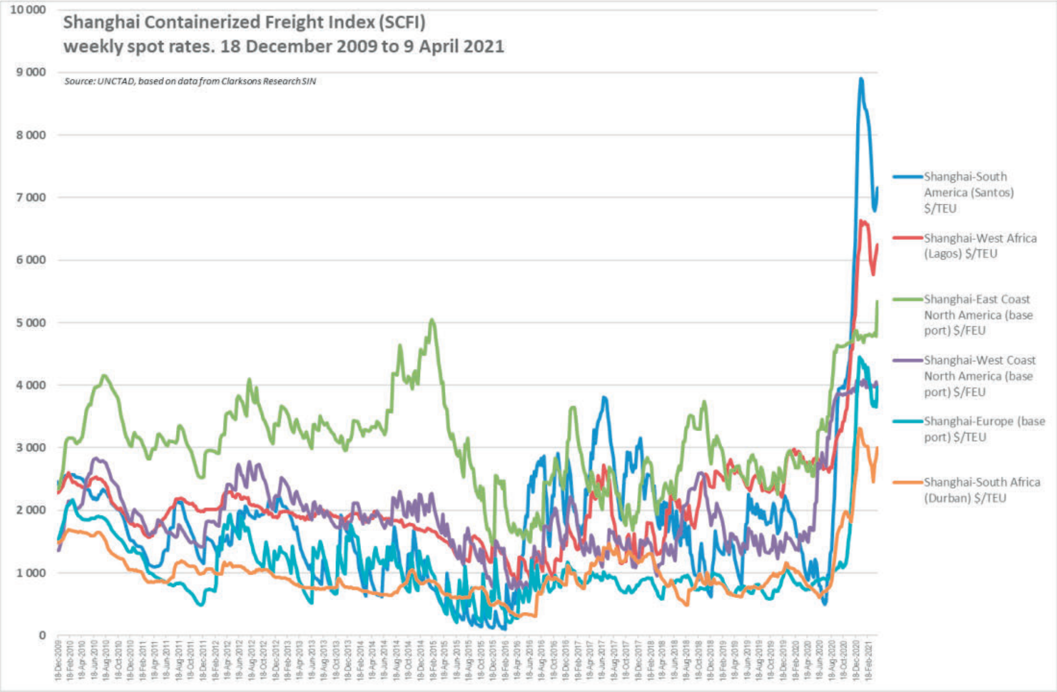
Chapter 3.3 below, discusses in more detail the development dimension, and the impact of the IMO short term measure on developing countries.

### *3.2.3 Freight Levels and Volatility*

To put the above results into perspective, it is worth illustrating how freight rates change over time, and how the changes that may result from the IMO short-term measure compare to freight rate levels and volatility (Figure 20, Figure 21, and Figure 22).

The blue line in Figure 21 represents the historical data of the spot freight rate (transports costs) for a 20-foot container from Shanghai to Santos, while the green dotted line represents the hypothetical freight rate if the transport costs had been 0.4% higher, in line with the EEXI-Only scenario in 2030 from Table 8. In Figure 22, the blue line represents the historical data, while the red dotted line represents an increase in transport costs of 7.1% in line with the estimated increase in transport costs of Brazilian imports by 2030 from Table 8.

Figure 20: Containerized freight rates, 2009 - 2021



*Source: UNCTAD, based on data provided by Clarksons Research, 2021.*

Figure 21: Containerized freight rates, Shanghai – Santos, EEXI-Only scenario 2009 - 2021

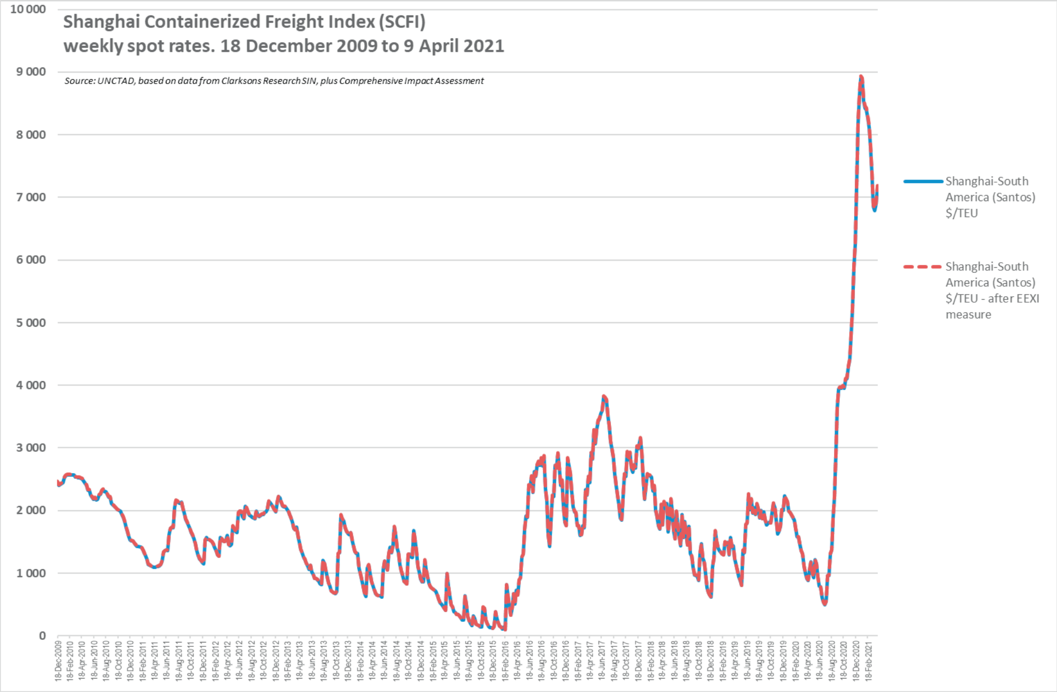
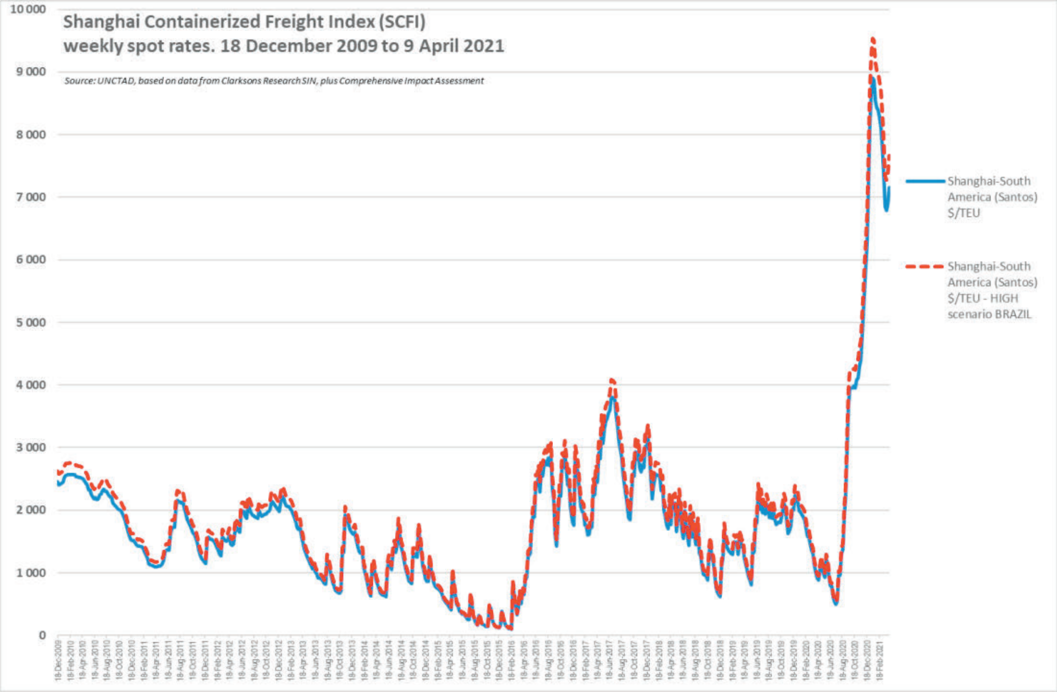


Figure 22: Containerized freight rates, Shanghai – Santos, HIGH-GHG reduction scenario for Brazilian imports, 2009 -2021



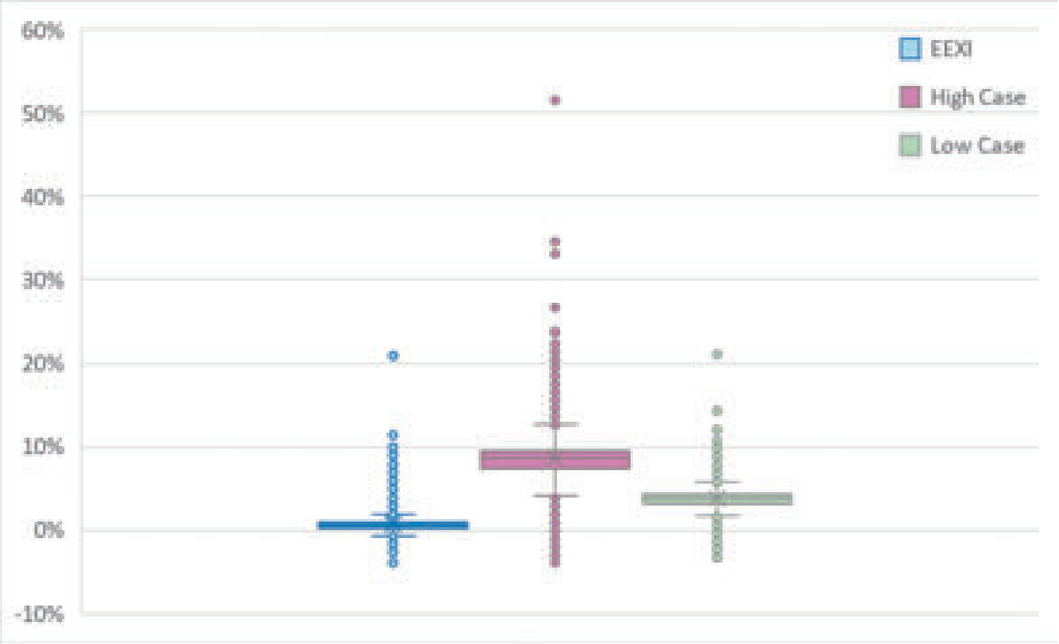
*Source: UNCTAD, based on data provided by Clarksons Research 2021, and estimates of higher shipping (transport) costs resulting from IMO short-term measure.*

### *3.2.4 Impact on Supply Chains*

In addition to the comprehensive assessment presented above, it was felt that an additional more granular analysis of the impacts on some sectors and supply chains would be beneficial to better appreciate some of the nuanced impacts of the IMO measure. This section provides a snapshot summary of the aggregate impact on supply chains, highlighting the extent to which individual supply chain trades may be most (or least) impacted when considered independently compared with aggregated country trade figures. A more granular analysis of illustrative case studies is carried out and presented in Chapter 4 of this Report and provides a more in-depth analysis of the cost impact on selected country trade supply chains.

Figure 23 provides a snapshot summary of aggregate maritime total logistics costs for all country-sector trade or supply chain pairs under each of the three GHG reduction scenarios, relative to 2030 baseline Current Regulations scenario. The analysis at supply chain levels or sector-trade pairs provides interesting granular insights with more nuanced results.

Figure 23: Percentage changes in total maritime logistics costs by regulatory scenario, relative to 2030 baseline, per country-country-sector trade

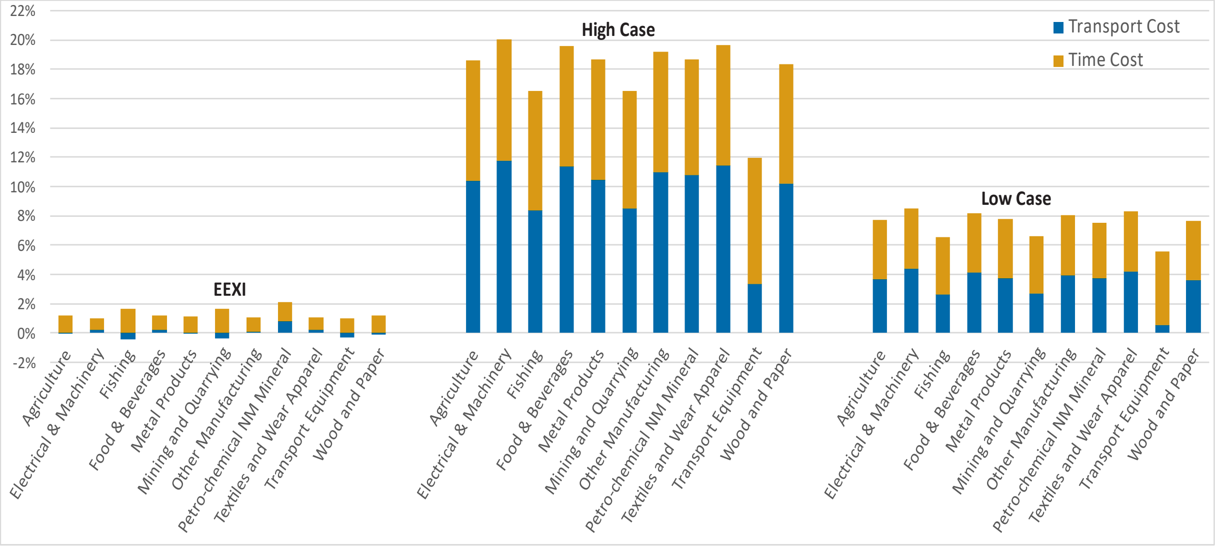


*Source: UNCTAD, based on data provided MDS Transmodal (MDST).*

At one end of the scale, Figure 23 indicates that for some supply chains and trade pairs, there is a positive impact of the IMO short-term measure as shown by trade pairs where the change in total maritime logistics costs is negative or below 0. Interestingly, this positive impact is replicated across all three GHG reduction scenarios. At the other end of the scale, some outlier supply chain trades may experience a steep increase in maritime logistics costs by as much as 58%. Given the scale of cost increases for these supply chains, this would most likely have major implications ranging from modal and nodal shifts, e.g., from sea to air or port to port; to wider supply chain reconfigurations, sourcing from neighbouring trading partners, regionalisation of trade flows and some loss of trade.

Another reading from Figure 23 is the relative alignment of EEXI-Only and LOW-GHG reduction scenario cost impacts. Both scenarios trigger similar upper (+24%) and lower (-7%) total cost changes against an average increase of 3.8% for LOW-GHG reduction and a negligeable 0.07% for EEXI-Only measures. Given that logistics costs are primarily born by cargo and supply chain interests, a small cost change of the magnitude shown in EEXI-Only and LOW-GHG reduction scenarios above may end up becoming internalized by supply chain stakeholders rather than being externalized to consumers or society.

Figure 24: Percentage changes in transport and time costs by sector and regulatory scenario, relative to the 2030 baseline scenario



*Source: UNCTAD, based on data provided MDS Transmodal (MDST).*

To illustrate the interplay between shipping (transport) costs and time-related costs, Figure 24 depicts average percentage changes of both sets of costs across sectors and three regulatory scenarios. It shows that time-related costs generally take a bigger proportion of total logistics costs than transport costs. This is particularly the case for sectors and supply chains such as ‘Transport Equipment’ where time-related costs far outweigh transport costs across the three regulatory scenarios. But the weight of time-costs relative to transport costs is more pronounced under the EEXI-Only scenario, reflecting the impact of speed reduction derived from the EEXI requirements. Conversely, for the HIGH-GHG reduction scenario, all trade sectors, except for ‘Transport Equipment’, show almost an equal weight of transport costs and time-related costs.

The above provides only a snapshot summary of average costs per sector and regulatory scenarios and an itemized analysis per country-sector trade pair would be required to appreciate the full extent of the impact and interplay between shipping (transport) costs and time costs. A more granular analysis will also be required to better understand the trade-offs that may take place at supply chain and trading levels, including decisions on modal shifts, product and trade substitutions, regionalization of trade, nearshoring, and other supply chain reconfigurations.

## 3.3 Impact on Trade, Income and GVC Participation

### *3.3.1 Aggregate Results*

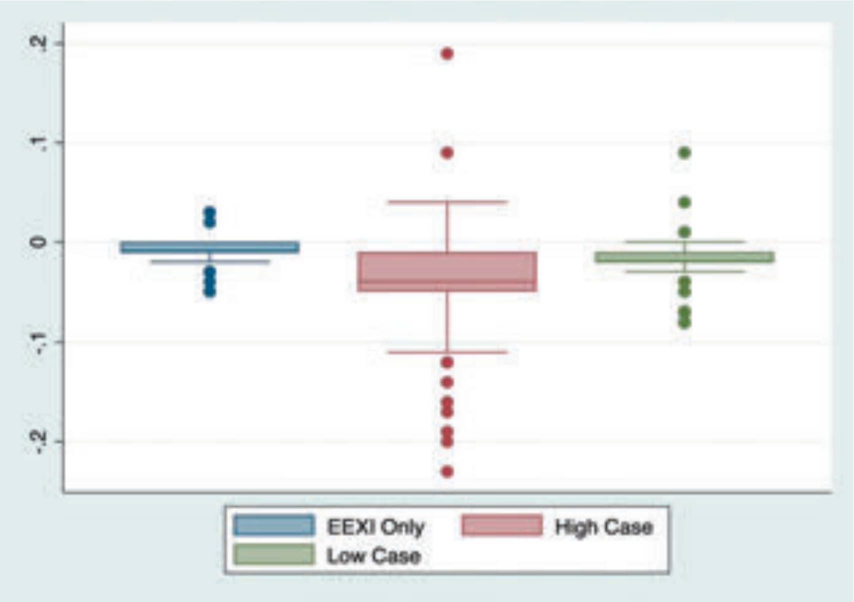
For an overview of model results, it is appropriate to proceed at the aggregate level. To do so, the analysis examines changes in real income (GDP), merchandise exports and merchandise imports across the 184 economies for which data are considered sufficiently reliable.[8]

Figure 25, Figure 26 and Figure 27 present the aggregate results. Summary results for the large number of individual countries, for which the model generated results, and in line with previous analysis on maritime logistics costs, are presented in box plots.

Starting with Figure 25, the data shows that changes in real income are typically small in all scenarios. For EEXI-Only, the median country sees a change in real income of -0.01%, while the HIGH- and LOW-GHG reduction cases have medians of -0.04% and -0.02% respectively. The distribution of country real income changes around the median is relatively tight in all three cases, which means that countries tend to see small changes in real income even in the HIGH-GHG reduction case. However, there is a substantial number of outliers where changes in real income are larger in absolute value, ranging between -0.1% and -0.2% at the bottom end and 0.1% and 0.2% at the high end in the HIGH-GHG reduction case. Table 11 contains full results by country, as summarized in the figures. Even in the HIGH-GHG reduction case, changes in real income are typically relatively small.

Figure 25 shows that changes in exports are considerably larger than changes in real income, as is typically the case for global trade simulations.

Figure 25: Percentage change in real income relative to the 2030 baseline, by scenario.



*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

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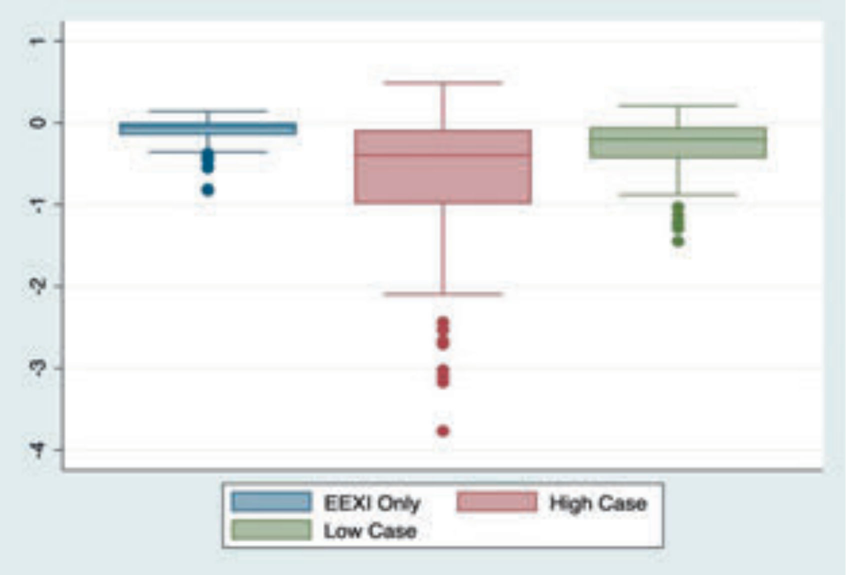
[8] The full dataset covers 185 economies, but Belarus has an implausibly high trade to output ratio, perhaps due to distortions caused by rerouting of third country trade. It is therefore dropped from the results discussion as an outlier.

For the EEXI-Only scenario, results display relatively small changes in total merchandise exports even when accounting of outliers. This is consistent with the results of previous analysis on the impact of EEXI-Only measures on maritime costs.

For the other two regulatory scenarios, there are more negative median values (-0.4% for the HIGH-GHG reduction and -0.2% for the LOW-GHG reduction) but also a broader dispersion of results. This suggests that while the impacts on global trade flows taken as a whole, are relatively small, the impact on some countries is much larger. This is particularly true in the HIGH-GHG reduction scenario where the most affected countries see falls of total merchandise exports of up to -4% by 2030. In summary, ten countries have seen a drop in total merchandise exports of more than 2% by 2030: Cuba, Argentina, Angola, Guinea, Jamaica, Belize, Senegal, New Caledonia, Australia, and United Republic of Tanzania. All these countries, except Australia and New Caledonia (a French territory), are classified as low and middle income.

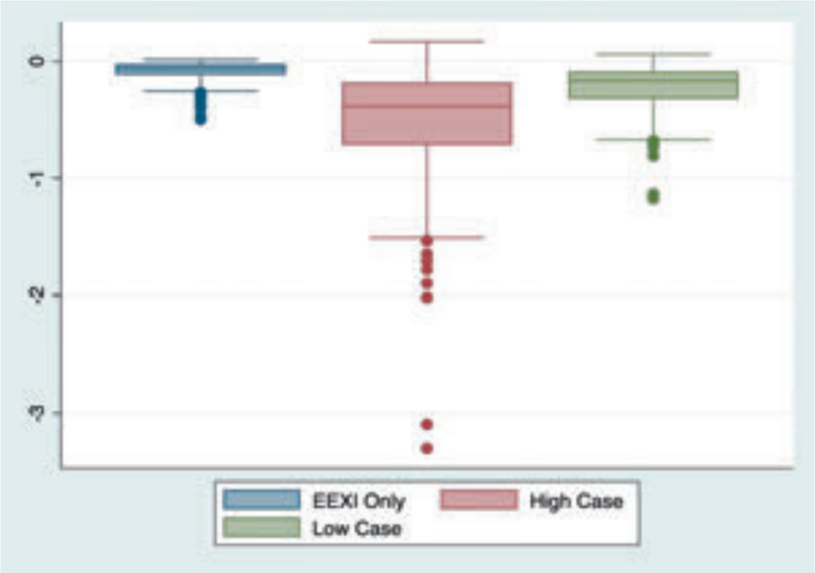
Figure 26 presents the same information for imports. Results are broadly similar in terms of the central tendencies of the data (median) and the degree of dispersion. However, in percentage terms, import changes tend to be a little smaller than export changes. In the HIGH-GHG reduction scenario, all but two countries see falls of approximately -2% or less in absolute value; the number of larger falls was higher for exports, as indicated by a more significant clustering of outlier points in Figure 25 relative to Figure 26. In the model, changes in exports and changes in imports are closely linked because each country's trade deficit is exogenous, i.e., it does not change owing to the shock applied to the model. The reason is that the trade deficit is largely determined by savings and investment decisions that are outside the model's scope.

Figure 26: Percentage change in total merchandise exports relative to the 2030 baseline, by scenario



*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

Figure 27: Percentage change in total merchandise imports relative to the 2030 baseline, by scenario

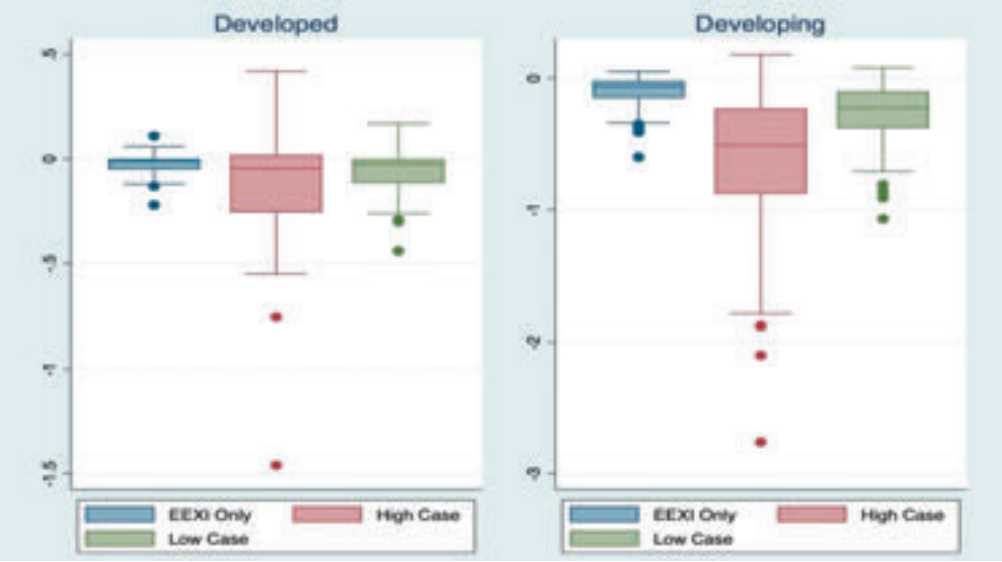


*Source: UNCTAD, based on the results of global trade model used for the impact assessment.*

### *3.3.2 Results by Country Group*

This section therefore focuses on the effects on exports, and breaks the data out by country groups as defined by the UN.

Figure 28: Percentage change in total merchandise exports relative to the 2030 baseline, by scenario and country group



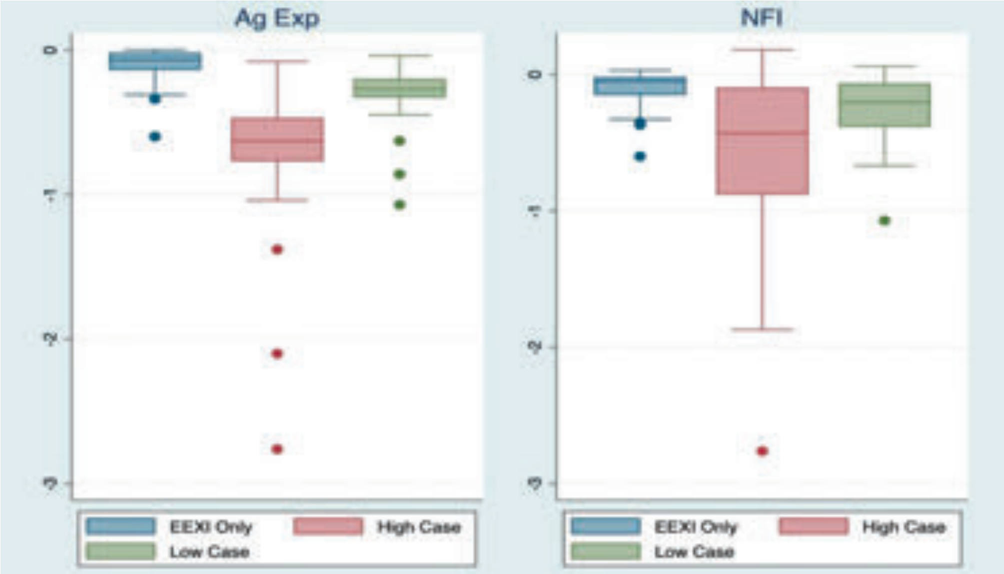
*Source: UNCTAD, based on the results of global trade model used for the impact assessment. For the composition of the country groupings see https://unctadstat.unctad.org/EN/Documentation.html.*

Figure 29 shows the distribution of impacts on export for the developing and developed country groups. Impacts under the EEXI-Only scenario are small in both cases, though they are larger in absolute value for developing countries than for developed ones. In the LOW-and HIGH-GHG reduction cases, these differences become more apparent. In both cases, the distribution is shifted downwards for developing countries relative to developed countries, which means that the former will experience larger export declines than the latter.

In the HIGH-GHG reduction scenario, the median impact for developed countries is -0.05%, but for developing countries, it is -0.5%. Looking at the central tendency, it becomes evident that developing countries are more negatively affected by the LOW- and HIGH-GHG reduction scenarios than are developed countries, although the impact in terms of baseline trade is still small when total merchandise exports are considered as an aggregate. Finally, the distribution of points shows that countries regarded as outliers in terms of the overall distribution tend to see much larger negative effects in the developing country group as opposed to the developed, up to double.

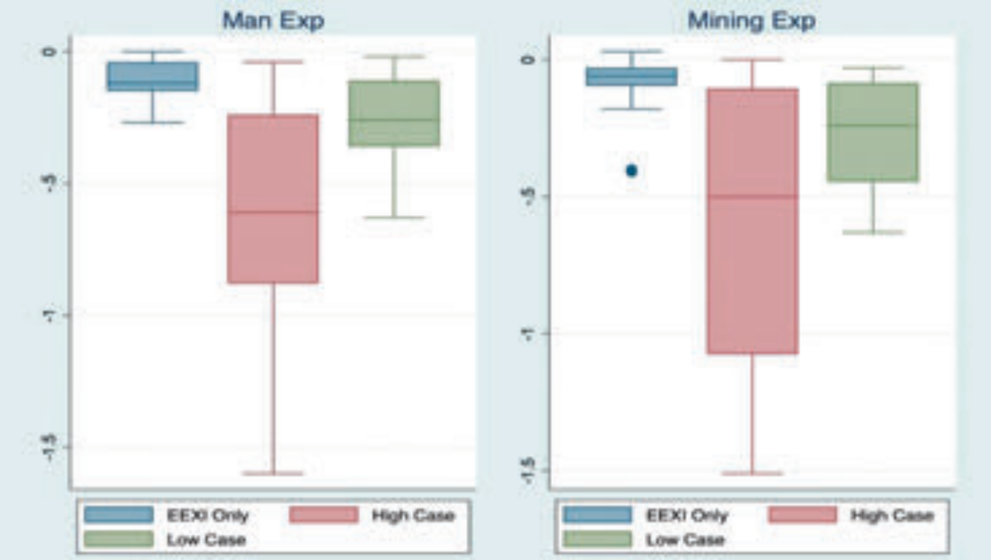
Figure 30 shows results for the agricultural exporters group and the net food importing group. Impacts are typically negative in both groups, although the dispersion of impacts is larger for the net food importers than for the agricultural exporters. Median impacts are very similar, at -0.4% for the net food importers and -0.6% for the agricultural exporters in the HIGH-GHG reduction case. Again, the conclusion is that these groups can expect to see a reduction in exports relative to the baseline, but that it is relatively small when the baseline considered is total merchandise exports. Under the EEXI-Only scenario, the reduction in exports is considerably smaller than under the HIGH-GHG or LOW-GHG reduction scenarios.

Figure 29: Percentage change in total merchandise exports relative to the 2030 baseline, by scenario and country group



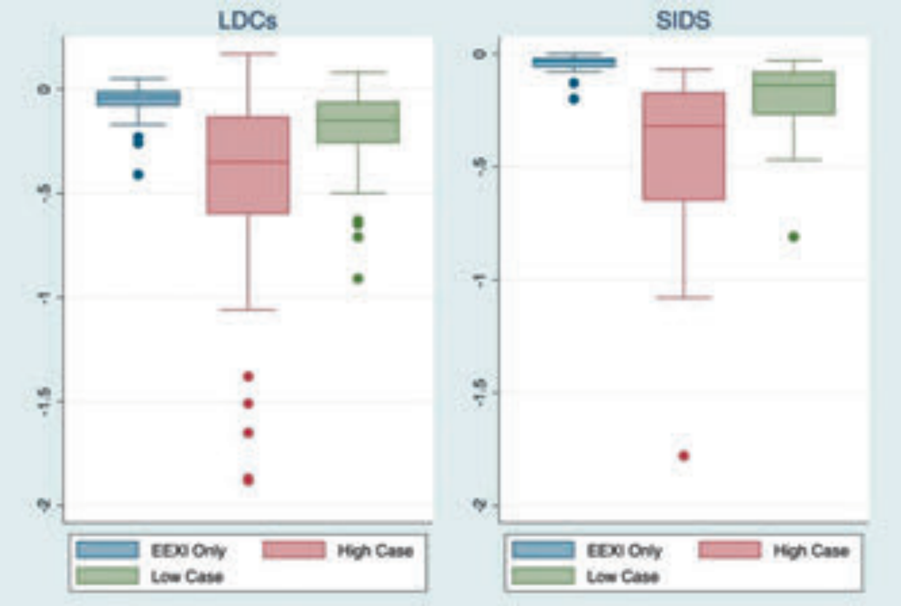
*Source: UNCTAD, based on the results of the global trade model used for the impact of assessment. Ag Exp are agricultural exporters; NFI are net-food importers. For the composition of the country groupings see [https://unctadstat.unctad.org/EN/Documentation.html](https://unctadstat.unctad.org/EN/Documentation.html).*

Figure 30: Percentage change in total merchandise exports relative to the 2030 baseline, by scenario and country group



*Source: UNCTAD, based on the results of the global trade model used for the impact assessment. Man Exp are manufacturing exporters; Mining Exp are exporters of mining commodities. For the composition of the country groupings see [https://unctadstat.unctad.org/EN/Documentation.html](https://unctadstat.unctad.org/EN/Documentation.html).*

Figure 31: Percentage change in total merchandise exports relative to the 2030 baseline, by scenario and country group



*Source: UNCTAD, based on the results of the global trade model used for the impact assessment. For the composition of the country groupings see [https://unctadstat.unctad.org/EN/Documentation.html.](https://unctadstat.unctad.org/EN/Documentation.html)*

Figure 30 turns to the group of manufacturing exporters, and the group of mining exporters. Both groups can expect to see a reduction in total merchandise exports in all three scenarios, following the same relative pattern as for other developing country groups. The reduction is generally not too large in an aggregate sense, even for the HIGH-GHG reduction scenario. The median manufacturing exporter sees a drop in total merchandise exports of -0.6% under the HIGH-GHG reduction scenario, while the median for mining exporters is very close at -0.5%. Dispersion is larger for the mining exporters relative to the manufacturing exporters.

Finally, Figure 31 examines two vulnerable groups, the Least Developed Countries (LDCs) and the Small Island Developing States (SIDS). Impacts for these two groups are typically more negative than for the other groups, with export falls close to 2% of baseline in some cases. Again, this figure is not large in a relative sense, given that the benchmark is total merchandise exports. Under the HIGH-GHG reduction scenario, the median fall in exports is -0.4% for the LDC group, and -0.3% for the SIDS group. Comparing these numbers with those for the other groups suggests that the central tendency is comparable to what is seen in other developing country groups, but the figure suggests that dispersion is greater. Table 10 presents the summary results by county group.

Table 10: Simulated average percentage change in income (GDP) by country group. Three IMO 2030 GHG reduction scenarios as compared to the 2030 baseline scenario (Current Regulations)

| Group | EEXI only | HIGH | LOW |
|---|---|---|---|
| Developed (coastal) | -0.0074 | -0.0342 | -0.0153 |
| Developing Africa (coastal) | -0.0114 | -0.0636 | -0.0271 |
| Developing Asia (coastal) | -0.0112 | -0.0542 | -0.0250 |
| Developing Latin America (coastal) | -0.0093 | -0.0493 | -0.0207 |
| SIDS | -0.0064 | -0.0489 | -0.0211 |
| LDC (coastal) | -0.0071 | -0.0538 | -0.0214 |
| Land-locked | -0.0010 | -0.0167 | -0.0081 |
| **Average all economies** | **-0.0067** | **-0.0410** | **-0.0179** |

*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*
*Note: a change of -0.01% is equivalent to a change of -0.0001 times the baseline 2030 GDP value.*
*Averages are unweighted, i.e., each country is given the same weight when generating the average.*

### 3.3.3 Disaggregated Results

While aggregate and group results presented above are informative in a general sense, they mask substantial heterogeneity at a disaggregated level. It is therefore important to look in detail at trade flows at the exporter-importer-sector level, to see whether the general pattern above of relatively small effects, albeit with some outliers, holds up. Full results are shown in Table 11.

Table 11: Disaggregated results by country and territory, percent change over the 2030 baseline (Current Regulations), by scenario

| | Real Income | | | Exports | | | Imports | | |
|---|---|---|---|---|---|---|---|---|---|
| | EEXI Only | High Case | Low Case | EEXI Only | High Case | Low Case | EEXI Only | High Case | Low Case |
| **Afghanistan** | 0.00 | -0.01 | -0.01 | -0.06 | -0.86 | -0.34 | -0.06 | -0.43 | -0.21 |
| **Albania** | -0.01 | -0.03 | -0.02 | -0.08 | -0.15 | -0.10 | -0.06 | -0.15 | -0.08 |

| | Real Income | | | Exports | | | Imports | | |
|---|---|---|---|---|---|---|---|---|---|
| | EEXI Only | High Case | Low Case | EEXI Only | High Case | Low Case | EEXI Only | High Case | Low Case |
| **Algeria** | -0.05 | -0.17 | -0.07 | -0.42 | -1.40 | -0.61 | -0.47 | -1.53 | -0.67 |
| **Andorra** | 0.00 | -0.01 | 0.00 | 0.02 | 0.10 | 0.04 | 0.00 | -0.01 | 0.00 |
| **Angola** | -0.03 | -0.23 | -0.08 | -0.38 | -3.10 | -1.03 | -0.40 | -3.30 | -1.18 |
| **Antigua and Barbuda** | 0.00 | -0.03 | -0.02 | -0.01 | -0.20 | -0.08 | -0.02 | -0.19 | -0.08 |
| **Argentina** | -0.02 | -0.17 | -0.07 | -0.55 | -3.17 | -1.29 | -0.27 | -1.78 | -0.73 |
| **Armenia** | 0.00 | -0.01 | -0.01 | 0.00 | -0.03 | -0.02 | -0.01 | -0.11 | -0.06 |
| **Aruba** | 0.00 | -0.05 | -0.02 | 0.02 | -0.25 | -0.09 | -0.01 | -0.21 | -0.08 |
| **Australia** | -0.01 | -0.08 | -0.02 | -0.31 | -2.10 | -0.61 | -0.50 | -3.10 | -1.14 |
| **Austria** | 0.00 | -0.01 | -0.01 | 0.00 | -0.02 | -0.02 | 0.00 | -0.02 | -0.02 |
| **Azerbaijan** | 0.00 | 0.00 | 0.00 | 0.02 | 0.13 | 0.05 | -0.01 | -0.03 | -0.02 |
| **Bahamas** | -0.01 | -0.05 | -0.02 | -0.03 | -0.31 | -0.15 | -0.01 | -0.19 | -0.08 |
| **Bahrain** | -0.01 | -0.05 | -0.02 | -0.30 | -1.05 | -0.52 | -0.20 | -0.78 | -0.38 |
| **Bangladesh** | -0.01 | -0.04 | -0.01 | -0.12 | -1.12 | -0.42 | -0.12 | -0.73 | -0.29 |
| **Barbados** | -0.01 | -0.05 | -0.02 | -0.03 | -0.70 | -0.31 | -0.02 | -0.30 | -0.13 |
| **Belgium** | -0.01 | -0.04 | -0.02 | -0.04 | -0.15 | -0.08 | -0.06 | -0.21 | -0.10 |
| **Belize** | -0.03 | -0.12 | -0.05 | -0.82 | -2.67 | -1.13 | -0.23 | -0.87 | -0.37 |
| **Benin** | 0.00 | -0.03 | -0.01 | -0.14 | -0.55 | -0.26 | -0.06 | -0.39 | -0.17 |
| **Bermuda** | 0.00 | -0.01 | -0.01 | 0.04 | 0.08 | 0.04 | -0.02 | -0.06 | -0.03 |
| **Bhutan** | 0.00 | -0.04 | -0.02 | 0.14 | 0.18 | 0.10 | 0.00 | -0.31 | -0.13 |
| **Bolivia (Plurinational State of)** | -0.01 | -0.06 | -0.02 | -0.08 | -0.32 | -0.14 | -0.10 | -0.46 | -0.19 |
| **Bosnia and Herzegovina** | 0.00 | -0.01 | 0.00 | 0.02 | 0.07 | 0.02 | 0.00 | 0.01 | 0.00 |
| **Botswana** | 0.00 | 0.01 | 0.00 | 0.04 | -0.23 | -0.14 | 0.00 | -0.02 | -0.01 |
| **Brazil** | -0.01 | -0.05 | -0.02 | -0.41 | -1.90 | -0.65 | -0.29 | -1.40 | -0.50 |
| **British Virgin Islands** | 0.00 | -0.05 | -0.02 | -0.07 | -1.23 | -0.55 | -0.04 | -0.44 | -0.20 |
| **Brunei Darussalam** | 0.00 | 0.04 | 0.00 | 0.05 | 0.44 | 0.06 | -0.05 | 0.01 | -0.11 |
| **Bulgaria** | 0.00 | -0.01 | -0.01 | 0.00 | 0.00 | 0.00 | -0.01 | -0.04 | -0.02 |
| **Burkina Faso** | 0.00 | -0.04 | -0.02 | -0.04 | -0.59 | -0.29 | -0.03 | -0.24 | -0.11 |
| **Burundi** | 0.00 | -0.02 | -0.01 | 0.01 | -0.23 | -0.09 | -0.03 | -0.46 | -0.19 |
| **Cabo Verde** | -0.01 | -0.05 | -0.02 | -0.06 | -0.30 | -0.14 | -0.07 | -0.34 | -0.16 |
| **Cambodia** | -0.01 | -0.03 | -0.01 | -0.04 | -0.22 | -0.10 | -0.05 | -0.21 | -0.10 |
| **Cameroon** | 0.00 | -0.04 | -0.02 | -0.05 | -0.87 | -0.39 | -0.07 | -0.82 | -0.37 |
| **Canada** | 0.00 | -0.02 | -0.01 | -0.03 | -0.23 | -0.09 | -0.04 | -0.32 | -0.13 |
| **Cayman Islands** | 0.00 | -0.02 | -0.01 | 0.02 | -0.03 | -0.02 | -0.04 | -0.25 | -0.11 |
| **Central African Republic** | 0.00 | -0.02 | -0.01 | -0.04 | -0.46 | -0.23 | -0.05 | -0.48 | -0.23 |
| **Chad** | 0.00 | 0.00 | 0.00 | 0.02 | 0.10 | 0.02 | -0.03 | -0.24 | -0.12 |
| **Chile** | 0.00 | -0.05 | -0.02 | -0.12 | -1.33 | -0.56 | -0.10 | -0.92 | -0.40 |
| **China** | -0.01 | -0.03 | -0.02 | -0.13 | -0.69 | -0.29 | -0.17 | -0.89 | -0.36 |
| **China, Hong Kong SAR** | -0.01 | -0.06 | -0.02 | 0.01 | -0.03 | -0.01 | 0.00 | -0.03 | -0.02 |
| **China, Macao SAR** | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | -0.01 | -0.08 | -0.04 |
| **China, Taiwan Province of** | 0.00 | -0.02 | -0.01 | -0.01 | -0.10 | -0.05 | -0.03 | -0.20 | -0.09 |
| **Colombia** | -0.01 | -0.04 | -0.02 | -0.13 | -0.97 | -0.42 | -0.09 | -0.66 | -0.28 |
| **Congo** | -0.01 | -0.08 | -0.03 | -0.10 | -0.68 | -0.22 | -0.12 | -0.81 | -0.32 |
| **Congo, Democratic. Republic of the** | 0.00 | -0.03 | -0.01 | -0.03 | -0.47 | -0.25 | -0.03 | -0.31 | -0.15 |
| **Costa Rica** | -0.01 | -0.04 | -0.02 | -0.10 | -0.68 | -0.30 | -0.08 | -0.57 | -0.25 |
| **Côte d'Ivoire** | -0.01 | -0.09 | -0.04 | -0.07 | -1.17 | -0.53 | -0.15 | -1.49 | -0.68 |
| **Croatia** | 0.00 | -0.01 | -0.01 | 0.01 | 0.03 | 0.01 | 0.00 | -0.01 | -0.01 |
| **Cuba** | -0.01 | -0.05 | -0.02 | -0.81 | -3.77 | -1.45 | -0.20 | -0.98 | -0.39 |

| | Real Income | | | Exports | | | Imports | | |
|---|---|---|---|---|---|---|---|---|---|
| | EEXI Only | High Case | Low Case | EEXI Only | High Case | Low Case | EEXI Only | High Case | Low Case |
| **Cyprus** | -0.01 | -0.04 | -0.02 | -0.12 | -0.61 | -0.33 | -0.06 | -0.25 | -0.13 |
| **Czechia** | 0.00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 |
| **Denmark** | 0.00 | -0.02 | -0.01 | -0.02 | -0.06 | -0.04 | -0.02 | -0.07 | -0.04 |
| **Djibouti** | 0.00 | -0.03 | -0.01 | -0.04 | -0.31 | -0.14 | -0.05 | -0.36 | -0.17 |
| **Dominican Republic** | -0.01 | -0.05 | -0.02 | -0.17 | -0.95 | -0.44 | -0.11 | -0.75 | -0.33 |
| **Ecuador** | -0.01 | -0.05 | -0.02 | -0.07 | -0.91 | -0.40 | -0.12 | -0.78 | -0.34 |
| **Egypt** | -0.01 | -0.04 | -0.02 | -0.45 | -1.69 | -0.80 | -0.25 | -0.97 | -0.46 |
| **El Salvador** | -0.01 | -0.03 | -0.01 | -0.10 | -0.33 | -0.16 | -0.05 | -0.21 | -0.10 |
| **Eritrea** | 0.00 | 0.00 | 0.00 | 0.00 | -0.11 | -0.05 | -0.03 | -0.30 | -0.13 |
| **Estonia** | 0.00 | -0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 |
| **Eswatini** | 0.00 | 0.01 | -0.01 | -0.11 | -0.62 | -0.33 | -0.02 | -0.11 | -0.06 |
| **Ethiopia** | -0.01 | -0.16 | -0.07 | 0.00 | -0.34 | -0.15 | 0.00 | -0.12 | -0.05 |
| **Fiji** | -0.01 | -0.05 | -0.02 | -0.27 | -1.59 | -0.54 | -0.09 | -0.58 | -0.21 |
| **Finland** | 0.00 | -0.02 | -0.01 | -0.04 | -0.13 | -0.07 | -0.04 | -0.15 | -0.08 |
| **France** | 0.00 | -0.02 | -0.01 | -0.03 | -0.14 | -0.07 | -0.04 | -0.20 | -0.09 |
| **French Polynesia** | 0.00 | -0.03 | -0.01 | 0.00 | -0.24 | -0.13 | -0.02 | -0.24 | -0.11 |
| **Gabon** | -0.01 | -0.05 | -0.01 | -0.11 | -0.80 | -0.22 | -0.08 | -0.71 | -0.23 |
| **Gambia** | 0.00 | -0.04 | -0.02 | -0.02 | -0.47 | -0.22 | -0.06 | -0.52 | -0.25 |
| **Georgia** | 0.00 | -0.01 | -0.01 | -0.04 | -0.18 | -0.09 | -0.02 | -0.12 | -0.05 |
| **Germany** | 0.00 | -0.01 | -0.01 | -0.02 | -0.08 | -0.04 | -0.02 | -0.12 | -0.06 |
| **Ghana** | -0.01 | -0.06 | -0.03 | -0.12 | -1.72 | -0.74 | -0.12 | -1.30 | -0.57 |
| **Greece** | -0.01 | -0.04 | -0.02 | -0.15 | -0.64 | -0.33 | -0.07 | -0.30 | -0.16 |
| **Greenland** | 0.00 | -0.01 | 0.00 | 0.12 | 0.21 | 0.07 | 0.01 | -0.08 | -0.05 |
| **Guatemala** | -0.01 | -0.04 | -0.02 | -0.23 | -0.96 | -0.42 | -0.13 | -0.64 | -0.28 |
| **Guinea** | -0.03 | -0.12 | -0.05 | -0.83 | -3.02 | -1.23 | -0.32 | -1.35 | -0.58 |
| **Guyana** | 0.00 | -0.02 | -0.01 | -0.55 | -1.74 | -0.73 | -0.10 | -0.65 | -0.29 |
| **Haiti** | 0.00 | -0.02 | -0.01 | -0.01 | -0.33 | -0.15 | -0.05 | -0.49 | -0.22 |
| **Honduras** | -0.01 | -0.04 | -0.02 | -0.10 | -0.54 | -0.23 | -0.08 | -0.44 | -0.19 |
| **Hungary** | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.01 | 0.00 | 0.02 | 0.00 |
| **Iceland** | -0.01 | -0.04 | -0.02 | -0.10 | -0.44 | -0.26 | -0.09 | -0.38 | -0.21 |
| **India** | -0.02 | -0.10 | -0.04 | -0.31 | -1.90 | -0.75 | -0.36 | -2.02 | -0.81 |
| **Indonesia** | -0.02 | -0.07 | -0.03 | -0.23 | -0.86 | -0.39 | -0.40 | -1.54 | -0.70 |
| **Iran, Islamic Republic of** | -0.02 | -0.11 | -0.05 | -0.36 | -1.87 | -0.84 | -0.25 | -1.13 | -0.52 |
| **Iraq** | 0.00 | 0.02 | 0.01 | 0.06 | 0.33 | 0.12 | 0.01 | 0.08 | 0.02 |
| **Ireland** | -0.01 | -0.03 | -0.02 | -0.03 | -0.06 | -0.04 | -0.07 | -0.19 | -0.10 |
| **Israel** | 0.00 | -0.02 | -0.01 | -0.05 | -0.26 | -0.13 | -0.07 | -0.34 | -0.16 |
| **Italy** | -0.01 | -0.03 | -0.01 | -0.05 | -0.21 | -0.10 | -0.08 | -0.34 | -0.16 |
| **Jamaica** | -0.01 | -0.08 | -0.04 | -0.28 | -2.71 | -1.22 | -0.10 | -0.86 | -0.38 |
| **Japan** | -0.01 | -0.04 | -0.02 | -0.17 | -0.66 | -0.29 | -0.17 | -0.83 | -0.33 |
| **Jordan** | -0.02 | -0.08 | -0.04 | -0.43 | -1.70 | -0.72 | -0.17 | -0.69 | -0.31 |
| **Kazakhstan** | -0.01 | -0.01 | -0.01 | -0.10 | -0.24 | -0.13 | -0.07 | -0.21 | -0.11 |
| **Kenya** | -0.01 | -0.06 | -0.03 | -0.02 | -0.56 | -0.25 | -0.06 | -0.64 | -0.27 |
| **Korea, Democratic People's Republic of** | 0.00 | -0.05 | -0.03 | 0.00 | -0.35 | -0.17 | -0.04 | -0.83 | -0.38 |
| **Korea, Republic of** | -0.05 | -0.20 | -0.08 | -0.31 | -1.08 | -0.48 | -0.29 | -1.12 | -0.48 |
| **Kuwait** | -0.01 | -0.02 | -0.02 | 0.00 | 0.04 | -0.03 | -0.04 | -0.14 | -0.10 |
| **Kyrgyzstan** | 0.00 | -0.01 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.06 | -0.03 |
| **Lao People's Democratic** | 0.00 | 0.00 | 0.00 | -0.01 | -0.12 | -0.06 | -0.02 | -0.10 | -0.05 |

| | Real Income | | | Exports | | | Imports | | |
|---|---|---|---|---|---|---|---|---|---|
| | EEXI Only | High Case | Low Case | EEXI Only | High Case | Low Case | EEXI Only | High Case | Low Case |
| **Republic** | | | | | | | | | |
| **Latvia** | 0.00 | -0.01 | 0.00 | -0.01 | 0.02 | 0.00 | -0.01 | -0.02 | -0.01 |
| **Lebanon** | -0.01 | -0.04 | -0.02 | -0.08 | -0.93 | -0.45 | -0.04 | -0.33 | -0.16 |
| **Lesotho** | 0.00 | -0.03 | -0.01 | 0.03 | 0.03 | 0.00 | -0.01 | -0.15 | -0.06 |
| **Liberia** | 0.00 | -0.02 | -0.01 | 0.02 | -0.23 | -0.11 | -0.09 | -0.93 | -0.44 |
| **Libya** | 0.00 | -0.01 | -0.01 | -0.03 | -0.12 | -0.09 | -0.07 | -0.31 | -0.18 |
| **Liechtenstein** | 0.00 | 0.00 | 0.00 | 0.03 | 0.22 | 0.09 | 0.00 | 0.07 | 0.03 |
| **Lithuania** | 0.00 | -0.02 | -0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.02 | 0.00 |
| **Luxembourg** | -0.01 | -0.03 | -0.01 | 0.00 | 0.06 | 0.02 | 0.00 | 0.03 | 0.01 |
| **Madagascar** | -0.01 | -0.07 | -0.03 | -0.04 | -0.64 | -0.28 | -0.07 | -0.77 | -0.32 |
| **Malawi** | 0.00 | -0.02 | -0.01 | -0.02 | -0.28 | -0.14 | -0.02 | -0.20 | -0.10 |
| **Malaysia** | -0.04 | -0.19 | -0.08 | -0.20 | -0.80 | -0.36 | -0.25 | -0.99 | -0.45 |
| **Maldives** | -0.01 | -0.07 | -0.03 | -0.01 | -1.23 | -0.43 | -0.06 | -0.44 | -0.18 |
| **Mali** | -0.01 | -0.05 | -0.03 | -0.11 | -1.85 | -0.87 | -0.08 | -0.72 | -0.35 |
| **Malta** | -0.02 | -0.07 | -0.03 | -0.08 | -0.35 | -0.20 | -0.07 | -0.30 | -0.16 |
| **Mauritania** | -0.01 | -0.09 | -0.04 | -0.19 | -1.27 | -0.58 | -0.10 | -0.69 | -0.32 |
| **Mauritius** | -0.01 | -0.10 | -0.04 | -0.10 | -1.58 | -0.69 | -0.05 | -0.85 | -0.35 |
| **Mexico** | 0.00 | -0.01 | -0.01 | -0.03 | -0.17 | -0.07 | -0.04 | -0.23 | -0.10 |
| **Moldova, Republic of** | 0.02 | 0.19 | 0.09 | -0.01 | -0.16 | -0.09 | -0.03 | -0.34 | -0.16 |
| **Mongolia** | -0.01 | -0.02 | -0.02 | -0.05 | -0.01 | -0.10 | -0.09 | -0.22 | -0.16 |
| **Montenegro** | 0.00 | 0.00 | 0.00 | 0.05 | 0.37 | 0.15 | 0.00 | 0.00 | 0.00 |
| **Morocco** | -0.01 | -0.04 | -0.02 | -0.14 | -0.59 | -0.28 | -0.12 | -0.47 | -0.23 |
| **Mozambique** | 0.00 | -0.02 | -0.01 | -0.46 | -1.64 | -0.62 | -0.12 | -0.52 | -0.20 |
| **Myanmar** | 0.00 | -0.01 | 0.00 | 0.01 | 0.00 | 0.00 | -0.17 | -1.65 | -0.71 |
| **Namibia** | 0.00 | -0.02 | -0.01 | -0.09 | -1.32 | -0.53 | -0.03 | -0.42 | -0.17 |
| **Nepal** | 0.00 | -0.03 | -0.01 | 0.02 | -0.34 | -0.12 | -0.02 | -0.40 | -0.15 |
| **Netherlands** | -0.02 | -0.05 | -0.02 | -0.06 | -0.27 | -0.12 | -0.07 | -0.33 | -0.14 |
| **New Caledonia** | -0.01 | -0.06 | -0.02 | -0.42 | -2.44 | -0.68 | -0.17 | -1.15 | -0.33 |
| **New Zealand** | -0.01 | -0.10 | -0.04 | -0.10 | -1.15 | -0.47 | -0.15 | -1.23 | -0.50 |
| **Nicaragua** | -0.01 | -0.03 | -0.01 | -0.20 | -0.84 | -0.38 | -0.09 | -0.40 | -0.18 |
| **Niger** | 0.00 | -0.02 | -0.01 | 0.00 | -0.11 | -0.07 | -0.04 | -0.28 | -0.13 |
| **Nigeria** | 0.00 | -0.04 | -0.02 | -0.04 | -1.03 | -0.46 | -0.06 | -0.74 | -0.33 |
| **North Macedonia** | 0.00 | -0.01 | 0.00 | 0.03 | 0.07 | 0.02 | 0.01 | -0.01 | -0.01 |
| **Norway** | -0.02 | -0.06 | -0.03 | -0.16 | -0.39 | -0.21 | -0.10 | -0.28 | -0.15 |
| **Oman** | -0.03 | -0.12 | -0.04 | -0.34 | -1.55 | -0.51 | -0.22 | -1.01 | -0.37 |
| **Pakistan** | -0.01 | -0.05 | -0.02 | -0.18 | -1.56 | -0.59 | -0.25 | -1.90 | -0.73 |
| **Panama** | -0.01 | -0.05 | -0.02 | -0.08 | -0.61 | -0.26 | -0.06 | -0.50 | -0.21 |
| **Papua New Guinea** | -0.01 | -0.06 | -0.03 | -0.28 | -1.16 | -0.57 | -0.15 | -0.73 | -0.32 |
| **Paraguay** | -0.01 | -0.04 | -0.02 | -0.27 | -1.23 | -0.50 | -0.11 | -0.61 | -0.25 |
| **Peru** | -0.01 | -0.04 | -0.01 | -0.21 | -1.55 | -0.55 | -0.14 | -0.91 | -0.35 |
| **Philippines** | -0.01 | -0.04 | -0.02 | -0.07 | -0.40 | -0.19 | -0.12 | -0.52 | -0.25 |
| **Poland** | 0.00 | -0.01 | -0.01 | -0.01 | -0.02 | -0.02 | -0.02 | -0.07 | -0.04 |
| **Portugal** | -0.01 | -0.04 | -0.02 | -0.06 | -0.31 | -0.14 | -0.05 | -0.24 | -0.11 |
| **Qatar** | 0.00 | -0.01 | -0.01 | -0.04 | -0.13 | -0.13 | -0.13 | -0.53 | -0.32 |
| **Romania** | 0.00 | -0.01 | 0.00 | 0.00 | -0.02 | -0.01 | 0.00 | -0.02 | -0.01 |
| **Russian Federation** | -0.01 | -0.03 | -0.01 | -0.17 | -0.44 | -0.22 | -0.21 | -0.60 | -0.29 |
| **Rwanda** | 0.00 | -0.04 | -0.02 | 0.05 | -0.13 | -0.09 | -0.02 | -0.41 | -0.16 |

| | Real Income | | | Exports | | | Imports | | |
|---|---|---|---|---|---|---|---|---|---|
| | EEXI Only | High Case | Low Case | EEXI Only | High Case | Low Case | EEXI Only | High Case | Low Case |
| **Samoa** | -0.01 | -0.05 | -0.02 | 0.01 | -0.09 | -0.07 | -0.09 | -0.50 | -0.20 |
| **San Marino** | 0.03 | 0.09 | 0.04 | 0.12 | 0.49 | 0.21 | -0.07 | -0.23 | -0.10 |
| **Sao Tome and Principe** | 0.00 | -0.02 | -0.01 | 0.00 | -0.09 | -0.05 | -0.04 | -0.29 | -0.14 |
| **Saudi Arabia** | -0.01 | -0.05 | -0.02 | -0.07 | -1.09 | -0.43 | -0.09 | -0.65 | -0.28 |
| **Senegal** | -0.01 | -0.07 | -0.03 | -0.19 | -2.53 | -1.23 | -0.12 | -1.23 | -0.59 |
| **Serbia** | 0.00 | -0.02 | -0.01 | -0.09 | -0.86 | -0.42 | -0.06 | -0.55 | -0.24 |
| **Seychelles** | 0.00 | -0.07 | -0.03 | 0.04 | -1.01 | -0.44 | -0.03 | -1.00 | -0.41 |
| **Sierra Leone** | -0.01 | -0.04 | -0.02 | -0.05 | -0.72 | -0.36 | -0.06 | -0.45 | -0.21 |
| **Singapore** | -0.02 | -0.09 | -0.04 | -0.05 | -0.32 | -0.15 | -0.04 | -0.26 | -0.12 |
| **Slovakia** | 0.00 | -0.01 | 0.00 | 0.02 | 0.07 | 0.02 | 0.01 | 0.03 | 0.01 |
| **Slovenia** | 0.00 | -0.01 | 0.00 | 0.01 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 |
| **Somalia** | 0.00 | 0.00 | 0.00 | 0.00 | -0.62 | -0.28 | -0.06 | -0.79 | -0.33 |
| **South Africa** | -0.02 | -0.12 | -0.04 | -0.25 | -1.67 | -0.57 | -0.23 | -1.71 | -0.63 |
| **South Sudan** | 0.00 | 0.00 | 0.00 | 0.02 | 0.18 | 0.08 | 0.01 | 0.17 | 0.06 |
| **Spain** | -0.01 | -0.04 | -0.02 | -0.09 | -0.41 | -0.20 | -0.10 | -0.42 | -0.20 |
| **Sri Lanka** | -0.01 | -0.08 | -0.03 | -0.16 | -1.72 | -0.63 | -0.18 | -1.51 | -0.57 |
| **Sudan** | 0.00 | 0.00 | 0.00 | 0.04 | 0.30 | 0.14 | -0.01 | 0.00 | -0.01 |
| **Suriname** | 0.00 | -0.07 | -0.03 | 0.02 | -1.42 | -0.59 | -0.02 | -0.64 | -0.27 |
| **Sweden** | -0.01 | -0.02 | -0.01 | -0.03 | -0.10 | -0.06 | -0.03 | -0.11 | -0.06 |
| **Switzerland** | 0.00 | 0.00 | 0.00 | 0.02 | 0.09 | 0.03 | 0.00 | -0.04 | -0.02 |
| **Syrian Arab Republic** | 0.00 | -0.01 | 0.00 | 0.01 | -0.06 | -0.04 | -0.02 | -0.17 | -0.09 |
| **Tajikistan** | 0.00 | 0.00 | 0.00 | -0.05 | -0.07 | -0.06 | -0.02 | -0.05 | -0.03 |
| **Tanzania, United Republic of** | -0.02 | -0.19 | -0.08 | -0.20 | -2.03 | -0.88 | -0.07 | -0.69 | -0.29 |
| **Thailand** | -0.03 | -0.16 | -0.07 | -0.21 | -1.03 | -0.48 | -0.21 | -1.00 | -0.47 |
| **Togo** | -0.01 | -0.05 | -0.02 | -0.11 | -0.65 | -0.26 | -0.11 | -0.63 | -0.26 |
| **Trinidad and Tobago** | 0.00 | 0.01 | 0.01 | -0.01 | -0.08 | -0.04 | -0.05 | -0.41 | -0.17 |
| **Tunisia** | -0.02 | -0.07 | -0.03 | -0.33 | -0.94 | -0.47 | -0.18 | -0.54 | -0.27 |
| **Turkey** | -0.01 | -0.04 | -0.02 | -0.18 | -0.60 | -0.30 | -0.10 | -0.32 | -0.16 |
| **Turkmenistan** | 0.00 | -0.01 | 0.00 | -0.07 | -0.14 | -0.09 | -0.02 | -0.05 | -0.03 |
| **Uganda** | -0.01 | -0.09 | -0.04 | -0.11 | -1.59 | -0.74 | -0.05 | -0.57 | -0.26 |
| **Ukraine** | -0.02 | -0.05 | -0.02 | -0.24 | -0.67 | -0.33 | -0.13 | -0.36 | -0.18 |
| **United Arab Emirates** | -0.01 | -0.06 | -0.03 | -0.22 | -0.86 | -0.43 | -0.16 | -0.67 | -0.32 |
| **United Kingdom** | -0.01 | -0.04 | -0.02 | -0.13 | -0.39 | -0.20 | -0.12 | -0.40 | -0.19 |
| **United States of America** | 0.00 | -0.01 | -0.01 | -0.06 | -0.49 | -0.21 | -0.05 | -0.31 | -0.13 |
| **Uruguay** | 0.00 | -0.02 | -0.01 | -0.08 | -0.67 | -0.27 | -0.04 | -0.31 | -0.13 |
| **Uzbekistan** | 0.00 | -0.01 | 0.00 | -0.04 | -0.12 | -0.07 | -0.08 | -0.32 | -0.16 |
| **Vanuatu** | 0.00 | -0.01 | -0.01 | 0.01 | -0.06 | -0.05 | -0.02 | -0.20 | -0.11 |
| **Venezuela (Bolivarian Rep. of)** | -0.02 | -0.08 | -0.03 | -0.18 | -0.73 | -0.32 | -0.25 | -1.20 | -0.53 |
| **Viet Nam** | -0.01 | -0.07 | -0.03 | -0.17 | -1.11 | -0.46 | -0.13 | -0.58 | -0.26 |
| **Yemen** | 0.00 | -0.02 | -0.01 | -0.03 | -0.40 | -0.24 | -0.07 | -0.55 | -0.28 |
| **Zambia** | 0.00 | -0.03 | -0.01 | -0.16 | -0.85 | -0.28 | -0.07 | -0.45 | -0.16 |
| **Zimbabwe** | -0.01 | -0.14 | -0.07 | -0.01 | -0.46 | -0.26 | 0.00 | -0.01 | -0.01 |

*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

The maps of Figure 32, Figure 33 and Figure 34 present the simulated changes (decline) in trade (imports plus exports) from Table 11 for the three main scenarios. Generally, developing countries tend to be relatively more affected by the IMO short-term measure.

Table 12 shows results at the sectoral level, providing some insights in their distribution. It summarizes information using standard statistics: the mean and median to measure the central tendency of the data, and the minimum and maximum to measure the range. All statistics are calculated using data on individual observations for exporter-importer-sector combinations and are computed at the level of each sector across all exporter-importer combinations.

Focusing first on the central tendency shows that whether the mean or median is used, the overall picture is in line with the results presented above: results tend to be small, and slightly negative. The median is less negative than the mean, which means that the latter statistic is influenced by relatively large negative numbers for some observations. This finding is borne out by the minimum to maximum range: at a disaggregated level, there are some very large trade impacts. In the HIGH-GHG reduction case, the largest impacts in absolute value reach the level of almost 50% of baseline exports.

Figure 32: Map with simulated impact on decline in trade (imports plus exports) in 2030 compared to the 2030 baseline Current Regulations scenario, EEXI-Only scenario

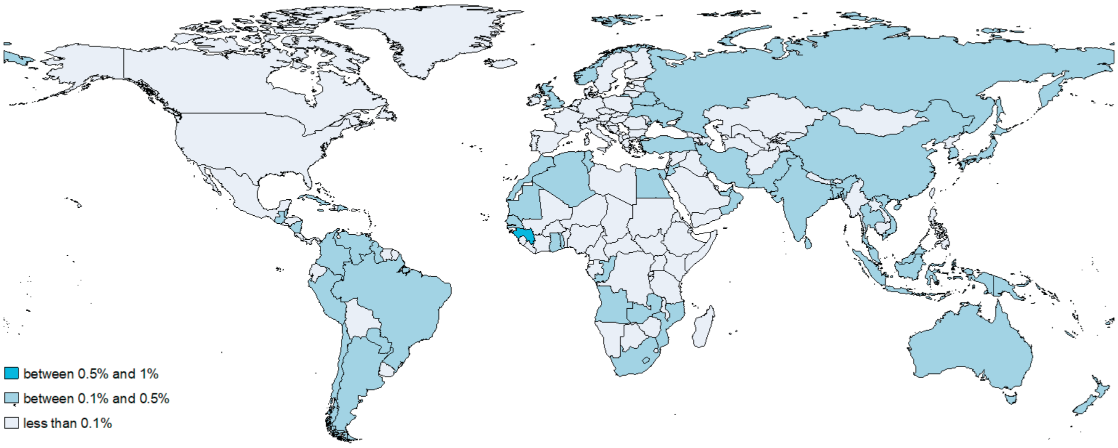


Figure 33: Map with simulated impact on decline in trade (imports plus exports), in 2030 compared to the 2030 baseline Current Regulations scenario- HIGH-GHG scenario

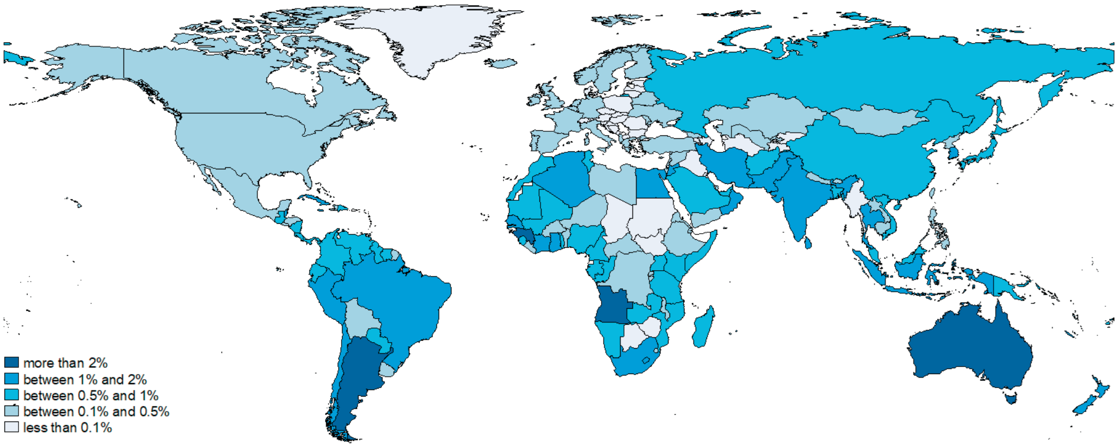
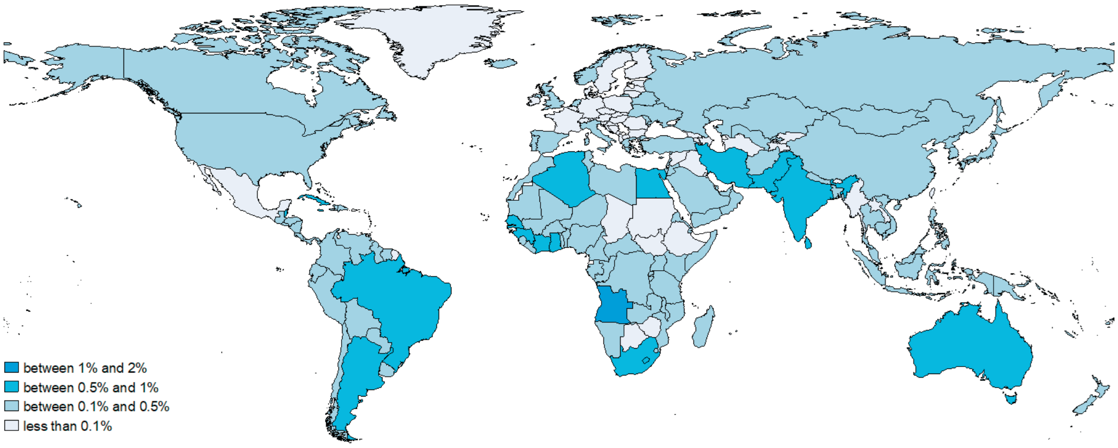


Figure 34: Map with simulated impact on decline in trade (imports plus exports), in 2030 compared to the 2030 baseline current regulations scenario- LOW-GHG scenario



*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

Table 12: Disaggregated results by sector in 2030, distribution of percent change in trade over the 2030 baseline Current Regulations scenario, by scenario

| | EEXI-Only | | | | HIGH-GHG reduction | | | | LOW-GHG reduction | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Min | Max | Mean | Median | Min | Max | Mean | Median | Min | Max |
| **Agriculture** | -0.01 | 0.00 | -21.26 | 5.42 | -0.44 | -0.06 | -49.70 | 4.67 | -0.15 | -0.02 | -24.96 | 2.16 |
| **Electrical and Machinery** | -0.03 | 0.00 | -3.18 | 0.45 | -0.41 | -0.01 | -24.92 | 3.63 | -0.19 | 0.00 | -12.53 | 1.21 |
| **Fishing** | -0.02 | 0.00 | -5.51 | 1.58 | -0.21 | 0.00 | -34.39 | 3.63 | -0.09 | 0.00 | -16.70 | 1.60 |
| **Food & Beverages** | -0.19 | 0.00 | -13.80 | 0.96 | -1.58 | -0.02 | -40.26 | 7.20 | -0.74 | 0.00 | -22.05 | 2.65 |
| **Metal Products** | -0.04 | 0.04 | -15.44 | 1.68 | -0.71 | 0.11 | -37.29 | 6.38 | -0.33 | 0.06 | -18.16 | 2.59 |
| **Mining and Quarrying** | -0.02 | 0.02 | -11.83 | 3.88 | -0.30 | 0.17 | -36.73 | 11.35 | -0.12 | 0.07 | -16.58 | 4.16 |
| **Other Manufacturing** | -0.03 | 0.02 | -10.57 | 1.81 | -0.47 | 0.08 | -30.01 | 6.45 | -0.21 | 0.04 | -15.37 | 2.43 |
| **Petroleum, Chemical and Non-Metallic Mineral Products** | 0.00 | 0.00 | -0.64 | 0.56 | 0.01 | 0.01 | -3.88 | 3.92 | 0.00 | 0.00 | -1.29 | 1.30 |
| **Textiles and Wearing Apparel** | -0.02 | 0.00 | -2.71 | 0.50 | -0.29 | 0.01 | -35.19 | 4.58 | -0.13 | 0.00 | -17.91 | 1.59 |
| **Transport Equipment** | -0.01 | 0.00 | -6.05 | 1.07 | -0.10 | 0.00 | -22.25 | 6.65 | -0.05 | 0.00 | -13.87 | 3.52 |
| **Wood and Paper** | -0.03 | 0.00 | -3.38 | 1.97 | -0.52 | -0.01 | -40.84 | 4.55 | -0.20 | -0.01 | -19.07 | 1.46 |

*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

This result highlights the importance of considering trade flows at a disaggregate level: to reconcile these results with the aggregate figures presented earlier, it is necessary to recognize that some trade flows with large percentage changes in fact have very low baselines in absolute dollar terms, so the percentage changes do not affect aggregates to any great extent; similarly, countries reallocate their exports across sectors according to the changed pattern of trade costs, which also attenuates some of the very large effects at an aggregate level. Nonetheless, in a distributional sense, the existence of very large falls in exports means that some producers in some countries stand to lose significantly from the changes associated with decarbonization of maritime shipping. Small aggregate losses should not obscure this point, as it will remain important to use other policies to ensure that the social consequences of these concentrated sectoral losses are not unduly harsh. This point is even more important since the largest falls in exports are seen in sectors like agriculture and low technology manufacturing (e.g., food and beverages), so impacts could affect relatively poor people in developing countries, which is an important negative consequence, governments need to respond to with appropriate social protection measures.

It is important to give a scale to these negative effects at a disaggregated level. Raw results cover 185 economies (and thus 184 trading partners) over 11 sectors, for a total of 374,440 observations. Of these, 5,670, or 1.5%, have a drop in exports of more than 10% of baseline. Therefore, while the problem of major trade declines is not particularly widespread in the data, it is not negligeable either. Given the size of the shocks, there is a clear case for supportive policies to ensure that changes in trade patterns do not undermine the achievement of sustainable development objectives.

### 3.3.4 *Global Value Chain Integration*

GVCs are a key part of the global economy. Economists often measure GVC integration using two simple metrics. Backward linkages are the percentage of a country's gross exports that consist of intermediate inputs sourced from other countries. Forward linkages are the percentage of a country's gross exports that consist of intermediate inputs used by other countries in the production of their exports. The DTC Global Trade Model (DTC GTM) used by UNCTAD for this comprehensive impact assessment makes it possible to see how backward and forward linkages change because of a shock to trade costs, like the ones associated with decarbonization of shipping. Further details can be found in the Technical Appendix enclosed to this Report.

On a global level, there is little evidence that the trade cost shocks associated with maritime decarbonization would tend to substantially reduce GVC backward and forward linkages. While there is some reduction in the HIGH-GHG reduction case, it is small relative to the baseline in all sectors. Changes for the other scenarios are smaller than for the HIGH-GHG reduction case, so it is safe to conclude that they involve minimal disruption to GVCs at an aggregate level. Again, however, significant changes in trade flows at a disaggregated level would translate into decreased backward and forward linkages at that same level, though the relative proportion is unlikely to change too much given the aggregate results.

Figure 35: Percentage of exports taking place within Global Value Chains (GVCs), 2030 baseline and HIGH-GHG reduction scenario, by sector

*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

Results at a more disaggregated level are not substantially different, in that they show all three scenarios having relatively small effects on GVC participation in a proportional sense. In other words, the trade reductions that take place because of decarbonization of maritime transport apply approximately equally to final goods and intermediates, which means that the proportion of backwards and forwards linkages in gross exports does not change by nearly as much as the disaggregated changes in exports discussed above.

Table 13 presents summary statistics for the three scenarios. Even in the HIGH-GHG reduction case, the median fall in GVC participation is less than 0.1 percentage points, which is small. The range is somewhat wider, but even the largest observed change is only slightly more than -1.5 percentage points at the bottom end, or nearly 2.0 percentage points at the top. So even at the extremes, there is little evidence that changes in trade costs it would entail would substantially disrupt GVC trade relative to other types of trade.

Table 13: Disaggregated changes in GVC participation, percentage points

| | Mean | Median | Minimum | Maximum |
|---|---|---|---|---|
| **EEXI Only** | -0.01 | -0.01 | -0.74 | 0.33 |
| **High Case** | -0.09 | -0.07 | -1.68 | 1.92 |
| **Low Case** | -0.04 | -0.03 | -0.69 | 0.89 |

*Source: UNCTAD, based on the results of the global trade model used for the impact of assessment.*

## 3.4 Development Considerations

Both developed and developing countries are expected to experience some negative impacts of the IMO short-term measure on their maritime logistics costs (i.e., increasing time and shipping costs), trade flows, and on their income or GDP. Countries with a higher GDP tend to be slightly less negatively affected than countries with lower GDP, although the correlation is not very strong and not relevant for all cases and scenarios (Table 14).

Figure 36 and Figure 37 illustrate two examples drawn out from Table 14. The partial correlation coefficient of -0.33 between the change in time costs and GDP per capita translates into an $R^2$ of 0.11 in Figure 36, and the partial correlation coefficient of +0.35 between the change in exports and the GDP per capita translates into an $R^2$ of 0.12 in Figure 37.

Developing coastal countries, including SIDS and LDCs, are simulated to experience a higher decrease in their GDP as compared to developed coastal countries, while land-locked countries can expect a relatively lower negative impact.

Land-locked countries are less affected by increases in maritime logistics costs than coastal countries. First, they tend to depend less on maritime trade and more on other modes of transport; thus, the increase in trade costs resulting from higher maritime logistics costs affect only a smaller share of land-locked countries' trade. Secondly, the increase in maritime logistics costs that affects their neighbouring coastal countries is likely to lead to increased trade with neighbouring countries, including neighbouring land-locked countries. For example, if the maritime logistics costs of Argentinean, South African, Ghanaian, Indian or Vietnamese imports increase, imports from neighbouring Paraguay, Botswana, Burkina Faso, Nepal, or Lao People's Dem. Rep., respectively could be expected to increase. Although this change in trade flows in favour of more regionalization may not be large, the results of the global trade model simulation seem to confirm this expectation: land-locked countries are simulated to experience a lower reduction in their GDP, imports and exports as compared to coastal countries (Figure 38, Figure 39, and Figure 40).

Table 14: Partial correlation coefficients between changes in costs and income, vis-à-vis levels of income compared to 2030 baseline scenario

| | GDP per capita | GDP total |
|---|---|---|
| **EEXI only scenario** | | |
| Transport costs % change | 0.26 | 0.02 |
| Time costs % change | -0.03 | -0.01 |
| Logistics costs % change | 0.20 | -0.00 |
| Total exports % change | 0.26 | -0.01 |
| Total imports % change | 0.18 | -0.08 |
| GDP % change | 0.11 | 0.02 |
| **HIGH scenario** | | |
| Transport costs % change | -0.04 | -0.06 |
| Time costs % change | -0.33 | -0.02 |
| Logistics costs % change | -0.21 | -0.06 |
| Total exports % change | 0.33 | 0.01 |
| Total imports % change | 0.25 | -0.05 |
| GDP % change | 0.17 | 0.07 |
| **LOW scenario** | | |
| Transport costs % change | 0.01 | -0.07 |
| Time costs % change | -0.13 | 0.07 |
| Logistics costs % change | -0.03 | 0.01 |
| Total exports % change | 0.35 | 0.02 |
| Total imports % change | 0.26 | -0.04 |
| GDP % change | 0.15 | 0.03 |

*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*
*Note: Only coastal countries are included in this calculation.*

Figure 36: Correlation between changes in time costs, vis-à-vis GDP per capita, HIGH scenario

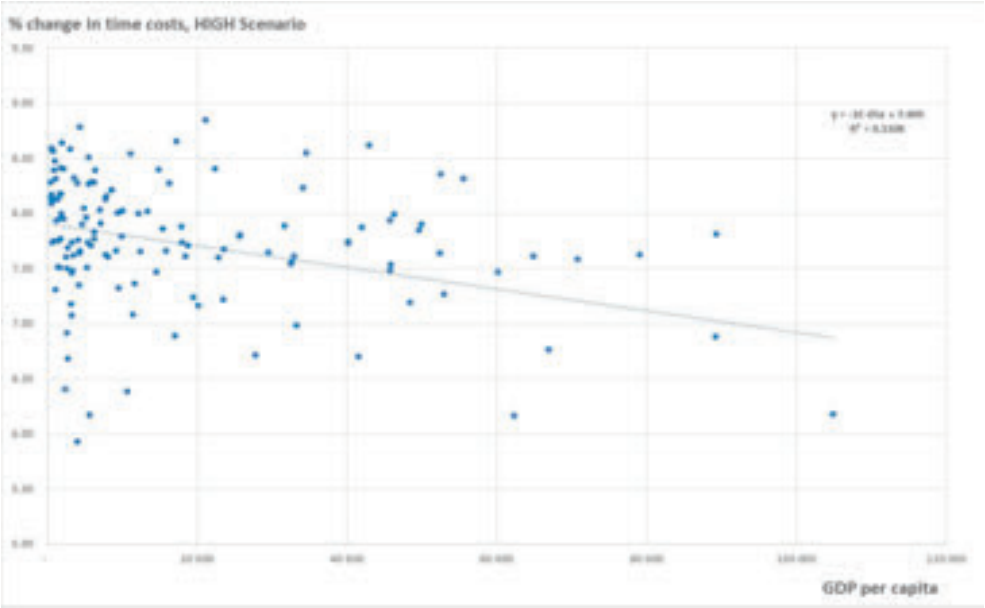
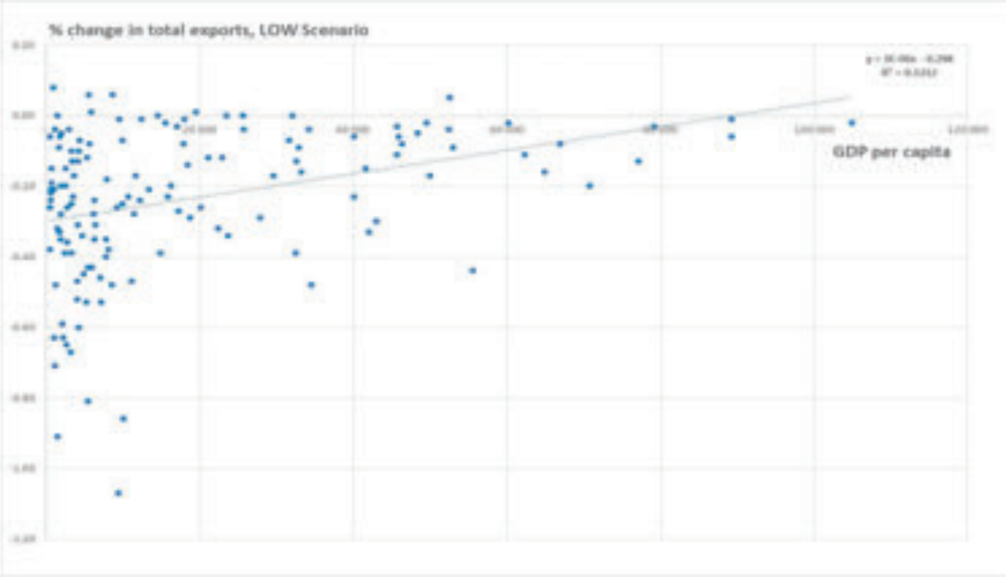


Figure 37: Correlation between changes in total exports, vis-à-vis GDP per capita, LOW scenario



*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

Figure 38: Simulated change in income (per cent of GDP), different country groups

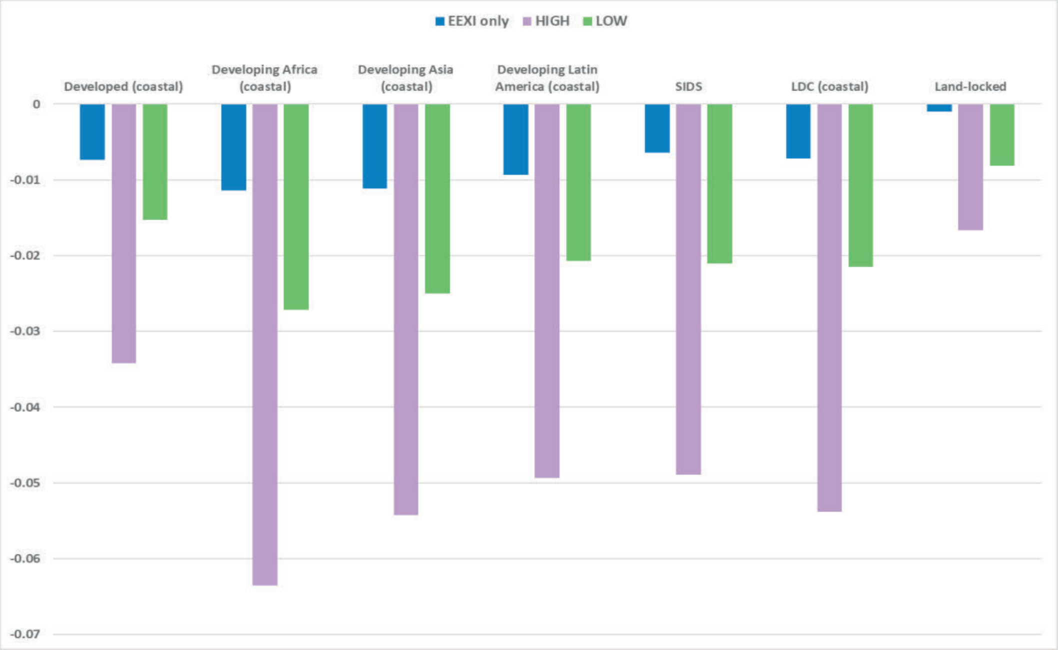


Figure 39: Simulated percentage change in exports, by country grouping

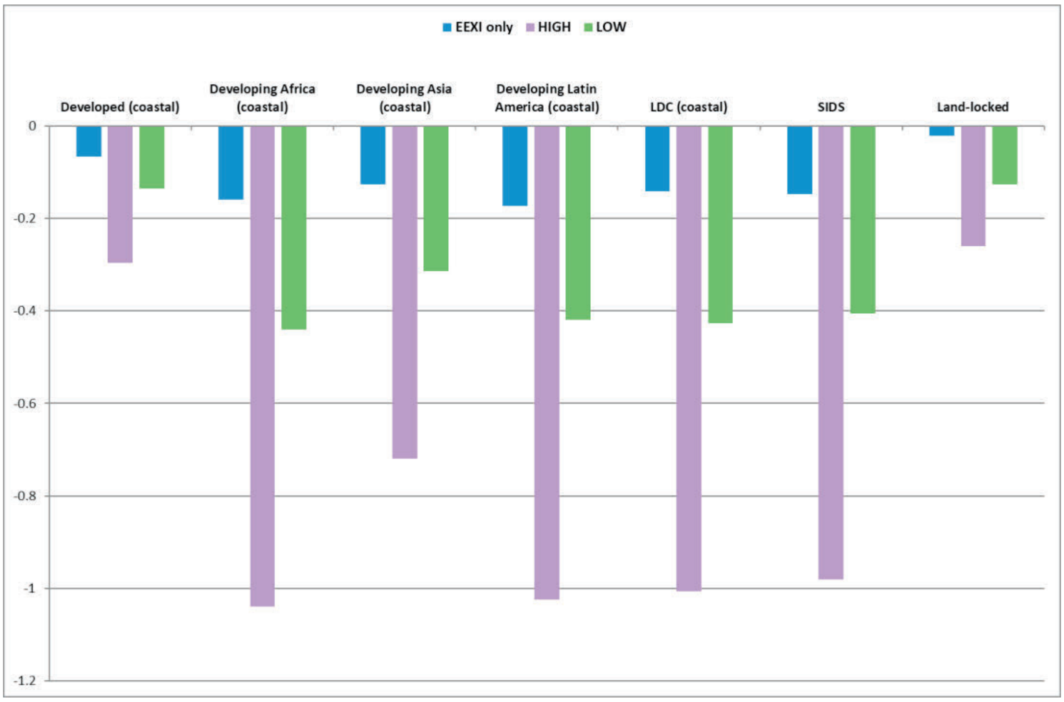
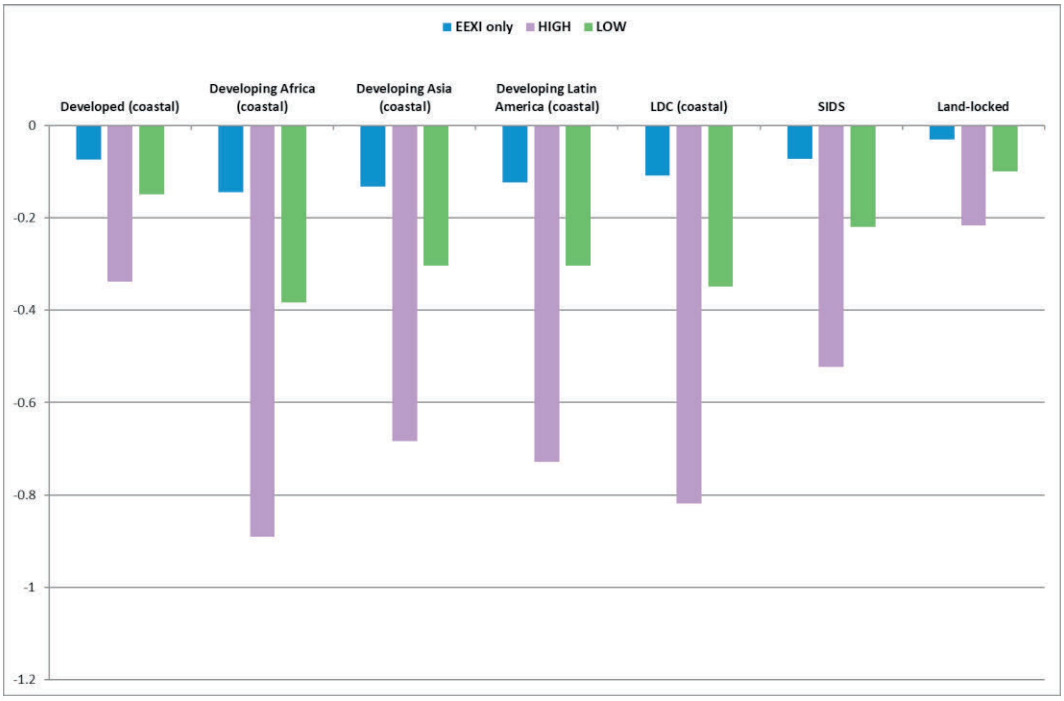


Figure 40: Simulated percentage change in imports, by country grouping



*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

While these averages and statistical correlations do not explain a causal relationship between the variables, they do suggest that developing countries, including LDCs and SIDS, may require support if they wish to mitigate the potential negative impact of the IMO short-term measure on their trade and development. Not only do they have fewer financial resources and institutional and technological capacities, but also are they more likely to be burdened by the negative impacts.[9]

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[9] See also the following UNCTAD reports and assessments about different aspects of development and technical and financial assistance requirements: "Closing the Distance - Partnerships for sustainable and resilient transport systems in Small Island Developing States" (https://unctad.org/webflyer/closing-distance-partnerships-sustainable-and-resilient-transport-systems-small-island). "Trade facilitation and development: Driving trade competitiveness, border agency effectiveness and strengthened governance" (https://unctad.org/webflyer/trade-facilitation-and-development-driving-trade-competitiveness-border-agency). "The New Frontier of Competitiveness in Developing Countries - Implementing Trade Facilitation" (https://unctad.org/webflyer/new-frontier-competitiveness-developing-countries-implementing-trade-facilitation). "Review of Maritime Transport" (https://unctad.org/topic/transport-and-trade-logistics/review-of-maritime-transport). "The least developed countries report" (https://unctad.org/topic/vulnerable-economies/least-developed-countries/ldc-report). "Trade and Development Report " (https://unctad.org/topic/macroeconomics/trade-development-report)

# 4 Illustrative Case Studies

## 4.1 Short Illustrative Cases focusing on Selected Trades

Summary outcomes of selected illustrative case studies assessing the potential impact of the IMO short-term measure on transport costs and time at sea, trade, and income, are presented in this section. The aim is to capture important trades for some developing countries, including LDCs and SIDS. For the illustrative case studies presented in this report, the analysis, results, and percentage changes featured for each of the three 2030 GHG reduction scenarios are expressed relative, or in comparison to, the 2030 baseline Current Regulations scenario.

To help compare the results presented for the selected cases, the median impacts (all countries generated from the data in Table 9) are presented below: The median shipping (**transport)** for an exporter are expected to increase by 0.12% under the EEXI-Only scenario, by 9.23% under the HIGH-GHG reduction scenario, and by 2.85% under the LOW-GHG reduction scenario. The median **time spent at sea** is expected to increase by 0.86% under the EEXI-Only scenario, by 8.40% under the HIGH-GHG reduction scenario, and by 4.07% under the LOW-GHG reduction scenario. Under the HIGH-GHG reduction scenario, **total maritime logistics costs** for the median exporter are expected to increase by 8.74%.

The median country’s bilateral maritime exports of all commodities to the world, are simulated to decline by 0.31%, while the median imports are simulated to drop by 0.21%, and the GDP of the median country is simulated to decrease by 0.04% under the HIGH-GHG reduction scenario (generated from the data in Table 11).

### *4.1.1 Algeria: Petroleum, Chemical and Non-Metallic Mineral Products Exports to Italy*

The transport costs of petroleum, chemical and non-metallic mineral products exports from Algeria to Italy are simulated to increase by 4.4% under the EEXI-Only scenario, by 6.1 under the HIGH-GHG reduction scenario, and by 4.4% under the LOW-GHG reduction scenario. Time spent at sea for these goods is simulated to increase by 1.3% under the EEXI-Only scenario, by 5.0% under the HIGH-GHG reduction scenario, and by 1.3% under the LOW-GHG reduction scenario by 2030.

Total maritime logistics costs for petroleum, chemical and non-metallic mineral products exports from Algeria to Italy are simulated to increase by 2.68% (EEXI-Only), 2.69% (LOW-GHG reduction) and 5.5% (HIGH-GHG reduction).

In terms of impacts on Algeria’s trade, exports of petroleum, chemical and non-metallic mineral products from Algeria to Italy are simulated to increase across all the three scenarios. The increase is by 0.41% (EEXI-Only scenario), by 0.58% (LOW-GHG reduction,) and by 1.45% (HIGH-GHG reduction scenario).

Nevertheless, total exports from Algeria to the world, all commodities included, are simulated to decline by 1.09%, while the country’s GDP is simulated to decrease by 0.17% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.2 Argentina: Agricultural Exports to China*

The transport costs of Argentinean exports to China in the agricultural sector are simulated to decrease by 1.7% under the EEXI-Only scenario, by 0.8% under the HIGH-GHG reduction scenario, and by 0.7% under the LOW-GHG reduction scenario. Time spent at sea, on the other hand, is simulated to increase by 1.8% (EEXI-Only scenario), 8.4% (HIGH-GHG reduction scenario), and 1.9% (LOW-GHG reduction scenario), respectively.

Total maritime logistics costs for agricultural exports from Argentina to China are simulated to decrease by 0.33% (EEXI-Only), increase by 0.3% (LOW-GHG reduction scenario) increase by 2.8% (HIGH-GHG reduction scenario).

In terms of impacts on Argentina’s trade, exports of agricultural products from Argentina to China are simulated to increase by 1.02% (EEXI-Only scenario), increase by 0.11% (LOW-GHG reduction), and decrease by 2.95% (HIGH-GHG reduction scenario).

Total exports of Argentina to the world, all commodities, are simulated to decline by 2.10%, and the country's GDP is simulated to decrease by 0.17% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.3 Bangladesh: Exports of Textiles and Wearing Apparel to the United States*

The transport costs of textiles and wearing apparel exports from Bangladesh to the United States are simulated to increase by 0.2% under the EEXI-Only scenario, by 9.7% under the HIGH-GHG reduction scenario, and by 2.7% under the LOW-GHG reduction scenario. Time spent at sea for these exports is simulated to increase by 0.5% (EEXI-Only), 8.5% (HIGH-GHG reduction scenario), and 3.6% (LOW-GHG reduction scenario), respectively.

Total maritime logistics costs for textiles and wearing apparel exports of Bangladesh to the United States are simulated to increase by 0.22% (EEXI-Only scenario), by 2.86% (LOW-GHG reduction scenario), and by 8.7% (HIGH-GHG reduction scenario).

In terms of impacts on Bangladesh’s trade, exports of textiles and wearing apparel to the United States are simulated to decline by 0.09% (EEXI-Only scenario), by 0.27% (LOW-GHG reduction scenario), and by 0.74% (HIGH-GHG reduction scenario).

Total exports of Bangladesh to the world, all commodities, are simulated to decline by 0.92%, while the country’s GDP is simulated to decrease by 0.04% under the HIGH-GHG reduction scenario (Table 11).

### 4.1.4 Bangladesh: Imports of Other Manufactured Goods from Viet Nam

The transport costs of other manufactured imports of Bangladesh from Viet Nam are simulated to decrease by 1.4% under the EEXI-Only scenario. Under the HIGH-GHG reduction scenario, these transport costs are simulated to increase by 3.0%, and under the LOW-GHG reduction scenario increase by 0.2%. Time spent at sea for these goods is simulated to increase by 2.8% under the EEXI-Only scenario, by 8.0% under the HIGH-GHG reduction scenario, and by 3.1% under the LOW-GHG reduction scenario.

Total maritime logistics costs for other manufactured imports of Bangladesh from Viet Nam are simulated to increase by 2.31% (EEXI-Only scenario), by 2.78% (LOW-GHG reduction scenario), and by 7.43% (HIGH-GHG reduction scenario).

In terms of impacts on Bangladesh's trade, imports of other manufactured goods from Viet Nam are simulated to decline by 3.27% (EEXI-Only scenario), by 3.85% (LOW-GHG reduction scenario), and by 9.89% (HIGH-GHG reduction scenario) as compared to the baseline scenario in 2030.

Total imports of Bangladesh from the world, all commodities, are simulated to decline by 0.52%, while the country's GDP is simulated to decrease by 0.04% under the HIGH-GHG reduction scenario (Table 11).

### 4.1.5 Belize: Exports of Food and Beverages to the United Kingdom

The transport costs of exports from Belize to the United Kingdom in the food and beverages sector are simulated to decrease by 2.8% under the EEXI-Only scenario and by 0.1% under the LOW-GHG reduction scenario; they are simulated to increase by 3.7% under the HIGH-GHG reduction scenario. Time spent at sea is simulated to increase by 2.8% (EEXI-Only scenario), 8.0% (HIGH-GHG reduction scenario), and 3.0% (LOW-GHG reduction scenario), respectively.

Total maritime logistics costs for exports of food and beverages of Belize to the United Kingdom are simulated to increase by 2.37% (EEXI-Only scenario), by 2.73% (LOW-GHG reduction scenario), and by 7.65% (HIGH-GHG reduction scenario).

In terms of impacts on Belize's trade, exports of food and beverages to the United Kingdom are simulated to decline by 1.98% (EEXI-Only scenario), by 2.21% (LOW-GHG reduction scenario), and by 6.26% (HIGH-GHG reduction scenario).

Total exports of Belize the world, all commodities, are simulated to decline by 1.04%, while the country's GDP is simulated to decrease by 0.12% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.6 Benin: Exports of Food and Beverages to Thailand*

The transport costs of exports from Benin to Thailand in the food and beverages sector are simulated to decrease by 1.9% under the EEXI-Only scenario and by 0.3% under the LOW-GHG reduction scenario; they are simulated to increase by 2.4% under the HIGH-GHG reduction scenario. Time spent at sea is simulated to increase by 3.5% (EEXI-Only scenario), 7.6% (HIGH-GHG reduction scenario), and 3.7% (LOW-GHG reduction scenario), respectively.

Total maritime logistics costs for food and beverages exports from Benin to Thailand are simulated to increase by 3.1% (EEXI-Only scenario), 3.4% (LOW-GHG reduction scenario) and 7.25% (HIGH-GHG reduction scenario).

In terms of impacts on Benin's trade, and compared to the baseline scenario in 2030, exports of food and beverages to Thailand are simulated to increase across all the three scenarios. The increase is by 0.06% under EEXI-Only scenario, by 0.06% (LOW-GHG reduction scenario) and by 0.09% (HIGH-GHG reduction scenario).

Total exports of Benin to the world, all commodities, are simulated to decline by 0.48%, and the country's GDP is simulated to decrease by 0.03% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.7 Chile: Mining and Quarrying Exports to China*

The transport costs of mining and quarrying exports from Chile to China are simulated to decrease by 1.8% under the EEXI-Only scenario, by 0.4% under the HIGH-GHG reduction scenario, and by 0.9% under the LOW-GHG reduction scenario. Time spent at sea for these exports is simulated to increase by 1.7% (EEXI-Only scenario), 8.5% (HIGH-GHG reduction scenario), and 1.8% (LOW-GHG reduction scenario), respectively.

Total maritime logistics costs for mining and quarrying product exports of Chile to China are simulated to increase by 0.78% (EEXI-Only scenario), by 1% (LOW-GHG reduction scenario), and by 6.1% (HIGH-GHG reduction scenario).

In terms of impacts on Chile's trade, exports of mining and quarrying products to China are simulated to decrease by 0.02% (EEXI-Only scenario), increase by 0.0015% (LOW-GHG reduction scenario), and decrease by 0.51% (HIGH-GHG reduction scenario).

Total exports of Chile to the world, all commodities, are simulated to decline by 0.91%, while the country's GDP is simulated to decrease by 0.05% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.8 Egypt: Agricultural product Imports from the United States*

The transport costs of agricultural imports of Egypt from the United States are simulated to decrease by 2.2% under the EEXI-Only scenario, increase by 0.6% under the HIGH-GHG reduction scenario, and decrease by 1.2% under the LOW-GHG reduction scenario. Time spent at sea for these imports is simulated to increase by 3.5% under the EEXI-Only scenario, by 7.8% under the HIGH-GHG reduction scenario, and by 3.7% under the LOW-GHG reduction scenario.

Total maritime logistics costs for agricultural product imports of Egypt from the United States are simulated to decrease by 0.5% (EEXI-Only scenario), increase by 0.22% (LOW-GHG reduction scenario), and by 2.72% (HIGH-GHG reduction scenario).

In terms of impacts on Egypt's trade, imports of agricultural products from the United States are simulated to decline by 0.16% (EEXI-Only scenario), by 0.38% (LOW-GHG reduction scenario), and by 1.06% (HIGH-GHG reduction scenario).

Total imports of Egypt the world, all commodities, are simulated to decline by 0.85%, and the country's GDP is simulated to decrease by 0.04% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.9 Fiji: Petroleum, Chemical and Non-Metallic Mineral Products Imports from Republic of Korea*

The transport costs of Fiji's petroleum, chemical and non-metallic mineral product imports sourced from Republic of Korea are simulated to increase by 4.3% under the EEXI-Only scenario, by 16.8% under the HIGH-GHG reduction scenario, and by 4.4% under the LOW-GHG reduction scenario. Time spent at sea for these goods is simulated to increase by 3.7% under the EEXI-Only scenario, by 6.3% under the HIGH-GHG reduction scenario, and by 3.7% under the LOW-GHG reduction scenario.

Total maritime logistics costs for petroleum, chemical and non-metallic mineral product imports of Fiji from Republic of Korea are simulated to increase by 4.02% (EEXI-Only scenario), by 4.09% (LOW-GHG reduction scenario), and by 11.76% (HIGH-GHG reduction scenario).

In terms of impacts on Fiji's trade, imports of petroleum, chemical and non-metallic mineral products from Republic of Korea are simulated to decline by 0.09% (EEXI-Only scenario), by 0.25% (LOW-GHG reduction scenario), and by 1.12% (HIGH-GHG reduction scenario).

Total imports of Fiji from the world, all commodities, are simulated to decline by 0.51%, and the country's GDP is simulated to decrease by 0.05% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.10 Guinea: Mining and Quarrying Exports to China*

The transport costs of mining and quarrying exports from Guinea to China are simulated to decrease by 1.6% under the EEXI-Only scenario, increase by 0.2% under the HIGH-GHG reduction scenario, and decrease by 0.7% under the LOW-GHG reduction scenario. Time spent at sea for these exports is simulated to increase by 1.6% (EEXI-Only scenario), 8.6% (HIGH-GHG reduction scenario), and 1.6% (LOW-GHG reduction scenario), respectively.

Total maritime logistics costs for mining and quarrying exports of Guinea to China are simulated to increase by 0.9% (EEXI-Only scenario), by 1.1% (LOW-GHG reduction scenario), and by 6.8% (HIGH-GHG reduction scenario).

In terms of impacts on Guinea's trade, exports of mining and quarrying products to China are simulated to decline by 1.49% (EEXI-Only scenario), by 1.88% (LOW-GHG reduction scenario), and by 12.06% (HIGH-GHG reduction scenario).

Total exports of Guinea to the world, all commodities, are simulated to decline by 1.51%, while the country's GDP is simulated to decrease by 0.12% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.11 Haiti: Food and Beverages Imports from the United States*

The transport costs of food and beverage imports of Haiti from the United States are simulated to decrease by 1.7% under the EEXI-Only scenario, while they are expected to increase by 3.7% under the HIGH-GHG reduction scenario and by 0.2% under the LOW-GHG reduction scenario. Time spent at sea for these imports is simulated to increase by 2.8% under the EEXI-Only scenario, by 7.9% under the HIGH-GHG reduction scenario, and by 3.9% under the LOW-GHG reduction scenario.

Total maritime logistics costs for food and beverages imports of Haiti from the United States are simulated to increase by 2.3% (EEXI-Only scenario), by 3.46% (LOW-GHG reduction scenario), and by 7.45% (HIGH-GHG reduction scenario).

In terms of impacts on Haiti's trade, imports of food and beverages from the United States are simulated to decline by 1.18% (EEXI-Only scenario), by 1.54% (LOW-GHG reduction scenario), and by 3.26% (HIGH-GHG reduction scenario).

Total imports of Haiti from the world, all commodities, are simulated to decline by 0.17%, while the country's GDP is simulated to decrease by 0.02% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.12 Kenya: Agricultural Exports to Netherlands*

The transport costs of Kenyan exports to the Netherlands in the agricultural sector are simulated to increase by 0.2% under the EEXI-Only scenario, by 9.7% under the HIGH-GHG reduction scenario, and by 2.9% under the LOW-GHG reduction scenario. Time spent at sea is simulated to increase by 0.7% (EEXI-Only scenario), 9.0% (HIGH-GHG reduction scenario), and 4.1% (LOW-GHG reduction scenario), respectively.

Total maritime logistics costs for agricultural exports of Kenya to the Netherlands are simulated to increase by 0.31% (EEXI-Only scenario), by 3.16% (LOW-GHG reduction scenario), and by 9.51% (HIGH-GHG reduction scenario).

In terms of impacts on Kenya's trade, exports of agricultural products to the Netherlands are simulated to decline by 0.06% (EEXI-Only scenario), by 0.15% (LOW-GHG reduction scenario), and by 0.23% (HIGH-GHG reduction scenario).

Total exports of Kenya to the world, all commodities, are simulated to decline by 0.47%, while the country's GDP is simulated to decrease by 0.06% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.13 Peru: Mining and Quarrying Exports to China*

The transport costs of mining and quarrying exports from Peru to China are simulated to decrease by 1.7% under the EEXI-Only scenario, by 0.2% under the HIGH-GHG reduction scenario, and by 0.8% under the LOW-GHG reduction scenario. Time spent at sea for these exports is simulated to increase by 1.7% (EEXI-Only scenario), 8.5% (HIGH-GHG reduction scenario), and 1.7% (LOW-GHG reduction scenario), respectively.

Total maritime logistics costs for mining and quarrying exports of Peru to China are expected to increase by 0.8% (EEXI-Only scenario), by 1.09% (LOW-GHG reduction scenario), and by 6.31% (HIGH-GHG reduction scenario).

In terms of impacts on Peru's trade, exports of mining and quarrying products to China are simulated to decline by 0.22% (EEXI-Only scenario), by 0.34% (LOW-GHG reduction scenario), and by 1.90% (HIGH-GHG reduction scenario).

Total exports of Peru to the world, all commodities, are simulated to decline by 0.69%, while the country's GDP is simulated to decrease by 0.04% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.14 Samoa: Petroleum Chemical and Non-Metallic Mineral Products Imports from Singapore*

The transport costs of petroleum chemical and non-metallic mineral products imports of Samoa from Singapore are simulated to increase by 4.4% under the EEXI-Only scenario, by 16.0% under the HIGH-GHG reduction scenario, and by 4.4% under the LOW-GHG reduction scenario. Time spent at sea for these goods is simulated to increase by 3.6% under the EEXI-Only scenario, by 6.3% under the HIGH-GHG reduction scenario, and by 3.7% under the LOW-GHG reduction scenario.

Total maritime logistics costs for petroleum chemical and non-metallic mineral products imports of Samoa from Singapore are simulated to increase by 3.96% (EEXI-Only scenario), by 3.97% (LOW-GHG reduction scenario), and by 10.61% (HIGH-GHG reduction scenario).

In terms of impacts on Samoa's trade, imports of petroleum chemical and non-metallic mineral products from Singapore are simulated to decline by 0.02% (EEXI-Only scenario), by 0.01% (LOW-GHG reduction scenario), and by 0.17% (HIGH-GHG reduction scenario).

Total imports of Samoa from the world, all commodities, are simulated to decline by 0.26%, while the country's GDP is simulated to decrease by 0.05% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.15 Senegal: Mining and Quarrying Exports to Norway*

The transport costs of mining and quarrying exports from Senegal to Norway are simulated to decrease by 2.5% under the EEXI-Only scenario, increase by 0.8% under the HIGH-GHG reduction scenario, and decrease by 1.1% under the LOW-GHG reduction scenario. Time spent at sea for these exports is simulated to increase by 3.9% (EEXI-Only scenario), 7.7% (HIGH-GHG reduction scenario), and 4.0% (LOW-GHG reduction scenario), respectively.

Total maritime logistics costs for mining and quarrying exports of Senegal to Norway are simulated to increase by 1.61% (EEXI-Only scenario), by 2.17% (LOW-GHG reduction scenario), and by 5.23% (HIGH-GHG reduction scenario).

In terms of impacts on Senegal's trade, exports of mining and quarrying products to Norway are simulated to decline by 0.88% (EEXI-Only scenario), by 0.91% (LOW-GHG reduction scenario), and by 2.11% (HIGH-GHG reduction scenario).

Total exports of Senegal to the world, all commodities, are simulated to decline by 1.88%, while the country's GDP is simulated to decrease by 0.07% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.16 Seychelles: Imports of Other Manufactured Goods from Pakistan*

The transport costs of other manufactured imports of Seychelles from Pakistan are simulated to decrease by 1.8% under the EEXI-Only scenario. Under the HIGH-GHG reduction scenario, these transport costs are expected to increase by 2.8%, and under the LOW-GHG reduction scenario decrease by 0.04%. Time spent at sea for these goods is simulated to increase by 3.4% under the EEXI-Only scenario, by 7.7% under the HIGH-GHG reduction scenario, and by 3.8% under the LOW-GHG reduction scenario.

Total maritime logistics costs for imports of other manufactured goods into the Seychelles from Pakistan are simulated to increase by 2.4% (EEXI-Only scenario), by 3.1% (LOW-GHG reduction scenario), and by 6.8% (HIGH-GHG reduction scenario).

In terms of impacts on Seychelles' trade, imports of other manufactured goods from Pakistan are simulated to decline by 3.44% (EEXI-Only scenario), by 3.83% (LOW-GHG reduction scenario), and by 7.76% (HIGH-GHG reduction scenario).

Total imports of Seychelles from the world, all commodities, are simulated to decline by 0.62%, while the country's GDP is simulated to decrease by 0.07% under the HIGH-GHG reduction scenario (Table 11).

### *4.1.17 South Africa: Agricultural Exports to Netherlands*

The transport costs of South African exports to the Netherlands in the agricultural sector are simulated to increase by 0.4% under the EEXI-Only scenario, by 10.2% under the HIGH-GHG reduction scenario, and by 2.9% under the LOW-GHG reduction scenario. Time spent at sea is simulated to increase by 1.3% (EEXI-Only scenario), 9.0% (HIGH-GHG reduction scenario), and 3.9% (LOW-GHG reduction scenario), respectively.

Total maritime logistics costs for agricultural product exports of South Africa to the Netherlands are simulated to increase by 0.72% (EEXI-Only scenario), by 3.24% (LOW-GHG reduction scenario), and by 9.8% (HIGH-GHG reduction scenario).

In terms of impacts on South Africa's trade, exports of agricultural products to the Netherlands are simulated to increase by 0.05% (EEXI-Only scenario), decrease by 0.034% (LOW-GHG reduction scenario), and increase by 0.3% (HIGH-GHG reduction scenario).

Total exports of South Africa to the world, all commodities, are simulated to decline by 1.24%, while the country's GDP is simulated to decrease by 0.12% under the HIGH-GHG reduction scenario (Table 11).

## 4.2 Illustrative Case 1: Iron Ore Exports from Brazil to China

### *4.2.1 Global Iron Ore Trade*

Total world seaborne trade was estimated at 11.08 billion tonnes in 2019.[10] Of this total, about 1.5 billion tonnes were accounted for by iron ore volumes, i.e., 13.5% of international maritime trade.

China is the largest world iron ore importer accounting for over two thirds of world iron ore imports in 2019 (Table 15). Australia and Brazil are the two leading world iron ore exporters, with market shares of 57.4% and 23.9%, respectively in 2019.

Table 15: World major iron ore exporters and importers, 2018-2020 (Percentage share in world iron ore trade volumes in tonnes)

| Iron ore exporters | | | | Iron ore importers | | | |
|---|---|---|---|---|---|---|---|
| | 2018 | 2019 | 2020[a] | | 2018 | 2019 | 2020[a] |
| **Australia** | **56.5%** | **57.4%** | **58.1%** | **China** | 71.0% | 71.9% | 76.2% |
| **Brazil** | **26.2%** | **23.9%** | **22.6%** | **Japan** | **8.4%** | **8.2%** | **6.5%** |

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[10] UNCTAD (2020). Review of Maritime Transport 2020. New York and Geneva.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **South Africa** | 4.3% | 4.6% | 4.3% | **Europe** | 7.9% | 7.5% | 6.0% |
| **Canada** | 3.2% | 3.5% | 3.6% | **Republic of Korea** | 5.0% | 5.1% | 4.7% |
| **India** | 1.3% | 2.0% | 3.1% | **Other** | 7.8% | 7.2% | 6.7% |
| **Sweden** | 1.5% | 1.5% | 1.6% | | | | |
| **Other** | 7.0% | 7.1% | 6.7% | | | | |

*Source: UNCTAD calculations, based on Clarksons Research Services, Dry Bulk Trade Outlook, Volume 27, No.1, January 2021, ISSN 1361-3189.*
*a: Estimations by Clarksons Research, based on available data in January 2021.*

The importance of China as the main destination for world maritime iron ore exports reflects China's rapid economic growth and expansion in its steel production. China accounted for 16% of global iron ore trade in 2000 before reaching 76% in 2020. More recently, growth in iron ore imports into China decelerated as the country started to gradually shift its economy away from an investment-led to a consumption-led growth.[11] While China's iron ore demand is expected to further moderate as the country reduces its steel production capacity and rebalances its economy, the country is, nevertheless, expected to remain the world top iron ore importer over the next decade. Meanwhile, iron ore imports into other Asian countries, such as India and ASEAN, are expected to increase.

### *4.2.2 Brazilian Exports of Iron Ore*

Brazil depends heavily on China for its exports of iron ore despite the long distances travelled and the relatively higher freight rates as compared with Australia, for example. Over 63% or nearly $11 billion of Brazil's total iron ore exports were shipped to China in 2018. These amounted to 4.4% of Brazil's total exports[12] (Table 16). Iron ore exports from Brazil to China increased from over 63% in 2018 to over 74% in 2020 when considering the value. With Malaysian ports used as Vale's transhipment facilities, Malaysia accounted for 9.0% of the market share in Brazil's iron ore exports in 2019. Much of the iron ore exports from Brazil to Malaysia were shipped to China while the remaining share went to Viet Nam.[13]

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[11] Annual average growth rate of crude steel production in China declined from 17.4 per cent in 2001-2010 to 5.3% in 2011-2020. Average growth rate of steelmaking capacity declined from 16.9% in 2000-2010 to 0.9% in 2011-2019. China's excess production capacity decreased from 424 million tonnes (40% of capacity) in 2010 to 157 million tonnes (13.6% of capacity) in 2019.

[12] Figures are based on export data from Brazil. Import data of trading partners have different numbers. For example, Chinese imports of iron ore from Brazil were estimated at $22.1 billion in 2019 according to COMTRADE, which was 63.4% higher than export-side data. The difference in unit value explains much of this gap as the difference in volume was small (i.e., 217,149,759 tonnes when looking at export data and 228,952,760 tonnes for import data). The difference in unit value can be partly explained by differences in valuation and time of recording; imports are valued on CIF basis (which includes transport and insurance costs) at the point of entry into the importing economy, while exports are valued on FOB basis (which does not include transport and insurance costs) at the point of exit from the exporter's economy.

[13] As to volume, 79% of iron ore exports from Brazil to Malaysia were shipped to China in 2019, and 12% to Vietnam (https://www.hellenicshippingnews.com/brazilian-iron-ore-exports-in-2019-make-for-a-sad-reading-for-dry-bulk-ship-owners/).

Table 16: Export of iron ore from Brazil to major importers ($ and percentage shares), 2018-2019

| Importing country | Exports of iron ore from Brazil | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (millions of USD) | | | (% of Brazil's exports of iron ore to the world) | | | (% of Brazil's total exports to the world) | | |
| | 2018 | 2019 | 2020 | 2018 | 2019 | 2020 | 2018 | 2019 | 2020 |
| **China** | 10,620 | 13,054 | 17,976 | 63.5 | 64.5 | 74.1 | 4.4 | 5.8 | 8.6 |
| **Malaysia** | 1,083 | 1,814 | 1,695 | 6.5 | 9.0 | 7.0 | 0.5 | 0.8 | 0.8 |
| **Japan** | 745 | 834 | 781 | 4.5 | 4.1 | 3.2 | 0.3 | 0.4 | 0.4 |
| **Oman** | 492 | 626 | 576 | 2.9 | 3.1 | 2.4 | 0.2 | 0.3 | 0.3 |
| **Netherlands** | 683 | 742 | 561 | 4.1 | 3.7 | 2.3 | 0.3 | 0.3 | 0.3 |
| **Bahrein** | 342 | 600 | 540 | 2.0 | 3.0 | 2.2 | 0.1 | 0.3 | 0.3 |
| **Korea, Republic of** | 416 | 454 | 424 | 2.5 | 2.2 | 1.7 | 0.2 | 0.2 | 0.2 |
| **Turkey** | 204 | 327 | 392 | 1.2 | 1.6 | 1.6 | 0.1 | 0.1 | 0.2 |
| **Philippines** | 177 | 170 | 239 | 1.1 | 0.8 | 1.0 | 0.1 | 0.1 | 0.1 |
| **France** | 328 | 306 | 191 | 2.0 | 1.5 | 0.8 | 0.1 | 0.1 | 0.1 |
| **Rest of World** | 1,629 | 1,310 | 884 | 9.7 | 6.5 | 3.6 | 0.7 | 0.6 | 0.4 |
| **World** | **16,719** | **20,237** | **24,259** | **100.0** | **100.0** | **100.0** | **7.0** | **9.0** | **11.6** |

*Source: UNCTAD calculations based on Comex Stat, Ministério da Economia, Governo do Brasil.*
*a HS260111.*

### 4.2.3 Transport Costs of Brazil's Iron Ore Exports to China

As shown in Table 17, over 99% of Brazil's iron ore exports to China were transported by sea.

Table 17: Exports of iron ore from Brazil to China by transport mode, 2018-2020

| | Millions of USD (FOB value) | | | % of total transport mode | | |
|---|---|---|---|---|---|---|
| | 2018 | 2019 | 2020 | 2018 | 2019 | 2020 |
| **Maritime**[a] | 10,620 | 13,007 | 17,308 | 99.999998 | 99.6 | 96.3 |
| **Air** | 0.0002 | 0.0101 | 0.0003 | 0.000002 | 0.0001 | 0.000002 |
| **Not declared** | - | 47 | 668 | - | 0.4 | 3.7 |
| **Total** | **10,620** | **13,054** | **17,976** | | | |

*Source: Comex Stat, Ministério da Economia, Governo do Brasil.*
*a: Sum of maritime and lake for 2019 and 2020.*

Shipping prices of Brazilian iron ore exports to China were valued at $18.58 per tonne of cargo in 2019 and $14.82 per tonne in 2020 (Figure 41).[14] These prices are more than double the iron ore freight rates from Australia to China. Differences in rates are also apparent when looking at iron ore freight rates over a longer period.

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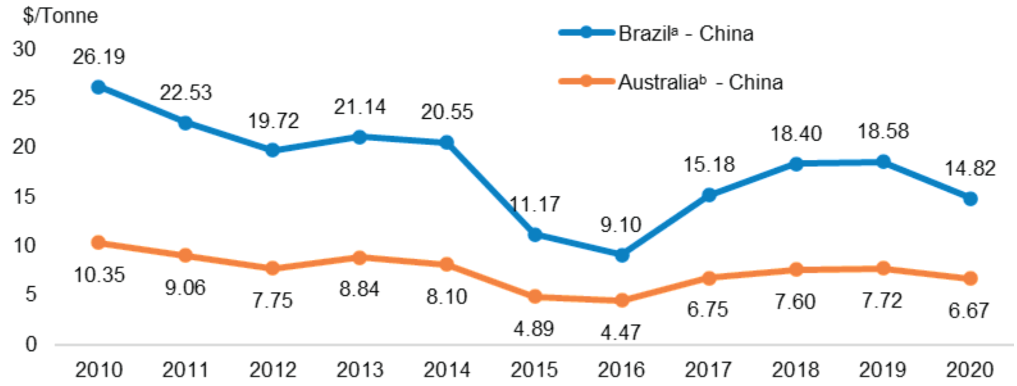
[14] These figures are largely in line with UNCTAD-MDST calculation/simulation of shipping costs for Mining and Quarrying Commodities in 2030 and which fed into the global economic model used to assess the impact of the IMO short term measure on States' trade and real income. According to the simulation exercise by UNCTAD-MDST, shipping costs for Mining and Quarrying sector in 2030 will average $14.7 per tonne for the Brazil-China trade and $7.2 per tonne for the Australia-China trade.

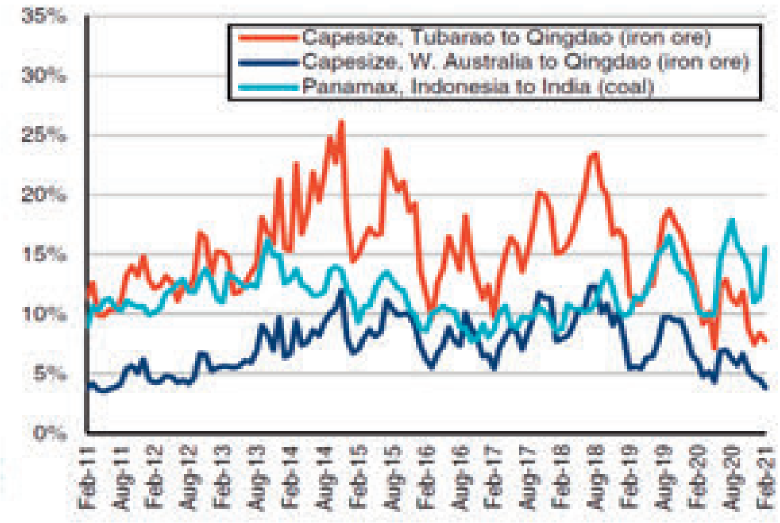
Expressed as a proportion of the iron ore cargo value, iron ore freight rates amounted to 14.7% in 2019 and 10.6% in 2020 (Figure 42).[15] In contrast, freight costs for Australia's iron ore exports to China amounted to only 7.6% of the cargo value in 2019 and 5.8% in 2020. Longer term trends indicate that iron ore shipping costs from Brazil to China are nearly double the shipping costs on the Australia-China route.

Figure 41: Freight rates per tonne of iron ore, from Brazil and Australia to China, 2010-2020



*Source: Clarksons Research Services, Shipping Intelligence Network, 2021-*
*a Tubarão (Brazil) - Qingdao (China) 177,000t Ore Capesize Voyage Rates.*
*b Dampier (Australia) - Qingdao (China) 172,000t Ore Capesize Voyage Rates.*

Figure 42: Freight as% of delivered cost of iron ore exports from Tubarão in Brazil and Western Australia to Qingdao in China, 2010-2020



*Source: Clarksons Research Services, Dry Bulk Trade Outlook, Volume 27, No. 3, March 2021, ISSN 1361-3189.*

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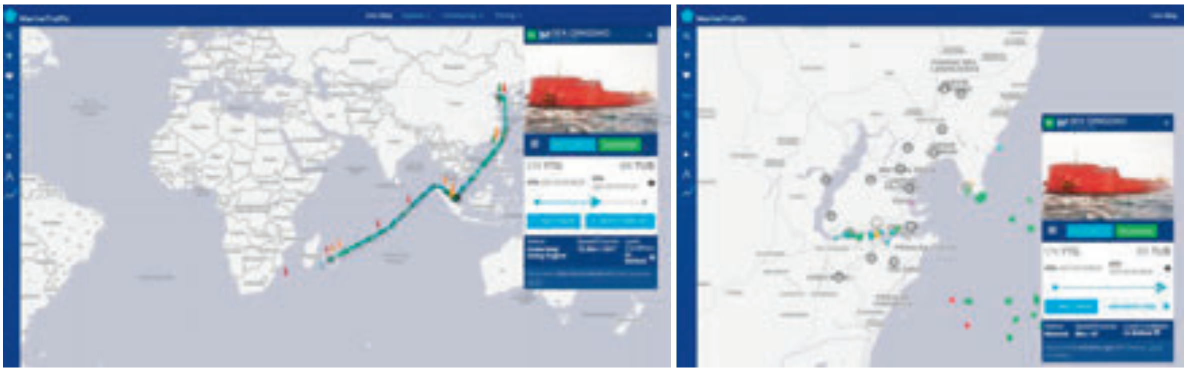
[15] Freight cost as a proportion of the Cost & Freight price (sum of freight and commodity prices).

### 4.2.4 Vessels Used for Iron Ore Transport

Dry bulk carriers deployed for the transport of iron ore from Brazil to China include the largest ships currently in existence. In 2019, there were 44 ore carriers with a cargo-carrying capacity of 350,000 DWT and above deployed journeys from both Brazil and Australia to China. Figure 43 shows the journey of an ore carrier on a return journey from China to Brazil with an actual time of departure of 3 February 2021 and actual time of arrival of 25 March 2021 (Journey of 50 days).

Figure 43: Example of vessel tracking for an ore carrier (Sea Qingdao)



*Source: MarineTraffic, http://marinetraffic.com, assessed on 26 February and 26 March 2021.*

A typical journey from Brazil to China may last 50.6 days,[16] when sailing[17] at an average speed of 9.8 knots[18] according to the AIS data provided by MarineTraffic for 2019 (Table 18).

Table 18: Ore carriers' journeys from Brazil and Australia to China, 2019

| **Destination** | **China** | | | | | | | **Rest of World** |
|---|---|---|---|---|---|---|---|---|
| **Exporter** | **Number of direct journeys** | **Average DWT** | **Maximum DWT** | **Number of ships deployed** | **Average speed** | **Average duration of journey (days)** | **Average distance Travelled (nm)** | **Number of direct journeys** |
| **Australia** | 472 | 248,628 | 297,488 | 63 | 9.35 | 16.3 | 3,537 | 109 |
| **Brazil** | 265 | 312,926 | 404,389 | 148 | 9.83 | 50.6 | 11,744 | 100 |

*Source: UNCTAD calculations, based on data provided by MarineTraffic.*
*Notes: Only includes laden journeys where departure and arrival are in 2019. Not including repositioning journeys within Brazil and within Australia*

Iron ore exports from Brazil to China are transported on ships that are 26% larger in terms of deadweight as compared to those that carry the ore from Australia to China. The distance is 3.3 times longer and the number of ships deployed to carry Brazilian exports are 2.3 times

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[16] Median duration (time at sea) of journey was 49.7 days in 2019.

[17] The average speed includes manoeuvring and waiting.

[18] The 9.8 knots figure describes the average of journeys from a given port in Brazil to a given port in China. As to the specific journeys on the Tubarao to Qingdao route, the average duration and speed were 42.7 days and 10.9 knots, respectively. It should be noted that MarineTraffic database which includes records for journeys from 1 January to 31 December 2019, had only three journeys for the Tubarao-Qingdao route out of total 265 journeys from Brazil to China.

higher, despite lower Brazilian export volumes[19] and the larger ship sizes characterizing iron ore exports from Brazil.

### *4.2.5 Impact of the IMO Short-Term Measure on Ships/Ship Operator Costs*

According to data received from DNV, there were 566 bulk carriers of 200,000 DWT and above in operation in 2019. DNV's model output data indicate that, under the baseline scenario in 2030 (Current Regulations Scenario with no new IMO policies in place), there will be 627 bulk carriers of 200,000 DWT and above in operation in 2030 and sailing at a speed which will be 14.7% slower than their design speed (Table 19). Under this baseline 2030 scenario, the bulk carrier fleet of 200,000 DWT and above will be carrying global bulk trade which DNV expects to increase between 2019 and 2030 by 13.3% in terms of tonne-miles.

DNV sets out three additional scenarios for 2030: A scenario with EEXI-Only, a HIGH-GHG reduction scenario and a LOW-GHG reduction scenario. DNV's model output data indicate that that under a HIGH-GHG reduction scenario, there will be a 25.1% speed reduction on average, relative to the design speed, representing an additional 10.5 percentage point speed reduction from the 2030 Current Regulations scenario. Consequently, 713 bulk ships of this size category i.e., of 200,000 DWT and above, would be required to deliver global dry bulk trade. In other words, 13.7% more ships will be added to carry the same amount of cargo. Thus, DNV expects that, in total, ships will make the same number of journeys per year[20] and that the dry bulk fleet will be performing the same transport work in terms of tonne-miles compared to the 2030 Current Regulations scenario.

There will be a very marginal change (i.e., a 0.6% increase) in **capital expenditure** per ship in the 2030 HIGH-GHG reduction scenario compared to the 2030 Current Regulations scenario. However, the capital expenditure for the same transport work will increase as more ships will be required to transport the same cargo volume in view of the speed reduction. As more ships will be required to carry the same volume of cargo, total capital expenditure is expected to increase by 14.5%. Meanwhile, total **operational costs** are expected to increase by 11.8% given the increased number of ships, although additional ships will have slightly lower operational costs per ship (i.e., a 1.7% decrease) given the use of more efficient technologies in newly built ships. Meanwhile, **fuel costs** are expected to increase only marginally (1.4% increase) with savings accrued through lower fuel consumption being countered by increased use of more expensive biofuel blends. Due to the additional speed

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[19] According to COMTRADE data, iron ore export volumes from Australia to China in 2019 were 3 times larger than iron ore exports from Brazil to China.

[20] The two DNV scenarios and calculations lead to no change in transport work performed in the HIGH-GHG reduction scenario compared with the Current Regulations scenario. The model assumes no change in total transport demand and computes changes in the number of ships and total ship costs while assuming that the same total number of tonne-miles are performed while speed is reduced. Therefore, there is practically no change in the total distance sailed or the total number of voyages. However, speed reduction will result in a 11.7 per cent reduction in voyages per ship.

reduction and the shift to lower emission fuels, CO2 emissions will be 15% lower in total, and 25% lower per vessel. The 2030 HIGH-GHG reduction scenario will result in a 7.8% increase in **total transport costs** (OPEX, CAPEX, and fuel expenditure) for bulk carriers of 200,00 dwt and above, as compared with the 2030 Current Regulations scenario (i.e., the baseline scenario with no new policies). Meanwhile and as DNV's model assumes almost no change in total transport demand, total cost intensity (total costs per tonne-mile) is expected to increase by 7.7%.[21]

Table 19: Ship cost changes under the 2030 HIGH-GHG reduction scenario (Bulk carriers of 200,000 dwt and above)

| Scenario in 2030 | | Speed reduction (% relative to design speed) | Number of ships | Cruising hours | Number of voyages | Transport work capacity (dwt-mile) | Transportation work (tonne-mile) |
|---|---|---|---|---|---|---|---|
| **Current Regulations** | **Total** | 14.7% | 627 | 3,435,753 | 8,973 | 10,220,941,397,109 | 6,559,927,950,432 |
| | **per ship** | | | 5,480 | 14.3 | 16,301,341,941 | 10,462,405,025 |
| **HIGH-GHG reduction** | **Total** | 25.1% | 713 | 3,924,673 | 9,012 | 10,223,919,686,546 | 6,561,839,453,822 |
| | **per ship** | | | 5,504 | 12.6 | 14,339,298,298 | 9,203,140,889 |
| **Change** | **Total** | **10.5 percentage point** | **13.7%** | **14.2%** | **0.4%** | **0.0%** | **0.0%** |
| | **per ship** | | | **0.5%** | **-11.7%** | **-12.0%** | **-12.0%** |

| Scenario in 2030 | | CO2 emissions (tonnes) | Carbon intensity (gCO2/ dwt-mile) | Annual CAPEX (millions of USD) | Base OPEX (millions of USD) | Fuel expenditure (millions of USD) | Total cost (millions of USD) | Total cost intensity (USD/ tonne-mile) |
|---|---|---|---|---|---|---|---|---|
| **Current Regulations** | **Total** | 20,749,982 | 2.03 | 1,320 | 1,637 | 2,435 | 5,393 | 0.082 |
| | **per ship** | 33,094 | | 2.10 | 2.61 | 3.88 | 8.60 | |
| **HIGH-GHG reduction** | **Total** | 17,519,454 | 1.71 | 1,511 | 1,830 | 2,471 | 5,812 | 0.089 |
| | **per ship** | 24,571 | | 2.12 | 2.57 | 3.47 | 8.15 | |
| **Change** | **Total** | **-15.6%** | **-15.6%** | **14.5%** | **11.8%** | **1.4%** | **7.8%** | **7.7%** |
| | **per ship** | **-25.8%** | | **0.6%** | **-1.7%** | **-10.8%** | **-5.2%** | |

*Source: UNCTAD calculations, based on data provided by DNV.*

### *4.2.6 Maritime Logistics Costs of Iron Ore Exports from Brazil to China*

In 2019, iron ore exports from Brazil to China attracted an average freight rate representing close to 14.7% of the iron ore export delivered value (Figure 42). As Brazil's iron ore exports

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[21] This is calculated as follows: 7.77 per cent increase in total transport costs (OPEX, CAPEX, and fuel expenditure) – 0.03% increase in total transportation work = 7.7% increase in total cost intensity.

by sea to China were valued at $13.0 billion in 2019 (Table 17), the corresponding total **shipping costs** are estimated at $1.9 billion[22] during the same year (Table 20).

According to calculations based on MDST data, shipping (transport) costs of Brazil's exports to China in the Mining and Quarrying sector[23] are expected to decrease by 0.8% under the 2030 HIGH-GHG reduction scenario compared to the 2030 Current Regulation scenario. With iron ore accounting for about half of Brazil's exports of Mining and Quarrying commodities, the change in costs for this broad category is relevant for iron ore. [24] A 0.8% decrease in the transport/shipping costs of Mining and Quarrying sector, would translate into a drop of $15 million to $1.9 billion in the transport/shipping costs of iron ore from Brazil to China under the HIGH-GHG reduction scenario. As maritime iron ore exports from Brazil to China stood at $13.0 billion in 2019, and assuming the same value continues to apply in 2030, the transport/shipping costs under the HIGH-GHG reduction scenario would be equivalent to about 14.6% of the export value. This represents a 0.1 percentage point decrease in transport/shipping costs when comparing the 2030 HIGH-GHG reduction scenario compared with the 2030 Current Regulation scenario.

Longer journeys at sea entail additional **time costs**, including in the form of inventory holding costs. Under the HIGH-GHG reduction scenario, the total cruising hours of ships from Brazil to China carrying commodities falling under the Mining and Quarrying trade sector, is expected to increase by 8.4% (based on UNCTAD-MDST calculation) given the speed reduction. As a result, a journey that would typically take 50 days from Brazil to China would, instead take up to 54 days.

To assess the cost implications of additional transit times, it is important to infer the value of time (VoT) for commodities falling under the Mining and Quarrying sector trade. Existing estimates indicate that the VoT for such commodities are at around $0.04 per tonne-hour, based on a modal choice simulation (see Appendix 2 of this report where VoT estimates are presented).

Iron ore shipments from Brazil to China averaged 312,926 DWT in 2019, based on MarineTraffic data on vessel movement (Table 18), the total number of journeys is estimated at 676 per year,[25] while journeys' duration averaged 50 days. Taking these considerations into account, the additional time costs for iron ore shipments from Brazil to

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[22] $13.0 billion (export value of iron ore from Brazil to China) * 14.7 per cent (freight cost as a share of the iron ore total export value) = $1.91 billion.

[23] Calculation of transport/shipping costs was conducted for 11 Eora sectors. Under this classification, iron ore is included in the broader Mining and Quarrying sector.

[24] About half (45%) of Brazil's Mining Quarrying sector exports to China were accounted for by iron ore in 2019 (51.6% was crude petroleum and natural gas). See WITS data at https://wits.worldbank.org/WITS/WITS/Restricted/Login.aspx.

[25] 211,573,852 tonnes of iron ore were shipped from Brazil to China by sea in 2019. As t there were 31,926 tonnes/journeys in 2019, the number of journeys can be derived as follows: 211,573,852 (tonnes/year) /31,926 (tonnes/journey) = 676 (journey/year). This is larger than 265 journeys reported in the AIS data (Table 18) as AIS data may have coverage limitations.

China can be estimated as follows: 0.04 ($/tonne-hour) * 312,926 (tonne/journey) * 676 (journey/year) * 96 (hour/journey)[26] = $0.8 billion in 2030 under the HIGH-GHG reduction scenario compared to the Current Regulations scenario. This amount is equivalent to a 6.4 percentage point increase in ad valorem terms.

To put these costs in perspective, it is worth assessing their implications for the maritime **logistics costs** i.e., the combined transport/shipping costs and time costs. These costs are particularly relevant for shippers, supply chain managers and cargo owners. Under the HIGH-GHG reduction scenario, maritime logistics costs would increase by 7.0% or 6.4 percentage points in ad valorem term.

Table 20: Cost changes of IMO short-term measure on maritime logistics costs of Brazil's iron ore exports to China

| | | 2030 | | Change from Current Regulations to HIGH-GHG reduction scenario in 2030 | |
|---|---|---|---|---|---|
| | | **Current Regulations** | **HIGH-GHG reduction** | **Change in level** | **Change in %, percentage point** |
| **Value of maritime iron ore exports in 2019** | (Millions of USD) | 13,007 | - | - | - |
| **Maritime logistics costs** | (% of goods value) | - | - | - | **6.4 percentage point** |
| | (Millions of USD) | - | - | 839 | 7.0% |
| **---- Transport/ Shipping costs** | (% of goods value) | 14.69 | 14.57 | - | -0.1 percentage point |
| | (Millions of USD) | 1,911 | 1,895 | -15 | -0.8% |
| **---- Time costs** | (% of goods value) | - | - | - | 6.6 percentage point |
| | (Millions of USD) | - | - | 854 | 8.4% |

*Source: UNCTAD calculations based on the analysis and modelling work carried out in the context of this report in collaboration with MDS Transmodal (MDST).*

### 4.2.7 Maritime Logistics Costs and Exports in the Mining and Quarrying Sector

The impacts of the IMO short-term measure on maritime logistics costs, trade flows and gross domestic product (GDP) are considered at a more aggregated level (Mining and Quarrying). However, with iron ore exports from Brazil to China accounting for about half of Brazil's Mining and Quarrying exports to China, trends in Mining and Quarrying provide a good indication of ways in which change in maritime logistics costs will affect iron ore trade from Brazil to China. As noted above, the transport/shipping costs of Brazil's exports of Mining and Quarrying sector products to China are expected to decrease by 0.8% under the

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[26] 4 days (additional days per journey in the HIGH-GHG reduction scenario compared with the Current Regulations scenario) * 24 hours.

HIGH-GHG reduction scenario, as compared with the Current Regulations scenario in 2030 (Table 21). In ad valorem terms, the expected change amounts to a decline of 0.1 percentage point. In contrast, cost of additional time spent at sea for these exports will increase by 8.4%, which is equivalent to an increase of 4.5 percentage points in ad valorem terms. As a result, the maritime logistics costs of Brazil’s exports to China in the Mining and Quarrying sector, including iron ore, are expected to increase by 6.4% under the HIGH-GHG reduction scenario as compared with the Current Regulations scenario. In ad valorem terms, this would amount to a 4.4 percentage point increase.

For more perspective, changes in maritime logistics costs of Australia, the biggest world iron exporter that has the potential to displace some of the iron ore exports from the Chinese import market, are also featured in Table 21. Maritime logistics costs of Australia’s exports of Mining and Quarrying sector products to China, are expected to increase by 6.8% under the HIGH-GHG reduction scenario as compared with the Current Regulations scenario. This is equivalent to a 2.5 percentage point increase in ad valorem terms. Reflecting Australia’s more advantage geographical position, the increase in Australia’s maritime logistics costs of iron ore exports to China are relatively lower than Brazil’s (nearly double).

Under the HIGH-GHG reduction scenario, Brazil’s exports to China in the Mining and Quarrying sector are expected to fall by 8.7% compared with the Current Regulations scenario. As China’s share in Brazil’s total Mining and Quarrying exports was 59.3% in 2019, the decline is equivalent to a 5.2% decrease in Brazil’s total Mining and Quarrying exports.[27] The elasticity of Brazil’s exports to maritime logistics costs is larger than 1 in absolute value (i.e., 1.36 = 8.7/6.4), implying that Brazil’s exports are sensitive to changes in maritime logistics costs.

In comparison, Australia’s exports in the Mining and the Quarrying sector are expected to decline by 5.7% in the HIGH-GHG reduction scenario relative to the Current Regulations scenario. Reflecting differences in the two countries’ maritime logistics costs for iron ore exports, the negative impact on Australia’s iron ore exports to China is smaller compared to Brazil. A smaller impact on Australia’s exports implies that part of Brazil’s exports to China in the Mining and Quarrying sector could be replaced by other iron ore exports of other suppliers, including Australia.

Similar arguments would apply in the case of exports to other Asian economies as given Brazil’s remoteness from this market. For example, Brazil’s exports of Mining and Quarrying products to India will fall by 9.6% under the HIGH-GHG reduction scenario compared to the Current Regulations scenario. In contrast, Australia’s exports to India are expected to fall by

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[27] It is also equivalent to a 1.2% decrease in Brazil’s total exports. This is calculated as follows: -8.7% (decrease in Brazil’s exports of Mining and Quarrying to China) * 13.3% (share of Brazil’s exports of Mining and Quarrying to China in Brazil’s total exports to the world) = -1.2%.

4%. Depending on the extent to which mining supply chains in Brazil will be able to absorb some of the simulated cost increases, Brazil could consider expanding its exports to other markets such as in Europe, North America and Africa,[28] although much of the iron ore demand today is in China.

Table 21: Impact of changes in maritime logistics costs on exports of Mining and Quarrying products from Brazil and Australia to China

| | | | EEXI-Only | HIGH-GHG reduction | LOW-GHG reduction |
|---|---|---|---|---|---|
| **Brazil** | **Maritime logistics costs** | (% change) | 1.0% | 6.4% | 1.3% |
| | | (Percentage change in costs in ad valorem term) | 0.7 | **4.4** | 0.9 |
| | **---- Transport/Shipping costs** | (% change) | -1.7% | -0.8% | -0.7% |
| | | (percentage point change in costs in ad valorem term) | -0.3 | -0.1 | -0.1 |
| | **---- Time costs** | (% change) | 1.8% | 8.4% | 1.8% |
| | | (percentage point change in costs in ad valorem term) | 1.0 | 4.5 | 1.0 |
| | **Impact of maritime logistics costs on exports** | (% change) | -1.4% | **-8.7%** | -1.7% |
| | **Impact of transport/shipping costs on exports** | | 0.8% | 0.6% | 0.4% |
| | **Impact of time costs on exports** | | -2.0% | -9.9% | -2.2% |
| **Australia** | **Maritime logistics costs** | (% change) | 0.7% | 6.8% | 0.9% |
| | | (percentage point change in ad valorem term) | 0.2 | **2.5** | 0.3 |
| | **---- Transport/shipping costs** | (% change) | -1.3% | -0.5% | -0.3% |
| | | (percentage point change in ad valorem term) | -0.1 | 0.0 | 0.0 |
| | **---- Time costs** | (% change) | 1.2% | 8.7% | 1.2% |
| | | (percentage point change in ad valorem term) | 0.3 | 2.5 | 0.3 |
| | **Impact of maritime logistics costs on exports** | (% change) | -0.5% | **-5.7%** | -0.6% |
| | **Impact of transport/ shipping costs on exports** | | 0.3% | 0.4% | 0.1% |
| | **Impact of time costs on exports** | | -0.7% | **-6.3%** | -0.7% |

*Source: UNCTAD calculations based on UNCTAD-MDST data, and the results of the global trade model used for the impact assessment.*

If the impact of increased maritime logistics costs on total trade is also considered, Brazil's total exports of all commodities under the HIGH-GHG reduction scenario would fall by 1.38% while its GDP would marginally decline by 0.02%. The impact on the country's real income is therefore expected to be negligible.

Asian economies that import iron ore from both Australia and Brazil are expected to have relatively large increases in their maritime logistics costs. Asian countries will likely consider

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[28] Brazil's exports of Mining and Quarrying products to the Netherlands, the biggest importer of iron ore in Europe, is expected to decrease by 4.2% in the 2030 HIGH-GHG reduction scenario, compared to the 2030 Current Regulations scenario. Australia's exports to the Netherlands are expected to decrease by 6.9%.

increasing domestic production when applicable and feasible as well as increasing scrap metal use. They could also consider using imports from less distant suppliers, including India. However, it is difficult to envisage a perfect substitution of iron ore imports from Australia and Brazil as other sources, including domestic mines and suppliers tend to produce lower grade iron ore and entail higher production costs.

#### *4.2.8 Maritime Freight Rate Volatility*

Maritime transport costs for dry bulk commodities such as iron ore are highly volatile. Figure 44 illustrates the fluctuations in the sector. Weekly volatility[29] of freight rates is evident with variation of rates per tonne of iron ore[30] being estimated 8.6% between 1 January 2010 and 26 February 2021. Much of the volatility results from the interaction between Very Large Ore Carriers (VLOCs), such as Valemax, and Capesize bulk carriers.[31] Typically, VLOCs operate under long-term (e.g., 25 years) contracts, while Capesize vessels operate in the spot market. Consequently, when there are many Vale VLOCs ballasting, the company would not need additional Capesize vessels from the spot market, resulting in a decline in the spot freight rates.

Further, if freight costs are expressed as a percentage of the value of the iron ore being shipped, volatility will be higher as iron ore prices, which are included in the ad valorem cost denominator, also fluctuate sharply. Iron ore price volatility increased after the collapse of the annual price negotiation regime for iron ore at the end of 2008.[32] Iron ore prices are driven by supply factors, such as weather-related disruptions and accidents in mines, and demand factors. Chinese demand for iron ore is influenced by several factors, including policy support measures (e.g., economic stimulus packages),[33] restructuring of the steel production sector, environmental sustainability objectives,[34] inventories of iron ore and steels, domestic iron ore production,[35] use of scrap metals, and the use alternative modes of transport and trade routes (e.g., overland from Mongolia). These are swing factors that can impact on China's iron ore demand above and beyond changes in freight rates and iron ore prices.

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[29] Standard deviation of weekly percentage change.

[30] Freight rate from Tubarao in Brazil to Qingdao in China, for 177,000t Ore Capesize.

[31] Capesize bulk carriers are vessels with a capacity over 150,000 DWT. Vessels over 200,00 DWT are considered as VLOCs. VLOC is a subcategory of the Capesize but often they are considered separately.

[32] After the collapse of the annual negotiation system, iron ore pricing shifted by using benchmark spot market indices. However, as the quality between different iron ores varies substantially, premiums for high-grade ores are determined by negotiations.

[33] Temporary increase in infrastructure spending would stimulate industrial production and manufacturing and therefore boost iron ore trade flows.

[34] Environmental sustainability objectives would promote imports of high-grade iron ores from Brazil and Australia. They could also promote reducing steel production capacity altogether or using scrap metal.

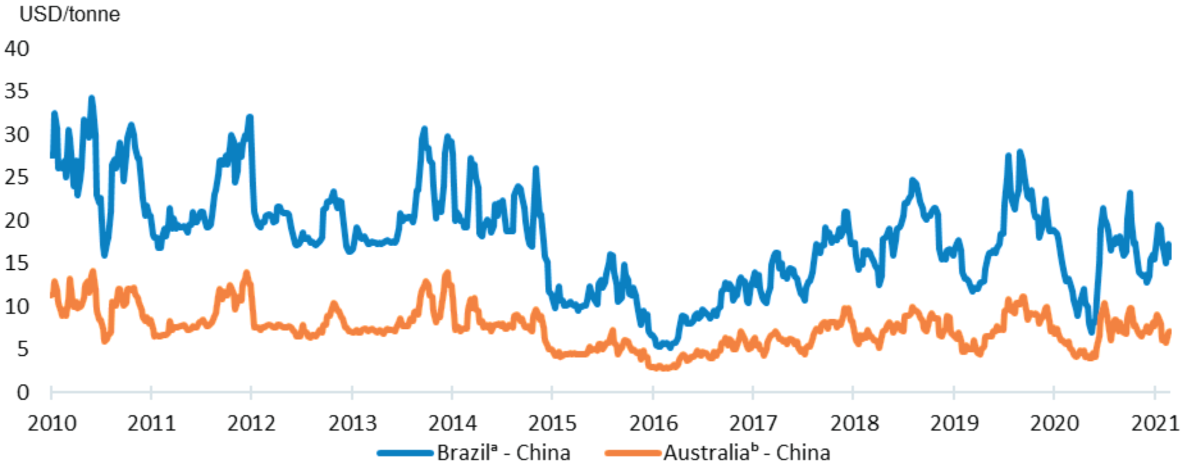
[35] China produced 867 million tonnes of iron ore in 2020 although the quality is lower than ore produced in Brazil and Australia. China's iron ore production cost is high (i.e., around $90/tonne compared to around $30/tonne in Australia).

In this context, it can be argued that general market volatility is much higher than the simulated change in the maritime logistics costs of iron ore exports from Brazil to China under the HIGH-GHG reduction scenario compared with the Current regulations' baseline scenario.

In ad valorem terms, the 8.6% variation measuring the market volatility is equivalent to a fluctuation of 1.26 percentage points. Meanwhile, the increase in maritime logistics costs expected under the HIGH-GHG reduction scenario is equivalent to a 6.4 percentage point ad valorem. This is much larger than the market volatility of 1.26 percentage points.

In addition, despite the high volatility of the spot freight market, the long-run average of the weekly price change is low. It has been negative due to oversupply of vessels and efficiency improvement: -0.1% (-4.8% per year) for the Capesize freight rates from Brazil to China during the last decade. Therefore, a systematic and long-term increase in maritime logistics costs will have a more significant adverse effect on transport demand than short-term volatility in iron ore freight rates. In addition, as VLOCs typically operate under long-term contracts, freight costs tend to be less volatile than spot freight rates for Capesize vessels.[36]

Figure 44: Weekly freight rates, 1 January 2010 - 26 February 2021



*Source: Clarksons Research Services, Shipping Intelligence Network.*
*a Tubarao (Brazil) - Qingdao (China) 177,000t Ore Capesize Voyage Rates.*
*b Dampier (Australia) - Qingdao (China) 172,000t Ore Capesize Voyage Rates.*

### *4.2.9 Demand/Supply Balance*

Currently, the orderbook for dry bulk carriers is very low compared to the last two decades (Figure 45). Building a new ship once an order is confirmed can take two to three years. Given the current low orderbook and the need for additional shipping capacity in view of the IMO short-term measure, the demand/supply balance is likely to also change.

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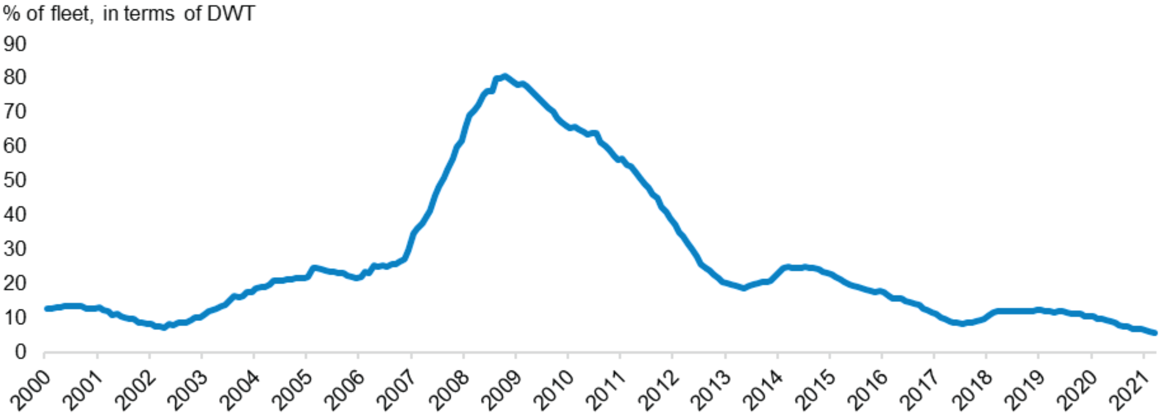
[36] See for example, https://www.argusmedia.com/en/blog/2018/march/2/valemaxes-could-spell-capesize-markets-doom.

Depending on the rate at which new additional carrying capacity becomes available, the demand and supply mismatch that may result could potentially lead to higher freight rate levels, beyond the changes estimated solely from the changes in capital and operational costs assessed under the 2030 scenarios (EEXI-Only, HIGH- and LOW-GHG reductions).

Figure 45: Orderbook for dry bulk carriers (Perc cent of fleet)



*Source: Clarksons Research Services, Shipping Intelligence Network, 2021.*

### *4.2.10 Summary of Main Points*

- China is the leading world importer of iron ore, accounting for over two thirds of world iron ore imports in 2019. Australia and Brazil are the two largest exporters, with market shares in 2019 estimated at 57.4% and 23.9%, respectively.
- Shipping costs of iron ore exports from Brazil to China averaged 14.7% of the iron ore export delivery prices in 2019.
- Dry bulk carriers deployed for the transport of iron ore include the largest ships currently in existence. There were 566 bulk carriers of 200,000 DWT and above in operation in 2019. In 2030, DNV forecasts that there would be 627 bulk carriers of 200,000 DWT and above in operation to carry forecasted under the 2030 baseline scenario (Current Regulations scenario, i.e., with no new IMO policies).
- Under the 2030 HIGH-GHG reduction scenario, DNV model output data indicate that the average speed will be 10.5 percentage points lower compared with the 2020 Current Regulations scenario. As a result, 713 ships would be required, (i.e., 13.7% more ships or 86 additional ships), to carry the same projected volume of cargo.
- As more ships are required, total ship costs (i.e., sum of OPEX, CAPEX, and fuel expenditure) for bulk carriers of 200,000 dwt and above will increase by 7.8% under the HIGH-GHG reduction scenario compared with the Current Regulations or baseline scenario.

- Compared with the Current Regulations scenario, maritime logistics costs for iron ore exports from Brazil to China will be higher under the HIGH-GHG reduction scenario. The increase in maritime logistics costs is driven by a 6.6 percentage point increase in time costs (including inventory holding costs) which result from speed reduction and longer sailing journeys. In contrast, transport/shipping costs will fall by 0.1 percentage points.
- Increased maritime logistics costs under the HIGH-GHG reduction scenario are expected to negatively affect Mining and Quarrying sector exports from both Brazil and Australia. However, Brazil's iron ore, and more broadly, Mining and Quarrying sector exports are expected to be more negatively impacted. Brazil's exports of Mining and Quarrying products to China will decrease by 8.7%, while Australia's exports are expected to decrease by 5.7%.
- Changes in the demand/supply balance of dry bulk carriers resulting from the need for additional ships to be built, to compensate for lower sailing speeds, may lead to higher freight rates in coming years, beyond the changes that may result from a regulatory or policy change such as the IMO short-term measure.

## 4.3 Illustrative Case 2: Imports of grain to Egypt from the United States

### *4.3.1 Global Grain Trade*

Grain products (including wheat, coarse grains, and soybean) are the third largest dry bulk commodity carried by sea after iron ore and coal. In 2020, global grain trade accounted for about 4.5% of world seaborne trade in volume terms.[37] The volume of world grains carried by sea increased at an estimated average annual growth rate of over 5% over the past seven years with total shipments reaching 514 million tonnes in 2020. Over the past decade, China has been consistently the largest single country importer of grains (Figure 46).

Since 2015, Egypt has been the third largest grain importer after China and Japan with total grain imports reaching 27 million tonnes in 2020. A net-food importer, Egypt depends heavily on maritime transport for its grains' imports.

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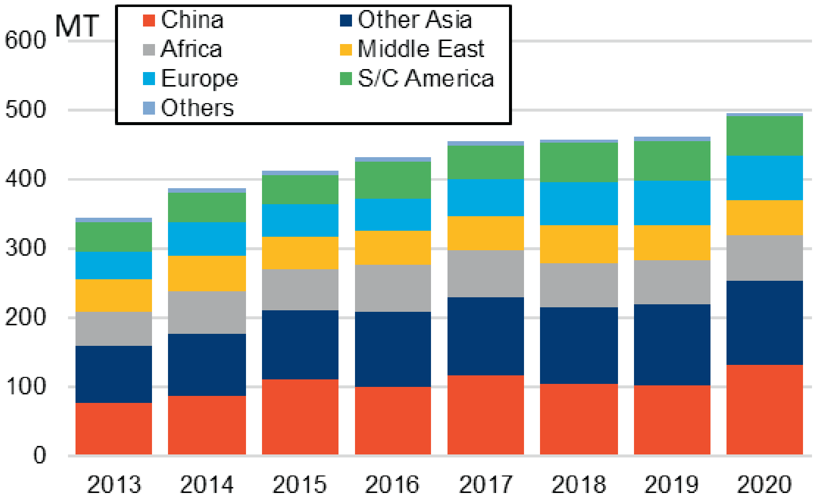
[37] Clarksons Research Services (2021). Seaborne Trade Monitor. Volume 8, No.3. March. ISSN: 2058-7570.

Figure 46: Global seaborne grain imports



*Source: Clarksons Research Services, Dry Bulk Trade Outlook, Volume 27, No. 1, January 2021.*

### *4.3.2 Egypt's Grain Imports*

In 2020, Egypt was the world's largest importer of wheat ($4.67 billion) or equivalent of around 12.69 million tonnes,[38] while imports of soybeans reached $1.5 billion or 4.2 million tonnes.[39] Wheat is used for bread, the staple food in Egypt while soybeans and soybean oil are used for both human consumption and animal feed.[40]

Egypt's wheat consumption has been growing steadily since 1960 with the total volume reaching 20.8 million tonnes in 2020. The country ranked as the 7th highest wheat consumer worldwide in 2020,[41] and the 9th in terms of soybean oil consumption, with volumes exceeding 1 million tonnes.[42]

Egypt grain imports are sourced from different countries including the United States which is among the top 5 exporters of grains to Egypt. The Russian Federation and Ukraine are also among the leading wheat exporters to Egypt. The United States accounted for 8.3% [43] of the total value of Egyptian wheat imports in 2019. Grain imports make up the largest share of Egypt's imports from the United States, amounting to 27.4% of the country's total import

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[38] See USDA, Foreign Agricultural Service website: https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Cairo_Egypt_03-15-2020.

[39] See Tridge: https://www.tridge.com/intelligences/soybean/EG/import?flow=i

[40] Wally, A. (2020). Grain and Feed Annual: Egyptian Wheat Imports Hold Steady Despite Increased Local Production (Report no. EG2020-0005). United States Department of Agriculture. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Cairo_Egypt_03-15-2020

[41] See Indexmundi: https://www.indexmundi.com/agriculture/?commodity=wheat&graph=domestic-consumption

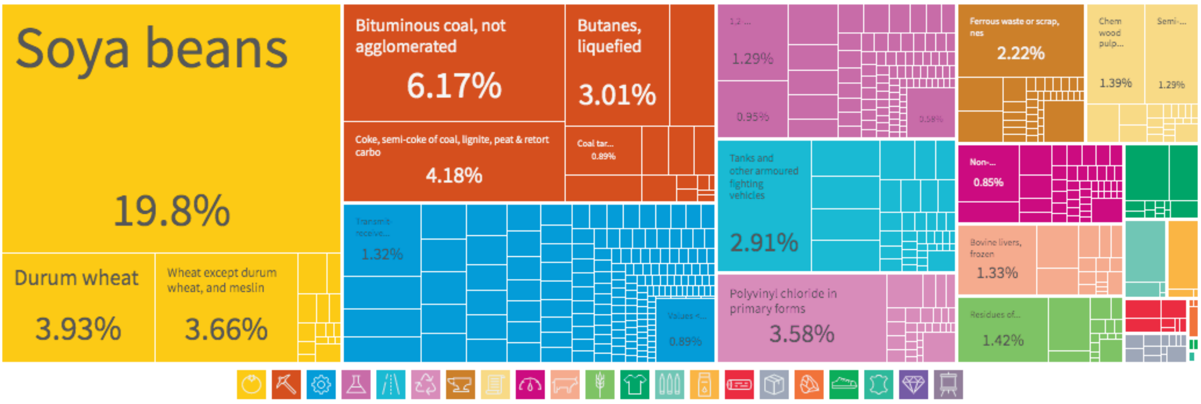
[42] See Indexmundi: https://www.indexmundi.com/agriculture/?commodity=soybean-oil&graph=domestic-consumption

[43] According to www.oec.world data.

values in 2019, or $1.4 billion[44] (Figure 47). In volume terms, wheat imports from the United States into Egypt reached 847,000 tonnes,[45] while soybean imports were estimated at 3.27 million tonnes.[46] Unlike grain imports from the Russian Federation and Ukraine which require shipments to travel across distances hovering around 1500 nautical miles or around 7 days journeys at 10 nautical miles, grain shipments from the United States to Egypt travel distances exceeding an average of 5000 nautical miles and involve journeys lasting over few weeks depending on the sailing speed.

Figure 47 features the various commodities imported into Egypt from the United States in 2019. Soybeans, durum wheat as well as "wheat except durum wheat and meslin", constitute Egypt's main grain imports from the United States.

Figure 47: Egyptian imports from the United States



*Source:* *[www.oec.world](http://www.oec.world)* *Egypt's import products from the United States (accessed on 20 March 2021).*

### 4.3.3 Transport of Grain from the United States to Egypt

Freight rates relating the voyage of 55,000t Panamax bulker carrying grain from the United States to Egypt ranged between 18.67 – 23.34 $/tonne over the 2015-2020 period[47] (Figure 48). Weekly freight rates for this type of ships and voyages exhibit significantly higher price fluctuations (see relevant section below).

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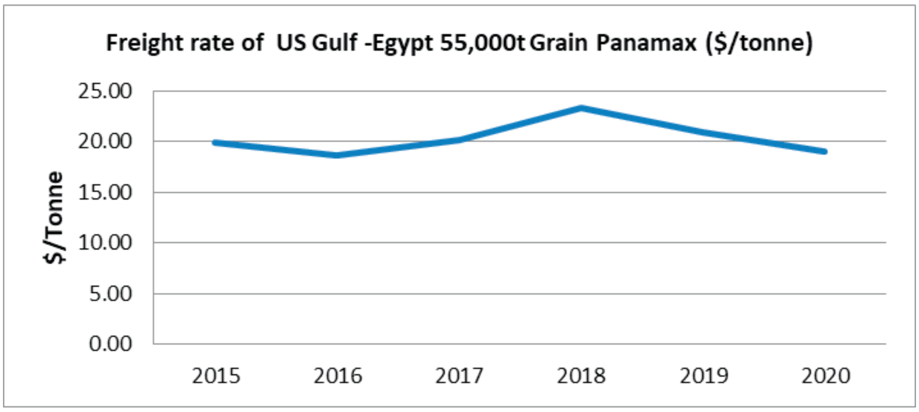
[44] According to www.oec.world data.

[45] See USDA, Foreign Agricultural Service website: https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Cairo_Egypt_03-15-2020.

[46] See USDA, Foreign Agricultural Service website: https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Cairo_Egypt_03-15-2020.

[47] See Clarksons Shipping Intelligence Network Timeseries for US-Gulf- Egypt 55,000t Grain Panamax Voyage.

Figure 48 United States Gulf- Egypt grain freight rates (55,000t Panamax vessel)



*Source: Clarksons Research, Dry Bulk Trade Outlook, Volume 27, No. 1, January 2021, ISSN 1361-3189.*

Using the average freight rate levels observed over the past 5 years as a reference, namely 21.56 $/tonne, and Egypt's grain import volumes originating from the United States and estimated at 4,117,000.[48] tonnes in 2019, expenditure on shipping costs for a Panamax vessel of 55,000t and carrying grain on a voyage from the United States to Egypt, would amount to $88.7625 million (i.e., 6.33% ad valorem shipping costs in 2019).[49]

Shipping costs of agricultural products originating from the United States to Egypt, were estimated at $12.14/tonne[50] or 3.56% in terms of ad valorem shipping costs in 2019 (Table 22).

Table 22: Shipping costs of agricultural product imports into Egypt from the United States

| Origin Country | Destination Country | Sector | Tonnes by sea (tonne) | Total value by sea ($) | Transport cost, ($/tonne) | Total transport costs ($) | Transport costs as percentage of total value (%) |
|---|---|---|---|---|---|---|---|
| **United States of America** | **Egypt** | **Agriculture** | **3,631,495.01** | **1,237,711,092** | **12.143** | **44,098,947.80** | **3.56** |

*Source: UNCTAD, based on data provided by MDS Transmodal (MDST).*

As shown in Table 22, the ad valorem shipping costs estimated for agricultural commodities exports from the United States to Egypt (i.e., 3.56%) are lower as compared to the equivalent estimation for grains noted above (6.33%). However, and while agricultural trade includes commodities other than grains, agricultural commodity group is used as a proxy to assess the implications of the increased costs for grain shipments. The comparison shows

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[48] See USDA, Foreign Agricultural Service website: https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Cairo_Egypt_03-15-2020.

[49] According to www.oec.world data, the import value of grains shipped from the United States to Egypt was estimated at around $1.4 billion in 2019.

[50] Based on the results of UNCTAD-MDS Transmodal analysis carried out in the context of this report and which estimated mean shipping costs of agricultural products exports from United States to Egypt in 2019.

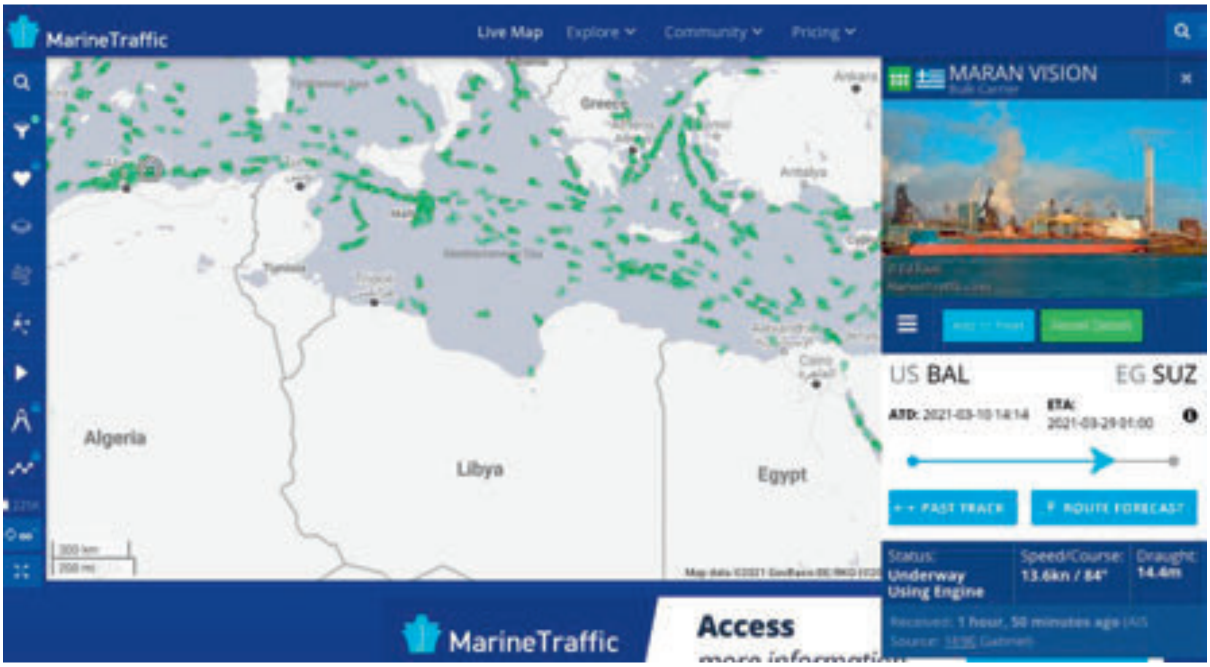
that grain shipping costs on the United States-Egypt route is within a reasonable range considering agricultural products category includes a broad variety of commodities with varied value densities. including those with higher values than grain.

### 4.3.4 Vessels Used for Grain Transport

Grains are typically transported using dry bulk carriers and a small share is transported using container ships. Based on the AIS data sourced from MarineTraffic, dry bulk carriers that serve the United States-Egypt route have on average, a carrying capacity of 57,702 dwt (Handymax bulk carriers). Nevertheless, there is some variation in terms of vessel sizes being deployed with the largest ship having a capacity of more than 200,000 dwt (Capesize). Existing data[51] indicate that typical ship types and sizes used to transport grains are Panamax bulk carriers with sizes ranging between 65,000-99,000 dwt and Handymax bulk carrier of 58,328 dwt.

Figure 49 shows the position of the bulk carrier "*Maran Vision",* on its journey from the Port of Baltimore in the United States to Egypt. The average duration of journeys on this route is estimated at 20 days with an average travel speed reaching 13.6 knots (Table 23 and Table 23).

Figure 49: Tracking a bulk carrier's journey from the United States to Egypt



US BAL — EG SUZ

ATD: 2021-03-10 14:14

ETA: 2021-03-29 01:00

Status: Underway Using Engine

Speed/Course: 13.6kn / 84°

Draught: 14.4m

Received: 1 hour, 50 minutes ago

Source: *MarineTraffic, http://marinetraffic.com, assessed on 25 March 2021.*

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[51] Based on UNCTAD Review of Maritime Transport2020.

Table 23: Bulk carriers' journeys from the United States to Egypt, 2019

| ***Destination*** | ***Egypt*** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Exporter** | **Number of direct journeys** | **Average DWT** | **Maximum DWT** | **Number of ships deployed** | **Average speed (knots)** | **Average duration of journey (days)** [52] | **Average Distance travelled (nm)** |
| **United States of America** | 524 | 57,702 | 203,028 | 499 | 13.6 | 20 | 5004 |

*Source: UNCTAD calculations, based on data provided by MarineTraffic.*
*Notes: Laden journeys only where departures and arrivals are in 2019. Not including repositioning journeys within the United States and within Egypt*

### *4.3.5 Impact of IMO Short-Term Measure on Costs*

MarineTraffic data on ship movements provided information on the type and size of ships that would normally be deployed to service the United States-Egypt grain trade, namely the dry bulk ships with an average size of 57,702 dwt and a maximum size of 203,028 dwt. For the purposes of this analysis and building on data provided by DNV, the focus is on dry bulk ships with sizes ranging between 60,000 to 99,999 dwt[53] to better capture the variation in ship types used. However, these ships do not only carry grain from the United States to Egypt, but other dry bulk commodities as well. Nevertheless, this ship size and category is used to illustrate the potential impacts of the IMO short-term measure on the costs to the carriers and shippers as well as the carbon emission indicators.

Building on DNV and MarineTraffic data, it is estimated that 3,962 vessels ranging between 60,000-99,999 dwt will be in operation in 2030 under the Current Regulation scenario (baseline). These ships are expected to carry grains from the United States to Egypt. Table 24 provides an overview of the impact of the three IMO 2030 scenarios that assume different levels of ambition in terms of GHG reduction targets. The three scenarios include the EEXI-Only scenario, the HIGH-GHG reduction scenario, and the LOW-GHG reduction scenario. The impact of these three scenarios as compared with the 2030 baseline scenario (Current Regulations) is assessed in terms of the number of ships of 60,000-99,999 dwt that will be deployed, their sailing speed, ship costs (CAPEX, OPEX, and fuel costs), as well as their CO2 emissions. Table 24 and Table 25 summarize the changes in these various ship-related indicators as compared with the 2030 baseline scenario with Current Regulations in place.

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[52] Calculated based on the average distance between the port of New York (United States) and the port of Alexandria (Egypt) available at www.sea-distances.org.

[53] DNV data does not use ship size category which exactly represents Panamax sized ship 65,000-99,999 dwt.

Table 24: Impact of IMO short-term measure on ship operator costs and CO2 emissions (dry bulk ships 60,000-99,999 dwt)[54]

| Scenario | Total ship number | Speed reduction per ship (%) | CO2 emissions per ship (Tonnes) | Total CO2 emissions (M Tonnes) | CAPEX per ship (M$) | Total CAPEX (B $) | OPEX per ship (M $) | Total OPEX (B $) | Total fuel costs (B $) | Total cost (B $) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Current regulations** | 3,962 | 0.1499 | 15,529.00 | 61.53 | 1.149 | 4.553 | 2.160 | 8.557 | 7.47 | 20.58 |
| **EEXI-Only** | 4,311 | 0.2168 | 13,041.00 | 56.22 | 1.114 | 4.802 | 2.157 | 9.299 | 6.90 | 21 |
| **LOW-GHG reduction** | 4,321 | 0.2184 | 12,930.00 | 55.87 | 1.113 | 4.807 | 2.157 | 9.320 | 7.07 | 21.2 |
| **HIGH-GHG reduction** | 4,519 | 0.2568 | 11,398.00 | 51.51 | 1.169 | 5.281 | 2.143 | 9.686 | 7.20 | 22.17 |

Table 25: Relative changes in ship operator costs and CO2 emissions across the three 2030 scenarios[55]

| Changes across scenarios | Extra ship | Speed reduction per ship (%) | CO2 emissions per ship (%) | Total CO2 emissions (%) | CAPEX per ship (%) | Total CAPEX (%) | OPEX per ship (%) | Total OPEX (%) | Total fuel costs (%) | Total cost (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| **EEXI-Only** | 349 | 6.68 | -16.02 | -8.62 | -3.07 | 5.5 | -0.123 | 8.67 | -7.610 | 2.05 |
| **LOW-GHG reduction** | 359 | 6.84 | -16.74 | -9.19 | -3.19 | 5.6 | -0.125 | 8.92 | -5.369 | 3.00 |
| **HIGH-GHG reduction** | 557 | 10.69 | -26.60 | -16.28 | 1.68 | 16 | -0.756 | 13.20 | -3.563 | 7.73 |

*Source: UNCTAD, based on data provided by DNV.*

Under the three 2030 scenarios for dry bulk ships with sizes of 60,000-99,999 dwt, DNV results indicate that, on average, ships' speed will be reduced by 6.7% (EEXI-Only), 6.8% (LOW-GHG reduction), and 10.7% (HIGH-GHG reduction) compared to the baseline scenario in 2030 (Current Regulations). As a result of these reductions, total CO2 emissions will decline by 8.62% % (EEXI-Only), 9.19% (LOW-GHG reduction), and 16.28% (HIGH-GHG reduction). Additional ships of 60,000 -99,999 dwt will be needed to carry the same amount of cargo. An additional 349 bulk carriers of 60,000-99.999 dwt will be required in the case of the EEXI-Only scenario, 359 and 557 vessels of the same type and size will be required under the LOW- and HIGH-GHG reduction scenarios, respectively.

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[54] DNV (2021). Support for IMO Impact Assessment: Cost Impact of approved IMO GHG regulations.

[55] DNV (2021). Support for IMO Impact Assessment: Cost Impact of approved IMO GHG regulations.

These ships will have slightly lower operational costs per day given the daily lower fuel consumption and per tonne-mile. However, given the increased number of ships necessary to carry the same volume of cargo, according to DNV results, this would lead to an increase in total capital expenditure of 5.5% (EEXI-Only), 5.6% (LOW-GHG reduction) and 16% (HIGH-GHG reduction). Furthermore, total operational expenditure would also see an increase of 8.7% (EEXI-Only), 8.9% (LOW-GHG reduction) and 13.2% (HIGH-GHG reduction).

According to DNV results, the estimated impact of the IMO short-term measure on ships will result in an increase of total costs, including CAPEX, OPEX and fuel costs for ship operators, of 2.05% (EEXI-Only), 3% (LOW-GHG reduction scenario), and 7.73% (HIGH-GHG reduction scenario) compared to the 2030 baseline scenario. In monetary terms, the total annual cost increase will amount to $0.42 billion[56] (EEXI-Only), $0.62 billion[57] (LOW-GHG reduction), and $1.59 billion[58] (HIGH-GHG reduction).

### *4.3.6 Impact of the IMO Short-Term Measure on Shipping Costs and Time Costs*

While in practice, some portion of the cost increments could be absorbed by carriers, depending on carriers' strategies and cost structure, for the purposes of this analysis, it is assumed that carriers will pass through the full the cost increase to shippers/cargo owners. In this context, the ad valorem maritime logistics costs (i.e., combined shipping cost and time costs as a proportion of the value of the goods) of grain shipments are expected to increase. As the results under the HIGH-GHG reduction scenario are relatively higher than the EEXI-Only and LOW-GHG reduction scenarios, the HIGH-GHG reduction scenario is likely to have a larger impact on the maritime logistics costs. Therefore, the present analysis focuses on the HIGH-GHG reduction scenario as being more relevant given the cost implications as well as its higher carbon emission reduction potential.

Shipping costs of agricultural product exports from the United States into Egypt are expected to increase by 0.58% under the HIGH-GHG reduction scenario.[59] Using the freight rate of 21.56 $/tonne as a baseline, shipping costs will increase to 21.68 $/tonne i.e., increase by about 0.13 $/tonne. The shipping cost expenditure will increase by an additional $0.52 million compared to Current Regulation scenario, taking the total to $89.27 million.[60]

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[56] Calculated by comparing total transport costs under EEXI-Only scenario and current regulations scenario as presented in Table 24.

[57] Calculated by comparing total transport costs under LOW-GHG reduction scenario and current regulations scenario as presented in Table 24.

[58] Calculated by comparing total transport costs under HIGH-GHG reduction scenario and current regulations scenario as presented in Table 24

[59] Based on UNCTAD-MDS Transmodal calculations.

[60] Total shipping costs (high scenario) for grain products: 21.68$/tonne x 4.117 Million tonnes = $89.27 million.

With the value of grain imports to Egypt in 2019 estimated at around $1.4 billion, the increased transport costs would amount to around 6.37% [61] or an *additional of 0.04%* compared to 6.33% of ad valorem transport costs of the grain imports value to Egypt from the US under baseline scenario.

In addition to shipping costs, time costs are an important consideration for shippers. Longer sailing time due to speed reduction would result in additional time costs. Time costs in the current analysis are based on the Value of Time (VOT) of Agriculture group within 11 EORA sectors. The VoT for Agricultural products is estimated at around 0.008 $/tonne.hour. The time costs of transporting a commodity are driven by inventory holding costs, depreciation costs, opportunity costs, and the possible disruption in supply chain operations, among other factors. In the 2030 baseline scenario, time costs of transporting grains from the United States to Egypt are estimated as follows: 0.008 $/Tonne.hour x 4.117 million tonnes x 640 hours = $21,097 million.[62] A HIGH-GHG reduction scenario would lead to 49 hours of additional sea transport time, on average, or a total journey of 690 hours. This translates into time costs of $22.725 million[63] or an increase of $1.63 million.

Maritime logistics costs are calculated by adding up the increase in shipping costs and time costs. These costs are particularly relevant for shippers and supply chain managers. Under the HIGH-GHG reduction scenario, maritime logistics costs would increase from $109.85[64] million to $111.99[65] million or an increase of 1.95%. Table 26 provides an overview of the total ship operators' costs as well as shippers costs as captured by shipping, time, and maritime logistics costs, respectively.

The grain case involving imports into Egypt from the United States has shown that when measured in absolute terms or looking at levels, shipping costs account for the higher proportion of the total maritime logistics costs. Nevertheless, in terms of the percentage changes, additional time costs resulting from the additional 49 hours of travel time, lead to a larger increase in costs ($1.63 million) when compared with the additional shipping costs ($0.52 million).

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[61] Shipping costs as percentage of values of goods: 89.27 million USD/1.4 Billion USD =6.37%.

[62] VOT for agricultural products (0.008 $/Tonne.hour) is based on the estimation done by Equitable Maritime Consulting, total cargo volume for wheat, corn, and soybean (4.117 million tonnes ) is based on USDA report in 2020:https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Cairo_Egypt_03-15-2020. Total average travel time (640 hours) is based on UNCTAD-MDS Transmodal estimation.

[63] Time costs are computed as follows: 0.008 $/Tonne.hour x 4.117 million tonnes x 690 hours = $22.725 Million

[64] Maritime logistics costs (current policy): transport costs (88.75 million USD) + time costs (21.097 million USD) = 109.847 million USD.

[65] Maritime logistics costs (HIGH-GHG reduction): transport costs (89.27 million USD) + time costs (22.725 million USD) = 111.99 million USD.

Table 26: Impact of the IMO short-term measure on Egypt's grain imports from the United States

| | | 2019 | 2030 | | Change from current policy to new policy scenario in 2030 | |
|---|---|---|---|---|---|---|
| | | | Current policy | HIGH-GHG reduction policy | Change in level | Change in % |
| **Ship operators** - bulk carriers of 60,000-99,999 DWT | | | | | | |
| **Total ship operator costs** [66] | (Billions of USD) | 21.25 | 20.58 | 22.17 | 1.59 | 7.73% |
| **Importers/Shippers costs: imports of grains into Egypt from the United States** | | | | | | |
| **Import value of grain in 2019**[67] | (Millions of USD) | 1.400 | | | - | - |
| **Transport cost**[68] | (% of goods value) | 6.33 | | 6.37 | - | 0.04% |
| | (Millions of USD) | 88.75 | | 89.27 | 0.52 | 0.58% |
| **Time cost**[69] | (% of goods value) | 1.52 | | 1.62 | - | 0.10% |
| | (Millions of USD) | 21.097 | | 22.725 | 1.63 | 7.72% |
| **Maritime logistics costs** | (% of goods value) | 7.85 | | 7.99 | - | 0.14% |
| | (Millions of USD) | 109.85 | | 111.99 | 2.14 | 1.95% |

*Source: UNCTAD calculations based on the analysis and modelling exercise carried out in the context of this report in collaboration with MDST Transmodal (MDST).*

### 4.3.7 Impact on Agricultural Products Trade Between Egypt and the United States

The shipping costs of Egypt's agricultural product imports from the United States are expected to decrease by 2.2% under the EEXI-Only scenario, decrease by 1.2% under the LOW-GHG reduction scenario, and increase by 0.6% under the HIGH-GHG reduction scenario. The time spent at sea for these imports is expected to increase by 3.5% under the EEXI-Only scenario, by 3.7% under the LOW-GHG reduction scenario, and by 7.8% under the HIGH-GHG reduction scenario. Total maritime logistics costs for agricultural imports of Egypt from the United States are expected to decrease by 0.51% under EEXI-Only scenario, increase by 0.23% under LOW-GHG reduction scenario and increase by 2.7% under HIGH-GHG reduction scenario. Table 27 provides an overview of the changes in maritime logistics costs across the three scenarios and their impacts on Egypt's imports of agricultural products. For more perspective, changes in of the maritime logistics costs of the Russian Federation and Ukraine, two main exporters of grain to Egypt are also featured.

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[66] Calculated based on DNV cost estimation data for Panamax bulkers of 60,000-99,000dwt.

[67] Based on trade value data obtained from www.oec.world

[68] Based on the multiplication of unit costs obtained from Clarksons Shipping Intelligence Network Timeseries for US-Gulf-Egypt 55,000t Grain Panamax Voyage and total grain import volume from USDA report: https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Grain%20and%20Feed%20Annual_Cairo_Egypt_03-15-2020.The percentage increase in shipping costs is based on UNCTAD-MDST calculations for the United States-Egypt imports of agricultural products under the HIGH-GHG reduction scenario.

[69] Time costs are calculated based on VoT multiplied by total travel time under the three scenarios, respectively and the total volume of cargo shipped, and which had been estimated by UNCTAD-MDS Transmodal.

Table 27: Impact of changes in maritime logistics costs agricultural product exports Egypt sourced from three main suppliers of grain

| Exporter | Importer | Sector | Maritime logistics cost change-EEXI-Only (%) | Maritime logistics cost change-LOW-GHG reduction (%) | Maritime logistics cost change-HIGH-GHG reduction (%) | Changes in export-EEXI-Only (%) | Changes in export-LOW-GHG reduction (%) | Changes in export-HIGH-GHG reduction (%) |
|---|---|---|---|---|---|---|---|---|
| **RUS** | EGY | Agriculture | -0.67 | 0.63 | 3.56 | 0.11 | -0.20 | -0.81 |
| **UKR** | EGY | Agriculture | 0.26 | 1.36 | 4.14 | -0.15 | -0.81 | -2.37 |
| **USA** | EGY | Agriculture | -0.51 | 0.23 | 2.72 | -0.16 | -0.38 | -1.06 |

*Source: UNCTAD calculation based on UNCTAD-MDST data and the results of the global trade model used for the impact assessment.*

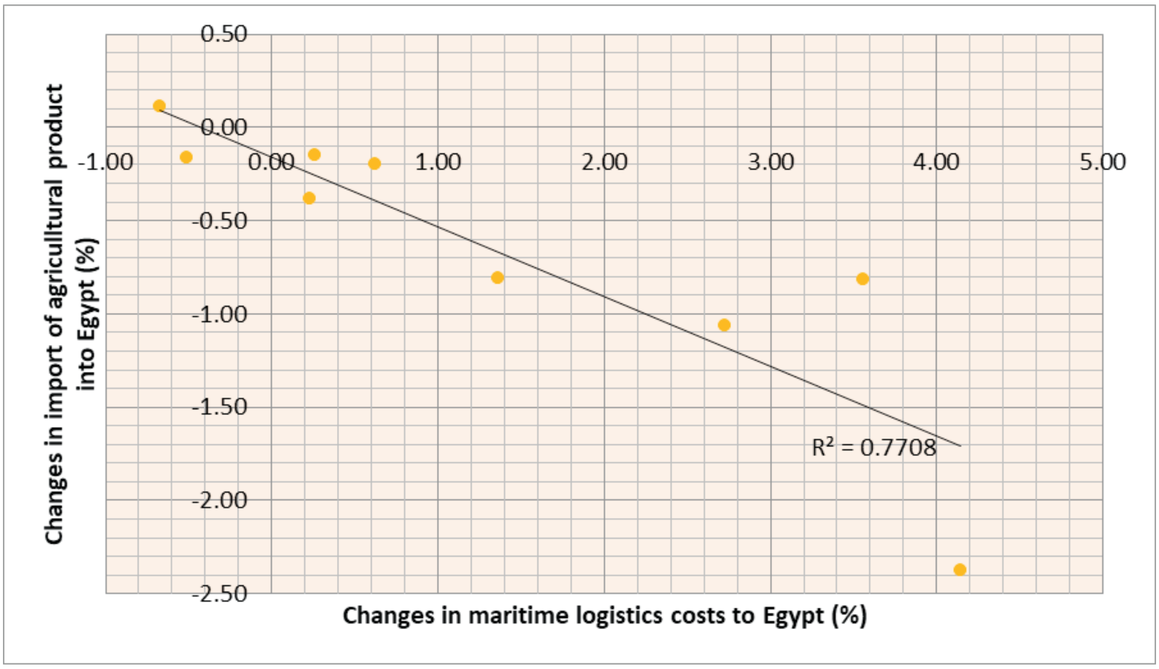
As shown in Table 27, maritime logistics costs associated with the carriage of agricultural products, including grains, from the United States to Egypt are expected to decline in the EEXI-Only scenario and to increase under the LOW-GHG reduction and HIGH-GHG reduction scenarios.

Specifically, under the HIGH-GHG reduction scenario, where maritime logistics costs increase by 2.72%, Egypt’s imports of agricultural products from the United States are expected to fall by 1.06%. A reduction in agricultural product import volumes into Egypt is also expected in the case of the Russian Federation (-0.81%) and Ukraine (-2.37%).

Figure 50 shows a visible negative correlation between changes in maritime logistics costs and simulated changes in imports of agricultural products into Egypt from the United States, Ukraine, and the Russian Federation under the three scenarios EEXI-Only, HIGH-GHG reduction and LOW-GHG reduction.

As shown in Figure 50, an increase in maritime logistics costs would result in a decrease of Egypt’s imports of agricultural products. That said, the elasticity of the change in export volumes against the change in maritime logistics costs varies for each trading partner. Imports from the United States have an elasticity of -0.39, and imports from the Russian Federation show an elasticity of -0.23 while imports from Ukraine have a higher elasticity of -0.57. This indicates that imports of agricultural products from Ukraine are relatively more sensitive to changes in maritime logistics costs compared to imports from the United States and the Russian Federation.

Figure 50 Maritime logistics costs and agricultural product imports into Egypt



*Source: UNCTAD calculation based on MDST data and the results of the global trade model used for the impact assessment.*

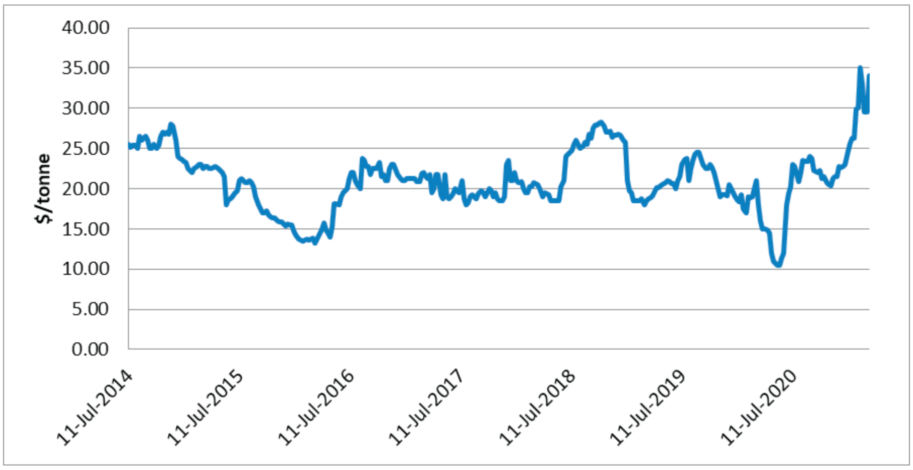
Lower imports of agricultural products from Ukraine, the Russian Federation and the United could, as applicable and feasible, lead Egypt to increase domestic production, impose quotas on exports of agricultural commodities, build larger stocks and reserves or seek nearby alternative sources of supply with lower total logistics costs when exporting to Egypt. It is likely that grain imports into Egypt would follow the same trend as other agricultural products captured under this broad commodity grouping.

Global Trade Model indicates that under the HIGH-GHG reduction scenario, Egypt's total trade imports from all trading partners would fall by 0.85% while its GDP would marginally decline by 0.04%.

### *4.3.8 Maritime Freight Rate Volatility*

Grain shipping costs as indicated by the voyage rates of Panamax vessels on the United States-Egypt Panamax route are quite volatile. Figure 51 highlights the volatility of the weekly freight rates of from 2014 until recently (2021). Changes in freight rates for this type of ship over a few weeks can easily be as much 23% increase in freight costs. This is very large compared to the simulated increase in shipping costs noted above (0.58% for shippers) and (7.73% for carriers/ship operators) under the HIGH-GHG reduction scenario. Hence, the increase in freight costs due to the IMO short-term measure is within the range of normal market volatility. That said and while freight rates volatility is a key feature in shipping markets, a systematic and long-term increase in shipping cost levels will have a different effect on demand than short-term fluctuations.

Figure 51: Freight rate fluctuations: Panamax vessel carrying grain on the United States-Egypt route ($per tonne)



*Source: Clarksons Research Services, Dry Bulk Trade Outlook, Volume 27, No. 1, January 2021, ISSN 1361-3189.*

### *4.3.9 Summary of Main Points*

- In 2020, global grain trade accounted for about 4.5% of world seaborne trade in volume terms. Grains are the third largest dry bulk commodity carried by sea after iron ore and coal.
- Since 2015, Egypt is the third largest grain importer after China and Japan, with total grain imports reaching 27 million tonnes in 2020. Egypt is a net food importing economy with heavy reliance on grain imports by sea to fulfil domestic requirements.
- Grain imports from the United States accounted for 8.3% of the total value of Egypt's imports of wheat in 2019 and made up the largest share of Egypt's imports from the United States. In 2019, around 28% of Egypt's imports were sourced from the United States ($1.4 billion). In 2019, wheat imports from the United States into Egypt reached 847,000 metric tonnes while soybean imports were estimated at 3.27 million tonnes.
- Shipping costs of grains originating from the United States and destined to Egypt hover around an average of 21.56 $/tonne, which is equivalent to 6.33% of the 2019 import values of grain.
- According to DNV's results simulating three 2030 scenarios, on average, the speed of dry bulk carriers of 60,000-99,999 dwt will be reduced by 6.7% (EEXI-Only), 6.8% (LOW-GHG reduction), and 10.7% (HIGH-GHG reduction) compared to the baseline scenario in 2030.
- Due to the speed reduction, additional vessels of 60,000 dwt-99,999 dwt will be needed. A total of 349 bulk carriers of 60,000-99.999 dwt will be added in the case of the EEXI-Only scenario and 359 under the Low scenario while 557 vessels will be added under HIGH-GHG reduction scenario.

- The estimated impact of the IMO short-term measure on ships and ship operators will result in an increase in total costs, including CAPEX, OPEX and fuel costs as follows: of 2.05% (EEXI-Only), 3% (LOW-GHG reduction), and 7.73% (HIGH-GHG reduction) compared to the 2030 baseline scenario. These increases are equivalent to $0.42 billion (EEXI-Only), $0.62 billion (LOW-GHG reduction), and $1.59 billion (HIGH-GHG reduction).
- Only a small increase in shipping costs (maritime transport costs) is foreseen 0.58% (under the most stringent measure or the HIGH-GHG reduction scenario).
- Time costs, under the HIGH-GHG reduction scenario, would increase by 7.72% compared to the 2030 baseline scenario (Current Regulations). On average, 49 hours of sea transport time will be added to ship voyages involving the transport of agricultural products from the United States to Egypt.
- Under a HIGH-GHG reduction scenario, maritime logistics costs would increase from $109.85 million to $111.99 million. This is equivalent to an increase from 7.85% to around 8% of the grain import values from the United States in 2019.
- The impact of IMO short-term measure on the time costs of grain imports from the United States to Egypt is higher (7.72%) than that on transport costs (0.58%).
- Total maritime logistics costs for agricultural product imports into Egypt from the United States are expected to decrease by 0.51% under the EEXI-Only scenario, increase by 0.23% under the LOW-GHG reduction scenario and increase by 2.7% under HIGH-GHG reduction scenario. Under the HIGH-GHG reduction scenario, Egypt's imports of agricultural products from the United States are simulated to decline by 1.06%, those from the Russian Federation by 0.81%, and those from Ukraine by 2.37%.

## 4.4 Illustrative Case 3: Cherries exports from Chile to China

### *4.4.1 Global Reefer and Deciduous Fruit Trade*

Global reefer shipping, which carries perishables including deciduous fruit,[70] such as fresh cherries, has been expanding over the years (Figure 52). Specialised reefer ships, tankers and containerships are usually used to carry reefer trade. Specialist juice tankers move small shipments of frozen fruit juice on South American export trades. Of all reefer cargo, perishables are generally transported onboard specialized reefer vessels or containerships equipped with reefer technologies. Over the years, reefer containers have been penetrating the reefer trade market at the expense of conventional specialized reefer vessels, with only

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[70] Deciduous fruit refer to fruits that grow on trees or bushes, losing their leaves for part of the year and includes fruits such as apples, pears, peaches, grapes, and stone fruit (e.g., cherries). For additional information, see Dynamar (2020), Reefer Analysis: Market Structure, Conventional, Containers. www.dynamar.com.

13% of world seaborne perishable reefer cargo being shipped onboard specialised reefer vessels, and 87% being carried on board reefer containers.[71]

World seaborne reefer trade stood at 130.5 million tonnes in 2019. Except for 2009, reefer trade has been growing consistently for many years, often surpassing the general trend. As perishable cargo tends to be less sensitive to economic disruptions, it held relatively well during the COVID-19 crisis compared to dry container cargo. World seaborne reefer trade is forecast to further grow at an average rate of 3.7% per year up to 2024, with Asia expected to remain the leading importer of perishables (Figure 53).[72]

Reefer trade of deciduous fruit, of which cherries is an important component, reached 21.5 million tonnes in 2019.[73] Deciduous fruit is highly seasonal, particularly with commodities like cherries, which are generally shipped during a very short but intense time window between November and December for timely delivery at the Chinese New Year.

Figure 52: Global reefer container traffic (Million forty-foot equivalent unit & % change)

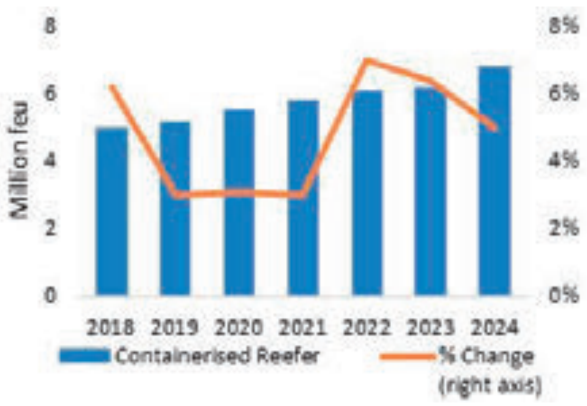
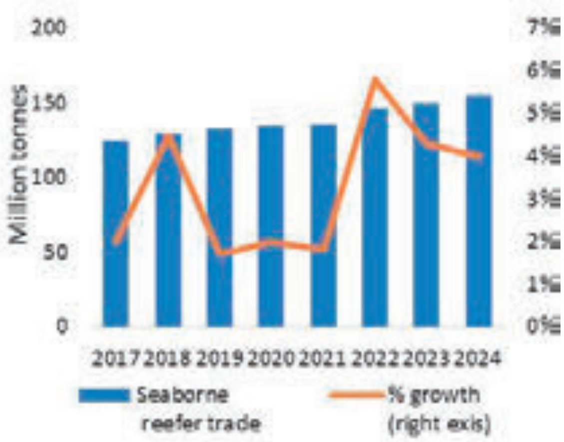


Figure 53: Seaborne perishable reefer trade forecast (Million tonnes and % change)



*Source: Drewry Maritime Research (2021). Reefer shipping. Annual review and forecast. Annual report 2020/21.*

Maritime trade of deciduous fruit reached 10.6 million tonnes accounting for over 50% of global deciduous fruit trade in 2019 (Figure 54).[74] Of this total, up to 92% were carried onboard reefer containerships. Perishables like cherries are notorious for their short shelf-life and require speedy delivery and the shortest transit times possible to maximize sales revenue and maintain market shares.

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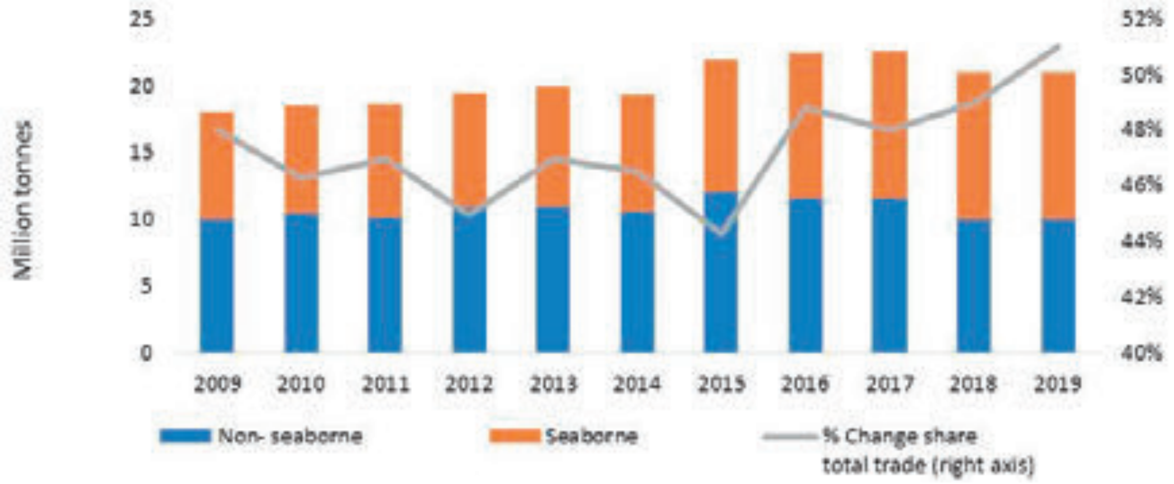
[71] Drewry Maritime Research (2021). Reefer Shipping. Annual review and forecast. Annual report 2020/21.

[72] Ibid.

[73] Ibid.

[74] Drewry Maritime Research (2021). Reefer Shipping. Annual review and forecast. Annual report 2020/21

Figure 54: Reefer trade in deciduous fruit by mode of transport (Million tonnes and % share)



*Source: Drewry Maritime Research (2021). Reefer shipping. Annual review and forecast. Annual report 2020/21.*

Chile was the third-largest South American exporter of perishables in 2019, after Ecuador and Brazil. Fruit is the main primary commodity exported from Chile, with the country being the largest world exporter of fresh apricots, cherries, peaches, plums, and sloes. Chile is the largest world exporter of fresh cherries, followed by Hong Kong SAR, China, the United States, Turkey, and Spain, among others (Table 28). Meanwhile leading cherry import markets include China, the Russian Federation, Germany, and Canada (In 2019, Chile exported a total of 220,196 tonnes of cherries, adding up to a world market share of 24.3%. A large share of perishable cargoes out of Chile is shipped by container, mainly through Valparaiso and San Antonio ports. For conventional ships, Valparaiso is the main port, ahead of Coquimbo. San Antonio is also the country's main container port.

Table 29).

Table 28: Top 15 world exporters of fresh cherries in tonnes and market shares, 2016 -2019

| | 2016 | | 2017 | | 2018 | | 2019 | |
|---|---|---|---|---|---|---|---|---|
| | Volume | % | Volume | % | Volume | % | Volume | % |
| **Chile** | 118,309 | 18.8% | 81,488 | 13.8% | 184,566 | 21.8% | 220,196 | 24.3% |
| **China, Hong Kong SAR** | 81,629 | 13.0% | 69,370 | 11.7% | 138,345 | 16.3% | 167,830 | 18.5% |
| **United States of America** | 72,368 | 11.5% | 106,656 | 18.0% | 83,972 | 9.9% | 81,153 | 9.0% |
| **Turkey** | 79,789 | 12.7% | 60,121 | 10.2% | 75,304 | 8.9% | 80,508 | 8.9% |
| **Spain** | 21,230 | 3.4% | 27,829 | 4.7% | 31,639 | 3.7% | 27,070 | 3.0% |
| **Azerbaijan** | 14,940 | 2.4% | 14,424 | 2.4% | 23,320 | 2.8% | 26,516 | 2.9% |
| **Greece** | 16,172 | 2.6% | 15,520 | 2.6% | 16,909 | 2.0% | 20,826 | 2.3% |
| **Uzbekistan** | 29,164 | 4.6% | 30,609 | 5.2% | 33,811 | 4.0% | 16,882 | 1.9% |
| **Austria** | 26,109 | 4.1% | 17,886 | 3.0% | 14,784 | 1.7% | 15,137 | 1.7% |
| **Canada** | 9,489 | 1.5% | 10,107 | 1.7% | 10,896 | 1.3% | 8,209 | 0.9% |
| **Moldova, Republic of** | 3,856 | 0.6% | 8,376 | 1.4% | 11,652 | 1.4% | 5,963 | 0.7% |
| **Netherlands** | 3,906 | 0.6% | 5,767 | 1.0% | 5,931 | 0.7% | 5,944 | 0.7% |
| **Germany** | 7,170 | 1.1% | 3,603 | 0.6% | 5,092 | 0.6% | 5,714 | 0.6% |
| **Islamic Republic of Iran** | | | | | | | 5,112 | 0.6% |
| **Argentina** | 3,482 | 0.6% | 3,663 | 0.6% | 3,646 | 0.4% | 4,883 | 0.5% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Grand Total** | 629,235 | | 591,928 | | 846,211 | | 905,670 | |
| **% of total** | | 77.5% | | 76.9% | | 75.6% | | 76.4% |

*Source: Food and Agricultural Organization (FAO) (accessed March 2021).*

In 2019, Chile exported a total of 220,196 tonnes of cherries, adding up to a world market share of 24.3%. A large share of perishable cargoes out of Chile is shipped by container, mainly through Valparaiso and San Antonio ports. For conventional ships, Valparaiso is the main port, ahead of Coquimbo. San Antonio is also the country's main container port.

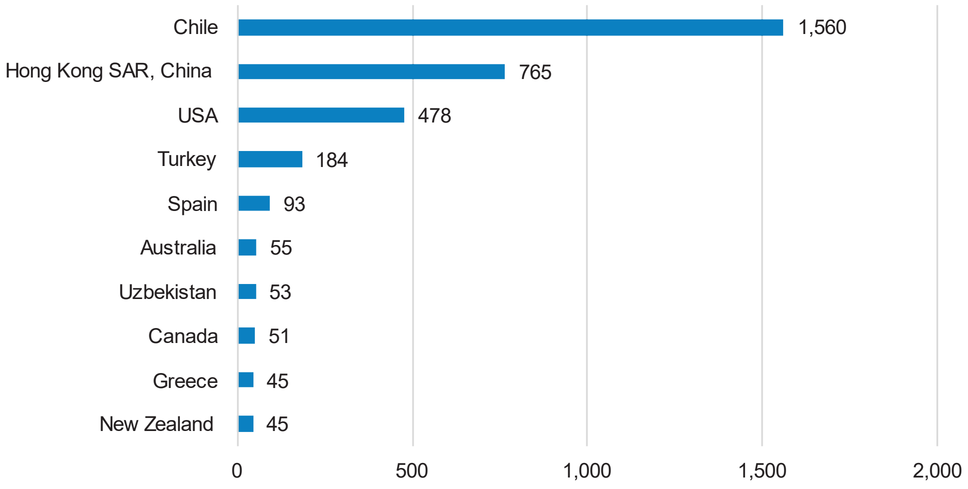
Table 29: Top 10 world importers of fresh cherries in tonnes and market shares, 2016 -2019

| | 2016 | | 2017 | | 2018 | | 2019 | |
|---|---|---|---|---|---|---|---|---|
| | **Volume** | **%** | **Volume** | **%** | **Volume** | **%** | **Volume** | **%** |
| **China** | 220,908 | 28.46% | 197,107 | 26.53% | 357,682 | 33.00% | 395,155 | 34.68% |
| **Russian Federation** | 57,517 | 7.41% | 61,586 | 8.29% | 82,024 | 7.57% | 74,718 | 6.56% |
| **Germany** | 45,251 | 5.83% | 51,469 | 6.93% | 44,751 | 4.13% | 48,620 | 4.27% |
| **Canada** | 23,583 | 3.04% | 32,631 | 4.39% | 27,609 | 2.55% | 28,252 | 2.48% |
| **Austria** | 29,243 | 3.77% | 19,789 | 2.66% | 17,586 | 1.62% | 20,136 | 1.77% |
| **Republic of Korea** | 13,805 | 1.78% | 17,648 | 2.38% | 18,067 | 1.67% | 15,856 | 1.39% |
| **United Kingdom** | 16,018 | 2.06% | 15,457 | 2.08% | 14,025 | 1.29% | 12,883 | 1.13% |
| **China, Taiwan Province of** | 11,854 | 1.53% | 14,674 | 1.98% | 12,920 | 1.19% | 12,306 | 1.08% |
| **Italy** | 10,885 | 1.40% | 6,198 | 0.83% | 8,865 | 0.82% | 11,731 | 1.03% |
| **France** | 5,971 | 0.77% | 6,397 | 0.86% | 8,315 | 0.77% | 10,449 | 0.92% |
| **World Total** | 776,229 | | 742,891 | | 1,083,998 | | 1,139,460 | |
| **% of world** | | 56.04% | | 56.93% | | 54.60% | | 55.30% |

*Source: Food and Agricultural Organization (FAO) (accessed March 2021).*

Figure 54 below underscores the importance of Chilean exports, which were valued at approximately $1.6 billion, i.e., more than double the value of exports from Hong Kong SAR, China, and more than three times the value of exports from the United States. By volume, Chilean cherry exports are only 1.3 times higher than exports from Hong Kong SAR, China, and less than three times the exports from the United States.

Figure 55: Export of fresh cherries by major exporter in 2019 (Millions of USD)



*Source: COMTRADE database (accessed April 2021).*

### 4.4.2 *Chile's Cherry Exports*

Exports of apricots, cherries, peaches, nectarines, plums, and sloes contribute approximately 0.2% of Chile's gross domestic product (GDP) and close to 5% of its Agricultural Sector GDP.[75] Chile's cherry exports increased over the years, except for 2017 (Table 30). China is the largest world importer accounting for over 90% of Chilean cherry exports by value and nearly 89% by volume in 2019 (Table 31). Other importers include the United States, Brazil, Hong Kong SAR, China, Taiwan, Province of China, the Republic of Korea, and the United Kingdom.

Table 30: Chile's total world exports of cherries, 2015 – 2019

| Year | Volume (tonnes) | Value (1,000$) |
|---|---:|---:|
| **2015** | 83,412 | 509,291 |
| **2016** | 118,309 | 850,547 |
| **2017** | 81,488 | 571,249 |
| **2018** | 184,566 | 1,078,972 |
| **2019** | 220,196 | 1,559,684 |

*Source: Food and Agricultural Organization (FAO) (accessed March 2021).*

Table 31: Exports of cherries from Chile to selected import markets, 2019

| Importer | Tonnes | Percentage share |
|---|---:|---:|
| **China** | 195.091 | 88.6% |
| **United States of America** | 5.251 | 2.4% |
| **Republic of Korea** | 4.514 | 2.0% |
| **Brazil** | 2.796 | 1.3% |
| **Other Asia, nes** | 2.693 | 1.2% |
| **United Kingdom** | 2.277 | 1.0% |
| **Ecuador** | 2.188 | 1.0% |
| **Thailand** | 1.086 | 0.5% |
| **Hong Kong SAR, China** | 879 | 0.4% |
| **Netherlands** | 509 | 0.2% |
| **World** | **220.196** | |

| Importer | Million USD | Percentage share |
|---|---:|---:|
| **China** | 1,413.8 | 90.6% |
| **Republic of Korea** | 33.6 | 2.2% |
| **United States of America** | 28.4 | 1.8% |
| **Brazil** | 13.3 | 0.9% |
| **United Kingdom** | 12.1 | 0.8% |
| **Thailand** | 8.7 | 0.6% |
| **Hong Kong SAR, China** | 5.5 | 0.4% |
| **Ecuador** | 4.3 | 0.3% |
| **Netherlands** | 3.4 | 0.2% |
| **Spain** | 2.4 | 0.2% |
| **World** | **1,559.7** | |

*Source: Food and Agriculture Organization (FAO) (accessed March 2021); COMTRADE database (accessed April 2021).*

### 4.4.3 *Transporting Chilean Cherry Exports*

Chilean cherry exports depend heavily on shipping. It takes shipments to China an average of three days to reach their destination when shipped by air and about 20 to 25 days when caried by sea.[76] Time and temperature control are two critical considerations for preserving cherries' shelf life. Cherries are a very time sensitive to handling and transport conditions.

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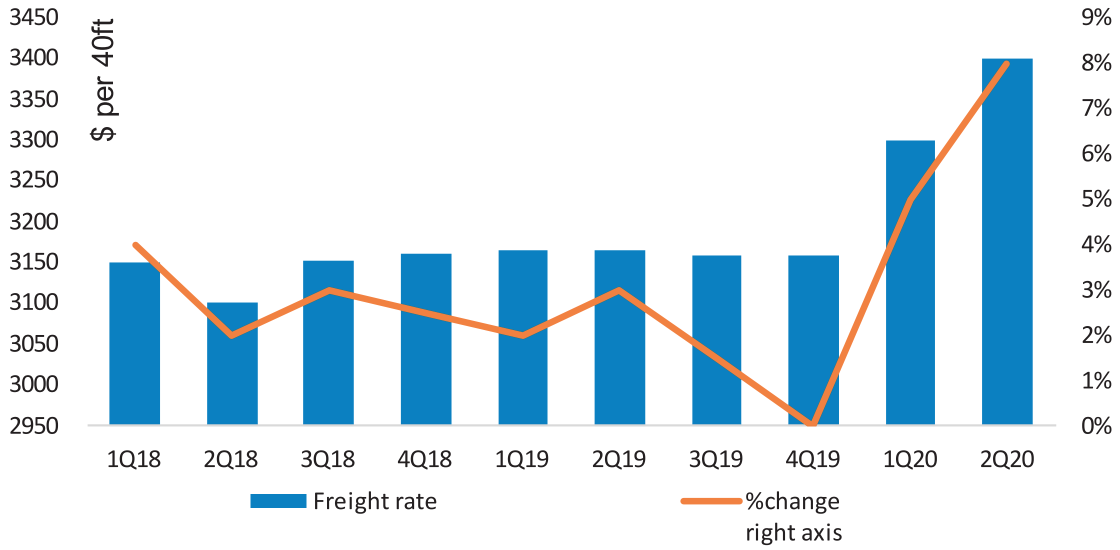
[75] See submission by Chile contained in document ISWG-GHG 7/2/17, 7 February 2020.

[76] Further information can be found at https://www.apec.org/Publications/2019/12/Analysis-of-the-Impacts-of-Slow-Steaming-for-Distant-Economies.

Thus, speed reduction and additional transit times may have negative implications for this special niche trade and its competitiveness.

UNCTAD estimates maritime transport costs of cherry exports from Chile to China at about 60% of the total maritime transport costs for deciduous fruit exports in 2016. Freight rates for cherries are strongly driven by the type of cargo carried and its characteristics and the seasonality of the commodity. Average reefer container freight rate levels remained stable over the past two years, with a strong year-on-year growth of 8% being recorded during the 2$^{nd}$ quarter of 2020 (Figure 56).

Figure 56: Drewry global reefer container freight rate index



*Source: Drewry (2021): Reefer shipping. Annual review and forecast. Annual report 2020/21.*

### *Vessels Transporting Chilean Cherry Exports to China*

Global reefer vessel slot-capacity expanded in 2019, a trend projected to continue at least till 2024. Meanwhile, the share of specialized reefer vessels is expected to further decline as reefer container vessels continue to gain market share.

Under the Stakeholder Analysis carried out under Task 4 of the Workplan, which had been approved by the Steering Committee established under ISWG-GHG 7 at IMO, ships that carry cherry exports from Chile to China have been matched by ship type and size with origin and destination ports. The analysis has shown that, cherries destined to the Chinese market are loaded at San Antonio port in Chile and unloaded in Shanghai. Relevant vessel sizes that had been matched, range between 3,000 and 14,500 twenty-foot equivalent unit (TEU). Based on this information and looking at AIS data on ship movement provided by MarineTraffic, it was observed that container vessels of 3,000-14,500 TEU from San Antonio to Shanghai, had performed a total of 44 journeys in 2019 (Table 32). Of these journeys, only two direct connections were recorded between San Antonio, on the one hand, and

Shanghai and Yantian, on the other (Table 33). The remaining 42 journeys all required a transhipment move at another port. The list of container vessels and liner shipping companies servicing this specific trade are featured in Table 34 and Table 35.

Bearing in mind the importance of minimizing transit times to preserve the limited shelf life of fresh cherry exports, it can be observed that additional transit times could prove challenging for this trade, with over 90% of maritime shipping journeys requiring the cargo to be transhipped before reaching its destination. A journey with a transhipment entails, on average, about 2 additional days.

Table 32: Journeys of container vessels of 3,000-14,500 TEU from Chile (San Antonio) to China (Shanghai), 2019

| ***Destination*** | ***China*** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Exporter** | **Number of direct journeys** | **Average DWT** | **Maximum DWT** | **Number of ships deployed** | **Average speed (knots)** | **Average duration of journey (days)** | **Average Distance travelled (nm)** |
| **Chile** | 2 | 93,821 | 102,742 | 2 | 18.8 | 23.6 | 10,628 |
| **Exporter** | **Number of indirect journeys via Hong Kong SAR, China** | **Average DWT** | **Maximum DWT** | **Number of ships deployed** | **Average speed (knots)** | **Average duration of journey (days)** | **Average Distance travelled (nm)** |
| **Chile** | 42 | 95,159 | 110,643 | 25 | 18.2 | 25.4 | 11,013 |

*Source: UNCTAD calculations, based on data provided by MarineTraffic.*

Table 33: Journeys of Container vessels of 3,000-14,500 TEU from Chile (San Antonio) to China (Shanghai), 2019

| ***Destination*** | ***China*** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Exporter** | **Destination port** | **Number of direct journeys** | **Average DWT** | **Maximum DWT** | **Number of ships deployed** | **Average speed (knots)** | **Average duration of journey (days)** | **Average Distance travelled(nm)** |
| **Chile** | **Shanghai** | 1 | 84,900 | 84,900 | 1 | 18.9 | 22.5 | 10,185 |
| | **Yantian** | 1 | 102,742 | 102,742 | 1 | 18.6 | 24.8 | 11,070 |
| **Exporter** | **Destination port** | **Number of indirect journeys via HK** | **Average DWT** | **Maximum DWT** | **Number of ships deployed** | **Average speed (knots)** | **Average duration of journey (days)** | **Average Distance travelled(nm)** |
| **Chile** | **Yantian** | 33 | 95,289 | 110,643 | 18 | 18.3 | 25.1 | 10,941 |
| | **Shenzhen** | 5 | 108,783 | 110,387 | 5 | 17.7 | 28.0 | 11,437 |
| | **Shanghai** | 2 | 72,156 | 81,002 | 2 | 18.5 | 25.6 | 11,348 |
| | **Ningbo** | 1 | 63,216 | 63,216 | 1 | 17.3 | 27.0 | 11,244 |
| | **Nanshan** | 1 | 100,680 | 100,680 | 1 | 21.0 | 20.6 | 10,381 |

*Source: UNCTAD calculations, based on data provided by MarineTraffic.*
*Note: Based on a set of 16,091 journeys for container vessels of 3,000-14,500TEU in 2019 and reflect laden or partially laden load conditions.*

Table 34: Direct connections to China, container vessels of 3,000-14,500 TEU, 2019

| IMO vessel number | Vessel name | Year built | TEU | Dwt | Owner |
|---|---|---|---|---|---|
| **9448803** | COSCO Prince Rupert | 2011 | 8,495 | 102,742 | Seaspan Corporation |
| **9085522** | Kure | 1996 | 7,403 | 90,456 | Costamare Shipping Co SA |

*Source: UNCTAD calculations, based on data provided by MarineTraffic.*

Table 35: Indirect connections to China, container vessels of 3,000-14,500 TEU, 2019

| IMO vessel number | Vessel name | Year built | TEU | Dwt | Owner |
|---|---|---|---|---|---|
| **9645877** | CSCL Winter | 2014 | 10,000 | 121,839 | COSCO Shipping Development Co Ltd |
| **9628166** | Value | 2013 | 8,827 | 110,643 | Costamare Shipping Co SA |
| **9466984** | Northern Jupiter | 2010 | 8,814 | 108,622 | NVA Norddeutsche Vermogenslage GmbH & Co. KG |
| **9166780** | Soroe Maersk | 1999 | 9,640 | 104,750 | Maersk AS |
| **9120841** | Sovereign Maersk | 1997 | 9,640 | 104,696 | Maersk AS |
| **9120853** | Susan Maersk | 1997 | 9,640 | 104,696 | Maersk AS |
| **9198575** | Clifford Maersk | 1999 | 9,640 | 104,696 | Maersk AS |
| **9219800** | Chastine Maersk | 2001 | 9,640 | 104,690 | Maersk AS |
| **9687526** | Copiapo | 2014 | 9,326 | 104,544 | Hapag-Lloyd Container Line GmbH |
| **9687588** | Coyhaique | 2015 | 9,326 | 104,544 | Hapag-Lloyd Container Line GmbH |
| **9595436** | Ever Lambent | 2012 | 8,452 | 104,409 | Evergreen Marine Corp (Taiwan) Ltd |
| **9604134** | Ever Lively | 2014 | 8,452 | 104,409 | Evergreen Marine Corp (Taiwan) Ltd |
| **9629067** | Ever Lucent | 2014 | 8,508 | 104,397 | Evergreen Marine Corp (Taiwan) Ltd |
| **9629110** | Ever Lovely | 2015 | 8,508 | 104,357 | Evergreen Marine Corp (Taiwan) Ltd |
| **9462718** | YM Unanimity | 2012 | 8,626 | 103,235 | Yang Ming Marine Transport Corp |
| **9448774** | COSCO Malaysia | 2010 | 8,495 | 102,834 | Seaspan Corporation |
| **9448803** | COSCO Prince Rupert | 2011 | 8,495 | 102,742 | Seaspan Corporation |
| **9352004** | Maersk Stepnica | 2008 | 9,662 | 102,367 | Maersk AS |
| **9461489** | SM Savannah | 2011 | 8,586 | 101,310 | SM Line Corporation |
| **9461506** | Mediterranean Bridge | 2011 | 8,586 | 101,310 | Sinokor Merchant Marine Co Ltd |
| **9305506** | Lloyd Don Giovanni | 2006 | 8,200 | 100,680 | Zeaborn Ship Management GmbH & Cie KG |
| **9495038** | Seroja Tiga | 2010 | 8,110 | 90,414 | Nissen Kaiun KK |
| **9409182** | Miramarin | 2010 | 6,574 | 85,523 | Cardiff Marine Inc |
| **9400100** | Mehuin | 2011 | 6,589 | 81,002 | Hapag-Lloyd Container Line GmbH |
| **9241293** | Ever Ethic | 2003 | 6,046 | 75,873 | Evergreen Marine Corp (Taiwan) Ltd |
| **9241308** | Ever Envoy | 2002 | 6,046 | 75,873 | Evergreen Marine Corp (Taiwan) Ltd |
| **9304784** | Xin Qin Huang Dao | 2004 | 5,688 | 69,023 | COSCO Shipping Development Co Ltd |
| **9300324** | Tian Chang He | 2005 | 5,576 | 67,209 | COSCO Shipping Lines Co Ltd |
| **9116589** | Ever United | 1996 | 5,364 | 63,388 | Evergreen Marine Corp (Taiwan) Ltd |
| **9168831** | Ever Uberty | 1999 | 5,652 | 63,388 | Evergreen Marine Corp (Taiwan) Ltd |

*Source: UNCTAD calculations, based on data provided by MarineTraffic.*

Various carriers, including Hapag Lloyd Container Line and Maersk AS are deploying reefer capacity on the Chile-China route, including through independent services (42%) or through vessel sharing agreements in consortium with other carriers (58%).[77] Some carriers are very active in the cherry business from Chile, modifying their entire service loops during the peak season to ensure fast and direct transit times to reach Shanghai in 23-24 days.

As previously noted, transit times are critical for cherry exports given their high perishable nature as well as their high FOB value which can exceed $100,000 per container, and which sells in a short window of time prior to the Chinese New Year.

Table 36: Container vessel capacity deployed on Chile-China route, 2019

| Vessel name | DWT | Port Name | Distance (nm) | Destination | Days | Speed in knots | Built | TEU | Major group owner |
|---|---|---|---|---|---|---|---|---|---|
| **Copiapo** | 104,544 | VALPARAISO, Chile | 10,353 | HK, China | 22.46 | 19.20 | 2014 | 9,326 | Hapag-Lloyd AG |
| **Copiapo** | 104,544 | VALPARAISO, Chile | 10,365 | HK, China | 22.92 | 18.84 | 2014 | 9,326 | Hapag-Lloyd AG |
| **Cautin** | 104,544 | VALPARAISO, Chile | 10,439 | HK, China | 22.82 | 19.06 | 2014 | 9,326 | Hapag-Lloyd AG |
| **Cochrane** | 104,544 | VALPARAISO, Chile | 10,516 | HK, China | 22.25 | 19.69 | 2015 | 9,326 | Hapag-Lloyd AG |
| **Cochrane** | 104,544 | VALPARAISO, Chile | 10,798 | HK, China | 22.79 | 19.74 | 2015 | 9,326 | Hapag-Lloyd AG |
| **Corcovado** | 104,544 | VALPARAISO, Chile | 10,113 | HK, China | 21.85 | 19.28 | 2015 | 9,326 | Hapag-Lloyd AG |
| **Cisnes** | 104,544 | VALPARAISO, Chile | 10,213 | HK, China | 22.64 | 18.79 | 2015 | 9,326 | Hapag-Lloyd AG |
| **Coyhaique** | 104,544 | VALPARAISO, Chile | 10,516 | HK, China | 22.63 | 19.36 | 2015 | 9,326 | Hapag-Lloyd AG |
| **MOL Benefactor** | 119,031 | VALPARAISO, Chile | 10,328 | HK, China | 22.48 | 19.14 | 2016 | 10,100 | Canada |
| **MOL Beyond** | 119,368 | VALPARAISO, Chile | 10,394 | HK, China | 21.98 | 19.71 | 2016 | 10,100 | Canada |
| **HMM Blessing** | 134,869 | VALPARAISO, Chile | 10,270 | HK, China | 23.07 | 18.55 | 2018 | 11,010 | Korea |
| **HMM Blessing** | 134,869 | VALPARAISO, Chile | 10,349 | HK, China | 22.83 | 18.89 | 2018 | 11,010 | Korea |
| **Average** | 112,041 | | 10,388 | | 22.56 | 19.19 | | 9,736 | |

*Source: UNCTAD, based on the 2019 vessel movement data provided by MarineTraffic.*

Table 37: Connections from Hong-Kong to Shanghai and Yantian

| Destination port in China | DWT | Average Distance (nm) | Average duration of journeys (Days) | Average Speed (knots) | TEU |
|---|---|---|---|---|---|
| **Average** | 109,935 | 326 | 1.28 | 11.1 | 9,617 |
| Shanghai | 109,839 | 745 | 2.92 | 11.4 | 9,612 |
| Yantian | 109,996 | 59 | 0.23 | 11.0 | 9,620 |

*Source: UNCTAD, based on the 2019 vessel movement data provided by MarineTraffic.*

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[77] Drewry Maritime Research (2021): Reefer shipping, Annual review and forecast, Annual report 2020/21.

The average duration of a journey from Valparaiso to Hong Kong SAR, China is 22.56 days and it takes an average of 1.28 days from Hong Kong SAR, China to reach Shanghai and Yantian, when sailing at a speed of 19.19 knots (Table 36). The additional time required to tranship via Hong Kong SAR, China is shown in Table 37. The average container vessel capacity deployed is close to 10,000 TEU, while distance exceeds 10,000 nautical miles, on average. A typical journey is nearly 23 days when sailing at average speed of 19.2 knots. At least more than one additional day will be required for the cherries to reach Shanghai and Yantian. The express service ensures that the cherries from Chile to China arrives in less than 24 days, i.e., within the critical time window. This type of dedicated services that seek to promote faster transit times can prove useful when considering ways in which increasing transit times resulting from reduced speed could be mitigated.

For example, in November 2020, a specific dedicated express service has been established to deliver cherries from Chile to China. The Mediterranean Shipping Company (MSC) has joined HMM, Ocean Network Express (ONE) and Hapag-Lloyd which are part of THE Alliance[78] to run the service. The express service is dedicated to transporting cherry and other fresh fruit cargo from Chile to Asia. It connects Valparaiso, Chile with a fast transit time to Hong Kong SAR, China in 23 days. Shipments will arrive in Nanshan and Shanghai in 25 and 26 days respectively, via transhipment from Hong Kong SAR, China. In addition, the MSC feeder network will extend to destinations in other Southeast Asian destinations.[79]

### *4.4.4 Impact of the IMO Short-Term Measure on Costs*

As cherries are carried on board reefer container vessels, the analysis pertaining to container vessels is therefore of some relevance to this specialized and highly time-sensitive commodity trade. More specifically, as vessels carrying cherries from Chile to China range between 3,000 and 15,000 TEU capacity,[80] considerations pertaining to the IMO short measure impacts on costs will focus on this container vessel category.

#### *Costs to Ship Operators/Carriers*

Container vessels of 3,000 to 14,500 TEU are in the category of vessels that would normally carry cherry exports from Chile to China. DNV expects an increased demand for ships due to the reduced speed resulting from the IMO short-term measure. Total ship operator/carrier costs (i.e., capital expenditure, operational expenditure, and fuel costs) for all container vessels irrespective of their size are expected to be greater under the three 2030 GHG reduction scenario, as compared to the baseline scenario in 2030 (Current Regulations scenario).

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[78] See https://container-news.com/cherry-aid-carriers-collaborate-to-shift-chilean-cherry-harvest/ (accessed in March 2021).

[79] See https://www.msc.com/che/news/2020-november/msc-introduces-cherry-express-service.

[80] See Stakeholder Analysis under Task 4 that considered cherries exports from Chile to China (Santiago-Shanghai).

Container vessels of 3,000-14,500 TEU will see an average speed reduction of 11.5% under the 2030 HIGH-GHG reduction scenario as compared to the 2030 Current Regulations scenario. This will lead to a 12.3% increase in the number of vessels required to carry the same amount of trade. As a result, ship costs or costs from the perspective of ship operators and carriers will increase by 12.8% under the 2030 HIGH-GHG reduction scenario. By vessel, the increase amounts to 0.4%. The increase in cost levels at the aggregate level, is mainly driven by capital expenditure (Table 38 and Table 39). For more perspective, it should be noted that under the 2030 EEXI-Only scenario, speed will be reduced by an average of 1.30% and 1.2% more ships will be required to offset the impact of reduced speed.

Thus, the need for additional ship carrying capacity in a reduced speed environment entails increments in capital expenditure for carriers. For vessels of relevance to the cherry exports from Chile to China i.e., container vessels of 3,000-14,500 TEU, CAPEX are expected to increase by 8.9% per vessel and by 22.3% on aggregate, under the 2030 HIGH-GHG reduction scenario as compared to the Current Regulations scenario. Increased capital costs reflect the cost of adding new container vessels to perform the same volume of transport work.

Table 38: Impact of IMO short-term measure on container vessels of 3,000-14,500 TEU, Changes from Current Regulations 2030 scenario

| Scenario (New policies) | | Speed reduction (%) | No. of ships in group | Distance sailed (nm) | Time cruising (hrs) | Total number of voyages | Deadweight | Transport work capacity (dwt-mile) | Transport work (ton-mile) |
|---|---|---|---|---|---|---|---|---|---|
| **EEXI-Only** | **Sum** | 1.3% | 1.2% | -0.04% | 1.2% | -0.1% | 1.0% | 0.1% | 0.1% |
| | **Per ship** | | | -1.2% | 0.02% | -1.2% | -0.2% | -1.1% | -1.1% |
| **HIGH-GHG reduction** | **Sum** | 11.5% | 12.3% | -0.5% | 12.4% | -0.6% | 12.5% | -0.03% | -0.03% |
| | **Per ship** | | | -11.4% | 0.1% | -11.4% | 0.2% | -11.0% | -11.0% |
| **LOW-GHG reduction** | **Sum** | 5.7% | 5.6% | -0.4% | 5.6% | -0.4% | 5.4% | -0.02% | -0.02% |
| | **Per ship** | | | -5.7% | 0.1% | -5.7% | -0.1% | -5.3% | -5.3% |

*Source: UNCTAD calculations, based on data provided by DNV (2021).*

Table 39: Impact of IMO short-term measure on container vessels of 3,000-14,500 TEU, Changes from Current Regulations 2030 scenario

| Scenario (New policies) | | CO2 emissions (tonnes) | Carbon intensity (gCO2/dwt-mile) | Annual CAPEX (USD) | Base OPEX (USD) | Fuel expenditure (USD) | Total cost (USD) | Total cost intensity (USD/ton-mile) |
|---|---|---|---|---|---|---|---|---|
| **EEXI-Only** | **Sum** | -1.3% | -1.3% | 2.5% | 1.1% | -0.1% | 0.6% | 0.6% |
| | **Per ship** | -2.4% | | 1.3% | -0.1% | -1.3% | -0.6% | |
| **HIGH-GHG reduction** | **Sum** | -25.3% | -25.3% | 22.3% | 10.9% | 10.5% | 12.8% | 12.8% |
| | **Per ship** | -33.5% | | 8.9% | -1.3% | -1.6% | 0.4% | |
| **LOW-GHG reduction** | **Sum** | -10.3% | -10.3% | 10.8% | 4.9% | 2.2% | 4.3% | 4.3% |
| | **Per ship** | -15.0% | | 5.0% | -0.6% | -3.2% | -1.2% | |

*Source: UNCTAD calculations, based on data provided by DNV (2021).*

Total operational costs for container vessels of 3,000-14,500 TEU are also expected to increase at an aggregate level across the three 2030 GHG reduction scenarios (1.1%, 4.9% and 10.9% for EEXI-Only, LOW-GHG and HIGH-GHG reduction scenarios, respectively). Increased costs reflect the deployment of more vessels and the cost associated with their operation as well as the additional cost of investing in energy-efficiency and cleaner vessels. In contrast, operational expenses per ship will fall by 1.3% under the HIGH-GHG reduction scenario. For individual ships, fuel cost expenditure is expected to drop, according to DNV data when moving from the Current Regulations scenario to the HIGH-GHG reduction scenario. At an aggregate level, fuel costs will increase by 10.5% while cruising time will rise by 12.4% in the 2030 HIGH-GHG reduction scenario as compared to the 2030 Current Regulations scenario.

### *Costs to Shippers and Trade*

DNV data on costs to ships and carriers/ship operators, were mapped out to match trade routes at country pair level and by commodity type. This helped generate costs that better reflect the perspective of shippers and trade and that are more relevant for assessing impact on the delivered price of trade. These costs include transport/shipping costs (i.e., the cost of the physical transport of trade or the freight costs), increased transit times and related costs (i.e., by assigning a monetary value to the additional sailing days), as well as total maritime logistics costs (i.e., the combined shipping/transport costs and time costs).

Table 40 presents changes in shipping/transport costs, time costs and maritime logistics costs for agricultural commodities shipped from Chile to China. While agricultural commodities include products other than cherries, this broad category is used a proxy to assess potential impact on cherries' trade since the latter accounted for over 78% of Chile's agricultural product exports to China by volume and over 28% by value, in 2019.[81] Table 16 also provides an overview of the changes in maritime logistics costs across the three GHG reduction scenarios for other cherry exporting countries, such as the United States, Argentina, Canada, Turkey and New Zealand.

Total maritime logistics costs for the carriage of agricultural commodities from Chile to China will increase by 8.79% under the 2030 HIGH-GHG reduction scenario as compared to the 2030 Current Regulations scenario. Added costs are equally distributed between the increase in shipping/transport costs (8.79%) and time cost (8.76%). Other exporters to China will also see an increase in their maritime logistics costs, albeit at lower rates as compared to Chile.

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[81] Calculations based on data on Chile's exports of cherries to China in volume and value in 2019 and WITS (World Integrated Trade Solution available at https://wits.worldbank.org) data on Chile's agricultural product exports to China in both volume and value terms.

The rise in the maritime logistics costs of New Zealand's agricultural exports to China, the 10th world cherry exporter to China in 2019 by value and at a closer distance from the Chinese market will surpass the increase in Chile's maritime logistics costs (9.92% under the HIGH-GHG reduction scenario against 8.79% for Chile). It is observed that increased time costs in the case of New Zealand are not as large as the increase in the transport/shipping costs. In comparison, the United States, the 3rd world exporter of cherries to China, after Chile and Hong Kong SAR, China, will experience an increase of 3.46% in the maritime logistics costs associated with its agricultural product exports to China. Much of this increase will be driven by higher time costs (more than four times the increase in transport/shipping costs). It may therefore be argued that cherry exports from Chile to China are unlikely to be displaced by other exporting countries. In comparison, maritime logistics costs of agricultural exports from the United States to China are more impacted by additional transit times while those of New Zealand are more affected by increased transport/shipping costs.

Table 40: Cost changes of agricultural exports to China, compared to baseline 2030 Current Regulations Scenario

| Origin Country | | Transport/shipping costs | | | Time costs | | | Maritime logistics costs | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | EEXI | High | Low | EEXI | High | Low | EEXI | High | Low |
| **Chile** | **% change** | **0.07%** | **8.79%** | **2.43%** | **0.49%** | **8.76%** | **3.78%** | **0.12%** | **8.79%** | **2.60%** |
| | **% change ad valorem** | **0.00%** | **0.11%** | **0.03%** | **0.00%** | **0.02%** | **0.01%** | **0.00%** | **0.12%** | **0.04%** |
| **Other Exporters** | | | | | | | | | | |
| **United States of America** | % change | -1.48% | 1.95% | -0.24% | 3.15% | 7.97% | 3.40% | -0.32% | 3.46% | 0.67% |
| | % change ad valorem | -0.10% | 0.13% | -0.02% | 0.07% | 0.17% | 0.07% | -0.03% | 0.30% | 0.06% |
| **Argentina** | % change | -1.73% | -0.77% | -0.73% | 1.83% | 8.39% | 1.90% | -0.33% | 2.83% | 0.30% |
| | % change ad valorem | -0.85% | -0.38% | -0.36% | 0.58% | 2.67% | 0.60% | -0.27% | 2.29% | 0.24% |
| **Canada** | % change | -0.82% | 4.87% | 0.93% | 2.73% | 8.00% | 3.52% | -0.29% | 5.33% | 1.32% |
| | % change ad valorem | -0.10% | 0.62% | 0.12% | 0.06% | 0.18% | 0.08% | -0.04% | 0.80% | 0.20% |
| **Australia** | % change | -0.41% | 6.04% | 1.80% | 1.15% | 8.70% | 1.57% | -0.12% | 6.54% | 1.75% |
| | % change ad valorem | -0.02% | 0.30% | 0.09% | 0.01% | 0.10% | 0.02% | -0.01% | 0.40% | 0.11% |
| **New Zealand** | % change | 0.10% | 10.04% | 3.18% | 0.88% | 8.83% | 3.83% | 0.178% | 9.92% | 3.24% |
| | % change ad valorem | 0.00% | 0.13% | 0.04% | 0.00% | 0.01% | 0.01% | 0.00% | 0.14% | 0.05% |
| **Turkey** | % change | 0.68% | 6.49% | 2.26% | 1.35% | 7.00% | 4.09% | 0.76% | 6.56% | 2.49% |
| | % change ad valorem | 0.01% | 0.13% | 0.04% | 0.00% | 0.02% | 0.01% | 0.02% | 0.15% | 0.06% |

*Source: UNCTAD calculations, based on data provided by MDS Transmodal (MDST).*

Maritime logistics costs of Chilean agricultural exports to markets other than China, are expected to increase at varying degrees across the various import markets, including not so distant markets. Distance does not seem to be the main driver as maritime logistics costs of Chilean agricultural exports to the Netherlands and the United Kingdom as well as to Brazil (relatively closer markets as compared to China) are expected to increase at double digit rates of 13.36%, 13.45% and 13.25%, respectively (Table 41). Meanwhile, the increase in maritime transport (shipping) costs is expected to be higher reaching 13,70%, 13,77% cent, 15.85% respectively.

Despite the shorter distance travelled, maritime logistics costs of Chilean agricultural exports to the United States will increase at a rate equivalent to that observed on the Chile-China route. These cases suggest that the increase in transport (shipping) costs may be the main factor to consider when devising strategies to mitigate the rise in overall maritime logistics costs associated with agricultural product exports from Chile to Brazil, the Netherlands, and the United Kingdom. Meanwhile, different strategies may be required in the case of the United States where additional transit times resulting from reduced speed may have a slightly higher impact than increased transport/shipping costs. If the additional costs were to be passed on to shippers, highly impacted countries such as the Netherlands and the United Kingdom may decide to substitute parts or their entire cherry imports by exploring alternative potential suppliers in relatively closer markets such as Turkey, Spain, and Italy. However, Spain and Turkey are relatively smaller exporters both in terms of volume and value and their cherry exports do not probably benefit from the scale effects that may favour the Chilean cherry exports.

Table 41: Impact of IMO short term measure on the maritime logistics costs of Chile's agricultural commodity exports to selected import markets, compared with the baseline 2030 Current Regulations scenario

| **Destination Country and territory** | | **Maritime transport costs** | | | **Time costs** | | | **Logistics costs** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **EEXI Only** | **High** | **Low** | **EEXI Only** | **High** | **Low** | **EEXI Only** | **High** | **Low** |
| **United States of America** | % change | -0.46% | 7.70% | 2.10% | 1.30% | 8.55% | 3.81% | -0.04% | 7.91% | 2.52% |
| | % change ad valorem | 0.00% | 0.07% | 0.02% | 0.00% | 0.02% | 0.01% | 0.00% | 0.09% | 0.03% |
| **China** | % change | 0.07% | 8.79% | 2.43% | 0.49% | 8.76% | 3.78% | 0.12% | 8.79% | 2.60% |
| | % change ad valorem | 0.00% | 0.11% | 0.03% | 0.00% | 0.02% | 0.01% | 0.00% | 0.12% | 0.04% |
| **China, Hong Kong SAR** | % change | 0.02% | 8.58% | 2.33% | 0.48% | 8.75% | 3.80% | 0.13% | 8.62% | 2.67% |
| | % change ad valorem | 0.00% | 0.06% | 0.02% | 0.00% | 0.02% | 0.01% | 0.00% | 0.08% | 0.03% |
| **Netherlands** | % change | 0.28% | 13.70% | 5.18% | 0.67% | 8.45% | 3.60% | 0.30% | 13.36% | 5.08% |
| | % change ad valorem | 0.01% | 0.48% | 0.18% | 0.00% | 0.02% | 0.01% | 0.01% | 0.50% | 0.19% |
| **United Kingdom** | % change | 0.01% | 13.77% | 5.23% | 0.63% | 8.62% | 3.82% | 0.05% | 13.45% | 5.14% |
| | % change ad valorem | 0.00% | 0.48% | 0.18% | 0.00% | 0.02% | 0.01% | 0.00% | 0.50% | 0.19% |
| **Brazil** | % change | 0.02% | 15.85% | 6.57% | 1.49% | 8.83% | 4.63% | 0.57% | 13.25% | 5.85% |
| | % change ad valorem | 0.00% | 0.09% | 0.04% | 0.00% | 0.03% | 0.02% | 0.00% | 0.12% | 0.05% |
| **China, Taiwan Province of** | % change | -0.33% | 7.23% | 1.75% | 0.80% | 8.66% | 3.58% | -0.07% | 7.56% | 2.17% |
| | % change ad valorem | 0.00% | 0.09% | 0.02% | 0.00% | 0.03% | 0.01% | 0.00% | 0.13% | 0.04% |
| **Korea, Republic of** | % change | -0.02% | 8.42% | 2.26% | 0.55% | 8.73% | 3.75% | 0.10% | 8.48% | 2.56% |
| | % change ad valorem | 0.00% | 0.08% | 0.02% | 0.00% | 0.02% | 0.01% | 0.00% | 0.10% | 0.03% |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Ecuador** | % change | -2.01% | 2.69% | -0.16% | 3.73% | 7.69% | 4.01% | -0.76% | 3.78% | 0.75% |
| | % change ad valorem | -0.01% | 0.01% | 0.00% | 0.00% | 0.01% | 0.00% | 0.00% | 0.01% | 0.00% |
| **Thailand** | % change | 0.10% | 8.81% | 2.54% | 0.46% | 8.41% | 3.62% | 0.11% | 8.80% | 2.57% |
| | % change ad valorem | 0.01% | 1.11% | 0.32% | 0.00% | 0.04% | 0.02% | 0.01% | 1.14% | 0.33% |
| **Korea, Dem. People's Rep. of** | % change | 0.09% | 8.81% | 2.44% | 0.41% | 8.76% | 3.84% | 0.16% | 8.80% | 2.71% |
| | % change ad valorem | 0.00% | 0.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | 0.01% |

*Source: UNCTAD calculations, based on data provided by MDS Transmodal (MDST).*

As observed in Table 28 and Figure 55 above, exports from Turkey and Spain are dwarfed by Chilean cherry exports, both in terms of value and volume. Maritime logistics costs for agricultural exports from Turkey to China are also expected to increase by around 6.56% cent under the 2030 HIGH-GHG reduction scenario as compared to the 2030 Current Regulations scenario. Turkey's transport (shipping) costs will increase by 6.45% and time cost by 7%. As to the United States, its maritime logistics costs seem be more sensitive to increased transit time as compared to Chilean maritime logistics costs. In this context, it will be difficult to envisage a situation whereby Chilean cherry exports to China could be displaced by other exporters, including those at closer distance from the Chinese market.

### *4.4.5 Impact of the IMO Short-Term Measure on Chilean Agricultural Exports to China*

Taking into consideration the changes in maritime logistics costs that could potentially result from the IMO short-term measure and based on simulation work using a global trade model, as indicated in previous sections to this report, it was observed that, under the HIGH-GHG reduction scenario, increased maritime logistics costs involving Chilean agricultural product exports to China, including cherry exports, will be positively impacted across all three IMO GHG reduction scenarios (Table 42). Exports of agricultural commodities from Chile to China are expected to increase, albeit at a marginal 0.16% under the HIGH-GHG reduction (0.08% under the EEXI-Only scenario and 0.02% under the LOW-GHG reduction scenario). Chile's exports of agricultural products to the world, including China are however simulated to decrease by 0.83%. Thus, the increase in export volumes of agricultural products from Chile to China, seem to be specific to the Chile-China trade. As regards total exports of all commodities to all trading partners, Chile's exports are expected to decline by 0.91% under the HIGH-GHG reduction scenario, along with its GDP which will fall by 0.05% (Table 19). Meanwhile, the GDP of other agricultural exporters, including the United States, Argentina, Canada, Australia, New Zealand, and Turkey, is expected to fall across practically the three GHG reduction scenarios.

Other cherry exporters, including the United States, Argentina, Canada, Australia, and Turkey, will see a decrease in their agricultural commodity exports to China under the three IMO GHG reduction scenarios. Like Chile, New Zealand, however, will see its agricultural product export to China increase by 0.4% under the HIGH-GHG reduction scenario (0.08%

under both the LOW-GHG reduction and the EEXI-Only scenarios). Like Chile, New Zealand will also see a decrease in its agricultural exports to the world (-0.88%, a larger drop as compared to Chilean exports).

The trade model results suggest that when it comes to the Chinese market, it would be difficult for other cherry exporters to displace Chilean cherry exports (based on the results relating to agricultural product exports and which include cherries). Increased maritime logistics costs in exporting countries other than Chile and New Zealand, would probably result in some shift in trade patterns whereby cherry exports would be diverted away from China. In this context, exports from Chile and New Zealand could help to fill the gap created in the Chinese market. A relatively larger and leading cherry exporter such as Chile will probably be able to capture the cherry trade lost to other exporters and consolidate its market share in the Chinese market.

The rate at which export volumes change against the change in maritime logistics costs (elasticity) varies for each trading partners. Exports of agricultural products from Chile to China are positively correlated with maritime logistics costs and have a relatively smaller elasticity of 0.02. In comparison, exports of agricultural products from the United States to China are negatively correlated with changes in maritime logistics costs and have a relatively larger elasticity of -0.32. Like Chile, exports from New Zealand to China show a positive correlation and a small elasticity of 0.04. This indicates that exports of agricultural products from Chile and New Zealand to China are relatively less sensitive to changes in maritime logistics costs compared to exports from the United States.

It should be noted that the increase in Chilean and New Zealand's export of agricultural exports to China, is specific to this commodity group and the route to China as their exports of these same products to other import markets, are expected to drop by 0.83% and 0.88%, respectively. Furthermore, their overall exports of all commodities shipped to the entire world are also expected to decrease nearly across the three 2030 GHG reduction scenarios.

Table 42: Impact of maritime logistics cost changes on agricultural commodity exports to China

| Major exporters | Impact of maritime logistics costs | | |
|---|---|---|---|
| | EEXI-Only | High | Low |
| **Chile** | 0.08% | 0.16% | 0.02% |
| **United States of America** | 0.11% | -1.09% | -0.27% |
| **Argentina** | 1.02% | -2.95% | 0.11% |
| **Canada** | 0.17% | -2.75% | -0.75% |
| **Australia** | 0.25% | -0.17% | -0.10% |
| **New Zealand** | 0.08% | 0.40% | 0.08% |
| **Turkey** | 0.01% | -0.17% | -0.10% |

*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

Table 43: Impact of maritime logistics cost changes on GDP of Chile and other agricultural commodity exporters

| Major exporters | Impact of maritime logistics costs | | |
|---|---|---|---|
| | EEXI-Only | High | Low |
| **Chile** | 0.00% | -0.05% | -0.02% |
| **United States of America** | 0.00% | -0.01% | -0.01% |
| **Argentina** | -0.02% | -0.17% | -0.07% |
| **Canada** | 0.00% | -0.02% | -0.01% |
| **Australia** | -0.01% | -0.08% | -0.02% |
| **New Zealand** | -0.01% | -0.10% | -0.04% |
| **Turkey** | -0.01% | -0.04% | -0.02% |

*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

### *4.4.6 Summary of Main Points*

- Chile was the largest exporting country of deciduous fruit in 2019, with apricots, cherries, peaches, nectarines, plums, and sloes contributing approximately 0.2% of Chile’s GDP and close to 5% of its agricultural sector GDP. A large share of perishable cargoes such as deciduous fruit shipped out of Chile is carried in container vessels, essentially, through Valparaiso and San Antonio ports.

- Chilean cherry exports depend heavily on shipping to reach their main consumption markets, notably China. Temperature control plays a critical role as cherries are a very time sensitive product to handle and transport.

- It takes Chilean cherry exports to China an average of three days to reach their destination when shipped by air and between 20 to 25 days when caried by sea.[82] While some Chilean cherry exports may be shipped by air to China, the likelihood of a complete modal shift from maritime to air transport would be unlikely because of the volume and the scale of the trade involved, the high air freight prices and the special handling requirements of cherries which are better served by maritime shipping.

- Cherries require the use of container reefer technology, a critical aspect for cherries’ shelf life. Container shipping offers an extensive network of services which links ports worldwide. At the same time, reefer containers enable the implementation of intermodal transport solutions, and the use of containers as refrigerated warehouses.

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[82] Further information can be found at https://www.apec.org/Publications/2019/12/Analysis-of-the-Impacts-of-Slow-Steaming-for-Distant-Economies.

- Thus, cherries are a particular case where speed reduction and additional transit times may have negative implications for the value of the trade and its competitiveness and for which shipping is crucial given the limited scope of a full shift to faster modes of transport such as air. Nevertheless, combined shipping and air transport could provide useful alternative solutions during peak season periods. For many years, Chilean cherry exports were shipped by sea to California, and then by air to Hong Kong SAR, China.[83]
- According to DNV's results simulating the impact on ship costs under the three 2030 GHG reduction scenarios, on average, the speed of container vessels of 3,000 to 14,500 TEU (i.e., vessel category of direct relevance to the Chilean cherry exports to China) will be reduced by 11.5% (HIGH-GHG reduction scenario) compared to the baseline scenario under the Current Regulations.
- For container vessels, CAPEX costs are expected to increase by 22.3% at the aggregate level and 8.9% per vessel under the 2030 HIGH-GHG reduction scenario as compared to the Current Regulations 2030 scenario. Total operational costs are also expected to increase across the three 2030 GHG reduction scenarios (1.1%, 4.9% and 10.9% for EEXI-Only, LOW-GHG and HIGH-GHG reduction scenarios, respectively). Meanwhile, cruising time will increase by 12.4% in the 2030 HIGH-GHG reduction scenario as compared to the 2030 Current Regulations scenario.
- As to shippers and cargo owners, changes in transport (shipping costs) and transit times are more relevant given their implications for the supply chain and landed prices. Total maritime logistics costs of Chilean agricultural commodity exports to China will increase by 8.79%, 2.6% and 0.12%, under the HIGH-GHG reduction scenario, the LOW-GHG reduction scenario, and the EEXI-Only scenario, respectively. Within maritime logistics costs, transport costs will increase by 8.79% under the 2030 HIGH-GHG reduction scenario, 2.43% under the LOW-GHG reduction scenario, and 0.07% under the EEXI-Only scenario. Time spent at sea is expected to increase by 8.76% under the HIGH-GHG reduction scenario, 3.78% under the LOW-GHG reduction scenario, and 0.49% under the EEXI-Only scenario.

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[83] See https://www.producereport.com/article/chilean-cherries-enter-china-combined-sea-air-shipments.

- Considering Chile’s high dependence on maritime transport for its cherry exports to China, an increase in maritime logistic costs would naturally be a concern. However, the results of the global trade model used for the impact assessment suggest that the overall net effect is likely to be more positive than expected with a marginal increase in agricultural commodity exports to China being expected under all three 2030 scenarios, including the most stringent HIGH-GHG reduction scenario. Agricultural commodity exports from Chile to China are simulated to increase by 0.16% under the 2030 HIGH-GHG reduction scenario. Exports from New Zealand are also simulated to increase by 0.40%, although from a low base as the country is ranked 10th worldwide in terms of cherry exports to China. In contracts, agricultural commodity exports from the United States to China are simulated to decrease by 1.09%.
- It should be noted that the increase in Chilean and New Zealand’s export of agricultural exports to China is specific to this commodity group and the route to China as their exports of these same products to other export markets, are expected to drop by 0.83% and 0.88%, respectively. Furthermore, their overall exports of all commodities shipped to the entire world are expected to decrease nearly across all three 2030 GHG reduction scenarios.

## 4.5 Illustrative Case 4: Pacific and Caribbean SIDS

Pacific and Caribbean SIDS represent a specific case as their economies heavily depend on international trade due to limited available resources inside their small territories. Imports to GDP ratio stood at around 40% in these regions,[84] almost two times higher than the world average (i.e., around 20%). Due to their geographical and physical characteristics as island states, their trade is primarily served by maritime transport. As maritime transport provides essential services to sustain daily economic needs in these regions, the impact of the IMO short-term measure should be carefully examined.

Maritime transport in the Pacific and Caribbean regions is characterized by heavy reliance on shortsea shipping, resulting in higher maritime transport costs relative to other regions. In the Pacific SIDS region, 42.5% of intra-regional ship journeys were made by containerships providing shortsea shipping services, while within Caribbean SIDS, that proportion was 34.3%. Over 35% of intra-regional ship journeys were made of Ro-Ro/Ro-Pax and general cargo ships in both regions. According to the data provided by DNV, these ship types have higher total transport cost intensity, ranging from 0.9 cents/ton-mile for general cargo to 1.6 cents/ton-mile for Ro-Pax in 2019.

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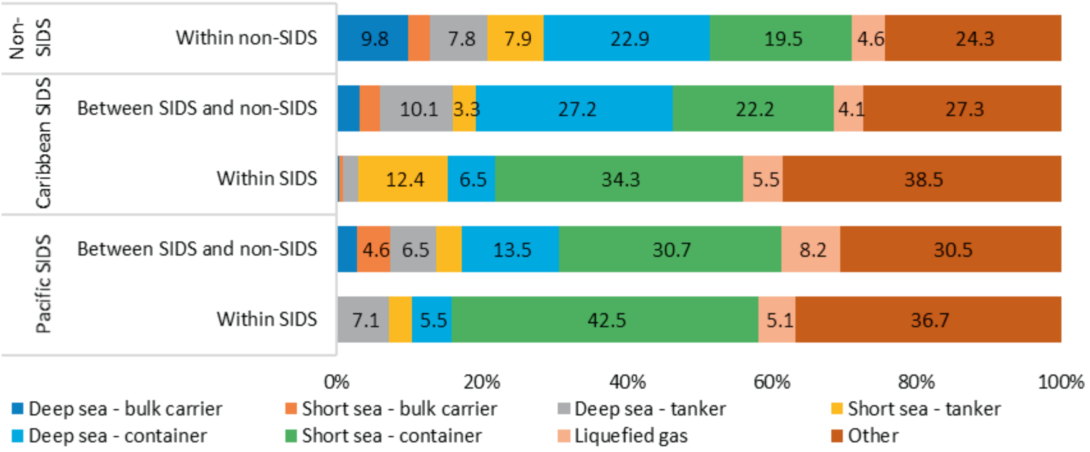
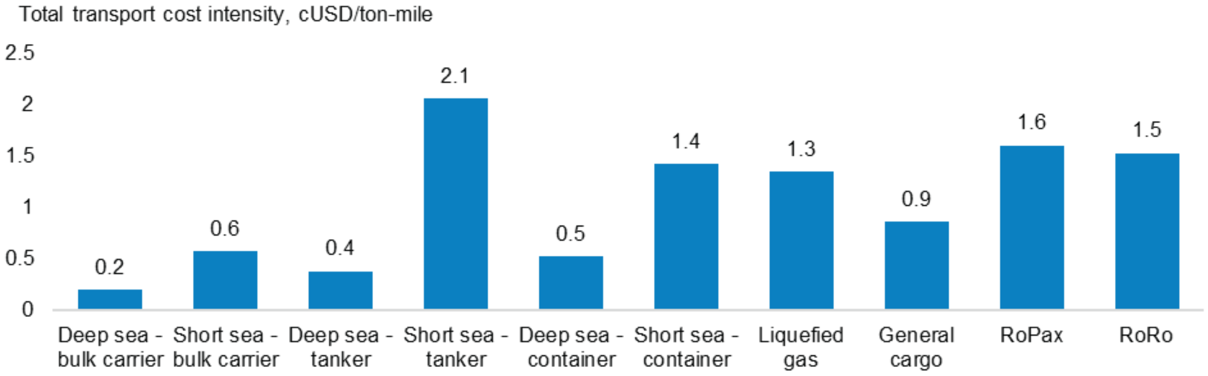
[84] For smaller economies like Anguilla and Nauru, the ratio was over 70%.

Figure 57: Ship types by journeys and routes for the Pacific/Caribbean SIDS and non-SIDS, 2019



*Source: UNCTAD, based on data provided by MarineTraffic.*

Figure 58: Total transport cost intensity by ship type, 2019



*Source: UNCTAD, based on data provided by DNV.*

Dependence on shortsea shipping also implies that more transhipments are required for exports and imports of goods in the Pacific and the Caribbean regions. Figure 3 depicts all journeys made by containerships and general cargo vessels involved in shortsea shipping in the Pacific SIDS. Few large economies serve as regional hubs transferring shipments to smaller countries. Network measures confirm the same pattern: Papua New Guinea and Fiji have higher hub and authority centrality scores.[85] In contrast, the smaller economies of Niue and the Cook Islands have low centrality scores (Figure 60).

It should be noted that even large economies in the Pacific SIDS are showing relatively low centrality scores (i.e., lower than the world average of 0.33 for hub centrality and 0.35 for authority centrality). These economies suffer from (dis)connectivity and may therefore feel the impact of the IMO short-term measure on maritime logistics costs even more.

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[85] Hub centrality measures connectedness of the node based on degree and quality of outgoing connections. Authority centrality measures connectedness of the node based on degree and quality of incoming connections.

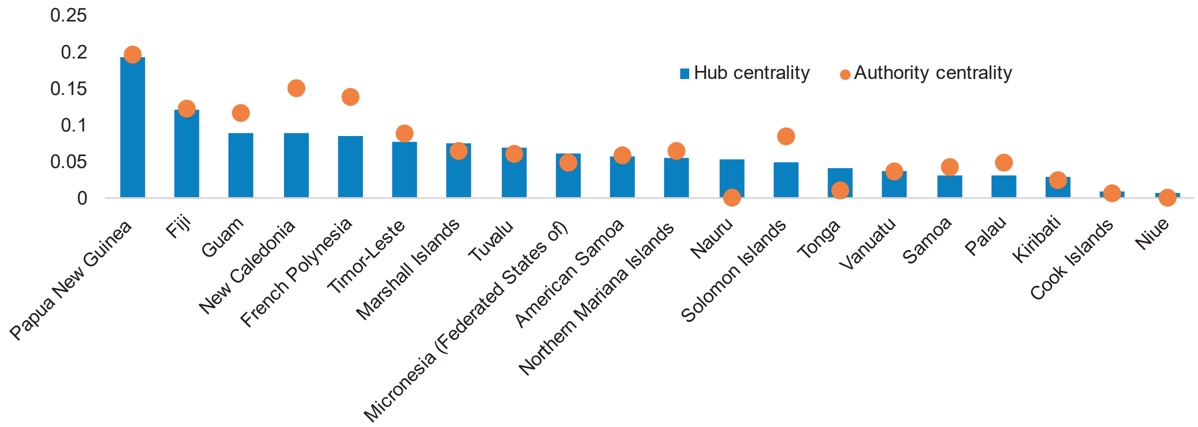
Figure 59: Journeys made by short sea containers and general cargos in Pacific SIDS

*Short sea containers*

*General cargos*

*Source: UNCTAD, based on data provided by MarineTraffic and NASA.*

Figure 60: Connectedness of Pacific SIDS, based on hub and authority centrality#, all ship categories



*Source: UNCTAD, based on data provided by MarineTraffic.*
*# Network measures are calculated based on global maritime shipping connections in 2019.*

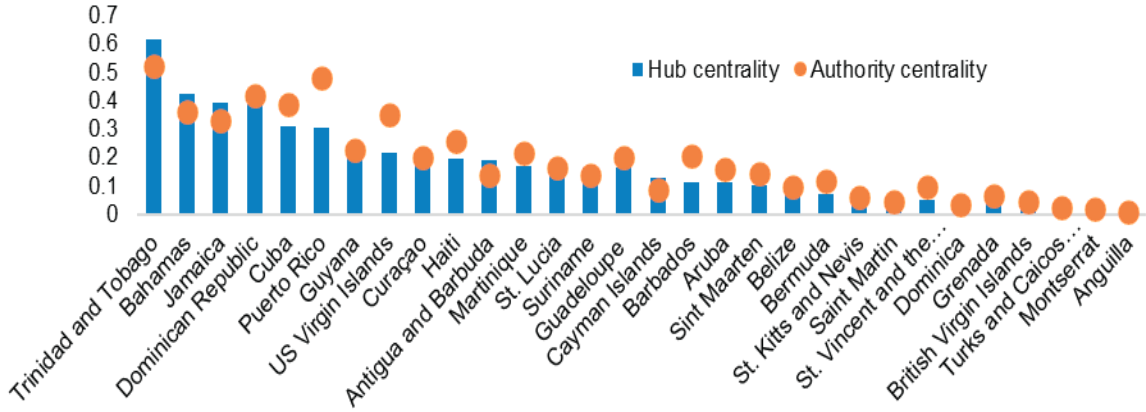
Caribbean SIDS exhibit a similar pattern. Large countries like Trinidad and Tobago, the Bahamas, Jamaica and the Dominican Republic serve as regional hubs to smaller economies.

Figure 61: Journeys (laden or partially laden) made by shortsea containers & Ro-Ro ships in Caribbean SIDS

| Short-Sea Containers | RoRo Ships |
|---|---|

*Source: UNCTAD, based on data provided by MarineTraffic and NASA.*

Figure 62: Connectedness of Caribbean SIDS, based on hub and authority centrality#, all ship categories



*Source: UNCTAD, based on data provided by MarineTraffic.*
*# Network measures are calculated based on global maritime shipping connections in 2019.*

UNCTAD's Liner Shipping Connectivity Index (LSCI)[86,87] shows the long-term dynamics of maritime connectivity in these regions. Only a few large Caribbean countries, namely, Dominican Republic, Jamaica, and the Bahamas, managed to grow as hubs (Figure 63). Most SIDS, including larger Pacific SIDS like Papua New Guinea and Fiji, have been faced with low connectivity for more than a decade even though the world average improved during this period.

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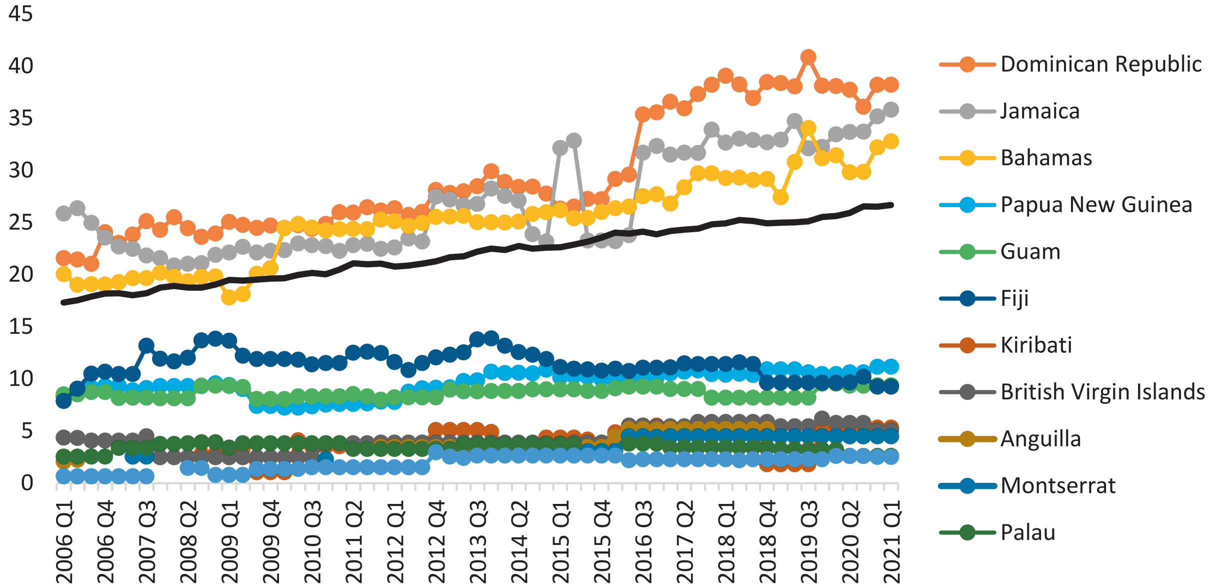
[86] The LSCI indicates a country's integration level into global liner shipping networks. It is an index set at 100 for the maximum value of country connectivity in the first quarter (Q1) of 2006, which was China.

[87] For further information, see also the port level Liner Shipping Connectivity Index (LSCI), as well as the Liner Shipping Bilateral Connectivity Index (LSBCI) on http://stats.unctad.org/maritime.

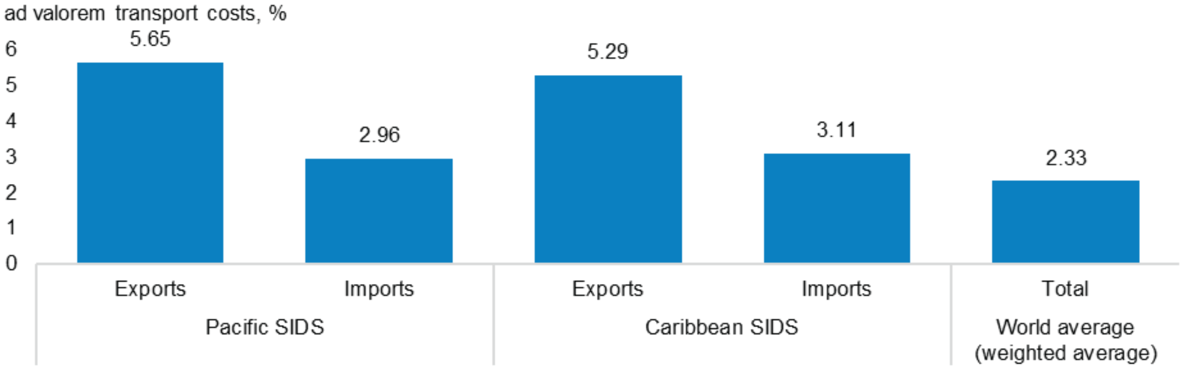
Due to the (dis)connectivity from the global shipping network, Pacific and Caribbean SIDS pay relatively higher transport costs. Shipping (transport)costs for exports of the Pacific SIDS and Caribbean SIDS, which are simulated at 5.65% and 5.29% of the export value, respectively, under the 2030 Current Regulations scenario, are over 120% higher than the world average (i.e., 2.33% of trade value) in ad valorem terms (Figure 64). Shipping costs for imports into the Pacific and Caribbean SIDS (i.e., 2.96% and 3.11%, respectively) are also over 20% higher than the world average.

Figure 63: Liner shipping connectivity index of selected Pacific and Caribbean SIDS



*Source: UNCTAD, based on data provided by MDS Transmodal*

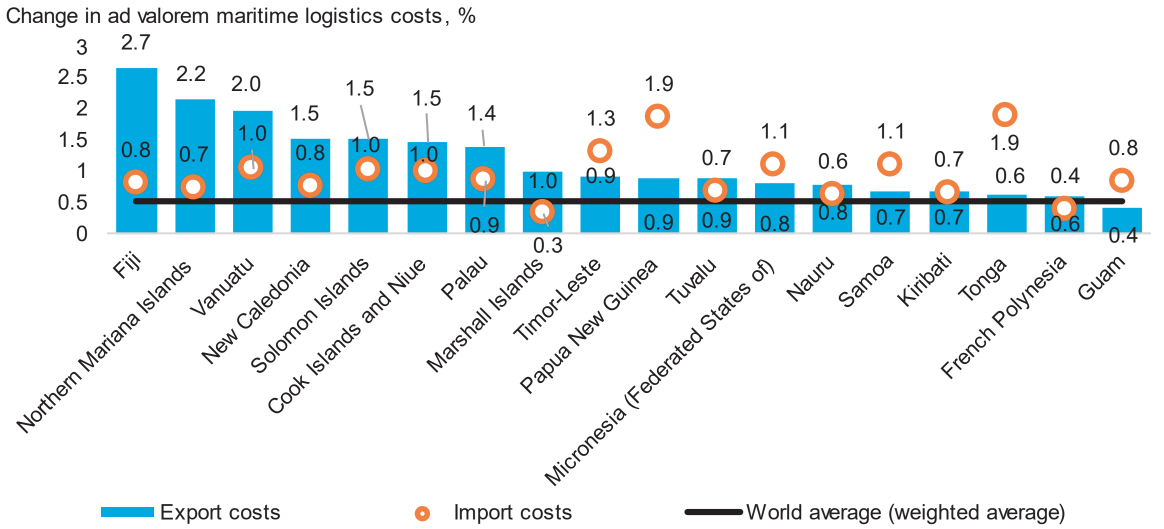
Figure 64: Maritime transport costs of Pacific SIDS, Caribbean SIDS and the World average, in ad valorem terms, 2030 baseline Current Regulations scenario



*Source: UNCTAD, based on data provided by MDS Transmodal (MDST).*

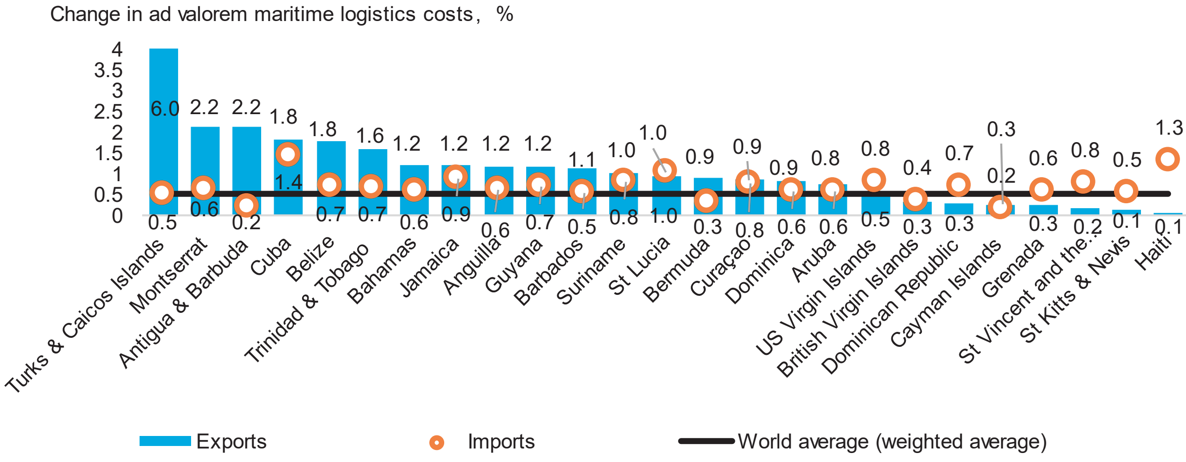
Under the HIGH-GHG reduction scenario, total maritime logistics costs (i.e., the sum of transport costs and time costs) of most of the Pacific SIDS trades are expected to increase more than the world average (i.e., 0.5% in ad valorem terms under the HIGH-GHG reduction scenario as compared to the Current Regulations scenario) (Figure 65). Total maritime logistics costs of most Caribbean SIDS are also expected to increase more than the world average (Figure 66).

Figure 65: Impact of the new IMO measure on maritime logistics cots in Pacific SIDS, by exports and imports, changes from the 2030 baseline Current Regulations scenario to HIGH-GHG reduction scenario



*Source: UNCTAD, based on data provided by MDS Transmodal (MDST).*

Figure 66: Impact of the new IMO measure on maritime logistics cots in Caribbean SIDS, by exports and imports, changes from Current Regulations scenario to HIGH-GHG reduction scenario



*Source: UNCTAD, based on data provided by MDS Transmodal (MDST).*

Figure 65 and Figure 66 show that, in general and when compared to larger economies, small economies are expected to experience a larger impact on their maritime logistics costs as a percentage of the value of trade as a result of the IMO short-term measure. For example, Northern Mariana Islands, Vanuatu, and the Cook Islands and Niue in the Pacific region and Turks and Caicos Islands, Montserrat, and Antigua and Barbuda in the Caribbean, are expected to be more negatively impacted than other SIDS in the Pacific and Caribbean regions.

However, there are several exceptions to this pattern. For example, Fiji and Cuba are relatively large countries in these regions, but they are expected to experience large impacts on their maritime logistics costs. In contrast, Kiribati and St. Kitts and Nevis are expected to see a smaller impact on their maritime logistics costs even though they are small economies.

Table 44 shows specific sectors and routes where maritime logistics costs will be most affected by the IMO short-term measure. For exports of Fiji, 46.4% of the increase in maritime export logistics costs are concentrated on exports of food and beverages to the United States. Similarly, 43.6% of the increase in Cuba's maritime logistics costs for its exports affect its exports of food and beverages to China, while 45.2% of the increase in maritime import costs affect imports of food and beverages from Viet Nam. For Kiribati, 51.2% of the increase in maritime export logistics costs affect fishing product exports to Thailand. For St. Kitts and Nevis, 44.3% of the increase in maritime logistics costs of exports affect exports of electrical and machinery products to the United States.

Table 44 Sector-route whose maritime logistics costs will be most affected by the IMO short-term measure, and its contribution to the total change in maritime logistics costs, Pacific SIDS and Caribbean SIDS

| | Export logistics costs | | Import logistics costs | |
|---|---|---|---|---|
| | Most affected sector-route | Contribution# (%) | Most affected sector-route | Contribution# (%) |
| **Pacific SIDS** | | | | |
| **Cook Islands and Niue** | Other Manufacturing to Tonga | 38.1% | Food & Beverages from Malaysia | 10.9% |
| **Fiji** | Food and beverages to USA | 46.4% | Petroleum Chemical and Non-Metallic Mineral Products from Republic of Korea | 25.9% |
| **French Polynesia** | Food & Beverages to France | 59.8% | Food & Beverages from France | 17.6% |
| **Guam** | Electrical and Machinery to Republic of Korea | 34.8% | Petroleum Chemical and Non-Metallic Mineral Products from Japan | 29.5% |
| **Kiribati** | Fishing to Thailand | 51.2% | Food & Beverages from Thailand | 15.4% |
| **Marshall Islands** | Transport Equipment to Republic of Korea | 39.8% | Transport Equipment from Republic of Korea | 42.4% |
| **Micronesia (Federated States of)** | Fishing to Thailand | 31.7% | Other Manufacturing from Philippines | 10.8% |
| **Nauru** | Mining and Quarrying to Republic of Korea | 44.7% | Food & Beverages from Nigeria | 14.8% |
| **New Caledonia** | Mining and Quarrying to Republic of Korea | 35.8% | Petroleum Chemical and Non-Metallic Mineral Products from Australia | 17.6% |
| **Northern Mariana Islands** | Food & Beverages to Madagascar | 74.3% | Petroleum Chemical and Non-Metallic Mineral Products from Japan | 39.1% |
| **Palau** | Food & Beverages to Ghana | 66.0% | Petroleum Chemical and Non-Metallic Mineral Products from US Minor Outlying Islands | 14.8% |
| **Papua New Guinea** | Petroleum Chemical and Non-Metallic Mineral Products to Japan | 28.6% | Metal Products from Qatar | 43.7% |
| **Samoa** | Metal Products to Algeria | 17.0% | Food & Beverages from USA | 14.1% |
| **Solomon Islands** | Wood and Paper to China | 49.1% | Petroleum Chemical and Non-Metallic Mineral Products from Republic of Korea | 16.3% |

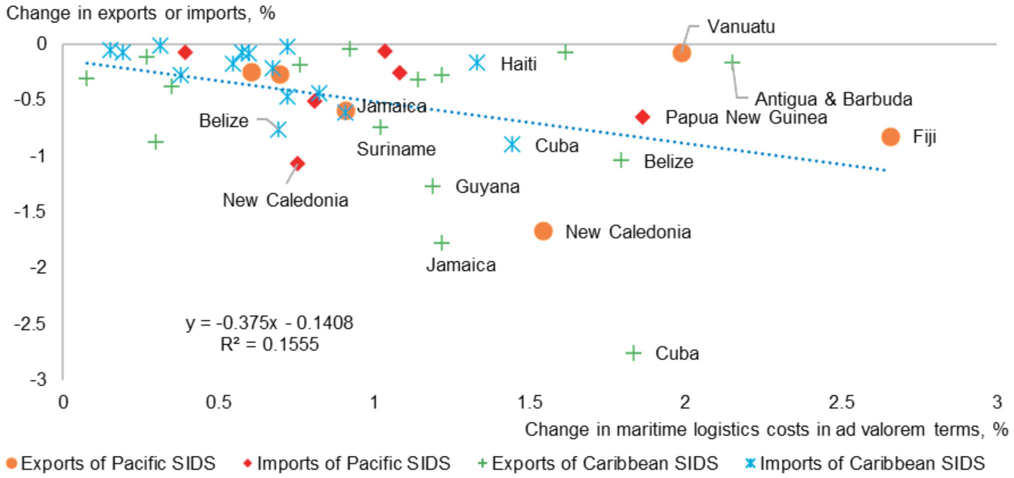
| | Export logistics costs | | Import logistics costs | |
|---|---|---|---|---|
| | Most affected sector-route | Contribution# (%) | Most affected sector-route | Contribution# (%) |
| **Timor-Leste** | Petroleum Chemical and Non-Metallic Mineral Products to Thailand | 54.0% | Other Manufacturing from Indonesia | 40.2% |
| **Tonga** | Agriculture to Republic of Korea | 29.6% | Other Manufacturing from Cook Islands and Niue | 50.7% |
| **Tuvalu** | Fishing to Thailand | 48.9% | Petroleum Chemical and Non-Metallic Mineral Products from China | 26.5% |
| **Vanuatu** | Food & Beverages to Burkina Faso | 45.8% | Agriculture from Burkina Faso | 15.4% |
| **Caribbean SIDS** | | | | |
| **Anguilla** | Petroleum Chemical and Non-Metallic Mineral Products to Papua New Guinea | 44.8% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 26.5% |
| **Antigua and Barbuda** | Food & Beverages to Senegal | 38.4% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 36.2% |
| **Aruba** | Food & Beverages to Yemen | 33.4% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 16.5% |
| **Bahamas** | Mining and Quarrying to USA | 65.2% | Petroleum Chemical and Non-Metallic Mineral Products from Colombia | 27.2% |
| **Barbados** | Other Manufacturing to Guyana | 21.8% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 25.2% |
| **Belize** | Food & Beverages to United Kingdom | 26.8% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 18.6% |
| **Bermuda** | Petroleum Chemical and Non-Metallic Mineral Products to Pakistan | 91.8% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 34.0% |
| **British Virgin Islands** | Petroleum Chemical and Non-Metallic Mineral Products to Dominican Republic | 26.2% | Petroleum Chemical and Non-Metallic Mineral Products from Brazil | 28.8% |
| **Cayman Islands** | Petroleum Chemical and Non-Metallic Mineral Products to Australia | 54.4% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 16.6% |
| **Cuba** | Food & Beverages to China | 43.6% | Food & Beverages from Viet Nam | 45.2% |
| **Curaçao** | Petroleum Chemical and Non-Metallic Mineral Products to Nicaragua | 45.0% | Petroleum Chemical and Non-Metallic Mineral Products from Russian Federation | 14.1% |
| **Dominica** | Other Manufacturing to Jamaica | 25.0% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 63.8% |
| **Dominican Republic** | Food & Beverages to USA | 19.5% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 18.9% |
| **Grenada** | Other Manufacturing to Uganda | 20.9% | Food & Beverages from USA | 12.5% |
| **Guyana** | Food & Beverages to United Kingdom | 18.6% | Metal Products from China | 10.2% |
| **Haiti** | Textiles and Wearing Apparel to USA | 58.5% | Food & Beverages from USA | 13.7% |
| **Jamaica** | Mining and Quarrying to USA | 43.5% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 26.0% |
| **Montserrat** | Mining and Quarrying to France | 44.6% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 41.0% |
| **Saint Kitts and Nevis** | Electrical and Machinery to USA | 44.3% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 22.1% |
| **Saint Lucia** | Mining and Quarrying to Trinidad & Tobago | 57.1% | Petroleum Chemical and Non-Metallic Mineral Products from Colombia | 60.3% |
| **Saint Vincent and the Grenadines** | Transport Equipment to India | 18.2% | Food & Beverages from USA | 15.3% |
| **Suriname** | Wood and Paper to China | 30.3% | Metal Products from China | 10.2% |
| **Trinidad and Tobago** | Metal Products to USA | 20.2% | Petroleum Chemical and Non-Metallic Mineral Products from USA | 22.0% |
| **Turks and Caicos Islands** | Food & Beverages to Mozambique | 84.3% | Food & Beverages from USA | 24.1% |
| **United States Virgin Islands** | Electrical and Machinery to Netherlands | 23.8% | Petroleum Chemical and Non-Metallic Mineral Products from Argentina | 60.8% |

*Source: UNCTAD, based on data provided by MDS Transmodal (MDST).*

*# Change in logistics costs of the most affected sector-route (in monetary terms) / change in logistics costs of the country's total exports or imports (in monetary terms) * 100. Changes are from the Current Regulations scenario to the HIGH-GHG reduction scenario.*

The global trade model simulates the impacts of increases in maritime logistics costs on exports and imports. Figure 67 shows that higher maritime logistics costs will have more significant negative impacts (I.e., fall in flows) on exports and imports in the Pacific and Caribbean SIDS.[88] For example, countries with higher maritime logistics costs, such as Fiji and Cuba, are expected to experience a fall in exports or imports.

Figure 67: Impact of the new IMO measure on maritime logistics cots and trade in Pacific SIDS and Caribbean SIDS, changes from Current Regulations scenario to HIGH-GHG reduction scenario



*Source: UNCTAD, based on data provided by MDS Transmodal (MDST) and the results of the global trade model used for the impact assessment.*

On average, expected adverse impacts on exports of the Pacific and Caribbean SIDS (i.e., a 0.6% decrease and a 0.7% decrease, respectively under the HIGH-GHG reduction scenario as compared to the Current Regulations scenario) are slightly larger than the world average (i.e., a 0.5% decrease) (Figure 68).

Average impacts on exports are driven by large negative impacts in a few countries like New Caledonia and Cuba. A total of 93.5% of the decrease in New Caledonia's exports is accounted for by a fall in the exports of mining and quarrying products to Japan (Table 45), implying some substitution by competitors.[89] Some 42.1% of the decline in Cuba's exports is accounted for by a drop in exports of food and beverages to China.

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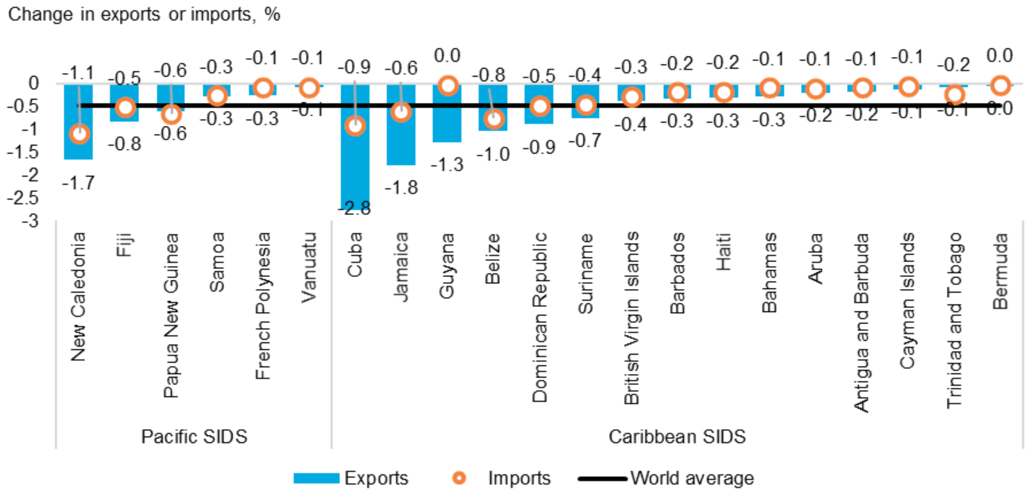
[88] The slope of the dotted trend line is negative, and it is statistically significant at 1 percentage level.
[89] For example, Japan is expected to increase imports of mining and quarrying from Indonesia and Papua New Guinea.

Figure 68: Impact of the new IMO measure on exports and imports in Pacific SIDS and Caribbean SIDS, changes from Current Regulations scenario to HIGH-GHG reduction scenario



*Source: UNCTAD, based on the results of the global trade model used for the impact assessment.*

If these exceptional cases are excluded, negative impacts on exports in these regions will be typically close to or slightly less than the world average. Negative impacts on imports are also close to or slightly less than the world average. The main export and import products in many Pacific and Caribbean SIDS are essential goods like agriculture, food and beverages, and mining and quarrying products. Exports and imports of these essential commodities are slightly less sensitive to maritime logistics cost changes than other commodities (Figure 4).

However, this does not necessarily mean that potential impacts on trade in these regions are negligible. Pacific and Caribbean SIDS economies are expected to switch some imports of food and beverages from distant countries to closer countries. For example, Antigua and Barbuda, one of the small countries in the Caribbean, is expected to decrease imports of food and beverages from the United States, Canada, Germany, and China and increase its imports of these products from countries in the same region, including Trinidad and Tobago, Guyana, and Barbados. SIDS economies in the Pacific and Caribbean regions have been trying to diversify their exports because exports are concentrated on a few destination markets and a few commodities, exhibiting these economies' vulnerability to external shocks. This diversification effort will become more challenging if their maritime logistics costs increase owing to the IMO shot-term measure.

Figure 69 shows simulated impacts of the higher maritime logistics costs on the GDP of the Pacific and Caribbean SIDS under the HIGH-GHG reduction scenario compared with the 2030 Current Regulations scenario. Countries that will face greater negative impacts on exports and imports, such as New Caledonia, Papua New Guinea, and Jamaica, are also expected to see larger declines in GDP.

Table 45 Sector-route whose exports or imports are most affected by the IMO short-term measure, and its contribution to the total change in exports or imports of the country or territory, Pacific SIDS and Caribbean SIDS

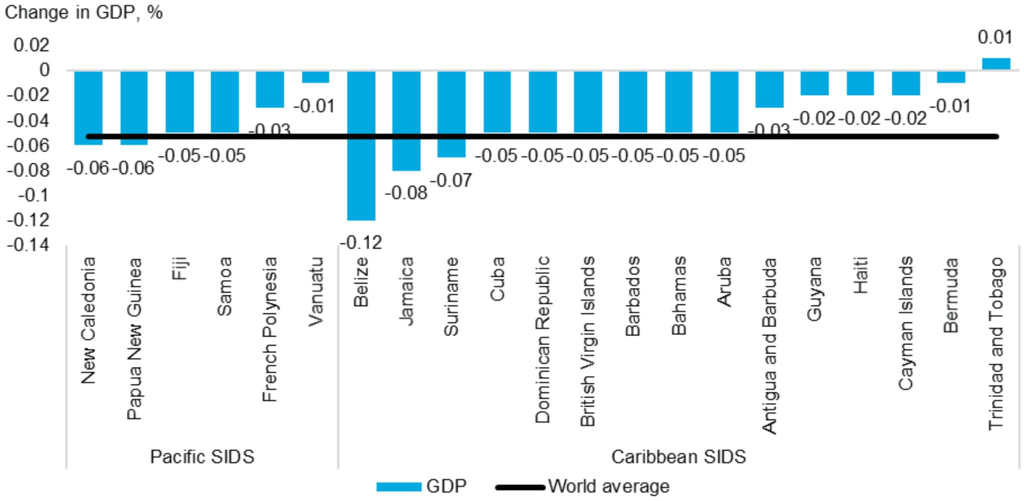
| | Exports | | Imports | |
|---|---|---|---|---|
| | **Most affected sector-route** | **Contribution# (%)** | **Most affected sector-route** | **Contribution# (%)** |
| **Pacific SIDS** | | | | |
| **Fiji** | Food & Beverages to United Kingdom | 62.5% | Electrical and Machinery from Singapore | 13.9% |
| **New Caledonia** | Mining and Quarrying to Japan | 93.5% | Electrical and Machinery from France | 18.9% |
| **Papua New Guinea** | Food & Beverages to Australia | 28.3% | Electrical and Machinery from Singapore | 12.9% |
| **French Polynesia** | Food & Beverages to France | 86.0% | Food & Beverages from France | 29.4% |
| **Vanuatu** | Transport Equipment to India | 92.9% | Food & Beverages from Singapore | 17.5% |
| **Samoa** | Food & Beverages to USA | 127.8% | Wood and Paper from New Zealand | 30.3% |
| **Caribbean SIDS** | | | | |
| **Aruba** | Petroleum, Chemical and Non-Metallic Mineral Products to Brazil | 64.7% | Mining and Quarrying from Netherlands | 47.0% |
| **Antigua and Barbuda** | Agriculture to Serbia | 9.9% | Food & Beverages from USA | 38.2% |
| **Bahamas** | Mining and Quarrying to USA | 63.8% | Food & Beverages from USA | 42.5% |
| **Belize** | Food & Beverages to USA | 82.3% | Food & Beverages from USA | 12.6% |
| **Bermuda** | Food & Beverages to Nigeria | | Food & Beverages from United Kingdom | 19.6% |
| **Barbados** | Food & Beverages to USA | 49.1% | Food & Beverages from USA | 12.3% |
| **Cuba** | Food & Beverages to China | 42.1% | Food & Beverages from Spain | 7.8% |
| **Cayman Islands** | Petroleum, Chemical and Non-Metallic Mineral Products to Brazil | 45.5% | Electrical and Machinery from India | 16.7% |
| **Dominican Republic** | Food & Beverages to USA | 52.1% | Food & Beverages from USA | 16.4% |
| **Guyana** | Food & Beverages to United Kingdom | 31.3% | Food & Beverages from USA | 16.1% |
| **Haiti** | Textiles and Wearing Apparel to USA | 30.9% | Food & Beverages from USA | 17.0% |
| **Jamaica** | Food & Beverages to USA | 43.8% | Food & Beverages from USA | 31.0% |
| **Suriname** | Food & Beverages to Netherlands | 27.6% | Food & Beverages from Netherlands | 11.4% |
| **Trinidad and Tobago** | Metal Products to Germany | 79.6% | Food & Beverages from USA | 14.7% |
| **British Virgin Islands** | Electrical and Machinery to Turkmenistan | 76.5% | Electrical and Machinery from Russian Federation | 29.9% |

*Source: UNCTAD, based on the results of the global trade model used in the impact assessment.*

*# Change in exports or imports of the most affected sector-route (in monetary terms) / change in the country's total exports or imports (in monetary terms) * 100. Changes are from the Current Regulations scenario to the High reduction scenario.*

However, as discussed above, small declines in the GDP of the SIDS economies does not necessarily mean that the impact on the regions is negligible. The simulation results on import patterns show that some substitution of food and beverages imports from distant countries to closer countries will occur. This substitution could potentially reduce the variety of products available to SIDS and reduce households' welfare in the Pacific and the Caribbean regions. Also, higher maritime logistics costs will make the economic diversification efforts of these economies more challenging. These potential impacts are difficult to quantify but will be non-negligible for SIDS economies.

Figure 69: Impact of the new IMO measure on GDP in Pacific SIDS and Caribbean SIDS, changes from Current Regulations scenario to HIGH-GHG reduction scenario



*Source: UNCTAD, based on the global trade model used for this impact assessment.*

## 4.6 Case Study Summary and Discussion

The case studies were included all to **illustrate** the impact both in logistics and trade terms of complexities associated with assessing the impact of the IMO short-term measure. While aggregate impacts of the IMO short-term measure may be considered small, for some countries and trade routes they are important. In addition, the case studies illustrate situations where the relationship between increases in costs or decreases in speeds and the resulting impacts may not be linear, as is the case for certain perishable cargos, for example.

For several specific trades, results from the global trade model indicate an increase in trade volumes, despite maritime logistics cost increases. One way of explaining what may appear to be a counter-intuitive result, is that in global comprehensive models, where trade costs increase for almost all trades, some suppliers will be able to increase their share if competing suppliers are confronted with even higher increases, or if other reasons lead to a substitution of some suppliers by others.

# 5 Additional Impacts and Considerations

## 5.1 Supporting the Energy Transition

### *5.1.1 The Impact of Technological Change*

Regulation directly affects the innovative process, while innovation and technical change have significant impacts on regulation. Traditionally, many sections of the global shipping and maritime transportation industry are compliance-led and at times display a lower propensity to innovate compared with other sectors. One can therefore argue that a targeted and structured regulatory process would have a positive impact on innovation and technical change, which would be beneficial to companies and industries, both in cost and productivity terms in the longer term. However, if such regulatory process is designed and implemented inconsistently, it may have adverse impacts not only in terms of missing its regulatory targets, but also of inhibiting technological change.

To stimulate the desired technological progress, the regulatory process must be vigilant. On the one hand, by unlocking regulatory, administrative and investment barriers, regulations can provide the necessary conditions for innovation and technological progress. Regulations can place technical demands and standards on firms and industries and put a greater emphasis on performance standards and harmonization to promote efficiencies and remove uncertainties. On the other hand, regulations can also erect barriers to the development of new technologies. Ineffective regulations can distort the choice and diffusion of technologies that are already explored and adopted. An unclear regulatory process can erect barriers to innovation by increasing the uncertainty and costs of the development process.

The results of the present UNCTAD impact assessment and previous work suggest that the IMO short-term GHG reduction measure strikes the right balance for enhancing efficiency (EEXI) and stimulating innovation (CII) albeit with a small regulatory cost. But for an industry which has achieved high levels of scale (size) and technical (cost) efficiencies, the main missing component for enhancing total factor productivity is that of technological change representing shifts in frontier technology.

Throughout the history of international shipping, technological progress has been a leap driver in firms' and the sector's productivity, such as when shifting from wind sailing ships to steamships or when replacing manual and operating processes with automated and standardised systems. Empirical evidence also suggests that some of the technological progress made in shipping and associated industries was also driven by regulation, for instance, following the introduction of the IMO ISPS maritime security regulations or because of the harmonisation of the FAL forms and the on-going efforts to implement national and regional Maritime Single Windows (MSW). In all these historical and regulatory occurrences, technological progress has only materialised gradually which suggests that technological change and its diffusion in shipping must be regarded effectively as a process rather than an event.

Since both UNCTAD's comprehensive assessment and other related work in the TORs are ex-ante regulatory impact assessments, they do not incorporate the ex-post benefits from technological change. This is made more difficult when the benefits from the induced technological change are only realised over time. Therefore, it is reasonable to assume that the simulated cost impacts of the IMO short-term GHG reduction measure would be reduced as the 'un-quantified' benefits of technological change start to materialise. For example, previous studies have shown that the shifts in the frontier technology following the introduction of maritime (ISPS) security regulations has amounted to an average of 5% increase in the total factor productivity (TFP) of shipping and maritime businesses. Similar trends with even higher positive impacts have also been observed in the case of urban transport regulatory policies prompting uptake on electrical vehicles' technology and the reduction of the total cost of (car) ownership. This also shows that where regulatory policies have been designed with a strong innovation component, they have led to much lower total costs over the longer term.

The above discussion highlights the real potential positive impact of both direct and induced technological change that would be triggered by the IMO-GHG short-term measure, drawing on evidence from similar regulatory policies and non-regulatory instruments. However, historical and empirical evidence also points out that the technological change and its diffusion in shipping and maritime industries are likely to materialise over time and that the current regulatory framework should be part of the long-term process of supporting the energy transition towards maritime decarbonisation.

### 5.1.2 Environmental Benefits and Spill-Over Effects

As per the TORs for Task 3, the Impact Assessment work undertaken in this Report only reports on the computed changes in maritime logistics costs, trade and income or GDP of States but does not estimate the environmental benefits from the IMO-GHG short-term measure. It is only reasonable to assume that further cost reduction (or increased benefits) would take place once the slipover impacts on 'society' are considered.

One important element in environmental policies is the quantification of externalities, be they external costs or social benefits, including items for which the market does not provide an observable measure of value. While (some) external costs of the IMO-GHG short term measure have been estimated as part of this Impact Assessment, for instance in terms of changes in time-related costs and impacts on countries' trade and income, no analysis was (yet) undertaken to estimate the benefits of the measure. Although this is outside the scope of this work and the TORs, it is possible to estimate the environmental, health and societal benefits from the IMO measure. One way to do this is to allocate a monetary value to each unit of reduced CO2 in 2030 and quantify those as environmental benefits. There are indeed several Carbon Calculus tools, some of which are used by countries as part of their Environmental Impact Assessment (EIA) and Cost-Benefit-Analysis (CBA) exercises.

Pertaining to some estimates of the environmental benefits of the IMO-GHG short term measure; it would then be possible to assess the environmental cost effectiveness of a measure, either by looking at input-cost minimisation or environmental-output maximisation, or both. For the former, the policy entails minimising cost input for a given environmental output. This way, this would be possible to assess the environmental effectiveness of the measure, under the three different GHG reduction scenarios.

The take from above is that while this Impact Assessment and other work undertaken have emphasised the impact on costs, both direct costs (on operators) and external costs (on States), one should also be reminded of the environmental benefits brought about by the IMO GHG short-term measure, with the understanding that any environmental regulation or policy should be considered both in terms of its cost effectiveness and environmental effectiveness. This has also implications on the process of energy transition and the role and use of technological change.

## 5.2 Impacts of Logistics and Supply Chain Strategies

Global decarbonisation and reduction of GHG emissions is not only and exclusively a maritime strategy but is also primarily a multi-sectoral global undertaking. In addition to the IMO short-term measure and Strategy for maritime decarbonisation, other sectors of the global economy are also pursuing similar strategies of decarbonisation.

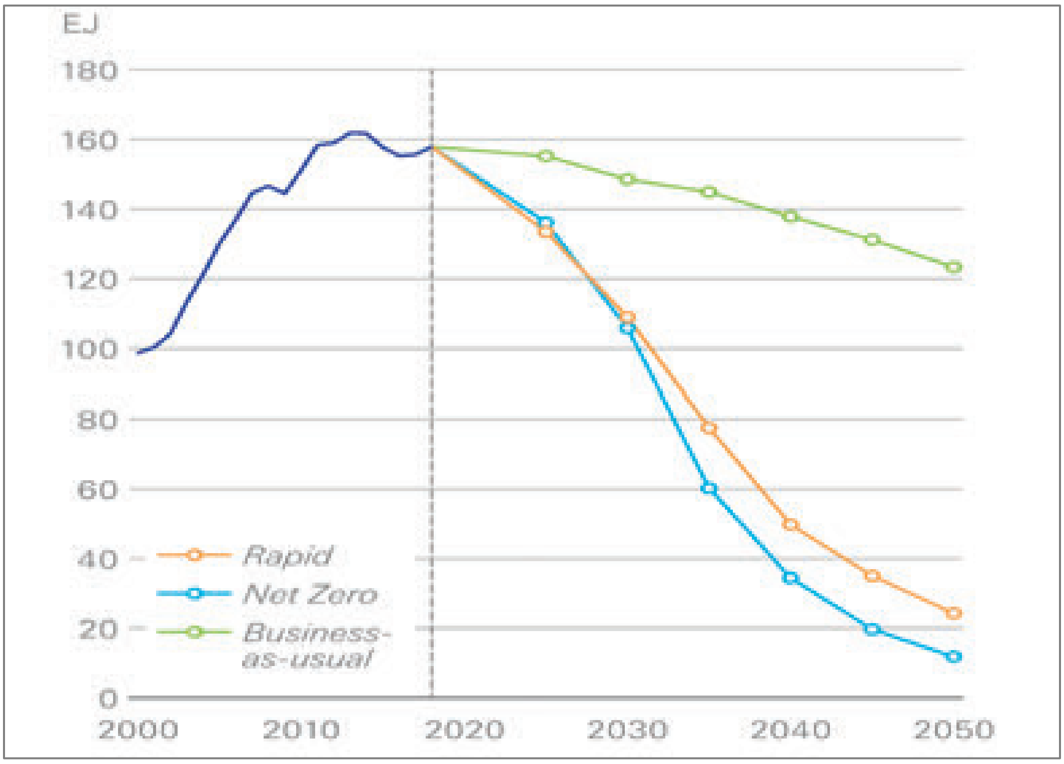
Since international shipping is an integral part of global supply chains, their proportion of GHG emissions can be traced back to the total GHG emissions of a product’s life cycle or a commodity’s supply chain. Understanding the interplay between these two sets of strategies is how the IMO’s short-term measure and long-term decarbonisation pathways interests with decarbonisation strategies of other sectors and supply chain trade policies.

### *5.2.1 Interplay between Fossil Fuel Energy Markets and the GHG Energy Transition*

A first, yet significant uncertainty, stems from the impact of the global energy transition on the long-term outlook for coal and tanker shipping and supporting offshore supply. It is estimated that around 40% of the world’s shipping fleet currently serves global energy production and transportation in one way or another. If the long path to decarbonisation is accompanied by a rapid energy shift away from those fossil fuels and their associated supply chains, then a large chunk of the downstream distribution industry servicing those markets and their supply chains, including the tanker and bulk ships carrying those fuels, the ports and terminals handling and storing them, and the offshore fleet supporting their production, will no longer be needed or by viable in the long run.

A good case in point is the long-term demand of coal and coal markets which are expected to shrink by over 80% over the next two to three decades pursuant to Government policies and global strategies towards net-zero emissions (Figure 70). The implications of such a steep expected decline in coal demand would simply be an equivalent dwindling of bulk coal shipping and port markets, as reflected by a recent global survey which has found that over 60% of lenders have committed to or are considering exiting coal ship financing. Similar trends may also apply to other fossil fuel markets and commodities, including oil and gas.[90]

Figure 70: Coal Long-term demand scenario outlooks



*Source: BP, Energy Outlook 2020*

Although exploring the inter-play between decarbonising this part of the shipping industry and the impact of IMO short-term GHG reduction measure maybe too trivial at this stage, it is nonetheless important to understand the wider impact of such changes on the assumptions used by DNV and this Impact Assessment on the global fleet composition and distribution.

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[90] International Bankers' Survey on the Financing of Coal Transportation by Dry Bulk Vessels, *Petrofin February 2020*

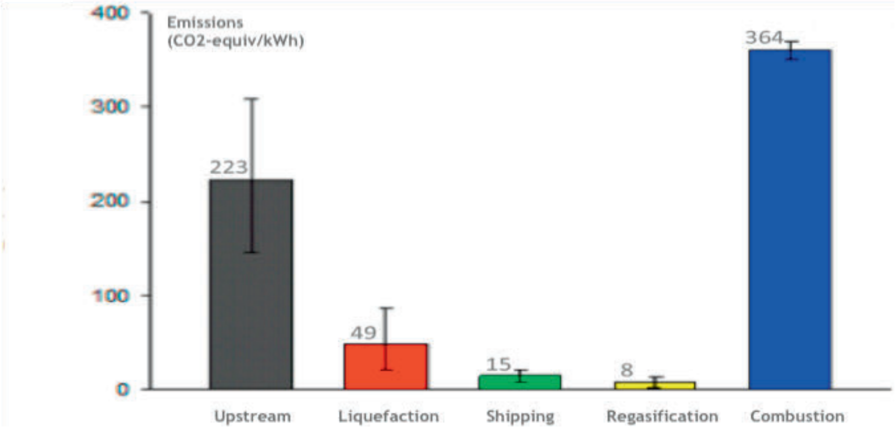
### *5.2.2 Interplay between Product's Life Cycle and Shipping Decarbonisation*

A second interplay stems from the relationship between a product's life cycle carbon emissions and the maritime transport contribution to those emissions. This is because a product's total carbon footprint is the sum of the carbon intensities and emissions embedded in its value chain. Many studies and databases provide insight on the breakdown of carbon footprint contributions at various stages of a product's value chain, which helps identify carbon hotspots and develop strategies and measures to curb them.[91]

Because supply chains are often highly fragmented, firms tend to focus on their own carbon footprint rather than emissions from upstream or downstream processes. But for supply chains with a high degree of vertical integration, such as those active in the bulk trades, vertically integrated firms may decide to offset carbon emissions by optimising full life cycle GHG emissions rather than focusing solely on individual GHG value chain components.

Take for example the LNG supply chain where several LNG producers have recently started delivering fully carbon-neutral LNG shipments by offsetting their carbon emissions against deforestation as well as coal-power based emissions. Other decarbonisation pathways may look at specific parts of the value chain, for instance by increasing LNG tanks of ships or simply replacing maritime transport with LNG pipelines deliveries.

Figure 71: Life cycle emissions of US LNG exports by life cycle stage of 100-year GWP (global warming potential)



*Source: Abrhamas LS et al. (2015).* [92]

Similar arrangements are taking place for various products and commodities at supply chain decision-making level. Since a large proportion of the shipping industry is still managed and operated in-house by supply chain cargo interests, i.e., industrial shipping, vertically integrated supply chains such as those for mineral and oil markets could pursue

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[91] Ecoinvent (www.ecoinvent.org) and GABI (www.gabi-software.com) offer extensive GHG life cycle assessment.

[92] Abrahams LS, Samaras C, Griffin WM and Matthews HS, 2015, Life Cycle Greenhouse Gas Emissions from U.S. Liquefied Natural Gas Exports: Implications for End Uses, *Environmental Science and Policy*, 2015, 49 (5), 3237-3245

decarbonisation strategies and targets that may distort the static functioning of shipping and logistics markets.

The above suggests that decarbonisation strategies aimed at a broader supply chain system, particularly those with a high degree of integration, would override those of its sub-system components, including those of transport and shipping markets servicing them. This is a reminder that the simulations made by DNV and used in this Impact Assessment had to be based on a 'ring-fenced' shipping market although the reality is that shipping demand and supply, and the decarbonisation decisions associated with it, are part of a wider product or commodity's supply chain which own dynamics ultimately drive shipping decisions.

### *5.2.3 Interplay within Maritime Supply Chains*

A third interplay is manifested within the maritime value chain itself such as when ship owners and operators integrate other segments of the maritime value chain. Take for instance a company such as Hyundai which fully control the maritime supply chain from shipbuilding and ship operations to port operations and terminal management. A choice by Hyundai of one decarbonisation pathway[93] or another would have direct implications on the entire supply chain and maybe viewed as a strategy to gain long-term competitive edge over other maritime supply chains.

Elsewhere, some large shipping companies tend also to operate downstream and/or upstream maritime services. Given the high levels of consolidation and vertical integration in many segments of the maritime industry, each integrated maritime supply chain may decide to choose a different decarbonisation pathway. Such contrasting pathways are best illustrated in the container shipping market with lines such as CMA-CGM already operating LNG-fuelled containerships whereas other lines such as Maersk publicly ruling out LNG as a transition fuel and preferring instead to hold on to their existing fleet. Although such strategies may be driven by market and competitive dynamics rather than decarbonisation targets, the implications are that the adoption of the IMO short-term measure pathways are likely to follow different directions rather than being implemented uniformly across time and space.

## 5.3 Impact of Market Demand and Supply Balances

The report identifies that the implementation on IMO's short term measure will require the deployment of approximately 13% more standing vessel capacity than would otherwise be required. If such capacity was not available at the time that when the measure was

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[93] In October 2020, HHI Group's Korea Shipbuilding, Hyundai Mipo Dockyard and Hyundai Glovis announced that they have received an Approval in Principle for the world's 1st liquefied hydrogen carrier from Liberian Registry and Korean Register.

implemented, there could be effects on the freight market: in a capacity constrained case, freight rates might rise sharply; in a worst case where capacity was unable to meet demand, freight rates would rise sharply, and some demand would be unmet or subject to very long delays.

To illustrate the possible effects on freight rates it is worth looking at past (and present) cases of very high-capacity utilisation to assess the freight rates that arose and to compare these with 10-year average rates. The exercise aims to provide illustrations of possible freight rate outcomes if capacity were not developed in time to cover demand in 2030. Examples of extreme freight rates relating to the case of Capesize bulk carriers in 2007-08 and the case of container shipping in the Asia-North America trades in 2020-21 are considered in this analysis.

A variety of factors can affect the effective capacity available to serve sea freight markets:

- Vessel size
- Vessel speed
- Shipbuilding capacity
- Ability and willingness of shipowners to invest
- Scrapping
- Suitability of port infrastructure and port productivity
- Availability of containers (in the container shipping sector)
- Political and regulatory measures (including sanctions, safety and environmental measures).

Shipbuilding capacity was an important contributor to the high freight market that existed in the period just before the Global Financial Crisis of 2007 to 2009. Port capacity constraints and resulting delays to vessels have been an important element in the recent rise in container market rates.

Newbuilding and freight markets in most sectors are cyclical, driven by the cash flow and balance sheets of shipowners, as illustrated by Figure 72.

Figure 72: The freight rate cycle

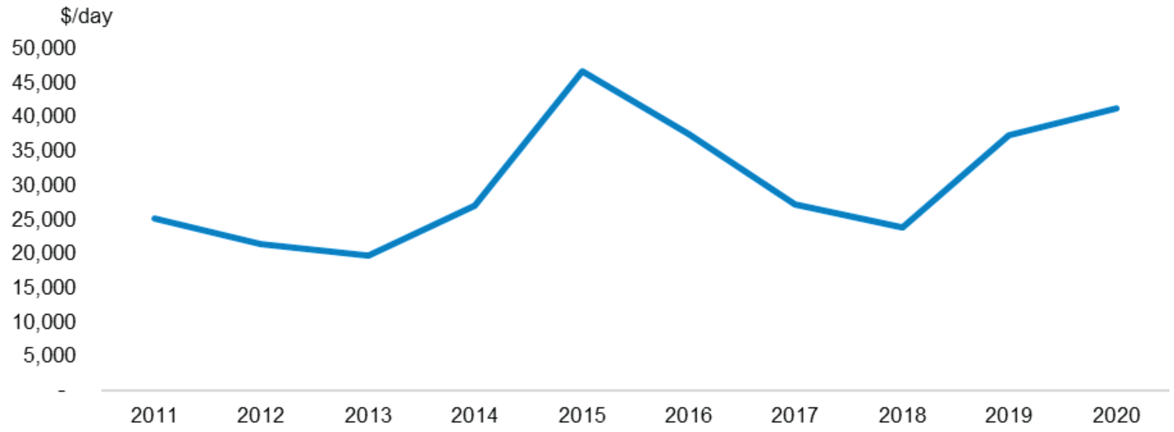
*Source: Drewry Maritime Research, 2021.*

In markets in which there are many players and where all participants are subject to the same stimuli (particularly earnings and asset prices), cyclical markets naturally emerge: high utilisation prompts high earnings and asset values, which encourage investment. Since a high proportion of market participants act in the same way, overcapacity and falling earnings and asset prices are the result.

The shipping market is therefore self-balancing unless there are external interventions, such as government support for failing shipping lines. A key consequence of this market characteristic is that extreme freight rates apply only for short periods. In shipping markets that are not highly fragmented, behaviour may be different and rate highs sustained for longer. The consolidation through merger and acquisition (M&A) in the container shipping sector in the past decade has shifted this market from high fragmentation to low fragmentation, although it is not yet concentrated. The cyclical behaviour described above is expected in all major shipping markets.

There are large variations between peak and trough freight rates in most sectors and significant short-term volatility in some major sectors, particularly crude and product tanker and Capesize dry bulk. Figure 73 below shows how 1-year time charter rates for very large crude carriers (VLCCs) have varied over the past 10 years.

Figure 73: VLCC 1-year time charter rates



*Source: Drewry Maritime Research, 2021.*

The chart shows a cyclic pattern of freight rates that is typical of shipping markets, including a peak to trough fall of approximately 50%. Large variations in freight rates over time are common in shipping, but there are extreme freight rates which occur much less frequently. Two cases are examined below. .

### *5.3.1 Shipbuilding*

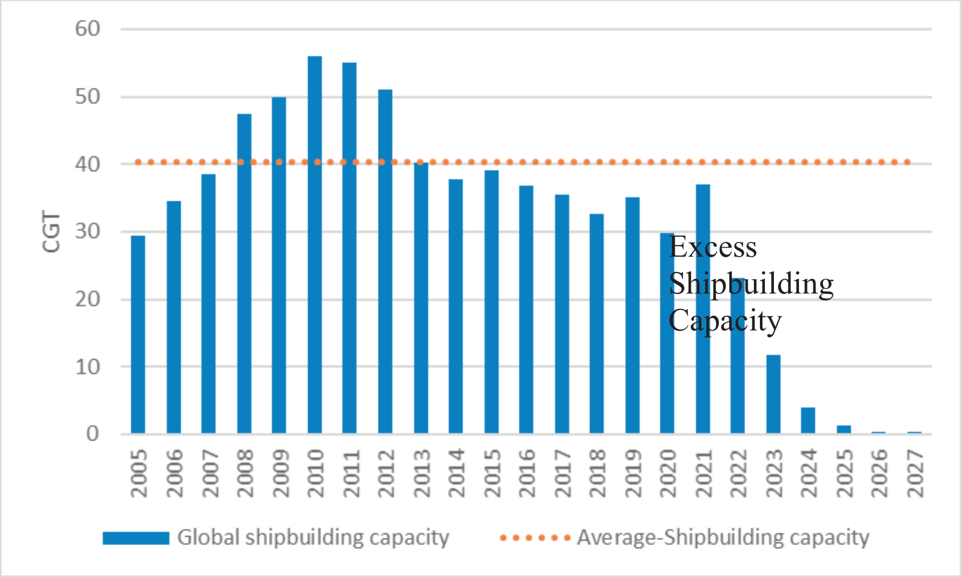
As discussed above, the demand and supply balance, combined with market sentiment, determines freight rates in shipping. Demand is affected by general economic growth in the world, trade in specific commodities and the distance the vessels have to sail to meet the demands. The supply of vessels is determined by the shipbuilding orderbook and delivery schedule, demolition of existing tonnage and speed of the vessels. If speed is reduced across the board, it will automatically reduce total fleet supply thereby exerting upward pressure on charter rates and freight rates. This deficiency in fleet supply can be remedied by building additional ships. However, global shipbuilding capacity may be a constraint in meeting additional shipping capacity demand.

Global shipbuilding annual capacity has been equivalent to approximately 7% of the global fleet on an average over the past decade and half. The capacity increased at a rapid CAGR of 13.7% between 2005 and 2010 (See Figure 74) driven by insatiable demand for commodities and therefore ships from China and other emerging countries during the early years of 21st century.

Despite this significant increase in shipbuilding capacity, there was demand and supply imbalance in many shipping sectors in the period before the Global Financial Crisis. The imbalance led to spiralling freight rates in many merchant shipping sectors.

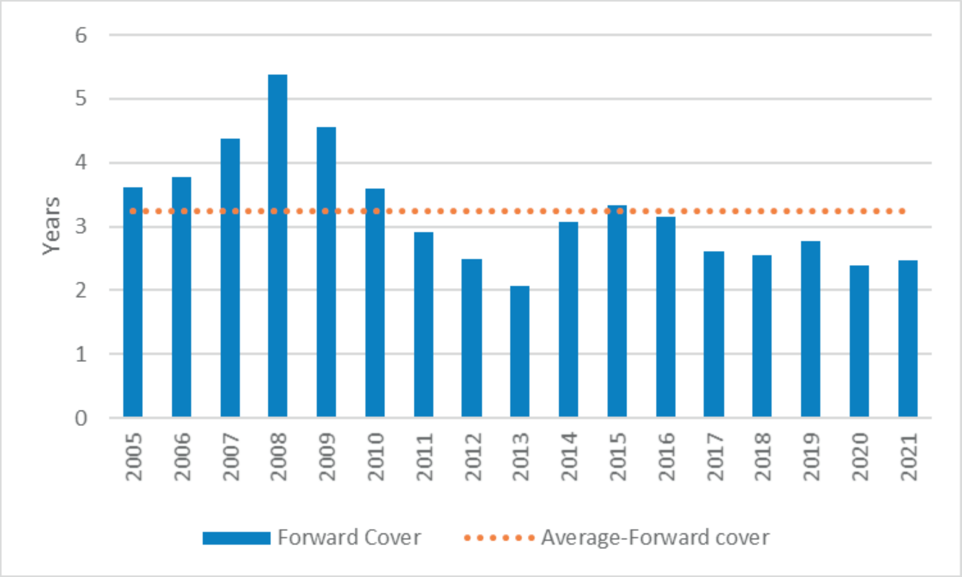
As the rate of growth in demand subsided after the Global Financial Crisis, shipbuilding capacity fell due to closures of yards suffering from financial troubles and of consolidation in the industry; in the last five years, total shipbuilding capacity has been below historical average. Despite significant fall in shipbuilding capacity in the recent years, however, there remains excess capacity as evidenced by the forward cover of the shipyards. Current forward cover is around 2.5 years for major global shipyards; it was above five years in 2008 (Figure 75).

Figure 74: Global Shipbuilding Capacity Development



*Note: CGT: Compensated Gross Tonnage.*
*Annual delivery of ships in terms of CGT has been considered as a proxy for shipbuilding capacity.*
*Source: Drewry, based on data provided Clarksons Research Studies.*

Figure 75: Forward cover of shipyards



*Note: Forward cover denotes the ratio between current total orderbook and total shipbuilding capacity.*
*Source: Drewry, based on data provided Clarksons Research Studies.*

Given the present forward cover, shipyards can absorb a significant rise in new orders should future slow steaming lead to excessive ordering. In such a situation, it is likely that there would be a rapid development of new shipyards as well. However, it is likely that, as in 2007-2008, the corresponding increase in shipbuilding capacity would follow the sharp increase in ordering and that the resulting scenario could be similar: a significant upward movement in freight rates in major merchant shipping sectors before new shipbuilding capacity could come onstream.

### 5.3.2 Capesize Case

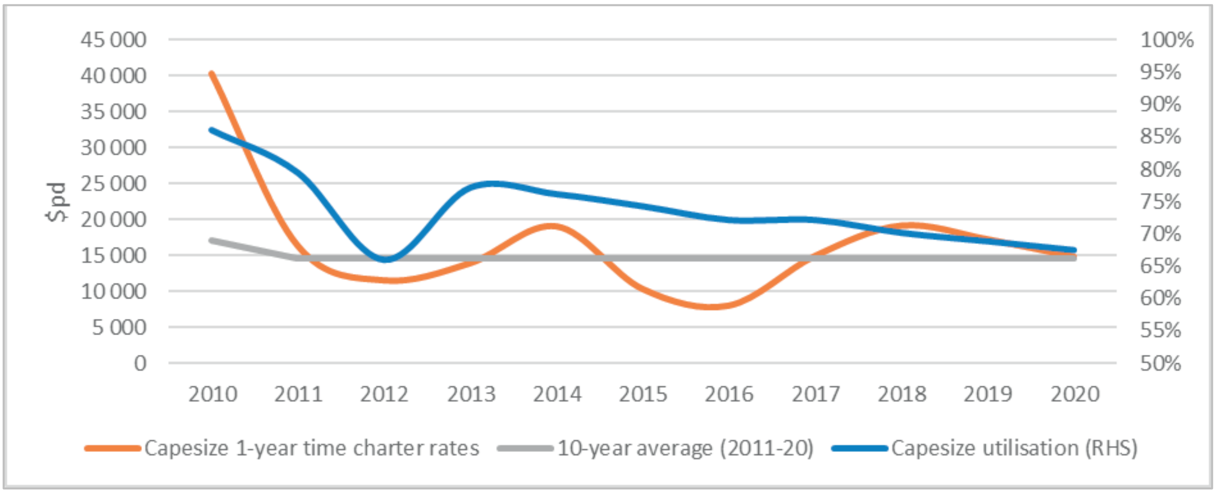
Dry cargoes such as iron ore, coal, grain, bauxite clinkers, sand, fertilizers and oil seeds are shipped in bulk by dry bulk vessels. Capesizes are large dry bulk vessels typically in the size range of 120,000 dwt to 220,000 dwt and are too big to pass through Panama Canal. They usually pass the 'Capes' – Cape of Good Hope or Cape Horn, hence the name 'Capesize'. They are mostly engaged in shipping iron ore and coal and recently have also been engaged in carrying bauxite. The charter rates of dry bulk vessels, although affected by market sentiment, are primarily driven by the demand for and supply of such vessels, rising with utilisation.

Cape-size vessels have commonly been deployed on the Brazil-China route carrying iron ore and on Australia-China route carrying iron ore and coal cargoes. The coal and iron ore trades on these routes account for more than 20% of total dry bulk commodity trade. Transatlantic coal routes (such as Colombia-Europe and US-Europe) have also been typically Capesize routes. Capesizes are not restricted to the above-mentioned routes; but have also been active on Canada-Far East and South Africa-Europe and recently on South Africa-India and Guinea-China routes as well. On Guinea-China, Capesize vessels have been engaged in shipping bauxite as annual trade of the commodity on the route has increased to around 10 million tonnes on average during 2016-20.

The Capesize market has seen standard cyclical performance in the period 2010-20, with downturns in 2012 and 2016 due to overtonnaging. A recovery in 2010 after the Global Financial Crisis saw rates recover and encouraged new orders. Earnings and utilisation since 2010 have been depressed with an average daily rate of US$14,000. In 2016, rates were barely able to cover the daily running costs of a vessel.

Utilisation was high in 2010 at 86%; since 2011, it has averaged 72%.

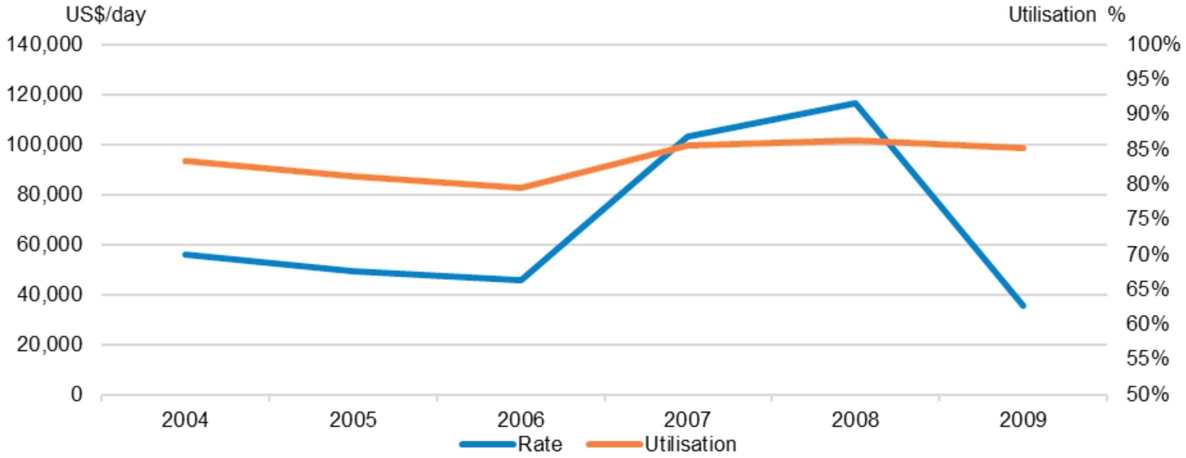
Figure 76: Capesize utilisation and 1-year time charter rates 2010-2020



*Source: Drewry Maritime Research, 2021.*

The Capesize market in 2004-09: Rapidly growing demand for coal and iron ore imports into China lifted average 1-year Time Charter (TC) rates for Capesize vessels during 2004-08 with rates reaching a high of $171,500pd during 2008, a phenomenal rise over 2002 when average 1-year TC rates were below $14,000pd. The average rate in 2008 was US$116,200pd (Figure 77).

Figure 77: Capesize time charter rates and utilization, 2004-2009



*Source: Drewry Maritime Research, 2021.*

Utilisation was high overall in 2004-08 and very high in 2007-08. In 2009 a combination of the effects of the Global Financial Crisis and an inflated orderbook that continued to lift vessel supply, caused demand to decline, which in turn caused charter rates to normalise. Effective capacity utilisation in 2009 was supported mainly because many owners and charterers withdrew their tonnage from the market to avoid trading below operating costs and waited until rates recovered. This brought the available supply down in 2009 making the utilisation look relatively high. Nonetheless, average annual charter rates fell by approximately 70% year-on-year.

Comparison of 2008 rates with 2020-20 levels: Table 46 compares the peak rates experienced in 2008 with the market from 2011-20 performance to illustrate the % variance in a case of extreme rates.

Table 46: Capesize, 1-year time charter rate, 2011 to 2020

| Comparison | US$/day |
|---|---|
| **Average 2011-20** | 14,600 |
| **Peak 2011-20** | 19,200 |
| **Low 2011-20** | 8,100 |
| **2008** | 116,200 |
| **% Variance to 2011-20 average** | 696% |
| **% Variance to 2010-20 peak** | 505% |
| **% Variance to 2011-20 low** | 1335% |

*Source: Drewry Maritime Research, 2021.*

### *5.3.3 Container Shipping Case*

Container shipping is the principal means of transport of general cargo in global trade. Containerised traffic includes consumer goods of all kinds, components, raw materials and refrigerated goods, including foodstuffs. Container shipping lines have developed increasingly comprehensive global networks to serve this cargo, covering all general cargo trades. Container shipping services are sold both as contracts (typically one year) or as spot.

A key characteristic of container shipping is its fixed day weekly services, by which lines aim to provide predictable and reliable services to shippers. The consequences of this characteristic are that operational gearing is high, and that maximizing vessel utilisation is a key preoccupation for day-to-day management. As a result, freight rates are very sensitive to market capacity utilisation. When head haul utilisation is at or higher than 90%, freight rates are stable or rise; at below 85%, they erode rapidly; at above 95% they can rise rapidly.

The pursuit of economies of scale by lines, particularly since the Global Financial Crisis has led to persistent overcapacity in liner trades and correspondingly depressed freight rates and profitability. A combination of industry concentration and the apparent halt of vessel sizes growth at 24,000 TEU mean that the market structure of liner shipping is now conducive to more effective capacity management and therefore to higher freight rates and profitability. This may reduce the frequency and depth of falls in rates and create a more stable pricing environment.

Introduction to Asia-North America trade: The Asia-North America trade is the largest deep-sea container trade in the world. The trade covers the Pacific Northwest (PNW: Canada and the northwest US), the Pacific Southwest (PSW: California), the US Gulf, and the East Coast. Some services to the East Coast run through the Panama Canal, others run through the Suez Canal.

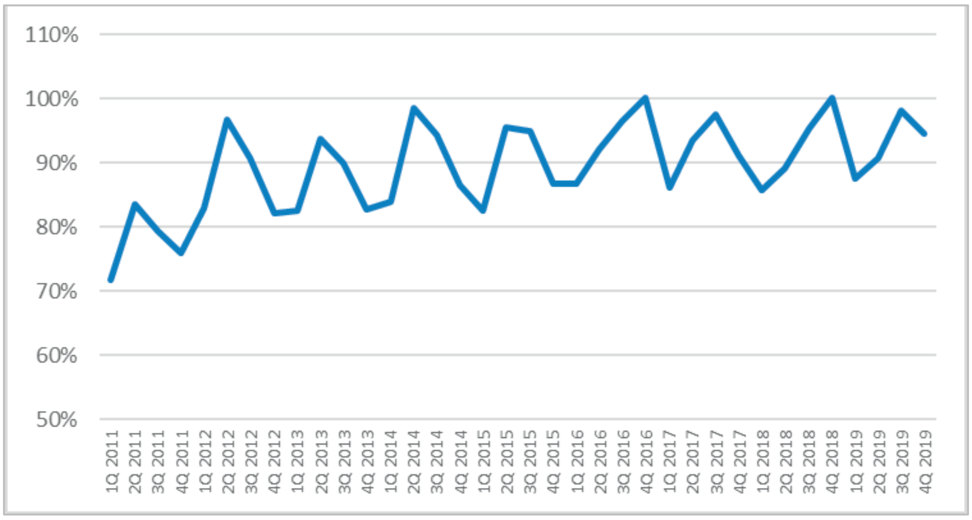
In 2019, 20.3 million TEU moved eastbound from Asia to North America and 7.3 million TEU westbound from North America to Asia.

The trade is served by the three main liner alliances and by several independent operators and is characterised by intense competition among shipping lines.

The trade is seasonal with patterns determined particularly by the Christmas retail season in North America and the Chinese New Year holiday, during which Chinese production drops significantly.

2011-19 utilisation: Figure 78 shows Transpacific East-Bound capacity utilisation (all coasts) from 2011-19. Average utilisation over the period was 89%, close to the 90% benchmark.

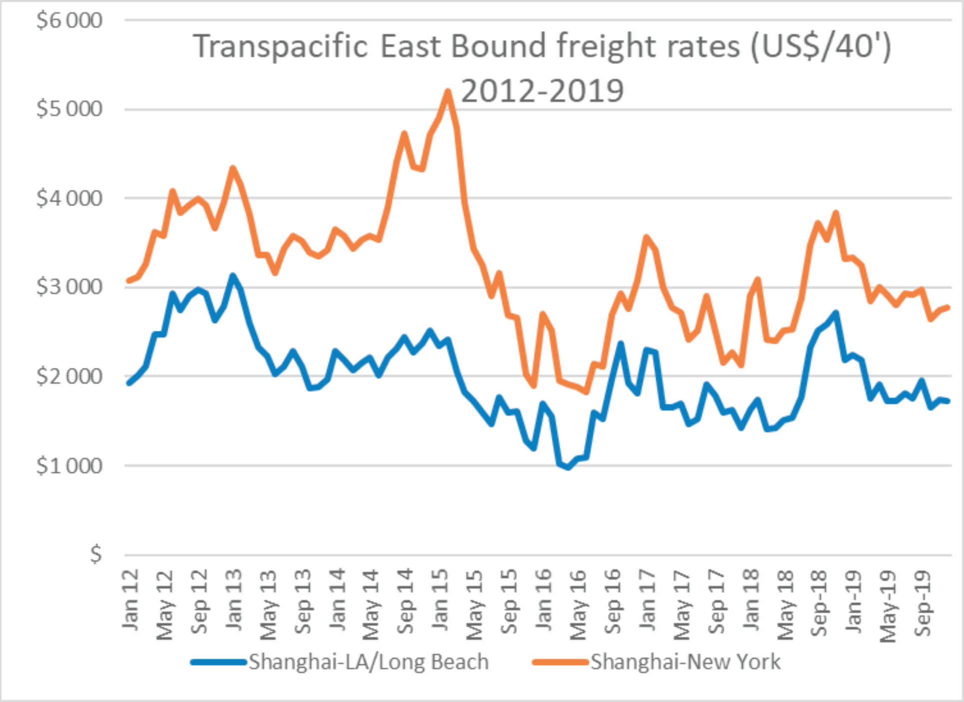
Figure 78: Transpacific East-Bound utilization, 2011-2019



*Source: Drewry Maritime Research, 2021.*

Significant seasonality in utilisation is evident, although the timing and size of peaks has varied dependent on the state of the US economy. Timing was also affected by the tariffs imposed during the trade dispute between the US and China which caused shippers to move cargo early before the dates on which new tariffs came into force.

Figure 79: Transpacific East-Bound freight-rates (US$/40'), 2012-2019



*Source: Drewry Maritime Research, 2021.*

Utilisation typically ranges from 85-95% with an annual peak of 100%. Full capacity utilisation has not been sustained for more than one quarter.

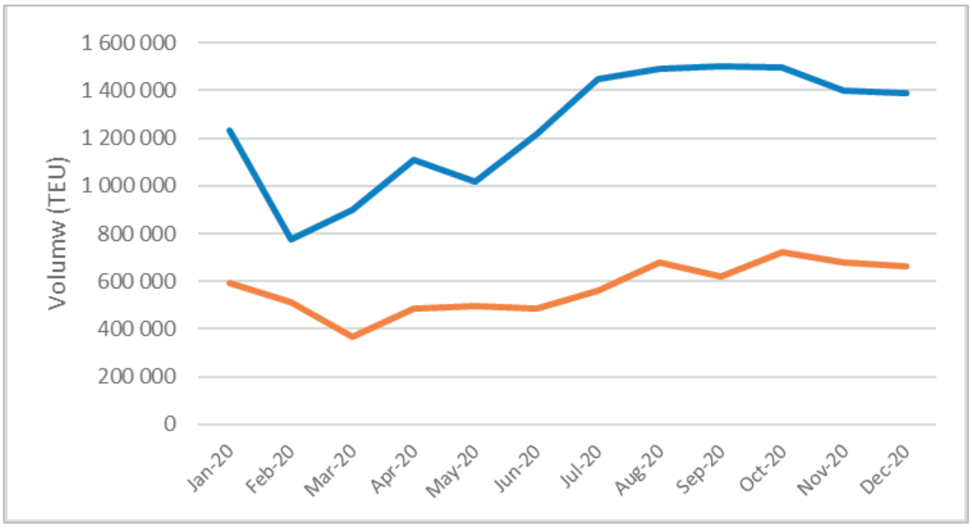
2012-19 freight rates: Spot freight rates in the period 2011-19 showed a seasonal pattern that mirrored that of utilisation. Superimposed on this pattern are other movements caused by changes in the economy and competitive environment; 2016, for example, was a year of very poor demand growth and a severe erosion of freight rates (Figure 79).

Shanghai-LA/Long Beach rates ranged from a high of US$3,140/40' in January 2013 to a low of US$980/40' in April 2016, a high to low fall of approximately 70%. The range of rates was similar in the trade to New York which had a peak of US$5,200/40' in early 2015 and a low of US$1,820/40' in May 2016, a high to low fall of approximately 65%. Intra-year rate ranges of in excess of 30% are common.

Over the period 2012-19, average rates were: Shanghai-LA/Long Beach – US$1,993/40'; Shanghai-New York – US$3,211/40'.

2020-21 demand, utilisation and rates: The outbreak of COVID-19 caused an immediate shock to the container shipping industry as Chinese society locked down during the Lunar New Year holiday and industry did not resume production. After the usual pre-Chines New Year peak in January, demand fell very steeply, particularly to the West Coast. There was some stabilization of volume in the second quarter but great uncertainty about the prospects for and likely shape of recovery as COVID-19 spread around the world and societies and economies locked down and contracted in response.

Figure 80: Asia-North America container shipping, 2020



*Source: Drewry Maritime Research, 2021.*

The effect of the China’s shut-down was a sharp fall in capacity utilisation, which bore the risk of a catastrophic collapse in sea freight rates. Lines had urgently to reduce capacity to match new demand levels and did so by a mixture of cancelling specific sailings (a practice known as “blanking”) and withdrawing services. They were able to do this because of the market structure provided by the liner alliances.

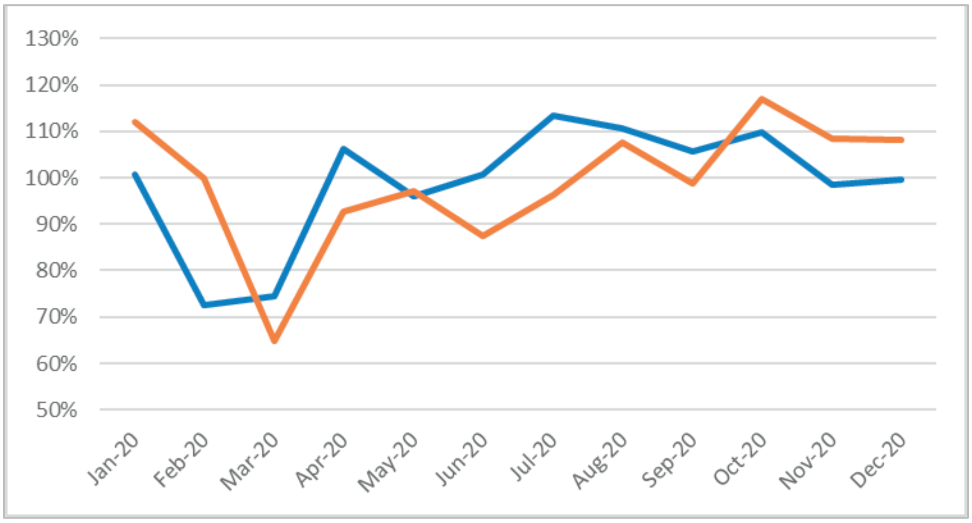
While utilisation in first quarter 2020 was very low, the action taken by lines returned it to normal levels by second quarter 2020 on the East Coast trade and to high levels on the West Coast.

The development of demand in the second half of 2020 took the industry by surprise: Transpacific East-Bound demand in the third quarter was 30% higher than that in the second quarter; lines now scrambled to reintroduce capacity to meet demand. Asia-WCNA utilisation hit 113% in July and Asia-ECNA utilisation reached 117% in October (Figure 79). Networks were effectively full.

The capacity shortage was compounded in Q4 by a growing and persistent shortage of containers; container productivity had fallen due to supply china inefficiencies arising from COVID-19, leading to longer on land dwell times and container production had been cut in the first half of 2020.

The effects, first of capacity management by the lines in Q1 and Q2, and second of the unexpected surge in demand in the second half of 2020, were stable rates following by continuous rises to record highs in early 2021 (Figure 82).

Figure 81: Asia – West Coast North America East Bound utilization, 2020

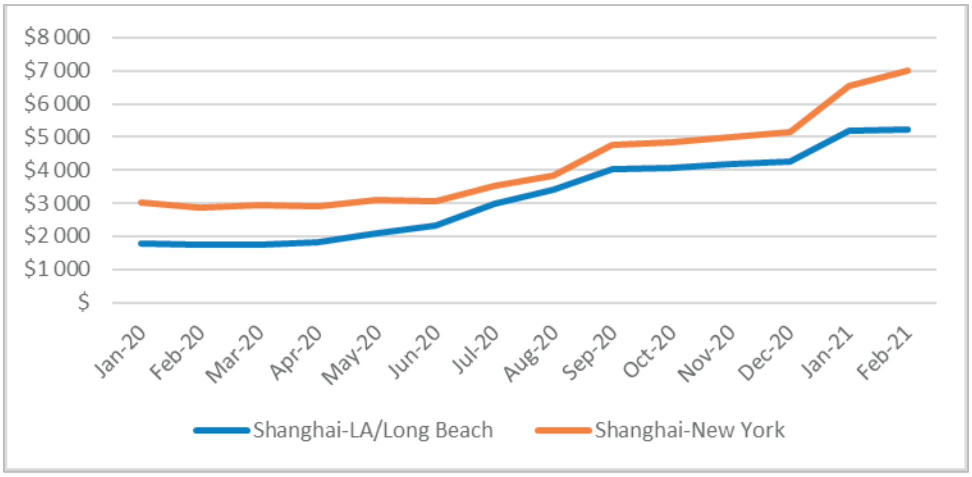


*Source: Drewry Maritime Research, 2021.*

In February 2021, the rate for Shanghai-LA/Long Beach reached US$5,230/feu' and the rate for Shanghai-New York US$7,000/40'. We have heard anecdotal reports of rates significantly higher than this, but do not have firm evidence.

Comparison of 2020 rates with past levels: Table 47 compares the peak rates experienced on the Transpacific trade with past performance to illustrate the % variance in a case of extreme rates.

Figure 82: Transpacific East Bound freight rates (US$/40'), 2020-2021



*Source: Drewry Maritime Research, 2021.*

Table 47: Comparison of container rates, 2012-2019

| Comparison | Asia-WCNA (US$/40') | Asia-ECNA (US$/40') |
|---|---|---|
| **Average 2012-19** | $1,993 | $3,211 |
| **Peak 2012-19** | $3,140 | $5,200 |

| | | |
|---|---|---|
| **Low 2012-19** | $980 | $1,820 |
| **Peak 2020-21** | $7,000 | $9,050 |
| **% Variance to 2012-19 average** | 251% | 182% |
| **% Variance to 2012-19 peak** | 123% | 74% |
| **% Variance to 2012-19 low** | 614% | 397% |

*Source: Drewry Maritime Research, 2021.*

### *5.3.4 Summary and Conclusions*

Sea freight markets are cyclical and, even in normal periods, experience wide fluctuations in rates. They are, over time, self-balancing.

Sea freight rates rise and fall with fleet utilisation. On rare occasions when fleet utilisation in any sector is very high, freight rates can reach extreme levels: in the Capesize 2007-08 case, rates peaked at 700% above the subsequent long-term average; in the present container shipping case, Transpacific East Bound rates in February 2021 were 251% and 182% over long-term averages to the East and West coasts respectively.

If the IMO's short term measure causes a decrease in vessel productivity, effective fleet utilisation will rise. If effective utilisation becomes very high in any sector, there is a risk that extreme freight rates may result. The capacity of the shipbuilding market to meet the demand for more ships will be an essential factor. Drewry estimates that the shipbuilding market's capacity is equivalent to 7% of the global fleet and would expect that a ramp up period of approximately 5 years would be needed to ensure that an additional 13% of vessel capacity, in addition to normal fleet replacement and growth, were available in time for the implementation of IMO's short-term measure.

## 5.4 Impact of Modal Shifts

Next to economic impacts on States, shift in modalities –especially from sea transport to faster modes such as air transport is a possible impact of increased maritime transport costs and time.[94] Depending on the level of increase in transport costs and time, its impacts on modal shift in international freight transport can vary across commodities and trade routes. Therefore, analysing the potential impacts of increased transport costs and time on the modal share of global freight transport would be useful particularly for the following purposes:

1. To investigate the potential for the policy measures to result in a net increase of CO2 emissions of global trade due to the shift from sea transport to faster but more carbon intensive modes of transport.

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[94] Halim, Ronald A.; Smith, Tristan; Englert, Dominik. (2019). Understanding the Economic Impacts of Greenhouse Gas Mitigation Policies on Shipping. What is the State of the Art of Current Modelling Approaches? World Bank Group. Available at http://documents.worldbank.org/curated/en/215561546957017567/pdf/WPS8695.pdf

2. To provide detailed insights on the impact of the measures on States with high dependency on maritime transport and limited alternative modes such as SIDS.

To this end, UNCTAD analysed the potential for modal shift by using mode choice models which have been estimated for 11 EORA commodities. The detailed description of the model can be found in Appendix 2. Specifically, the same mode-choice models, which have been built to estimate the Value of Time (VoT), are used in this analysis.

Impacts of increase in transport costs and time are simulated under a HIGH-GHG reduction scenario and compare them with the 2030 baseline Current Regulations scenario to obtain the relative changes in the modal share of each mode of transport. Specifically, the impact of an average increase in transport costs of 10.1% and average increase in transport time around 8.2% was tested.[95] For the sake of simplicity, this increase in transport costs and time is applied to all routes and commodities.

The results (Table 48) show that, on a global scale and on an aggregate commodity level, these changes in maritime logistics costs would only slightly reduce maritime modal share (-0.0975%) and they will increase the modal share of other modes, particularly air and rail by 0.033% and 0.048% respectively. This indicates that some commodities, particularly those with high VoTs might shift to faster modes to supply their demands.

Trade data for 2019 is used to exemplify the impacts of the potential modal shift on the volume of goods carried by each mode. This trade data is used because trade projection (in terms of volume) for the year 2030 is not available. Based on UNCTAD-MDST estimate, global trade volume in 2019 amounted to 11,509,110,477 tonnes.[96] Building upon this data, the volume shifted for each mode presented in the table below.

Table 48: Changes in modal share of major modes of transport serving global trade

| Mode | Modal share difference (HIGH scenario –Baseline, %) | Tonnes shifted (tonne) |
|---|---|---|
| **Air** | 0.03286 | 3,782,365 |
| **Sea** | -0.09747 | -11,218,333 |
| **Rail** | 0.04786 | 5,507,798 |
| **Road** | 0.01675 | 1,928,170 |

*Source: UNCTAD, based on Equitable Maritime Consulting (EMC) calculations.*

It is noteworthy that even though the shift on the global level is marginal, this could translate to a stronger shift at a disaggregate level for specific trade routes and particular commodities. It is to be expected that shift to other modalities might vary widely across routes and commodities. Hence, there could be routes that will see, for instance, a higher

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[95] Based on the increase in shipping costs and time under High scenario as estimated by MDST.

[96] Based on 2019 trade data provided by MDST covering 230 territories and 11 EORA commodities.

shift from sea transport o other modes. This might especially be the case for island countries which rely primarily on two modes of transport: air and maritime shipping.

The shift of a small maritime modal share (<0.1%) in terms of volume, translates into an increase in the volume that needs to be carried by air. Given that other transport modes carry a smaller share of global trade volumes, from the other modes' perspective, the volume is not negligible, leading to some increase in CO2 emissions for air, rail, and road modes. The results suggest that there is a need for more research to be able to analyse the impacts of modal shift on CO2 emissions with higher precision and at a more granular level, such as at country pair and detailed commodity sector level.

To carry out such an analysis, global trade projections, in terms of the volume of commodities in 2030 will be particularly useful. These trade projections and modal shift analysis should also take into account the potential re-configuration of the global value chain structures (e.g., onshoring and offshoring), which in turn, would affect the total transport work (in tonne-kilometres) and carbon emissions of each mode serving global trade. An example of a modelling framework which integrates analysis on global trade projection, modal choice and carbon emissions can be found in the literature.[97]

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[97] See for example, Avetisyan, Misak. (2018). Impacts of global carbon pricing on international trade, modal choice and emissions from international transport. Energy Economics, 76, 532-548. doi: https://doi.org/10.1016/j.eneco.2018.10.020.
Halim, Ronald A., et al. (2018). Decarbonization Pathways for International Maritime Transport: A Model-Based Policy Impact Assessment. Sustainability, 10(7), 2243.
Tavasszy, L.A., et al. (2016). Effect of a full internalization of external costs of global supply chains.

# 6 Summary and Conclusions

Conducting an impact assessment prior to the adoption and implementation of the IMO short-term measure on GHG reduction in shipping is an example of good practice in the field of regulatory governance. Insight gained will help improve understanding of the potential negative impacts or unintended effects that may arise for countries and supply chains across the three IMO GHG reduction scenarios. It can also help ensure that the IMO measure achieves its set goal while, at the same time, ensuring that potential implementation and compliance costs that may arise are effectively addressed.

Achieving the IMO Initial Strategy for maritime decarbonization targets is crucial for sustainable development, in an increasingly fragile, inter-linked and complex global eco-system. Yet, navigating through the energy transition away from fossil-fuel dependent combustion systems remains a major challenge for the maritime transport industry and related stakeholders. There is also a need for the sector to strike a balance between varying economic, social, and environmental needs while transitioning towards cleaner shipping. In this respect, the global Sustainable Development Goals (SDGs) and the 2030 Agenda for Sustainable Development adopted in 2015, have emphasized that achieving economic progress and development need not be at the expense of environmental protection and societal well-being.

Achieving environmental protection through an effective energy transition can also generate co-benefits. In the longer term, it can be expected that increased energy efficiency coupled with the use of cleaner and renewable energy sources will generate dividends to all stakeholders. Initial investments in fleet renewals, innovative ship designs, fuel technologies, including in ports and across the energy supply chain, will bear fruit in the longer term and can, over time, lead to lower costs and higher returns on investment. Ensuring a global level playing field for ship owners and operators is important, as is the need to assist stakeholders expected to be adversely impacted by the energy transition outlays and costs. This will help ensure that decarbonization costs and investments are fairly distributed across various maritime stakeholders.

The energy transition and maritime decarbonization agenda is of direct relevance to countries that are most affected by climate change impacts, including Small Island Developing States (SIDS) and Least Developed Countries (LDCs). SIDS and LDCs are not only confronted with relatively prohibitive shipping and logistics costs, which undermine their trade and logistics competitiveness, but they also rely heavily on international trade to meet their consumption needs. SIDS are particularly relying on maritime transport as their main link to regional and global markets.

It is against this background that UNCTAD has been requested by the IMO Secretariat to carry out Task 3 of the Workplan approved by the established Steering Committee for the conduct of the Comprehensive Impact Assessment of the short-term GHG measure approved at MEPC 75. Under Task 3, UNCTAD was requested to carry out a quantitative and qualitative assessment of the impacts on countries and States, including developing countries, SIDS and LDCs. The Task also required carrying out selected case studies to illustrate the conditions and impacts on specific countries, trades, and regional markets.

To deliver on Task 3, UNCTAD adopted a two-pronged analytical approach involving two interlinked steps. The first step involved an assessment of the changes in maritime logistics costs — including shipping (transport) and time-related costs — resulting from the IMO GHG short-term measure. In the second step, UNCTAD used a global trade model to simulate the impact of estimated changes in maritime logistics costs, on the trade flows (imports and exports), GDP, and GVC-related trade of 184 economies.

UNCTAD's assessment of the changes in total maritime logistics costs drew heavily upon the input data received from DNV under Task 2 of the Workplan. DNV assessed the impact of the IMO short-term measure on ship costs and transit speed across three 2030 GHG reduction scenarios (EEXI-Only, HIGH-GHG reduction and LOW-GHG reduction) as compared to the 2030 baseline scenario (Current Regulations). DNV's modelling assumes full compliance with given CII reduction requirements. The three GHG reduction scenarios were defined as follows:

- "EEXI-Only": Regulatory scenario including EEXI requirements only.
- "HIGH": Regulatory scenario including both EEXI and CII requirements. For CII, a supply-based metric (emission per transport capacity: g CO2/dwt-nm) has been used to determine the reduction from 2008 to 2019, giving an average reduction requirement of 21.5 per cent between 2019 and 2030.
- "LOW": Regulatory scenario including both EEXI and CII requirements. For CII, a demand-based metric (emission per actual transport work: g CO2/tonne-nm) has been used to determine the reduction from 2008 to 2019, giving an average reduction requirement of 10.2% between 2019 and 2030.
- ""BASELINE": Current Regulatory scenario with only EEDI requirements being adopted, including those entering into force in 2022.

Following several analytical steps, including ship mapping, Origin-destination (O/D) trade-pair assignments and Value of Time (VoT) estimations, it was possible to convert DNV's data on ship costs and time-at-sea into shipping (transport) costs and time-related costs. Together these two cost headings are combined to compute changes in maritime logistics costs. The computed percentage changes in maritime logistics costs were fed as input data into a global trade model used by UNCTAD to assess the impact of changes in maritime logistics costs on the trade flows, GDP, and GVC-related trade of 184 economies. The analysis generated a relatively comprehensive view of how states can be expected to be affected by the IMO short-term measure.

Table 10 indicates how the average global economic GDP as well as the GDP per country across various country groupings and regions will be affected by changes in total maritime logistics costs resulting from the IMO short-term measure. These effects have been simulated for the three 2030 GHG reduction scenarios as compared to the 2030 baseline scenario (Current Regulations). Detailed results by country are reported in Table 11 of this report.

As may have been expected, a regulatory measure that alters the cost structure for ships, is likely to result in cost changes for ship carriers and operators. These, in turn, would alter maritime logistics costs paid by shippers, thereby resulting in changes in both trade flows and GDP.

Impacts on GDP (Table 11) and trade flows (see also Figure 32ff) depend on various factors, including countries' trade openness, i.e., the share of imports and exports in their GDP, the maritime transport dependence of their trade, the price or time elasticities of demand, the type of commodities traded and their characteristics (e.g., time sensitivity), as well as the type of ships used by type of commodity and distance (see also Figure 17). Differences across the computed changes in maritime logistics cost that may result from the IMO short-term measure as indicated in Table 7, will also lead to variations in how countries' trade flows (imports plus exports; see also Figure 32ff) and GDP will be affected (Table 11).

Under all three 2030 scenarios, developing coastal countries exhibit stronger declines in GDP as compared to developed coastal countries. Variations in impacts across the two country groupings is larger when looking at the results under the HIGH- and LOW- GHG reduction scenarios, as compared to the results obtained for the EEXI-Only scenario.

Despite these averages, variations in maritime logistics costs, trade and GDP observed cannot be attributed or explained solely by variations in countries' levels of development. UNCTAD's impact assessment has shown that the IMO short-term measure will affect some developed and developing countries above average, while other developed and developing countries will be affected below average. Nevertheless, some aspects are likely to affect developing countries even more. Such aspects include distance to markets, dis-economies of scale, commodity export dependency (e.g., agricultural products and basic commodities), as well as the type, size, and other characteristics of the ships that serve their markets.

The largest impacts on time at sea, shipping (transport) costs, and total maritime logistics costs will occur under the HIGH-GHG reduction scenario (Table 7). The next largest impact will be experienced under the LOW-GHG reduction scenario and the EEXI-Only scenario, respectively.

To put things into perspective, changes in maritime logistics costs that may result from the IMO short-term measure are compared to freight rate levels and trends (see Figure 20, Figure 21, and Figure 22, as well as Chapter 5.3). The comparison shows that, in general, freight rate market volatility is far higher than the changes that may result from the IMO short-term measure.

While any such comparison should be handled with care given the differences pertaining to the shocks involved, their duration and their root causes, it is worth noting that the decline in global GDP or country level GDP as featured in the UNCTAD Impact Assessment (Table 10), are dwarfed by the contraction in world GDP resulting from the COVID-19 disruption (-3.9% in 2020) and can be lower than the fall in global output of the 2008-2009 financial crisis (-1.3%). Along the same vein, reductions in trade flows resulting from the IMO short-term measure, tend to be relatively lower in comparison with the trade contractions seen during the financial crisis and the COVID-19 disruption, or those projected to result from unmitigated GHG emissions and climate change. These considerations offer some perspective as they help put within context, the impact of the IMO short-term measure as computed by UNCTAD. They also enable a comparison with a given point of reference such as the COVID-19 pandemic and the Global Financial Crisis.

In addition to assessing the aggregate impacts, UNCTAD analysed the implications of the IMO short-term measure at the country, country-pair and at supply chain levels to further detail and nuance the results. While the overall average impact is expected to be negative since higher maritime logistics costs would induce lower trade flows and reduced GDP levels, some bilateral trades, are nevertheless expected to be positively impacted. At the other end of the spectrum, some supply chain trades that may be considered outliers or out of range, , may experience steep increases in maritime logistics costs of more than 50% in the case of some trades. Such increases would most likely have major implications ranging from modal and nodal shifts, e.g., from sea to air or port to port; to wider supply chain reconfigurations, e.g., shift in trade flows, including some regionalisation, sourcing from neighbouring trading partners, or loss of trade.

Overall, the distribution of impacts is skewed, with the median impact found to be lower than the average impact. This means that the average is influenced by relatively large negative numbers for a small number of observations. Put differently, more than 50% of the countries will be affected at a lesser rate than the average, while a small number will be particularly strongly affected by the IMO short-term measure (see also Chapter 3.2.2).

It should be noted that the actual impact of the IMO short-term measure could be lower than the main outcomes presented in this report. Some considerations that could help explain a situation where actual impacts are lower than the modelled impacts, include the following:

- The model simulations are static, while in practice service providers and trades may adjust earlier on during the decade to 2030. Many of the ships that will be in service in 2030 are not yet built, and market responses could mitigate the potential negative impacts of the IMO short-term measure (Chapter 5.1).
- The IMO short-term measure can be expected to stimulate investment and uptake of new technological advances in shipping and ports. Ultimately, greater use of cleaner fuels and technologies, including renewables will likely reduce shipping's marginal costs (Chapter 5.1).
- A higher fuel price in 2030 would increase the benefit of the IMO short-term measure, as lower speeds would lead to further cost savings.

On the other hand, actual impacts could also be higher than the main outcomes presented in this report. Possible explanatory factors may include the following:

- It is assumed that the additional ships that will be required due to reduced speed will all be contracted and built by 2030. However, depending on ship owners' behaviour and ship-yard capacities, this assumption may be debatable as not all ships will necessarily be built and delivered just in time when needed; or they may be built later. A shift in the supply/demand, which in turn would generate higher freight rate levels could be the final outcome (Chapter 5.3).
- Using averages as metrics tends to generally conceal non-linear impacts. More specifically, with regards to changes in speed, some commodities are likely to become uncompetitive if certain thresholds in terms of tolerable or acceptable transit times are exceeded (the case studies in chapter 4 present examples of more complex possible chains of impacts).
- A lower fuel price in 2030 could undermine some of the benefits of the IMO short-term measure, as far as cost savings from lower speeds are concerned.

The world in 2030 for which the UNCTAD Impact Assessment has been undertaken, remains uncertain. Trade volumes, the geography of trade, and available technologies can be different from those assumed in this UNCTAD Impact Assessment. Furthermore, the ships of the future that will be in service in 2030 are yet to be built.

Bearing in mind the uncertainty and the various assumptions that characterize the work carried out under both Tasks 2 and Task 3 of the Workplan, it should be noted that the impact of the IMO short-term measure in the form of changes in maritime logistics costs, trade flows and GDP levels, cannot be determined with a high degree of precision. The assessment by UNCTAD presents the impacts that can be expected as being the most likely given the current state of knowledge, the information and data available at present, as well as the various assumptions made, in particular assumptions underpinning ship cost calculations under Task 2 (Chapter 2.2).

Aggregate global impacts of the proposed IMO short-term measure on maritime logistics costs can be considered small when compared to typical market variability of freight rates. Also, the global impact on GDP and trade flows can be considered small when compared to the long-term impact of other disruptions such as a pandemic or climate change factors.

However, for some countries, the negative impacts of the IMO measure assessed in this report are relatively higher than for others. Aware of the resource constraints of some developing countries, including SIDS and LDCs, UNCTAD expects that some countries will likely require support to mitigate the increased maritime logistics costs and alleviate the consequent negative impact on their respective real income and trade flows.

# Appendix 1: Assigning DNV Data to Country-Sector Trade Pairs and Port-to-Port Travel Times at Sea

## Databases Used

To account for the geographical distribution of DNV ship cost and speed reduction data and assign those to bilateral country trades and travel times at sea, three additional databases and one look-up table which were used to ‘add value’ to the DNV estimates.

- Data from MarineTraffic that described all voyages for the relevant ships for 2019 by port calls and whether laden or in ballast.
- MDS Transmodal (MDST) global database of the deployment of all container ships, by operator, port calls, distances covered and ship parameters, approximately 1,800 in any one year employing some 5,000 ships.
- MDST World Cargo Database (WCD), which describes all international trade by tonnes, value, Standard International Trade Classification (SITC, 5 digit) and estimated mode of appearance.

A look up table was used to convert SITC codes to Eora codes in order to model the impact of shipping cost changes on trade values and GDP. The Eora headings were: Agriculture, Electrical and Machinery, Fishing, Food & Beverages, Metal Products, Mining and Quarrying, Other Manufacturing, Petroleum Chemical and Non-Metallic Mineral Products, Textiles and Wearing Apparel, Transport Equipment, and Wood and Paper.

## Demand and Cost Allocation to Shipping Services

For container services, the main complexity is that a single service would consist of a group of ships serving multiple regions. The MDST database of container services can be used to define the global regions through which each service passes and so show the total shipping capacity available (TEU p.a.) for any inter-regional trade and the proportion provided by each separate service. It was therefore possible to allocate demand (from WCD) to each service (with a ship size category attached) in the relevant market. For each rotation, it was assumed that capacity was simply used once in each direction. It was then possible to determine for each region-to-region movement the proportion of total capacity provided by ships of different sizes. The mean cost for container services for each region-region movement could therefore be established by summing up the cost of each relevant service. Note that MDST allowed for some omissions of Ro-Ro ferries by assuming that only a proportion of intra-regional traffic was carried by Lo-Lo container services. Similarly, it was possible to estimate the cost of each service through its ship size and sea miles from the DNV cost models. Estimates were made of pure shipping costs (effectively charter plus bunker costs) which were $X as compared with DNV's estimated costs of $XX for container ships for 2019. An appropriate calibration factor was used to align results with DNV's. A similar approach was made for each of the non-container vessel types.

For non-containerized traffic, this was assimilated to bulk traffic by assuming that each laden voyage between two countries could be regarded as a stand-alone event and not part of a multi-porting service. Since DNV results did not include the origin and destination of ships, MarineTraffic data was used, including each port call in 2019 for all those categories of ship costed out by DNV. The data was analysed to determine all voyages described as laden between ports, including hours at sea and distance covered over the total distance sailed PLUS the total time taken and distances covered between the point and time a vessel arrived laden between one discharge port and the next. In this way the total cost (measured by time and distance) involved for both the ballast leg and the laden leg, plus the time in port loading and discharging, could be taken into account in addition to the time cargo was actually at sea (laden time and distance only).

## 2019 Calibration

In its model, DNV took into account demand growth assumptions for each ship segment in 2030 and established a base year model for 2019. To determine the impact of the different DNV scenarios at 2019 trade levels, DNV results were interpreted in terms of hourly costs, cost per mile (energy costs) and mean speed for each 2019 ship segment and then for each of the three 2030 GHG reduction scenarios with the objective of testing their impact on each trade flow.

# Appendix 2: Value of Time (VoT)

The Value of Time (VoT) concept is typically used in decision and policy making to estimate the impact and cost of time for goods' transport and delivery. The VoT is commonly expressed as the monetary value of a unit transport time for each unit of goods transported. It is often defined as the Willingness-To-Pay (WTP) for each reduction in the unit time from the total transport time of the goods, i.e., the marginal benefit that can be obtained from reducing a unit of time from the total amount of time needed to move goods from origin to destination. However, because maritime freight transport involves multiple decision makers, the WTP or marginal benefit attached to the VoT varies from one stakeholder to another.

For the UNCTAD impact assessment, the focus was put on the VoT from the shippers' (cargo interests) perspective which includes inventory and holding costs, depreciation, and additional interest costs, as well as the costs derived from the potential disruption in goods' production or distribution process.

## Estimation of VoT

A Multinomial-logit discrete choice model was used to predict the choices of shippers given a set of alternative modes of transport and their determinants. Where the shipper's utility function is specified as follows:

$$ut_{o,d,p,m} = \mu\,(asc_m + TC_{o,d,m}TD_{o,d,m} + VoT_p\,TT_{o,d,m} + Ct^m\,contig_{od} +$$

$$Rt\,RTA_{od} + lg.lang_{od} + A_o + A_d)$$

$$p_{o,d,p,m} = \frac{e^{u_{o,d,p,m}}}{\sum_{m=1}^{M} e^{u_{o,d,p,m}}}$$

*Where:*

$p_{odpm}$ *: the choice probability for origin-o, destination-d, commodity-p, and mode-m,*

$ut_{odpm}$*: the choice utility for origin-o, destination-d, commodity-p, and mode-m,*

$asc_m$*: mode specific constant,*

$C_p$*: transport cost coefficient for commodity-p,*

$TD_{odm}$*: transport distance from origin-o, to destination-d, by mode-m (km),*

$TC_{odm}$*: unit transport cost for origin-o, destination-d, mode-m ($/tonne.km),*

$VoT$*: the value of time ($/tonne.hour),*

$TT_{odm}$ *: transport time from origin-o, destination-d, and mode-m (hour),*

$Ct^m$*: contiguity coefficient for mode m, and*

$contig_{od}$*: binary variable for the contiguity - (a situation where an origin country shares the same border with destination country) between origin-o and destination-d (1,0),*

$Rt$*: trade agreement coefficient*

$RTA_{od}$*: binary trade agreement variable between origin and destination country (1,0)*
$Lg$*: language coefficient*
$Lang_{od}$*: binary language variable between origin-o and destination-d (1,0)*
$A_o, A_d$*: origin, destination specific constant (fixed effects) respectively.*
$\mu$*: scaling factor to map unto utility space.*

Due to the aggregate nature of the COMTRADE dataset that records annual bilateral trade values in CIF (Costs, Insurance and Freight) and FOB (Freight on Board) terms across HS-6 commodity groups, broken down by 5 modes of transport (air, sea, road, and rail, and non-standard transport mode), the estimation method uses a non-linear optimization method based on a multi-objective evolutionary algorithm called "non-dominated sorting genetics algorithms II (NSGAII)". The goal of this method is to find a set of model parameter's values that minimize the root mean square error (RMSE) between the observed and modelled modal shares across all modes and to maximize the coefficient of determination (R-squared). We use observations of trade values at EORA commodity level to estimate the coefficient of the model.

- The RMSE is computed using the following formula: $\sqrt{\frac{\sum_{odm}\left(p_{odm}^{modeled}-p_{odm}^{observed}\right)^2}{o.d.m}}$
- R2 is computed using the following formula: $1-\frac{\sum\left(p_{odm}^{modeled}-p_{odm}^{observed}\right)^2}{\sum\left(p_{odm}^{observed}-average(p_{odm}^{observed})\right)^2}$

## The data

Trade observation data used to estimate the model are based on trade records reported in the UN COMTRADE database for the year 2016 (Figure 83). The observation data, at 11 EORA commodity group levels, are an aggregation of more detailed HS6 digit observations which included 5,193 commodity groups. Classification based on EORA commodity groups, results in a dataset of 6,067 trade observations for each commodity group, on average. At HS6 digit level, a total observation of 1,454,977 trade records is available. Therefore, the observation data is sufficiently large, and it covers a broad range of countries with the whole spectrum of economic development status including those from developing countries, LDCs, and SIDS.

For transport time and distance data, geographical variables between countries and by modes were generated using a global transport network model. The network is implemented on a GIS data model that combines four major modes: air, sea, road, rail. The maritime routes were obtained from the Global Shipping Lane Network data of Oak Ridge

National Labs CTA Transportation Network Group.[98] The data include actual travel times for different sea segments. It is possible to connect this network to ports, based on data from the latest World Port Index Database of the National Geospatial-Intelligence Agency.[99] The computation of travel distances and time was generated based on a shortest path algorithm, taking into account the border passing time, and the reachability of the destinations using all modes.

Figure 83: Global freight maritime transport network

*Source: UNCTAD, based on Equitable Maritime Consulting's (ECM) international freight transport network model.*

Socio-economic variables such as common language, land contiguity and trade agreement, were obtained from different databases. CEPII database of common official language is used.[100] Correlates of war project provides the land contiguity observations[101] and ITF database provides trade agreement data.[102]

## Estimation results and summary

Eleven Multinomial Logit models were estimated models representing each of the 11 EORA commodity groups. Table 49 provides summary statistics of the estimation results.

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[98] http://geocommons.com/datasets?id=25.

[99] http://msi.nga.mil/NGAPortal/MSI.portal.

[100] Jacques Melitz and Farid Toubal, 2012. Native language, spoken language, translation and trade. CEPII, Working Papers 2012-17.

[101] Correlates of War (COW) project. https://correlatesofwar.org/data-sets/direct-contiguity.

[102] Martinez, L., J. Kauppila and M. Castaing Gachassin (2014), "International Freight and Related CO2 Emissions by 2050: A New Modelling Tool", International Transport Forum Discussion Papers, No. 2014/21, OECD Publishing, Paris, https://doi.org/10.1787/5jrw1kslrm9t-en.

Table 49: Summary statistics of the error term, Mode of Transport Model, Average RMSE and R-squared

| Commodity | Name | RMSE | R-squared | No of observation |
|---|---|---|---|---|
| **1** | Agriculture | 0.13 | 0.90 | 6256 |
| **2** | Fishing | 0.12 | 0.91 | 3228 |
| **3** | Mining and Quarrying | 0.14 | 0.88 | 5092 |
| **4** | Food & Beverages | 0.14 | 0.88 | 6140 |
| **5** | Textiles and Wearing Apparel | 0.18 | 0.77 | 7092 |
| **6** | Wood and Paper | 0.17 | 0.82 | 6076 |
| **7** | Petroleum, Chemical and Non-Metallic Mineral Products | 0.19 | 0.77 | 6092 |
| **8** | Metal Products | 0.18 | 0.77 | 6328 |
| **9** | Electrical and Machinery | 0.18 | 0.75 | 7048 |
| **10** | Transport Equipment | 0.19 | 0.76 | 5856 |
| **11** | Other Manufacturing | 0.18 | 0.76 | 7532 |
|  | ***Mean*** | ***0.16*** | ***0.82*** | ***6067*** |

*Source: UNCTAD, based on Equitable Maritime Consulting's (EMC) international freight mode choice model.*

Based on the estimated model's parameters, the VoTs (Value of Time) for 11 EORA commodities are shown in Table 50, Table 51 and Table 52. These estimates were used to quantify time-related costs for ships' speed reductions across various segments and scenarios by DNV. Table 52 and Table 53 provide the coefficients of the estimated mode choice models.

Table 50: Estimated VoTs for 11 EORA sectors

| Commodity | VoT ($/tonne-hour) |
|---|---|
| Agriculture | **0.008** |
| Fishing | **0.097** |
| Mining and Quarrying | **0.040** |
| Food & Beverages | **0.305** |
| Textiles and Wearing Apparel | **0.093** |
| Wood and Paper | **0.028** |
| Petroleum, Chemical and Non-Metallic Mineral Products | **0.071** |
| Metal Products | **0.393** |
| Electrical and Machinery | **0.383** |
| Transport Equipment | **0.102** |
| Other Manufacturing | **0.177** |

*Source: UNCTAD, based on estimations provided by Equitable Maritime Consulting (EMC).*

Table 51: Coefficient for alternative specific constants, Cost, and VoT

| Commodity_ID | Asc Air | Asc Maritime | Asc Rail | Asc Road | Cost coeff | VoT |
|---|---|---|---|---|---|---|
| **Agriculture** | -4.80 | 4.27 | -2.35 | 0.00 | -0.28 | -0.008 |
| **Fishing** | 2.01 | 3.41 | -2.46 | 0.00 | -0.11 | -0.097 |
| **Mining and Quarrying** | -2.77 | -0.96 | -2.08 | 0.00 | -0.73 | -0.04 |
| **Food & Beverages** | -2.67 | -0.66 | -2.32 | 0.00 | -0.36 | -0.305 |
| **Textiles and Wearing Apparel** | -1.35 | -0.50 | -3.38 | 0.00 | -0.13 | -0.0925 |
| **Wood and Paper** | -4.18 | -2.96 | -2.76 | 0.00 | -0.28 | -0.0275 |
| **Petroleum, Chemical and Non-Metallic Mineral Products** | -4.47 | -3.28 | -1.39 | 0.00 | -0.03 | -0.071 |
| **Metal Products** | -4.16 | -2.99 | -1.80 | 0.00 | -0.08 | -0.393 |
| **Electrical and Machinery** | -3.73 | -3.60 | -3.74 | 0.00 | -0.74 | -0.383 |
| **Transport Equipment** | -0.60 | -0.16 | -2.14 | 0.00 | -0.01 | -0.102 |
| **Other Manufacturing** | -2.39 | -1.77 | -3.21 | 0.00 | -0.14 | -0.177 |

*Source: UNCTAD, based on Equitable Marine Consulting's (EMC) international freight mode choice model.*

Table 52: coefficient for Mu. Contiguity, trade, and language

| Commodity_ID | Mu | Cont RL | Cont RD | Trade | Language |
|---|---|---|---|---|---|
| **Agriculture** | -8.32E-08 | 4.57 | 1.37 | 0.63 | -2.61 |
| **Fishing** | -6.25E-08 | 1.78 | 2.62 | 0.99 | -1.78 |
| **Mining and Quarrying** | -7.59E-09 | 3.65 | 4.52 | 0.14 | 1.57 |
| **Food & Beverages** | -5.24E-08 | 1.55 | 2.67 | 0.70 | -1.41 |
| **Textiles and Wearing Apparel** | -9.74E-08 | 3.32 | 3.04 | 2.03 | 3.09 |
| **Wood and Paper** | -9.40E-08 | 0.30 | 0.60 | 0.46 | 2.06 |
| **Petroleum, Chemical and Non-Metallic Mineral Products** | -8.47E-08 | 0.66 | 3.94 | 3.71 | -2.95 |
| **Metal Products** | -5.62E-08 | 2.45 | 1.98 | 3.13 | 2.83 |
| **Electrical and Machinery** | -9.37E-08 | 1.84 | 4.38 | 2.80 | -0.87 |
| **Transport Equipment** | -5.35E-08 | 1.44 | 0.05 | 2.70 | 0.93 |
| **Other Manufacturing** | -5.41E-08 | 0.19 | 4.73 | 0.33 | -2.22 |

*Source: UNCTAD, based on Equitable Maritime Consulting's (EMC) international freight mode choice model.*

# Appendix 3: DTC Global Trade Model

## General Description

The DTC Global Trade Model (DTC GTM) belongs to the family of "new quantitative trade models" (Ottaviano, 2015). It is a multi-sector general equilibrium model of the world economy that uses cutting edge economic theory to relate changes in trade policies to counterfactual changes in trade, production, and Global Value Chain (GVC) integration. Relative to the previous generation of models, such as the standard GTAP model, DTC's GTM has a number of advantages:

- *Incorporation of current trade theory*: The model uses a standard Ricardian model of trade in which countries produce goods using different technologies; these technological differences form the basis of comparative advantage. The models on which the DTC GTM is based have been published in leading peer-reviewed journals and represent a step forward in the understanding of international trade relative to the 1990s, when the standard GTAP model was developed.
- *Small number of well-estimated structural parameters*: All trade models include structural parameters that need to be estimated econometrically. The DTC GTM requires only one such parameter per sector in the model, i.e., 26 in this case. Egger et al. (2018) have provided high quality estimates of these parameters using the same modelling framework. By contrast, the standard GTAP model includes over 10,000 structural parameters, many of which are drawn from external sources using different modelling assumptions or based on external assumptions.
- *Focus on value chains*: The DTC GTM produces the standard impact analysis that other trade models also produce, such as changes in exports and imports, as well as a measure of welfare (real GDP). But in addition, it also makes use of recent developments in the literature to look at the impact of changes in trade policies on integration into GVCs at a disaggregated (country pair-sector) level. Therefore, it is possible to see not just whether or not a country increases its exports in a given sector, but also whether those exports involve more international production sharing with its partners.
- *Use of standard data*: The DTC GTM does not use proprietary or purpose-built data, as is the case for models in the GTAP family. Instead, it is transparently programmed in a general-purpose language (Python) and can use any multi-region input-output table.

To give maximum country coverage, this application uses the Eora multi-region input-output table as its input. This data source makes it possible to produce impact assessments for 184 countries in 11 goods sectors; the model also includes 15 other sectors, primarily services, but impacts in these areas are of relatively little interest, as they do not rely heavily on maritime transport. The most recent baseline year for this dataset is 2015, which is the year used here.

The model is based on a complex set of relationships governing production, consumption, and trade. But the intuition is straightforward. Consumption is modelled by a representative household in each country consuming final goods from each sector. The production side of the model incorporates technology differences across countries, which are reflected in different efficiencies in the production of intermediates. Each sector produces intermediate goods using a combination of labour and intermediate goods from all sectors, with constant returns to scale technology and perfect competition. Producers source intermediate goods from the lowest cost supplier globally, after accounting for the impact of bilateral trade costs. Final goods are produced by constant elasticity of substitution technology using intermediates from all sectors, again from the lowest cost supplier. Trade costs take the standard iceberg form, i.e. ad valorem tariffs and ad valorem equivalents of non-tariff measures. Trade of intermediates and final goods is governed by a structural gravity equation derived from these assumptions. National income (welfare) is the sum of labour income, tariff rebates, and an exogenous trade deficit. The model is closed by setting income equal to expenditure.

For simulation purposes, the model's input is a list of percentage changes in bilateral trade costs, expressed in ad valorem equivalent terms. The model is solved in percentage changes for the endogenous variables, and so does not need to observe all variables in levels (such as technology, which is fixed). A nonlinear solution algorithm is used to map the changes in bilateral trade costs to changes in input costs, prices, bilateral trade, and national income, all subject to the same closure condition.

The model does not disaggregate bilateral trade by mode of transport, as no multi-region input-output table contains that information. Bilateral trade costs are therefore assumed to be a function of trade costs by mode of transport, so since the model is solved in percentage changes it can be shown that adjustment for modal influence only requires addition of a modal share by value when constructing the trade cost changes; it is not necessary to observe total transport costs.

## Technical Description

This section presents full technical details for the DTC Global Trade Model.

### *Consumption Side*

The consumption side of the model comes from Caliendo and Parro (2015). LN measures the supply of labour of representative households in country N (subscript) maximize Cobb

Douglas utility by consuming final goods in sector J (superscript), with consumption shares $\alpha_n^j$ summing to unity.

$$(1)\ u(C_n) = \prod_{j=1}^{J} \left(C_n^j\right)^{\alpha_n^j}$$

### *Production Side*

The production side of the model also comes from Caliendo and Parro (2015) via Aichele and Heiland (2018), which can be seen as a multi-sector generalization of Eaton and Kortum (2002). As in Aichele and Heiland (2018), there is provision for different shares in intermediate and final consumption.

Each sector produces a continuum of intermediate goods $\omega^j \in [0,1]$. Each intermediate good uses labor and composite intermediate goods from all sectors. Intermediate goods producers have production technology as follows:

$$(2)\ q_n^j(\omega^j) = z_n^j(\omega^j)\left[l_n(\omega^j)\right]^{\beta_n^j} \prod_{k=1}^{J} \left[m_n^{k,j}(\omega^j)\right]^{\gamma_n^{k,j}}$$

Where:

$z_n^j(\omega^j)$ is the efficiency of producing intermediate good $\omega^j$ in country n; $l_n(\omega^j)$ is labor; $m_n^{k,j}(\omega^j)$ are the composite intermediate goods from sector k used for the production of intermediate good $\omega^j$; and $\beta_n^j$ is the cost share of labor and $(1-\beta_n^j)\gamma_n^{k,j}$ is the cost share of intermediates from sector k used in the production of intermediate good $\omega^j$, with $\sum_{k=1}^{J} \gamma_n^{k,j} = 1$.

Production of intermediate goods exhibits constant returns to scale with perfect competition, so firms price at marginal cost. The cost of an input bundle can therefore be written as follows:

$$(3)\ c_n^j = \Upsilon_n^j w_n^{\beta_n^j} \left( \prod_{k=1}^{J} \left(P_n^{km}\right)^{\gamma_n^{k,j}} \right)^{1-\beta_n^j}$$

Where: $P_n^{km}$ is the price of a composite intermediate good from sector k; w is the wage; and $\Upsilon_n^j$ is a constant.

Producers of composite intermediate goods in country n and sector j supply their output at minimum cost by purchasing intermediates from the lowest cost suppliers across countries, similar to the mechanism in the single sector model of Eaton and Kortum (2002).

Composite intermediate goods from sector j are used in the production of intermediate good $\omega^k$ in amount $m_n^{j,k}(\omega^k)$ in all sectors k, as well as final goods in consumption $C_n^j$. The composite intermediate is produced using CES technology:

$$(4)\ Q_n^j = \left[\int r_n^j(\omega^j)^{1-\frac{1}{\sigma^j}} d\omega^j\right]^{\frac{\sigma^j}{\sigma^j-1}}$$

Where: r is demand from the lowest cost supplier, and $\sigma$ is the elasticity of substitution across intermediate goods within a sector.

Solving the producer's problem gives an expression for demand:

$$(5)\ r_n^j(\omega^j) = \left(\frac{p_n(\omega^j)}{P_n^j}\right)^{-\sigma^j} Q_n^j$$

Where: $p_n(\omega^j)$ is the lowest price of a given intermediate good across countries; and $P_n^j = \left[\int p_n(\omega^j)^{1-\sigma^j} d\omega^j\right]^{\frac{1}{1-\sigma^j}}$ is the CES price index.

### *Trade Costs and Equilibrium*

Trade costs consist of tariff and NTM components as in Aichele and Heiland (2018), in the standard iceberg formulation for imports by country n from country i, with trade costs potentially differing by end use (intermediate, m, or final, f):

$$(6)\ \kappa_{ni}^{jv} = \left(1 + t_{ni}^{jv}\right) * \tilde{t}_{ni}^{jv}, v \ni (m, f)$$

Where t is the ad valorem tariff, and $\tilde{t}$ is NTM-related trade costs, including potentially policy measures but also geographical and historical factors that drive a wedge between producer prices in the exporting country and consumer prices in the importing country (Anderson and Van Wincoop, 2004). Unlike in Caliendo and Parro (2015), we assume that all sectors are tradable; this assumption accords with the reality in our data, where sectors are sufficiently aggregate that trade always takes place, at least to some degree.

A particular issue in this application is the fact that NTM-related trade costs include transport costs, which vary by mode. A simple approach to dealing with that problem is to use the multiplicative property of iceberg costs, and assume that total transport costs are a value-weighted average of costs by mode:

$$(6a)\ \tilde{t}_{ni}^{jv} = \prod_{m=1}^{M} \varphi_{m,ni}^{\frac{X_{m,ni}}{X_{ni}}}$$

Where $\varphi$ is the cost of shipping goods by mode m, and the exponent is the modal share of bilateral trade by value. For solution purposes (see below), only the share of maritime shipping is required on the assumption that costs remain constant in other modes, due to cancelling in proportional change terms.

With this definition of trade costs, the price of a given intermediate good in country n is:

$$(7)\ p_n^j(\omega^j) = \min_{\mathrm{i}} \frac{c_i^j \kappa_{ni}^{jm}}{z_i^j(\omega^j)}$$

As in Eaton and Kortum (2002), the efficiency of producing $\omega^j$ in country n is the realization of a Fréchet distribution with location parameter $\lambda_n^j \geq 0$ and shape parameter $\theta^j > \sigma^j - 1$. The intermediate price index can therefore be rewritten as:

$$(8)\ P_n^{jm} = A^j \left[ \sum_{i=1}^{N} \lambda_i^j \left( c_i^j \kappa_{ni}^{jm} \right)^{-\theta^j} \right]^{-\frac{1}{\theta^j}}$$

Where $A^j$ is a constant.

Then from the utility function, prices are:

$$(9)\ P_n^f = \prod_{j=1}^{N} \left( \frac{P_n^{jf}}{\alpha_n^j} \right)^{\alpha_n^j}$$

Bringing together these ingredients gives a relationship for bilateral trade at the sector level that follows the general form of structural gravity, but developed in an explicitly multi-sectoral framework and with different relations for intermediate and final consumption:

$$(10)\ \pi_{ni}^{jv} = \frac{X_{ni}^{jv}}{X_n^{jv}} = \frac{\lambda_i^j \left[ c_i^j \kappa_{ni}^{jv} \right]^{-\theta^j}}{\sum_{h=1}^{N} \lambda_h^j \left[ c_h^j \kappa_{nh}^{jv} \right]^{-\theta^j}}$$

For analytical purposes, a key feature of the gravity model in equation 10 is that the unit costs term depends through equation 3 on trade costs in all sectors and countries. This result is an extension of the multilateral resistance reasoning in Anderson and Van Wincoop (2003) to the case of cross-sectoral linkages.

Goods market equilibrium is defined as follows, where Y is the gross value of production:

$$(11)\ Y_n^j = \sum_{i=1}^{N} \frac{\pi_{in}^{jm}}{1 + t_{in}^{jm}} X_i^{jm} + \sum_{i=1}^{N} \frac{\pi_{in}^{jf}}{1 + t_{in}^{jf}} X_i^{jf}$$

With:

$$(11)\ X_n^{jm} = \sum_{k=1}^{J} \frac{\pi_{in}^{jm}}{1 + t_{in}^{jm}} \gamma_h^{j,k} \left( 1 - \beta_h^k \right) Y_h^k$$

$$(12)\ X_n^{jf} = \alpha_n^j I_n$$

National income is the sum of labour income, tariff rebates, and the exogenous trade deficit:

$$(12)\ I_n = w_n L_n + R_n + D_n$$

Where: I represents final absorption as the sum of labour income, tariff revenue, and the trade deficit; R is tariff revenue, and trade deficits sum to zero globally and to an exogenous constant nationally. So aggregate trade deficits are exogenous, but sectoral deficits are endogenous.

The model is then closed by setting income equal to expenditure:

$$(13)\ \sum_{j=1}^{J} X_n^{jm} \sum_{i=1}^{N} \frac{\pi_{ni}^{jm}}{1 + t_{ni}^{jm}} + \sum_{j=1}^{J} X_n^{jf} \sum_{i=1}^{N} \frac{\pi_{ni}^{jf}}{1 + t_{ni}^{jf}} - D_n = \sum_{j=1}^{J} Y_n^j$$

Caliendo and Parro (2015) show that the system defined by equations 3, 8, 10, 11, and 13 can be solved for equilibrium wages and prices, given tariffs and structural parameters.

### *Counterfactual Simulation*

Using exact hat algebra (Dekle et al., 2007), it is simpler to solve the model in relative changes than in levels. This process is equivalent to performing a counterfactual simulation in which a baseline variable $v$ is shocked to a counterfactual value $v'$ and the relative change is defined as $\hat{v} = \frac{v'}{v}$. Aichele and Heiland (2018) show that counterfactual changes in input costs are given by:

$$(14)\ \hat{c}_n^j = \hat{w}_n^{\beta_n^j} \left( \prod_{k=1}^{J} \hat{P}_n^{km\,\gamma_n^{k,j}} \right)^{1-\beta_n^j}$$

The change in the price index is:

$$(15)\ \hat{P}_n^{jv} = \left[ \prod_{i=1}^{N} \pi_{ni}^{jv} \left[ \hat{\kappa}_{ni}^{jv} \hat{c}_i^j \right]^{-\theta^j} \right]^{-\frac{1}{\theta^j}}$$

The change in the bilateral trade share is:

$$(16)\ \hat{\pi}_{ni}^{jv} = \left[ \frac{\hat{\kappa}_{ni}^{jv} \hat{c}_i^j}{\hat{P}_n^{jv}} \right]^{-\theta^j}$$

Counterfactual intermediate goods and final goods expenditure are given by:

$$(17)\ X_n^{jm'} = \sum_{k=1}^{N} \gamma_n^{j,k}\,(1-\beta_n^k)\left(\sum_{i=1}^{N} X_i^{km'}\,\frac{\pi_{in}^{km'}}{1+t_{in}^{km'}} + X_i^{kf'}\,\frac{\pi_{in}^{kf'}}{1+t_{in}^{kf'}}\right)$$

With:

$$(18)\ X_n^{jf'} = \alpha_n^j I_n{}'$$

$$(19)\ I_n' = \widehat{w}_n w_n L_n + \sum_{j=1}^{J} X_n^{jm'}\left(1-F_n^{jm'}\right) + \sum_{j=1}^{J} X_n^{jf'}\left(1-F_n^{jf'}\right) + D_n$$

The trade balance condition requires:

$$(20)\ \sum_{j=1}^{J} F_n^{jm'} X_n^{jm'} + \sum_{j=1}^{J} F_n^{jf'} X_n^{jf'} - D_n = \sum_{j=1}^{J}\sum_{i=1}^{N} X_i^{jm'}\,\frac{\pi_{in}^{jm'}}{1+t_{in}^{jm'}} + \sum_{j=1}^{J}\sum_{i=1}^{N} X_i^{jf'}\,\frac{\pi_{in}^{jf'}}{1+t_{in}^{jf'}}$$

The change in welfare is given by the change in real income:

$$\widehat{W}_n = \frac{\widehat{I_n}}{\prod_{j=1}^{J}\left(\hat{p}_n^{jf}\right)^{\alpha_n^j}}$$

The relative change in trade costs is given by the definition of the counterfactual simulation, and in our specification can cover NTMs as well as tariffs. Solving the model using exact hat algebra makes it possible to conduct the counterfactual experiment without data on productivity, and importantly, without trade costs data other than those that are being simulated; due to the multiplicative form of iceberg trade costs, solution in relative changes means that trade cost components, such as geographical and historical factors, which are constant in the baseline and counterfactual simply cancel out. The parameters $\beta_n^j$ (cost share of labour), $(1-\beta_n^j)\gamma_n^{k,j}$ (cost share of intermediates), and $\alpha_n^j$ (share of each sector in final demand) can be calibrated directly from the baseline data, as can value added ($w_n L_n$). Egger et al. (2018) provide updated estimates of the trade elasticity $\theta^j$ at the same level of disaggregation used in our data.

Caliendo and Parro (2015) develop an iterative procedure for solving the model, which We follow here in the modified version developed by Aichele and Heiland (2018).

### *Trade in Value Added*

We follow Aichele and Heiland (2018) in extending the Caliendo and Parro (2015) framework to consider value added trade, which helps identify the proportion of gross value trade that is considered to take place within GVCs. We differ from them, however, in the concept of value-added trade that we use. They use Johnson and Noguera (2012) and Koopman et al. (2014), but as Wang et al. (2013) point out, the measures derived in those papers only provide consistent results at an aggregate level; we are interested in a bilateral and sectoral disaggregation, so we follow the same basic approach of Aichele and Heiland (2018) but then apply the key result from Wang et al. (2013) when it comes time to decompose gross value trade into its value added components.

Given the model setup described in the previous subsection, Aichele and Heiland (2018) derive input-output coefficients as follows:

$$(20)\ \left(1 + t_{ih}^{km}\right) a_{ih}^{k,j} = \pi_{ih}^{km}\left(1 - \beta_h^j\right)\gamma_h^{k,j}$$

Where: a is the input-output coefficient; and $\left(1 - \beta_h^j\right)\gamma_h^{k,j}$ is the cost share of intermediates from sector k.

Equation (20) makes clear that if the model dataset includes a baseline input-output table (A), as is necessary, then it is straightforward to calculate a counterfactual input-output matrix (A’), using the outputs of the counterfactual solution defined above.

Wang et al. (2013) show that gross exports can then be fully and consistently decomposed into value added components at the bilateral level as follows (with sectoral superscripts suppressed for readability):

$$(21)\ \pi_{ni}^{j} = DVA + FVA + PDC$$

$$DVA = \left(V^i B^{ii}\right)' * Y^{ni} + \left(V^i L^{ii}\right)' * \left(A^{ni} B^{nn} Y^{nn}\right)$$
$$+\left(V^i L^{ii}\right)' * \left[A^{ni} \sum_{h\neq n,i}^{N} B^{hn} Y^{hh} + A^{ni} B^{nn} \sum_{h\neq n,i}^{N} Y^{hn} + A^{ni} \sum_{h\neq n,i}^{N} B^{hn} \sum_{k\neq n,i}^{N} Y^{kh}\right]$$
$$+\left(V^i L^{ii}\right)' * \left[A^{ni} B^{nn} Y^{in} + A^{ni} \sum_{h\neq n,i}^{N} B^{hn} Y^{ih} + A^{ni} B^{in} Y^{ii}\right]$$

$$FVA = \left(V^n B^{in}\right)' * Y^{ni} + \left[\left(\sum_{h\neq n,i}^{N} V^h B^{ih}\right)' * Y^{ni}\right]$$
$$+\left(V^n B^{in}\right)' * \left(A^{ni} L^{nn} Y^{nn}\right) + \left(\sum_{h\neq n,i}^{N} V^h B^{ih}\right)' * \left(A^{ni} L^{nn} Y^{nn}\right)$$

$$PDC = \left(V^i L^{ii}\right)' * \left(A^{ni} B^{in} \sum_{h\neq n,i}^{N} Y^{hi}\right) + \left(V^i L^{ii} \sum_{h\neq n,i}^{N} A^{hi} B^{ih}\right)' * \left(A^{ni} X^{n}\right)$$
$$+\left(V^n B^{in}\right)' * \left(A^{ni} L^{nn} E^{n*}\right) + \left(\sum_{h\neq n,i}^{N} V^h B^{ih}\right)' * \left(A^{ni} L^{nn} E^{n*}\right)$$

Where: E is exports to country n from country i, with a star indicating a country total across all other partners; Y is final demand for country i’s output in country n; and DVA, FVA, and

PDC are domestic value added, foreign value added, and pure double counting, respectively. A is an input-output matrix, with superscripts used to define sub-matrices by country pair. B is the global Leontief inverse based on A, with superscripts again indicating sub-matrices. V is the matrix of value-added shares, calculated directly from A. Y is the matrix of final demand. X is the vector of gross output by country. L is the local Leontief inverse, defined as follows for the three-country case (n, i, and k):

$$L = \begin{bmatrix} B_{11}^{nn} & B_{12}^{nn} & 0 & 0 & 0 & 0 \\ B_{21}^{nn} & B_{22}^{nn} & 0 & 0 & 0 & 0 \\ 0 & 0 & B_{11}^{ii} & B_{12}^{ii} & 0 & 0 \\ 0 & 0 & B_{21}^{ii} & B_{22}^{ii} & 0 & 0 \\ 0 & 0 & 0 & 0 & B_{11}^{kk} & B_{12}^{kk} \\ 0 & 0 & 0 & 0 & B_{21}^{kk} & B_{22}^{kk} \end{bmatrix}$$

The above presentation is at the country pair level for simplicity, but Wang et al. (2013) show that it can be extended to the sectoral level. The decomposition can therefore show DVA, FVA, and PDC in, for example, China's exports of electrical equipment to the USA. The sum of FVA and PDC is typically understood as a measure of production sharing, and we adopt that interpretation here.

Our approach to analysing value-added trade is straightforward. The Wang et al. (2013) decomposition for the baseline case can be calculated directly from the observed input-output table. We then use A' as calculated above to conduct a second decomposition for the counterfactual input-output table. The difference between the two shows the extent of changes in GVC trade as a result of the change in trade costs assumed for the counterfactual.

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