INTERNATIONAL MARITIME ORGANIZATION

E

MARINE ENVIRONMENT PROTECTION COMMITTEE
82nd session
Agenda item 7

MEPC 82/INF.8/Add.3
26 July 2024
ENGLISH ONLY
Pre-session public release: ☒

REDUCTION OF GHG EMISSIONS FROM SHIPS

Report of the comprehensive impact assessment of the basket of candidate GHG reduction mid-term measures – full report on Task 4 (Stakeholders' analysis)

Note by the Secretariat

SUMMARY

Executive summary:	This document provides the full report on Task 4, Complementary qualitative/quantitative stakeholders analysis, of the comprehensive impact assessment of the basket of candidate GHG reduction mid-term measures as conducted by Starcrest Consulting.
Strategic direction, if applicable:	3
Output:	3.2
Action to be taken:	Paragraph 2
Related documents:	MEPC 80/17, MEPC 80/17/Add.1; MEPC 81/7, MEPC 81/7/Add.1; MEPC 82/7, MEPC 82/7/1, MEPC 82/7/2, MEPC 82/7/4; MEPC 82/7/4/Add.1, MEPC 82/7/4/Add.2, MEPC 82/7/4/Add.3, MEPC 82/7/4/Add.4, MEPC 82/INF.8, MEPC 82/INF.8/Add.1, MEPC 82/INF.8/Add.2 and MEPC.1/Circ.885/Rev.1

Introduction

1 The comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures consists of five distinct and interrelated tasks (MEPC 82/7/4, paragraph 5). This document provides the full report of the complementary qualitative/quantitative stakeholders' analysis conducted by Starcrest Consulting, as set out in the annex.

Action requested of the Committee

2 The Committee is invited to take into account the information provided in this document when considering documents MEPC 82/7/4 and MEPC 82/7/4/Add.4.

***

NAVIGATING THE FUTURE: SAFETY FIRST!

ANNEX

Comprehensive Impact Assessment

of the Basket of Candidate
Mid-Term GHG Reduction Measures
Task 4 - Complementary Qualitative/Quantitative Stakeholders' Analysis

INTERNATIONAL
MARITIME
ORGANIZATION



Prepared by:

STARCREST CONSULTING GROUP, LLC
ENVIRONMENTAL MANAGEMENT • AIR QUALITY • CLIMATE • SUSTAINABILITY

July 2024

Disclaimer

This report has been completed by Starcrest Consulting Group, LLC (Starcrest). It contains the report on Task 4 on complementary qualitative and quantitative stakeholders' analysis of the Comprehensive impact assessment of the basket of candidate mid-term greenhouse gas (GHG) reduction measures.

Whilst this report has been commissioned by the International Maritime Organization (IMO), the information contained within this report represents the views of its authors only. It should not be interpreted as representing the views of the IMO, the Steering Committee on the comprehensive impact assessment of the basket of candidate mid-term measures, or the States that are represented on the Steering Committee. This comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures consist of five distinct but interrelated tasks for which different reports have been prepared.

Task 4 of the Comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures is being undertaken solely to assist the members of the IMO's Marine Environment Protection Committee (MEPC) in making evidence-based decisions. Any information included in this report is provided solely for analytical purposes and should not be interpreted as suggestions or recommendations for how the basket of mid-term GHG reduction measures should be designed. The policy combination scenarios and any other information included in this report are provided solely for analytical purposes and should not be interpreted as suggestions or recommendations for how the basket of mid-term GHG reduction measures should be designed.

The designations employed and the presentation of material on any map in this report do not imply the expression of any opinion whatsoever on the part of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Explanatory notes

The chosen trades reflect partial impacts and that the relative impacts on these specific trades do not reflect the combined impact on states. All these routes are included in Task 2.

There was a significant project disruption that occurred on 23 June 2024, when it was discovered during QA/QC review cycles and with the help of the Task 2 Project Leader, that there had been an accident with the transmittal of the Task 2 business-as-usual low growth (BAULG) scenario file. The BAULG scenario is used to benchmark the five selected MTM scenarios evaluated as part of Task 4. The Project Team pivoted and brought in more resources and worked 'heroic' hours to update all the underlying data, analyses, QA/QC reviews, and report preparation. The primary focus of the ***robust*** QA/QC efforts since the analyses redo has been on ensuring that the underlying data and estimates are sound, and the Project Team states that they are sound.

At the end of the project timeline, the QA/QC focused on ensuring the correct results are provided in the report, ensuring that the Executive Summary is readable and accessible, and that the Member State sections are aligned on content. Due to the limitations of project time, the one area that is not fully QA/QC'd is ensuring that the report is consistent across terminology, nomenclature, descriptions, etc. Any such inconsistencies should not be seen as issues with the analysis, but as an issue of expiring project deadlines. Finally, please note that the Project Team did meet its deadlines despite the challenges.

Please note that there may be minor numerical inconsistencies between the various tables and figures of this report, due to rounding associated with numbers, percentage, etc. presented in tables. Estimates are calculated using more significant figures than presented in the various tables.

Acknowledgements

Starcrest would like to thank all those who contributed to the Task 4 Stakeholder Analysis effort. The timeline was again highly challenging and the report could not have been completed in a meaningful way without the large number of people who contributed their time, understanding, context and operational insights; along with those who gathered data to close down data gaps, organized stakeholder input and perspectives, reviewed documents, provided economic and commodity data, and a broad range of other input and insights. The authors truly appreciate everyone's timely efforts, expertise, cooperation, and their professionalism. The following organizations contributed to this report:

Argentina

Cámara Argentina de Fruticultores Integrados (CAFI)
Cámara de la Industria Aceitera de la República Argentina (CIARA)
Centro de Economía Internacional - Ministerio de Relaciones Exteriores, Comercio Internacional y Culto
Centro de Exportadores de Cereales (CEC)
Consorcio de Exportadores de Carnes Argentinas
Instituto de Promoción de la Carne Vacuna Argentina (IPCVA)
Internacional y Culto
Ministerio de Relaciones Exteriores, Comercio Internacional y Culto
Permanent Representatives to the IMO

Belize

Banana Growers Association
BEC Shipping
Belize Customs & Excise Department
Belize Sugar Industries Limited
Koop Sheet Metal
Ministry of Agriculture
Port of Belize Ltd
Port of Big Creek
Santander Sugar Group
Statistical Institute of Belize
The Belize Chamber of Commerce & Industry

Brazil

Associação Nacional dos Exportadores de Cereais (ANEC)
Suzano
Vale

Chile

Frutas de Chile
General Directorate of the Maritime Territory and Merchant Marine (DIRECTEMAR)
Permanent Representative of Chile to the IMO
Undersecretariat for International Economic Relations-Ministry of Foreign Affairs

Cook Islands
Cook Islands Ambassador and Permanent Representative to the IMO
Cook Islands Ministry of Finance and Economic Management
Cook Islands Ministry of Foreign Affairs and Immigration
Cook Islands Ports Authority
Cook Islands Trading Corporation Limited
Prime Foods Limited

Peru
Dirección General de Capitanías y Guardacostas (DICAPI)
Ministerio De Energía y Minas
Ministry of Economy and Finance
Ministry of Foreign Trade and Tourism
Ministry of Health
Ministry of Transport and Communications
National Port Authority

South Africa
Alternative Permanent Representative to the IMO
National Department of Transportation
The Perishable Products Export Control Board (PPECB)
Transnet National Ports Authority (TNPA)

Togo
Ministry of Maritime Economy, Fisheries, and Coastal Protection

Tonga
Department of Energy (under MEIDECC)
Marine and Ports Division (under MOI)
Matson Shipping Company
Ports Authority Tonga
Swire Shipping Company
Tonga Statistics Department

United States
Bureau of Transportation Statistics
Georgia Ports Authority
Illinois Soybean Association
MARAD's Office of Policy and Plans
Port of Longview
Port of Southern Louisiana
Soy Transportation Coalition
United Soybean Board
US Department of Agriculture
US Department of Transportation Maritime Administration (MARAD) Office of Environment and Innovation Bureau of Transportation Statistics

The authors would like to thank the Chair and the Members of the Comprehensive Impact Assessment Steering Committee for their review and leadership through a very compressed schedule.

The authors would like to thank the following individuals for their contribution to the Task 4 project:

SC Moderator
Hanqiang Tan, First Secretary (Maritime), High Commission of the Republic of Singapore

IMO Secretariat
Air Pollution and Energy Efficiency, Climate and Clean Air Team, Subdivision for Protective Measures

DNV
Tore Longva, Lead CIA MTM Task 2, DNV
DNV Task 2 Project Team

UNCTAD
Onno Hoffmeister, Chief Statistics Production Unit, UNCTAD Statistics
Jan Hoffman, Head, Trade Logistics Branch, Division of Technology and Logistics, UNCTAD

External QA/QC reviewers
Ioannis Moutzouris, Ph.D. (UK)
Le Dai, Ph.D (China)
All the Members on observers of the CIA Steering Committee that provided constructive verbal and written comments throughout the study on the work products provided.

Marine Benchmark
Börje Berneblad, Vice president & Senior analyst
Torbjörn Rydbergh, Managing Director

Prepared by:
Bruce Anderson, Eduardo Lugo, Lee Kindberg, Giulia Gaadt, & Nohemi Taguite

Reviewed by:
Paul Johansen, Jan de Kat, & Eric Kindberg

Document Manager:
Kirsten Lopez-Palm

Cover:
Melissa Silva

July 2024

Starcrest Consulting Group, LLC, Poulsbo

Prepared for: International Maritime Organization, London

Table of Contents

Executive summary ES-1

1 Introduction 1

2 Approach 8

3 Case studies overview 22

4 Stakeholders' analysis – Argentina 24
4.1 Geography, population, and economy 24
4.2 Identified commodities and routes studied 26
4.3 Quantitative analysis 27
4.4 Qualitative analysis 40
4.5 Findings 44

5 Stakeholders' analysis – Belize 48
5.1 Geography, population, and economy 48
5.2 Identified commodities and routes studied 49
5.3 Quantitative analysis 50
5.4 Qualitative analysis 58
5.5 Findings 62

6 Stakeholders' analysis – Brazil 66
6.1 Geography, population, and economy 66
6.2 Identified commodities and routes studied 67
6.3 Quantitative analysis 68
6.4 Qualitative analysis 76
6.5 Findings 80

7 Stakeholders' analysis – Chile 83
7.1 Geography, population, and economy 83
7.2 Identified commodities and routes studied 85
7.3 Quantitative analysis 86
7.4 Qualitative analysis 94
7.5 Findings 98

8 Stakeholders' analysis – Cook Islands 102
8.1 Geography, population, and economy 102
8.2 Identified commodities and routes studied 104
8.3 Quantitative analysis 105
8.4 Qualitative analysis 119
8.5 Findings 123

9 Stakeholders' analysis – Peru 127
9.1 Geography, population, and economy 127
9.2 Identified commodities and routes studied 128
9.3 Quantitative analysis 130
9.4 Qualitative analysis 140
9.5 Findings 143

10 Stakeholders' analysis – South Africa 146
10.1 Geography, population, and economy 146
10.2 Identified commodities and routes studied 148
10.3 Quantitative analysis 148
10.4 Qualitative analysis 156
10.5 Findings 159

11 Stakeholders' analysis – Togo 162
11.1 Geography, population, and economy 162
11.2 Identified commodities and routes studied 164
11.3 Quantitative analysis 165
11.4 Qualitative analysis 173
11.5 Findings 176

12 Stakeholders' analysis – Tonga 179
12.1 Geography, population, and economy 179
12.2 Identified commodities and routes studied 181
12.3 Quantitative analysis 181
12.4 Qualitative analysis 191
12.5 Findings 195

13 Stakeholders' analysis – United States 199
13.1 Geography, population, and economy 199
13.2 Identified commodities and routes studied 201
13.3 Quantitative analysis 201
13.4 Qualitative analysis 209
13.5 Findings 213

14 Stakeholders' analysis – Quantitative results, trends, and conclusions 216

15 Summary of findings from the qualitative analysis & recommendations 245

Appendix A – Detailed approach A-2
Appendix B – Bibliography of selected resources B-2

List of Tables

Table ES.1: Selected commodities ES-7
Table ES.2: Selected Task 2 Scenarios used for Task 4 ..... ES-9

Table 2.1: Task 4 Key datasets descriptions & data provider 8
Table 2.2: Selected Task 2 Scenarios used for Task 4 11
Table 2.3: Example SWOT Analysis grid for qualitative responses 18

Table 3.1: Summary overview of stakeholder assessments 23

Table 4.1: Shipping distances from Argentina to market for selected commodities 26
Table 4.2: Argentina – Fleet characteristics, by case study 28
Table 4.3: Average route distance, speed, & longer transit ,times, by speed reduction group 29
Table 4.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group... 30
Table 4.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year 31
Table 4.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year 34
Table 4.7: 2030, 2040, & 2050 case study transit-weighted average total commodity cost intensity, by scenario & forecasted year 37
Table 4.8: SWOT analysis of Argentina's commodities and their sensitivity to cost changes 41
Table 4.9: SWOT analysis of Argentina's commodities and their sensitivity to transport time changes. ... 43

Table 5.1: Shipping distances to and from Belize for selected commodities 50
Table 5.2: Belize – Fleet characteristics, by case study 51
Table 5.3: Average route distance, speed, & longer transit ,times, by speed reduction group 51
Table 5.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group... 52
Table 5.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year 53
Table 5.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year 55
Table 5.7: 2030, 2040, & 2050 case study transit-weighted average total commodity cost intensity, by scenario & forecasted year 56
Table 5.8: SWOT analysis of Belize's commodities and their sensitivity to cost changes 59
Table 5.9: SWOT analysis of Belize's commodities and their sensitivity to transport time changes..... 61

Table 6.1: Shipping distances from Brazil to market for selected commodities 68
Table 6.2: Brazil – Fleet characteristics, by case study 69
Table 6.3: Average route distance, speed, & longer transit ,times, by speed reduction group 69
Table 6.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group... 70
Table 6.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year 71
Table 6.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year 73
Table 6.7: 2030, 2040, & 2050 case study transit-weighted average total commodity cost intensity, by scenario & forecasted year 74
Table 6.8: SWOT analysis of Brazil's commodities and their sensitivity to cost changes 77
Table 6.9: SWOT analysis of Brazil's commodities and their sensitivity to transport time changes 79

Table 7.1: Shipping distances to and from Chile for selected commodities 85
Table 7.2: Chile – Fleet characteristics, by case study 87
Table 7.3: Average route distance, speed, & longer transit ,times, by speed reduction group 87
Table 7.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group... 88
Table 7.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year 89
Table 7.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year 91
Table 7.7: 2030, 2040, & 2050 case study transit-weighted average total commodity cost intensity, by scenario & forecasted year 92
Table 7.8: SWOT analysis of Chile's commodities and their sensitivity to cost changes 95
Table 7.9: SWOT analysis of Chile's commodities and their sensitivity to transport time changes. 97

Table 8.1: Shipping distances to and from Cook Islands for selected commodities 105
Table 8.2: Cook Islands – Fleet characteristics, by case study 106
Table 8.3: Average route distance, speed, & longer transit times by speed reduction group 107
Table 8.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group. 108
Table 8.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year 109
Table 8.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year 113
Table 8.7: 2030, 2040, & 2050 commodity case study transit-weighted average total commodity cost intensity, by scenario and forecasted year 116
Table 8.8: SWOT analysis of the Cook Islands' commodities and their sensitivity to cost changes 120
Table 8.9: SWOT analysis of the Cook Islands' commodities and their sensitivity to transport time changes 122

Table 9.1: Shipping distances from Peru to market for selected commodities 129
Table 9.2: Peru – Fleet characteristics, by commodity case study 131
Table 9.3: Average route distance, speed, & longer transit ,times, by speed reduction group 131
Table 9.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group. 132
Table 9.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year 133
Table 9.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year 135
Table 9.7: 2030, 2040, & 2050 commodity case study transit-weighted average total commodity cost intensity, by scenario and forecasted year 137
Table 9.8: SWOT analysis of Peru's commodities and their sensitivity to cost changes 140
Table 9.9: SWOT analysis of Peru's commodities and their sensitivity to transport time changes..... 142

Table 10.1: Shipping distances from South Africa to market for selected commodities 148
Table 10.2: South Africa – Fleet characteristics, by commodity case study 149
Table 10.3: Average route distance, speed, & longer transit ,times, by speed reduction group 149
Table 10.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group150
Table 10.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year 151
Table 10.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year 153
Table 10.7: 2030, 2040, & 2050 commodity case study transit-weighted average total commodity cost intensity, by scenario and forecasted year 154
Table 10.8: SWOT analysis of South Africa's commodities and their sensitivity to cost changes 157
Table 10.9: SWOT analysis of South Africa's commodities and their sensitivity to transport time changes. 158

Table 11.1: Shipping distances from Togo to market for selected commodities 165
Table 11.2: Togo – Fleet characteristics, by commodity case study..... 166
Table 11.3: Average route distance, speed, & longer transit ,times, by speed reduction group 166
Table 11.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group167
Table 11.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year..... 168
Table 11.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year 170
Table 11.7: 2030, 2040, & 2050 case study transit-weighted average total commodity cost intensity, by scenario & forecasted year 171
Table 11.8: SWOT analysis of Togo's commodities and their sensitivity to cost changes..... 174
Table 11.9: SWOT analysis of Togo's commodities and their sensitivity to transport time changes. 175

Table 12.1: Shipping distances to and from Tonga for selected commodities..... 181
Table 12.2: Tonga – Fleet characteristics, by commodity case study..... 182
Table 12.3: Average route distance, speed, & longer transit ,times, by speed reduction group 182
Table 12.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group183
Table 12.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year..... 185
Table 12.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year 187
Table 12.7: 2030, 2040, & 2050 commodity case study transit-weighted average total commodity cost intensity, by scenario and forecasted year 188
Table 12.8: SWOT analysis of Tonga's commodities and their sensitivity to cost changes..... 192
Table 12.9: SWOT analysis of Tonga's commodities and their sensitivity to transport time changes 194

Table 13.1: Shipping distances from the United States to market for selected commodities 201
Table 13.2: US – Fleet characteristics, by commodity case study 202
Table 13.3: Average route distance, speed, & longer transit ,times, by speed reduction group 202
Table 13.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group203
Table 13.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year..... 204
Table 13.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year 206
Table 13.7: 2030, 2040, & 2050 commodity case study transit-weighted average total commodity cost intensity, by scenario and forecasted year 207
Table 13.8 – SWOT analysis of US's commodities and their sensitivity to cost changes..... 210
Table 13.9 – SWOT analysis of US's commodities and their sensitivity to transport time changes. 212

Table 14.1: 2030 Task 4 total commodity cost intensity results for all case studies by scenario & speed reduction group 217
Table 14.2: 2040 Task 4 Task 4 total commodity cost intensity results for all case studies by scenario & speed reduction group..... 219
Table 14.3: 2050 Task 4 Task 4 total commodity cost intensity results for all case studies by scenario & speed reduction group..... 221
Table 14.4: 2030, 2040, & 2050 Scenario 23 FRACCI & TCCIsr results for all case studies, by year & speed reduction group 225
Table 14.5: 2030, 2040, & 2050 Scenario 24 FRACCI & TCCIsr results for all case studies, by year & speed reduction group 229
Table 14.6: 2030, 2040, & 2050 Scenario 31 FRACCI & TCCIsr results for all case studies, by year & speed reduction group 233
Table 14.7: 2030, 2040, & 2050 Scenario 32 FRACCI & TCCIsr results for all case studies, by year & speed reduction group 237
Table 14.8: 2030, 2040, & 2050 Scenario 46 FRACCI & TCCIsr results for all case studies, by year & speed reduction group 241

Table A.1: Task 4 Key datasets descriptions & data provider A-3
Table A.2: Selected Task 2 Scenarios used for Task 4 ..... A-7
Table A.3: Full qualitative question set A-16
Table A.4: Example SWOT Analysis grid for qualitative responses A-18

List of Figures

Figure ES.1: Illustration of maritime transport costs ES-2
Figure ES.2: Average number of ship-side, speed reduction, & balanced driven commodity case studies ES-11
Figure ES.3: Import essential goods average number of ship-side, speed reduction, & balanced driven commodity case studies ES-12
Figure ES.4: Export trade goods average number of ship-side, speed reduction, & balanced driven commodity case studies ES-12

Figure 1.1: Illustration of maritime transport costs 3
Figure 2.1: Illustrative flow chart of main efforts under Task 4 9
Figure 2.2: APEC Module 2 – Economic impacts illustration 15

Figure 4.1: Key economic indicators for Argentina 25
Figure 4.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group ... 38
Figure 4.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group ... 39
Figure 4.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group ... 39

Figure 5.1: Key economic indicators for Belize 49
Figure 5.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group ... 57
Figure 5.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group ... 57
Figure 5.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group ... 58

Figure 6.1: Key economic indicators for Brazil 67
Figure 6.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group ... 75
Figure 6.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group ... 75
Figure 6.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group ... 76

Figure 7.1: Key economic indicators for Chile 84
Figure 7.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group ... 93
Figure 7.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group ... 93
Figure 7.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group ... 94

Figure 8.1: Map of the Cook Islands 102
Figure 8.2: Key economic indicators for Cook Islands 104
Figure 8.3: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group . 117
..... 117
Figure 8.4: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group . 117
Figure 8.5: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group . 118

Figure 9.1: Key economic indicators for Peru 128
Figure 9.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group . 138
Figure 9.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group . 138
Figure 9.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group . 139

Figure 10.1: Key economic indicators for South Africa 147
Figure 10.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group 155
Figure 10.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group 155
Figure 10.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group 156

Figure 11.1: Key economic indicators for Togo 163
Figure 11.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group 172
Figure 11.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group 172
Figure 11.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group 173

Figure 12.1: Key economic indicators for Tonga..... 180
Figure 12.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group 189
Figure 12.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group 189
Figure 12.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group 190

Figure 13.1: Key economic indicators for the United States 200
Figure 13.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group 208
Figure 13.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group 208
Figure 13.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group 209

Figure 14.1: Average number of ship-side, speed reduction, & balanced driven commodity case studies 222
Figure 14.2: Import essential goods average number of ship-side, speed reduction, & balanced driven commodity case studies 223
Figure 14.3: Export trade commodities average number of ship-side, speed reduction, & balanced driven commodity case studies 224
Figure 14.4: 2030 Scenario 23 combined results for all case studies, by speed reduction group..... 226
Figure 14.5: 2040 Scenario 23 combined results for all case studies, by speed reduction group..... 227
Figure 14.6: 2050 Scenario 23 combined results for all case studies, by speed reduction group..... 228
Figure 14.7: 2030 Scenario 24 combined results for all case studies, by speed reduction group..... 230
Figure 14.8: 2040 Scenario 24 combined results for all case studies, by speed reduction group..... 231
Figure 14.9: 2050 Scenario 24 combined results for all case studies, by speed reduction group..... 232
Figure 14.10: 2030 Scenario 31 combined results for all case studies, by speed reduction group..... 234
Figure 14.11: 2040 Scenario 31 combined results for all case studies, by speed reduction group..... 235
Figure 14.12: 2050 Scenario 31 combined results for all case studies, by speed reduction group..... 236
Figure 14.13: 2030 Scenario 32 combined results for all case studies, by speed reduction group..... 238
Figure 14.14: 2040 Scenario 32 combined results for all case studies, by speed reduction group..... 239
Figure 14.15: 2050 Scenario 32 combined results for all case studies, by speed reduction group..... 240
Figure 14.16: 2030 Scenario 46 combined results for all case studies, by speed reduction group..... 242
Figure 14.17: 2040 Scenario 46 combined results for all case studies, by speed reduction group..... 243
Figure 14.18: 2050 Scenario 46 combined results for all case studies, by speed reduction group..... 244

Figure A.1: Illustrative flow chart of main efforts under Task 4 ..... A-4
Figure A.2: APEC Module 2 – Economic impacts illustration..... A-11
Figure A.3: Illustration of overall process of Task 4..... A-15
Figure A.4: Illustrative QA/QC process for Task 4 deliverables A-20

List of Acronyms

APEC	Asian Pacific Economic Cooperation
BAF	Bunker Adjustment Factor
BAU	Business as usual
BAULG	Business as usual low growth
BCEAO	La Banque Centrale des Etats de l'Afrique de l'Ouest, West African States
CAF	Currency Adjustment Factor
CAFI	Cámara Argentina de Fruticultores Integrados, Argentina
CEC	Centro de Exportadores de Cereales, Argentina
CEI	Centro de Economía Internacional, Argentina
CI	Cost Increase
CIA	Comprehensive Impact Assessment
CIARA	Cámara de la Industria Aceitera de la República, Argentina
CISO	Cook Islands Statistics Office
CITC	Cook Islands Trading Corporation Ltd.
CO_2	Carbon dioxide
CV	Yearly total export or import value, currency
D_{BAU}	Average marine transit observed from fleet analysis
DCI_{SR}	Depreciation Cost Increase change due to Speed Reduction, %
DGFT	Directorate General for Foreign Trade, Belize
DGIECE	Dirección General de Investigación y Estudios sobre Comercio Exterior, Peru
DIRECTEMAR	Dirección General del Territorio Marítimo y de Marina Mercante, Chile
D_{SR}	Days added to marine transit due to speed reduction from fleet analysis, days
ECOWAS	Economic Community of West African States
ETS	Emissions Trading System
FCI_{SR}	Financial or interest cost increase change due to speed reduction, %
FOB	Free on Board
FRACCI	Freight Rate Adjusted Commodity Cost Intensity
GDP	Gross Domestic Product
GDPI	GDP Impact from commodity case study
GFI	GHG Fuel Intensity
GHG	Greenhouse Gas
GTAP	Global Trade Analysis Project
HS code	Harmonized System Code
IBGE	Instituto Brasileiro de Geografia e Estatística, Brazil
ICR	Insurance Cost Rate, %/day
ICI_{SR}	Insurance Cost Increase change due to Speed Reduction, %
ICT	Information and Communications Technology
IMO	International Maritime Organization
INDEC	El Instituto Nacional de Estadística y Censos, Argentina
INE	El Instituto Nacional de Estadísticas, Chile
IPCVA	Instituto de Promoción de la Carne Vacuna Argentina
km	kilometer
km^2	square kilometer
KPI	Key Performance Indicator
LDCs	Least Developed Countries
LPG	Liquefied petroleum gas
MEIDECC	Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications, Tonga

MEPC	Marine Environment Protection Committee
MFAITW	Ministry of Foreign Affairs, International Trade, and Worship, Argentina
MFEM	Ministry of Finance and Economic Management, Cook Islands
MOI	Ministry of Infrastructure, Tonga
MPUELE	Ministry of Public Utilities, Energy, Logistics, and E-Governance, Belize
MTCC Pacific	IMO Maritime Technology Cooperation Centre - Pacific
MTM	Mid-term Measures
NDA	Non-Disclosure Agreement
nm	nautical miles
PPECB	Perishable Products Export Control Board, South Africa
PPP	Purchasing Power Parity
PSS	Peak Season Surcharge
QA / QC	Quality Assurance/Quality Control
RSPO	Roundtable on Sustainable Palm Oil
SC	Steering Committee
SC GDP	Sector Category GDP, national currency or USD (currency)
SCZ	Suez Canal Surcharge
SHAs	Stakeholder Assessments
SIB	Statistical Institute of Belize
SIDS	Small Island Developing State
SR	speed reduction
SSA	Statistics South Africa
STM	Short-term Measures
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TCCI	Total Commodity Cost Intensity
$TCCI_{MTM}$	Total Commodity Cost Intensity change due to speed reduction & MTM, %
$TCCI_{SR}$	Total Commodity Cost Intensity change due to Speed Reduction
teu	Twenty-foot Equivalent Unit
THC	Terminal Handling Charges
TNPA	Transnet National Ports Authority, South Africa
ToR	Term of Reference
TSD	Tonga Statistics Department
TTT	Time, Temperature, Tolerances
TtW	Tank-to-Wake
UN DESA	United Nations, Department of Economic and Social Affairs
UNCTAD	United Nations Trade and Development
US	United States
USD	United States Dollar
WBG	World Bank Group
WMU	World Maritime University
WtW	Well-to-Wake

Executive summary

This study comprises the Task 4 complementary qualitative and quantitative stakeholder analyses, which is one of five tasks of the Comprehensive Impact Assessment of the mid-term GHG reduction measures (CIA MTM). This portion of the CIA MTM is conducted by Starcrest Consulting Group, LLC (Starcrest). It assesses the possible impacts of certain policy combinations of candidate mid-term measures in 10 selected Member States, namely Argentina, Belize, Brazil, Chile, Cook Islands, Peru, South Africa, Togo, Tonga, and the United States, across 39 identified commodity case studies and specific trade routes (including ports of origin and ports of destination) selected by the participating Member States. Cook Islands and Tonga are Small Island Developing States (SIDS) and Togo is a Least Developed Countries (LDCs) in this study. The 39 commodity case studies include a mix of essential goods and trade commodities.

This study aligns with Step 4, paragraph 15 of the Revised Procedure for Assessing Impacts on States of Candidate Measures, found in MEPC.1/Circ.885/Rev.1 and the Revised work plan for the conduct of the Comprehensive Impact Assessment of the basket of candidate mid-term measures – Task 4 complementary qualitative/quantitative Stakeholders' Analysis (Task 4 Work Plan) (MEPC 82/7, Annex 1).

Each of the first four tasks of the CIA MTM provides different perspectives on the potential impacts of the various policy combinations of the MTM. Task 1 provides a systematic review of relevant literature related to CIA MTM (Literature Review). Tasks 2, 3, and 4 provide three different perspectives on understanding the potential impacts from the MTM. Task 2, conducted by DNV,[1] examines the impacts of the MTMs on the global fleet of vessels and their future costs. Task 3, conducted by UNCTAD,[2] focuses on economic impacts at the country and regional levels. Task 4 (this report) examines costs and timing impacts due to ship-side and ocean transit time and economic impact implications on 39 actual commodities shipped to or from 10 different countries on selected trade routes.

To use an analogy, Tasks 2 and 3 are global perspectives on the potential impacts of the fleet and countries from the various scenarios, similar to the view from the International Space Station. In these global analyses and results, there are aggregations that 'flatten' the 'topography' of what is seen below. Task 4 is taken from the local perspective, where aggregations are minimized, akin to flying through the landscape where features like mountains and valleys are more prominent. As such, Task 4 does not inform on what could happen globally, it provides context and informs what could happen to nationally important sectors. ***This is the purpose of this analysis.***

Task 2: Assessment of Impacts on the Fleet modeled the costs of transitioning the international fleet through the basket of mid-term measures – the ship-side cost intensity increases due to the various selected MTM scenarios for the three forecasted years of 2030, 2040, and 2050. It is assumed that the ship-side cost increase estimates are absorbed by the freight rates that the shipping line charges the commodity/cargo owner ***Ultimately these costs are borne by end consumers.***[3]

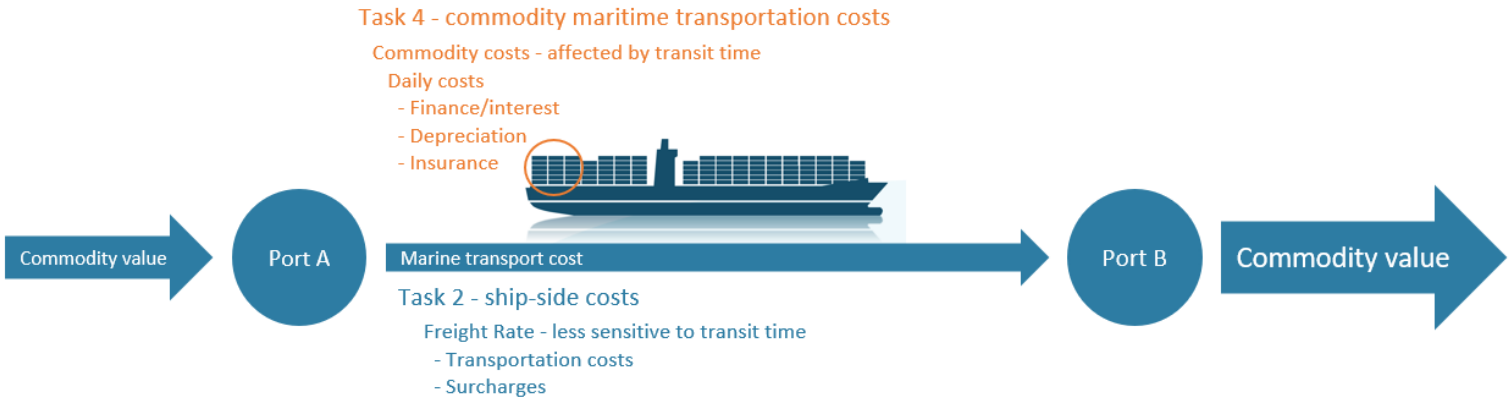
[1] DNV, *Comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures, Task 2: Assessment of Impacts on the Fleet, Final Report*, July 2024 [DNV 2024]
[2] UNCTAD, *Comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures, Task 3 Assessment of Impacts on States, Final Report*, July 2024 [UNCTAD 2024]
[3] First, the additional cost is paid either by the importer or exporter, depending on the terms in the purchase/sale agreement. The extra cost is then passed to all the supply chain actors, who finally charge the costs to the final consumer (end consumer) who is the one paying for additional costs and inefficiencies.

Task 3 (Assessment of impacts on States) used the modelled outputs from Task 2 to conduct global modeling simulations at the national and regional level to determine GDP and trade flow impacts at a country/regional level. This is done by using an adapted Global Trade Analysis Project (GTAP) model, for which the underlying database is aggregated to 115 countries and 15 sectors. '***It is important to note that for most SIDS and LDCs, GTAP does not represent them as single economies, but are aggregated to part of a composite one.'***[4] For information on impacts on States, see UNCTAD 2024.

It is important to note that Task 4 was not able to discern how revenue is moved internally within a country to a specific segment or part of a segment within the overall economy. ***Therefore, the revenue disbursements associated with those scenarios that include revenue, were not considered in Task 4.*** The Task 4 impacts shown ***do not take into account*** any future revenue disbursements. To understand potential country revenue disbursements by applicable scenario, see UNCTAD 2024.

Two key cost elements make up the total increases related to the MTM: ship-side cost increases and cargo-side cost increases due to longer transit times. The ship-side cost increases include everything modelled by DNV in Task 2, which includes the impacts of both the Short-Term Measures (STM) and MTM, as well as projecting the use of vessel speed reductions and other compliance measures over time. Increases in the cargo costs due to longer transit times are not modeled in Task 2. These cargo related increases are from daily costs that include finance/interest charges, depreciation, and insurance for additional vessel transit time to reach the destination. For each of the 39 commodity case studies, Task 4 provides the separate and combined ship-side and cargo-side cost changes. Together, these are the total commodity cost intensity increases. The concept described above is illustrated in Figure ES.1.

Figure ES.1: Illustration of maritime transport costs



In cases where cargo is transshipped at intermediate ports (cargo is unloaded and transferred to another ship to continue its voyage to its destination port), our analysis covers all water transit times (only ship navigational time), but not the port stays. For this analysis, the time the cargo spends within intermediate ports is assumed not to change and so is not included in maritime transport cost changes.

Task 4 does ***not*** prescribe nor estimate where speed reduction should be used for any commodity case study or ship segment. Task 4 does provide the projected commodity cost impacts should speed reductions be implemented by the ship operator due to cost, compliance needs or other timing criteria. This study should be seen as a 'sensitivity analysis' for the 10 participating Member States, and the ship type, size and age, market and commodity combinations. These analyses can be informative for other stakeholders with similar combinations of trade and fleet types.

[4] UNCTAD 2024

To support the specific analyses, a broad range of data, contextual information, and insights/perspectives is captured by Task 4. This information was provided by participating Members States and their national stakeholders, as well as Leaders of Tasks 2 and 3 and data provider Marine Benchmark. National stakeholders included a broad range of organizations including: industry representatives, trade associations, product/sector associations, institutes, government ministries, exporters, shipping lines, ports, customs departments, national statistic offices, and Chambers of Commerce.

Note that for this report, cost increases refer to commodity cost intensity increases and the terms are used interchangeably.

Key findings

What variables drive cost increases?

The ultimate maritime transport cost increases for each of the 39 commodity case studies are driven by their unique combinations of the following variables:

- **Ship-side cost increases** – These are the cost increases modeled by DNV for Task 2 across the fleet for each MTM scenario and the forecast years (2030, 2040 and 2050). For each scenario, the cost impacts are dependent on the ship type, size, and age. ***These cost increases include all the ship-side estimated costs associated with the various MTM scenarios***. These costs vary widely for each ship type, size, and age combination based on the many assumptions and scenarios documented and referenced in Task 2 (DNV 2024). These include:
  - **CAPEX** – capital expenses associated with the ship, including newbuild ships, fleet renewal, capital improvements on existing ships associated with the MTM, energy-efficiency retrofits on existing ships, etc.
  - **OPEX** – operational expenses including fuel, crew, provisions, maintenance, etc.
  - **Carbon capture and control** – carbon capture CAPEX and OPEX expenditures, as applicable.
  - **Regulatory costs** – costs associated with regulations including MTM, except joining compliance pools under the GFI flexibility mechanism.
- **Cargo-side cost increases** – These are elements on the cargo-side that result in cost increases, including
  - **Cargo value** – Higher value commodities are generally more sensitive to increases in time than they are to ship-side cost increases (maritime transport costs or freight rates) due to their typically lower *ad valorem* rates; generally higher value cargoes and time-sensitive commodities tend to incur higher freight rates. Lower value commodities are generally more ship-side cost sensitive than time sensitive and tend to have higher *ad valorem* rates.
  - ***Ad valorem* rate** – The *ad valorem* rate is the maritime transport cost as a percentage of the total landed commodity cost (ocean freight rate as a percentage of total landed commodity cost). For this study, the landed cost is the total value of the commodity at the receiving port including costs associated with maritime transport. Generally, the lower the *ad valorem* rate, the lower the sensitivity to ship-side cost increases, and the higher the sensitivity to time delays. The same is generally true in reverse. Generally, the higher the *ad valorem* rate the higher the sensitivity to ship-side costs (maritime transport costs/freight rates), and the lower sensitivity to time delays.

  - **Longer transit times** – The longer transit time resulting from voluntarily reduced transit speeds may generally reduce ship-side energy consumption, but generally adds cargo-related daily costs such as finance/interest charges, depreciation, and insurance. In addition, for perishable commodities or commodities that have shelf life or expiration limitations, added time in transit can reduce cargo value due to reduced remaining shelf life, deterioration, spoilage, and expiration. This might impact Member States' competitive positions. Note that Tasks 2, 3, and 4 all incorporate potential longer transit times based on the speed reduction groups presented in Task 2.
- **Distance to market** – The distance to market is the total nautical miles to transport cargo from port of origin to port of destination. Many variable costs are distance-related across both ship-side and cargo-side. However significant differences in vessel size, age and efficiency can provide or reduce economies of scale, making the actual freight rate picture complex.

Quantitative findings following from the 39 identified commodity case studies from the 10 participating Member States

- As one would expect, ***commodity cost increases are observed across all scenarios*** and forecasted future years.
- In general, among the five scenarios evaluated, policy ***Scenarios 31/32*** were on average approximately 50% higher in 2030 compared to Scenarios 23/24. All four scenarios are estimated to have significant relative cost increases, on average 5.5 to 6.6 times, across all 39 commodity case studies in 2040 and on average 7 times in 2050, compared to 2030.
- In general, the strive ***Scenario 46*** 'brings forward' to 2030, the significant increases seen in 2040 and 2050 from the other scenarios, as noted above.
- By 2050 all five MTM scenarios associated cost increases generally align.
- The ***most cost sensitive commodity group*** is imported essential goods. While trade goods may be important to a particular segment of an economy, essential goods are necessary to the broader economy and support life and health. Higher costs for essential goods are a particular concern for countries with various combinations of limited national GDP, limited population and infrastructure to provide economies of scale, limited disposal income to absorb cost increases, limited alternative transportation options to import essential goods, and country's remoteness to key trading partners. For example, the increases expected to the United States's (US) wood chip exports will have no impact beyond that limited sector, while increases to essential goods imported to SIDS and LDCs will have societal impacts.
- ***Key drivers in determining commodity cost intensity changes:*** Commodity cost intensity changes may be driven primarily by ship-side commodity cost increases, by cost increases due to speed reduction, or a balance of these.
- ***Ship-side commodity cost intensity*** changes drive the majority of case studies across all three forecasted years, across all scenarios, and across all speed reduction groups. The cost increases for the 13 imported essential goods cases studies were primarily impacted by ship-side cost increases across all three forecasted years.
- The case studies with the ***greatest ship-side driven commodity cost increase*** are Tonga's kava exports and the US's wood chips exports, due to their relatively lower value and much higher *ad valorem* freight rates of 30.2% and 32.1%, respectively.
- The ***most sensitive commodities related to speed reduction*** were observed in Argentina, Brazil, Chile, Peru, South Africa, Togo, and the United States.
- Lower speed reductions of 10% ***do not*** drive commodity cost increases after 2030.
- Perishables are the ***most speed sensitive commodity group*** due to spoilage, or degradation, product expiration thresholds, medium to higher product value, and long distances to market. This finding aligns with and supports UNCTAD's similar finding.

- The case studies that are the ***most sensitive speed reduction driven commodity*** due to their generally lower *ad valorem* rates or product expiration/shelf life were:
  - Cook Islands eggs due to very tight expiration dates – a few days delay can render the product expired and full value is lost.
  - Peru's copper due to its higher value, production facility time sensitivity, distance to market and an extremely lower *ad valorem* freight rate of around 1.3%, meaning ship-side cost increases impact less than 2% of the commodity's landed cost.
  - Argentina's chilled bovine meat due to its higher value, product time sensitivity, distance to market, and its extremely lower *ad valorem* freight rate of 2.7%, meaning ship-side cost increases impact less than 3% of the commodity's landed cost.
  - Chilean cherries that must arrive timely and in perfect blemish-free form to receive their highest prices. Even minor spoilage significantly reduces product value.

Qualitative insights following from the stakeholder analysis carried out in the 10 participating Member States

- Several stakeholders emphasized the ***importance of efficient transport for perishable commodities,*** where timely delivery and temperature control are crucial for maintaining quality and market competitiveness. Extended transit times due to slower speeds could impact shelf life and market share and could lead to shortages of essential goods. Note that over three quarter of the commodities identified by participating Member States and evaluated were agricultural products.[5]
- Several stakeholders across a variety of fields reported that ***higher transportation costs tied to distance*** can impact market accessibility, competitiveness, product pricing, or market expansion strategies. Importers may choose suppliers with shorter transit times to assure quality and minimize costs, and exporters may face challenges in competing with suppliers from locations with lower transportation costs. Adjustments in product pricing may be necessary to maintain profitability, and market expansion efforts may be affected.
- Several stakeholders stated that higher maritime transport demand and shortages increase freight costs, ***affecting market competitiveness***.
- Ultimately, according to several of the stakeholders, changes in freight costs (rates) ***will affect prices for consumers***.
- A few stakeholders noted that transportation costs (freight rates) impact product ***affordability and accessibility***. Certain goods may no longer be imported at all due to increased costs and time frames. This is a particular concern for one of the Small Island Developing States (SIDS) participating in this task.
- Stakeholders from both SIDS highlighted ***concerns over increased transport times*** affecting certain goods and freight rates. Challenges posed by rising freight costs and logistical complexities are exacerbated by their remote locations.
- The stakeholders from one SIDS stated that perhaps the ***most notable challenge*** is the lack of long-term and consistent research done for isolated SIDS on the decarbonization of shipping or the unknown implications future fuels could have for the evaluated commodities.
- One stakeholder from the LDC in this study expressed concerns about ***LPG-dependent communities***, where GHG reduction regulations could exacerbate the economic and social challenges LDCs already face.

[5] Speed reduction is one of the active ways of complying with the STM, shipping companies may have several reasons to use planned speed reduction as a strategy. The shipping company's business decision will include concerns that are not always apparent to the cargo owner, such as penalties for not meeting GHG or other compliance requirements, and long-term issues such as the current Red Sea crisis.

- Stakeholders from one SIDS emphasized that they ***are mostly reliant*** on imported fuel, foodstuffs and other essential goods.

Key Uncertainties

- Since Task 4 integrates both the outputs of Task 2 and the data from Task 3, ***all the uncertainties with those two reports are applicable in this study***.
- ***Ad valorem*** rates for each Member State were based on the detailed UNCTAD Trade and Development dataset that underlies Task 3's modelling of State impacts. There are no specific rates for Cook Islands nor Tonga, and an aggregated 'Pacific SIDS' rate was used.
- Related to Task 4, future ship-side cost impacts outputs from Task 2 are aggregated by ship type, size, and age combinations. There are uncertainties associated with determining when to apply the ship-side impacts in an aggregated combination when analyzing a limited number of specific ships. This is especially true when ships have similar aspects to another ship type, size, and age combination.
- Related to Task 4, when trying to apply aggregated cost impacts to specific ships, one of the key cost impacts is related to whether the ship joins a ***compliance pool*** or not. A compliance pool is a group of ships where some ships over comply and are compensated by under complying ships. At the global level this is not an issue, but when looking at specific ships, this becomes an uncertainty.
- Cross referencing stakeholder qualitative responses with publications, papers, or to confirm the response is consistent with economic or industrial theories, ***was not completed*** as part of this project nor part of the scope.

Stakeholders in participating Member States

There were 10 participating Member States which were selected by the CIA Steering Committee to be part of Task 4. As in the previous CIA, the participating Member States selected a limited number of commodity case studies, which can be divided into two groups for the purposes of this report:

- **Essential goods -** those commodities needed to sustain life and society such as food, water, medicine, fuel, building materials, electronic equipment (communications, computers, etc.), and many others. Impacts from higher maritime transport costs and/or longer transits could include shortages, and might lead to rationing or disruption of the society that depends on these goods.
- **Trade commodities -** a broad group of goods that are traded between countries and include everything from foods (perishables and nonperishables), raw materials, partial or finished products, animals, waste products, and fuels. Impacts from higher maritime transport costs and/or longer transits could include financial and employment disruption within the sector or portion of the national economy are associated with the trade commodity.

The differences between these types of goods lie in their fundamentally different potential for negative impacts. For people fully dependent on marine transportation to sustain life and society, potential negative impacts caused by port arrival delays of essential good imports could for example result in shortages for those essential goods or fuels that are not warehoused or stored in quantities sufficient to cover the delay period. In stark contrast, potential negative impacts from longer transit times for trade commodities generally affects only a specific sector of a country's greater economy; however, life will continue to be sustained and only a segment of society will be impacted. It is important to note that countries' selected commodities can include both essential goods imported, and trade commodities imported or exported. In this study all selected essential goods were imports, and the selected exports were all trade goods.

Note that one country's essential good is another country's trade commodity; it depends on the direction of trade.

Selection of commodity case studies by the 10 participating Member States

Of the 10 participating Member States in the MTM stakeholder analysis, six participated previously and four new Member States were added to increase geographical coverage of the cohort. The original six included Argentina, Brazil, Chile, Cook Islands, Peru, and the US. The new participating Member States include Belize, South Africa, Togo, and Tonga. It was agreed by the CIA Steering Committee that the original participating Member States in the CIA STM could continue with the same number of commodities as in the past, and due to time constraints and scope, the new Member States could choose a maximum of 3 each. In total 39 commodity case studies were identified, as listed below in Table ES.1.

Table ES.1: Selected commodities

Case Study	Country	Trade Direction	Cargo type
1a	Argentina	Export	Soybeans
1b	Argentina	Export	Soybean meal
1c	Argentina	Export	Chilled bovine meat
1d	Argentina	Export	Apples and pears
1e	Argentina	Export	Soy oil
1f	Argentina	Export	Corn
2a	Belize	Export	Bananas
2b	Belize	Export	Sugar
2c	Belize	Import	Steel
3a	Brazil	Export	Iron ore
3b	Brazil	Export	Soybeans
3c	Brazil	Export	Woodpulp (paper and paper products)
4a	Chile	Export	Cherries
4b	Chile	Import	Petroleum oils
4c	Chile	Export	Lithium carbonate
5a	Cook Islands	Import	Miscellaneous edible preparations
5b	Cook Islands	Import	Pharmaceutical goods
5c	Cook Islands	Import	Fuels (LPG)
5d	Cook Islands	Import	Articles of iron and steel
5e	Cook Islands	Import	Edible vegetables, certain roots, & tubers
5f	Cook Islands	Import	Electrical machinery & equip
5g	Cook Islands	Import	Meat & edible meat offal
5h	Cook Islands	Import	Dairy produce, birds eggs, natural honey+
5i	Cook Islands	Import	Products of the milling industry, etc.
6a	Peru	Export	Copper
6b	Peru	Export	Grapes
6c	Peru	Export	Pota (squid)
7a	South Africa	Export	Iron ore
7b	South Africa	Export	Citrus foods
7c	South Africa	Export	Grapes
8a	Togo	Import	Essence (LPG)
8b	Togo	Import	Iron and steel
8c	Togo	Import	Palm oil
9a	Tonga	Import	Petroleum oils
9b	Tonga	Export	Fish
9c	Tonga	Export	Kava
10a	United States	Export	Soybeans
10b	United States	Export	Wood and wood products
10c	United States	Export	Automobiles

Note that essential goods do not necessarily have any premiums above trade goods related to transport costs (freight rates).[6] Where they differ is in the impacts.

[6] It is a common industry practice that freight rates for reefer containers are higher than the ones for dry containers.

Approach

Task 4 analysis looks at specific ship-side cost increases with no speed reduction and the combination of ship-side cost increases and commodity cost increases across the three speed reduction (SR) groups as modeled by DNV in Task 2. Task 4 is centered on two primary analyses:

- **Quantitative analysis** – provides a sensitivity analysis related to the 39 identified commodity case studies, and their potential cost impacts related to ship-side cost increases from the MTM as modelled by DNV and potential cargo-side cost impacts from the speed reductions defined by DNV and modelled by Starcrest.
- **Qualitative analysis** – gathered national level stakeholder contextual input for 16 questions focused on speed reduction, higher costs and other factors. Stakeholder responses were analyzed using a strength, weakness, opportunity, and threat (SWOT) analysis adapted to center on cost increases and longer transit times. Similar to the CIA STM, these responses were not validated as part of the project, but presented solely as stakeholder responses to provide contextual information that could not be determined in the modelling.

The approach and methods used in this study align and build upon the stakeholder analysis of the CIA STM and as directed in the MTM Task 4 Work Plan. An additional quantitative step for the CIA MTM was the integration of the ship-side cost intensity changes as modeled by DNV for the selected scenarios of the basket of candidate MTM. An additional qualitative tool was the use of the SWOT analysis approach to organize and present responses provided *inter alia* around two main themes: sensitivities of the selected case studies to cost intensity increases and potentially longer transit times, similar to the CIA STM. The advantage of the SWOT analysis tool is that it allows for the qualitative inputs to be more easily considered around these two main themes.

As noted above and consistent with the previous CIA STM, two primary analyses are integral parts of Task 4, the complementary quantitative and qualitative analyses. These are highlighted below.

Quantitative analysis

The selection of scenarios to include in the quantitative analysis completed under Task 4

Due to time constraints, the scope of Task 4 does not include all the scenarios that DNV modeled for Task 2. Therefore, a bracketing approach was approved by the CIA Steering Committee. A key consideration for the scenarios selected for Task 4 is the need to select from the group of scenarios UNCTAD modeled in Task 3, thus ensuring alignment between the tasks. For Task 3, UNCTAD modeled the following Task 2 scenarios:

- 21, 22, 23, 24, 26, 31, 32, 36, 43, and 46

For scenarios 26, 31, 32, and 46, UNCTAD also modeled four revenue distribution scenarios. Due to time and scope constraints, it was not feasible to model all of UNCTAD's scenarios in Task 4.

It is important to note that Task 4 was not able to discern how revenue is moved internally within a country to a specific segment or part of a segment within the overall economy. ***Therefore, the revenue disbursements associated with those scenarios that include it, were not considered in Task 4.*** Some of the scenarios are designed to generate excess funds that are intended to be used to help offset impacts, among other expenditures like research and development. For more information on revenue disbursement see DNV's report on Task 2 and UNCTAD's report on Task 3.

In consultation with DNV and UNCTAD, and approval by the CIA Steering Committee, and in consideration of the discussions related to tank-to-wake (TtW) and well-to-wake (WtW) emissions, five MTM scenarios were selected for inclusion in Task 4, as presented in Table ES.2.

Table ES.2: Selected Task 2 Scenarios used for Task 4

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination						
			Policy code	GFI scope	GFI flexibility RU % of price	GFI flexibility SU % of price	Levy USD/tCO_2eq	Levy Reward % of cost gap	Feebate Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

Scenario pairs 23/24 and 31/32 differ only in TtW and WtW, and their differences are observed in the Task 2 modelling outputs. The business-as-usual low growth (BAULG) scenario was used as a benchmark to determine ship-side cost intensity changes for each of the forecasted scenarios.

While some Member States on the Steering Committee would have preferred to have additional scenarios considered, the above approach was ultimately approved. Note that from DNV's perspective, feebate-based scenarios were expected to fall between the selected scenarios for Task 4.

Total commodity cost intensity changes

In terms of potential impacts from the five selected MTM scenarios and the speed reduction groups, two key components were found to drive the total commodity cost intensity changes that were analyzed:

- **Ship-side cost intensity changes.** These cost changes include all cost elements associated with the ship (capital expenditures, operational costs, regulation costs, carbon capture costs, global fleet capacity associated with speed reduction, etc.) for the forecasted years 2030, 2040, and 2050. Ship-side cost intensity changes modeled by DNV were assumed to be fully reflected in freight rates over the low growth BAU scenario.
- **Commodity cost intensity changes due to speed reduction.** These cost changes are associated with the cargo (commodities value) and include the daily cost increases of finance/interest rates, depreciation, and insurance costs that increase with each additional day resulting from speed reduction.

These cost changes are added and are part of the landed costs of commodities upon arrival at the destination port compared to BAU transit times. Task 4 assumes that both cost intensity changes will be ultimately passed on to the final consumer.

DNV in Task 2 modelled four speed reduction (SR) groups:

- **SR 0%** - ***this group assumed no speed reduction*** and the associated cost increases are ***solely*** from the ship-side cost intensity changes associated with the MTM, for each scenario and forecasted year by DNV in Task 2.
- **SR 10%** - this is a 10% reduction in the observed ship baseline speed. For Task 4, the average speeds for each of the specific ship type, size, and age combinations identified for each of the 39 commodity case studies were reduced by 10% and the days of increased transit time (delay) were determined.
- **SR 20%** - similar to SR 10%, except using a 20% reduction in speed.
- **SR 30%** - similar to the others, except a 30% reduction in speed. This is the highest level of speed reduction identified by DNV in this CIA.

Speed reduction was a critical part of the STM and was one of the primary options for meeting the Carbon Intensity Indicator (CII). For the MTM, speed reduction is still a relevant element but diminished in that the SR 50% included in the STM study was not included in Task 2 or this task.

The ship-side cost intensities were derived from comparing the various scenario modelled outputs to the BAULG modelled outputs provided by DNV. There was close coordination between Starcrest and DNV throughout the Task 4 effort. Speed reduction was applied to identified ships associated with the 39 commodity case studies on identified illustrative routes based on information provided by UNCTAD and Marine Benchmark, which is the same data that Task 2 uses. There was close coordination between Starcrest and other Task Leaders and data providers throughout Task 4.

In order to combine ship-side and commodity-side cost impacts both needed to be converted to the same basis – in this case a total commodity cost basis. To do so, detailed *ad valorem* freight rates from UNCTAD were multiplied times the applicable Task 2 ship-side cost intensities. This resulted in 'freight rate adjusted commodity cost intensity' (FRACCI) which could then be added to the commodity cost intensity increases due to speed reduction, as applicable. This approach was coordinated and aligns with UNCTAD's modeling for Task 3. Due to the specific nature of the Task 4 commodity case studies, it was agreed between UNCTAD and Starcrest to use UNCTAD's specific (detailed) rates and not the aggregated rates used in the state level modeling in Task 3. The rates used in both tasks are 2021 basis rates, which are the latest rates from UNCTAD.

Results were produced at the ship type level, and aggregated to the case study level, to the participating Member State level, and to the entire project level including all 39 commodity case studies. The model inputs, fleet data, and extractions of Task 2 model outputs, result calculations and aggregations, figures, and report were reviewed multiple times by different internal reviewers to make sure quality assurance and quality control (QA/QC) checks were completed across all aspects of the project. The approach, methods, equations, defaults, and references are documented in detail in Appendix A and the Bibliography in Appendix C, and summarized in Section 2 of this report.

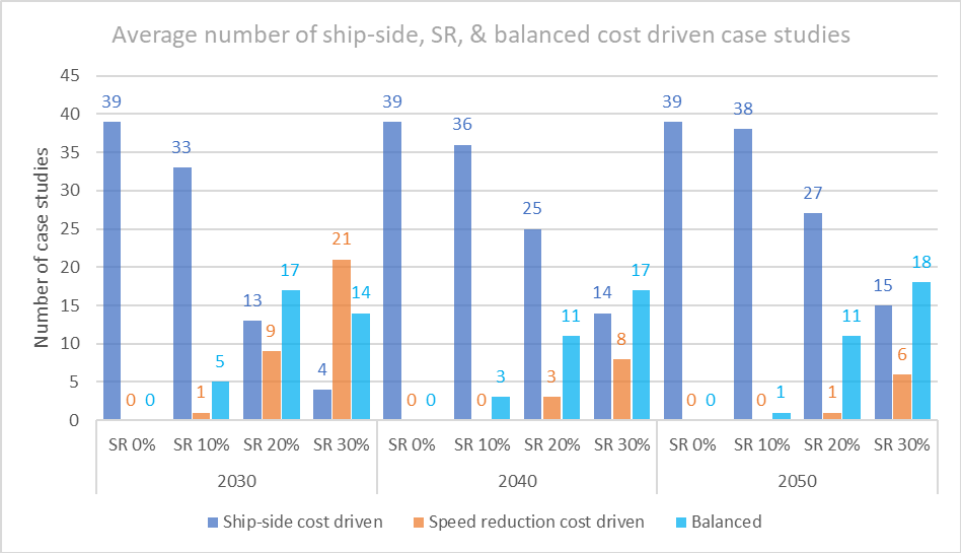
The 39 commodity case studies fell into three categories with respect to the cost intensity change drivers, associated with the MTM:

- **Ship-side cost intensity driven case studies**. These case studies typically include lower value commodities, traded on shorter to medium distance routes, and have relatively medium to higher *ad valorem* freight rates.
- **Speed reduction commodity cost intensity driven case studies**. These cases studies typically include higher value commodities, traded on medium to long distance routes, and have relatively lower *ad valorem* freight rates.

- **Balanced cost driven case studies**. These case studies were generally equally driven by both costs and associated with commodities traded on medium distance routes, with relatively medium *ad valorem* freight rates. These were less common than the other two types.

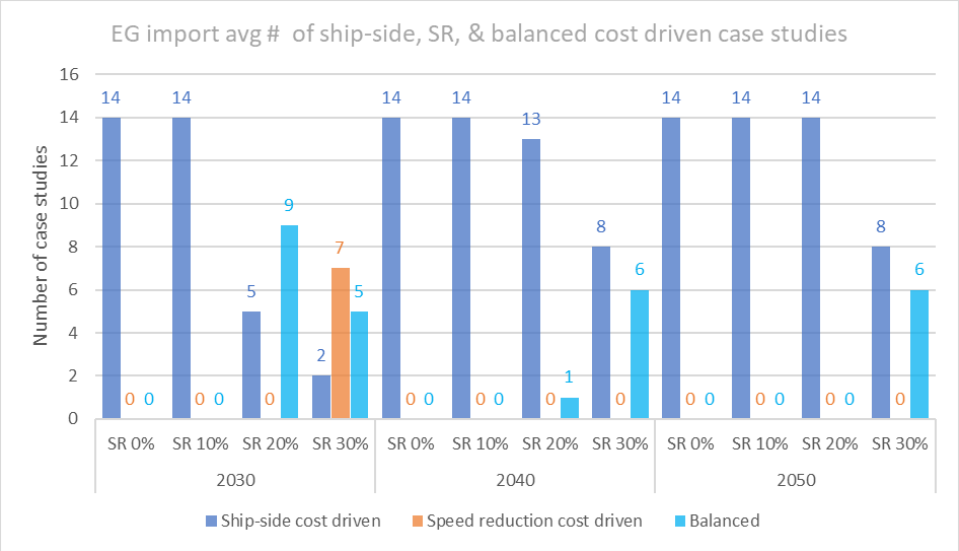
Taking into account all 39 commodity case studies and the five MTM scenarios analyzed, the average number of commodity cases by each type of driver, by speed reduction group, and forecasted year is presented in Figure ES.2. As observed from the figure, the ship-side cost intensity driver is the predominant driver across all commodity, scenario, speed reduction group, and forecasted year combinations, with the exception of 2030 SR 30%, for which speed reduction is the primary driver. Note that SR 0% is ***only*** the impact of the MTMs (***no speed reduction***).

Figure ES.2: Average number of ship-side, speed reduction, & balanced driven commodity case studies



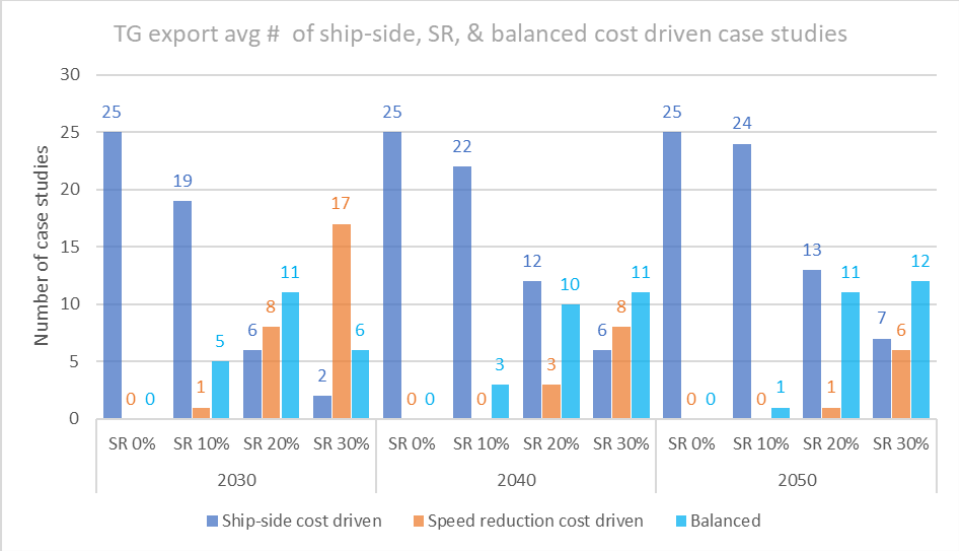
Looking at the 14 imported essential goods commodity case studies across the forecasted years, the ship-side cost intensity change is the primary driver for cost change with one exception: in 2030 the higher speed reduction groups are led by speed reduction and then balanced, as presented in Table ES.3. Note that other than this one case, speed reduction is not a primary driver across any of the years and speed reduction groups.

Figure ES.3: Import essential goods average number of ship-side, speed reduction, & balanced driven commodity case studies



Looking at the 25 export trade goods commodity case studies across the forecasted years, the ship-side cost intensity changes drive cost changes for the group with no or lower speed reductions, while at the highest speed reduction groups there is combination of all three, as presented in Table ES.4. Speed reduction is only the primary diver at the highest speed reduction group in 2030.

Figure ES.4: Export trade goods average number of ship-side, speed reduction, & balanced driven commodity case studies



Qualitative analysis

The previous CIA STM Task 4 solicited contextual information and insight from participating Member State stakeholders that are connected to their selected case studies and organized and documented that information to inform the development and implementation of the STM. The STM qualitative analysis focused on impacts from speed reduction as a means to comply with the CII.

As noted above, the MTM Task 4 analysis combines modeling of ship-side cost increases due to the basket of candidate MTM from Task 2, in conjunction with potential commodity cost increases due to vessel speed reductions, which DNV assumed would continue to be a component of compliance strategies. Building on the approach used for the STM and included the MTM Task 4 Work Plan, qualitative information was again sought from and provided by the participating Member States and their stakeholders.

A set of 16 questions on the impacts of cost and time changes to commodity movements was developed in conjunction with the participating Member states. The Member States then took these questions to their national resource teams to gather and provide input for each commodity. These stakeholders shared their knowledge and expertise through the questions related to their commodities of interest, and through other materials, meetings, and correspondence. Similar to the CIA STM, Starcrest did not 'validate' or cross reference stakeholder responses provided by participating Member States; this was outside the Task 4 Work Plan and would be a project unto itself.

The SWOT framework was suggested by the SC as a tool for undertaking the qualitative analysis and was then included in the Task 4 Work Plan. SWOT analyses were used to organize and present qualitative responses, data, and input in a way that is standardized, allows for comparisons across Member States, and is more accessible than the call out boxes used previously in the STM report.

Two SWOT analyses were developed for each participating Member State. These focused on 1) sensitivities related to maritime transport cost increases, and 2) sensitives associated with potential longer transit times due to speed reduction. The stakeholder responses were typically aggregated by the participating Member State's focal point and sent to the Project Team to be reviewed for clarity and understanding, with the aim of identifying which information could be included in the two SWOTs and where to place each response within the framework. In addition, the responses were reviewed to identify which information could inform quantitative results like shelf life, spoilage, product value devaluation, and other related parameters.

For those responses where additional clarity was needed, the Project Team reached out to the participating Member State focal point to gather additional information through emails and online meetings. For each Member State, the SWOTs were completed by the Project Team along with identification of key findings from the materials submitted and shared with the Member States for review feedback to ensure that the materials were interpreted correctly.

Note that some of the data submitted was deemed confidential by the data provider. The participating Member States worked with their cohorts to determine what information could be shared and what needed to remain confidential.

Uncertainties

The following are key uncertainties associated with this analysis:

- Since Task 4 integrates both the outputs of Task 2 and the data from Task 3, ***all the uncertainties with those two reports are applicable to this study*.**
- ***Ad valorem*** rates for each Member State were based on the detailed UNCTAD Trade and Development dataset that underlies Task 3's modelling of State impacts. There are no specific rates for Cook Islands nor Tonga, and an aggregated 'Pacific SIDS' rate was used. The uncertainty around those aggregated rates compared to the actual situation for each of those States is unknown.

- Related to Task 4, in Task 2 future ship-side cost impacts are aggregated by ship type, size, and age combinations. There are uncertainties associated with determining when to apply the ship-side impacts of an aggregated combination when analyzing a limited number of specific ships. This is especially true when ships have similar aspects to another ship type, size, and age combination. This becomes a '*boundary issue*.' For example, the two general cargo ships servicing the Cook Islands and Tonga are classified as general cargo 5,000 – 9,999 deadweight tonnes, that are 17 years old, hold just over 500 teus, design speed of 15 knots, and have cranes. In the Task 2 model there is also a category of container 0 – 999 teu with the same age group, which these ships also fit, with an average design speed of 15 knots, and may also have cranes. These ships operate solely in the Pacific, and in discussions with DNV, it was agreed that the impacts of the MTMs would likely be driven by compliance pooling options and the latter vessel group was more representative.
- Related to Task 4, again when trying to apply aggregated cost impacts for specific ships, one of the key cost impacts is related to whether the ship joins a compliance pool or not. At the global level this is not an issue, but when looking at specific ships, this becomes an uncertainty.
- As noted from the Task 2 Project Leader, "joining a ship pool to meet compliance of MTM. Compliance pools under the flexibility mechanism and while it is voluntary to join a pool, you must comply with the regulations. The modelling has shown that it is more cost effective to join a pool. DNV have not been able to ascertain the correct price."[7]
- There was no cross referencing/validation of stakeholder qualitative responses with publications, papers, or to confirm the response is consistent with economic or industrial theories. Similar to the CIA STM, the stakeholder input was to provide context from the national level from professionals and experts in the Member State that were associated/highly familiar with the trade. It was outside the scope of the Task 4 Work Plan to cross reference all the input received for the potential that respondent(s) might be trying to 'influence' policy decisions.

Quality assurance and control

Starcrest implemented its multi-review quality assurance and control (QA/QC) approach for the conduct and completion of Task 4 deliverables. The approach ensures that information, data, calculations, results, and drafted sections of the analysis are reviewed multiple times from within the Drafting team, an internal team of QA/QC experts outside the Drafting team, from the Member States that provided input, and third-party reviewers including external QA/QC reviewers nominated by the United Kingdom and China, as well as both verbal and written comments from Steering Committee members. The necessary time and resources were used to ensure that the analysis was fully reviewed and is sound. While the report itself also went through numerous QA review cycles, due to project timeline constraints and the sheer size of the document, there may be some inconsistencies.

Discerning impacts from cost changes

As noted above, this analysis is a 'sensitivity analysis' that readers could use to determine what drives the impacts of the 39 commodity case studies. It illustrates what the various magnitudes the cost increases are by MTM policy scenario, with and without speed reduction, and by forecasted year. There is no established IMO MEPC bright line that indicates severity of impact, nor does this report suggest any bright lines. In order to understand the forecasted numbers below, one needs to take into account several contextual items including:

- Essential goods vs trade commodities. As noted above the impacts are fundamentally different.

[7] Email exchange with Tore Longa, Project Manager Task 2, 18 July 2024

  - Related to essential goods, Member State's GDP, GDP per capita, and income per capita to understand the capacity of the society to absorb higher costs.
  - Related to trade goods, the sectoral/sub sectoral contribution to the national GDP, the number of employees associated with the trade, and supporting/reliant in-country industries.
- Size of population to absorb costs and take advantage of economies of scale.
- Are there alternative competitive transportation modes available to move the commodity?
- The remoteness of the country from its trading partners.
- Are there trade agreements that reduce the cost impacts or amplify the cost impacts?

Refer to the individual Member State section in the report for more information and commodity specific results.

Forecasted cost increases by forecasted year

2030

The 2030 Task 4 total commodity cost intensity results for all 39 case studies, by scenario and by SR groups are presented below.

- The expected total commodity cost intensity increases for **SR 0%** across all case studies and scenarios are:
  - Scenario 23 0.09% to 4.62%, with an average of 1.21%
  - Scenario 24 0.15% to 4.44%, with an average of 1.25%
  - Scenario 31 0.22% to 5.60%, with an average of 2.00%
  - Scenario 32 0.22% to 8.54%, with an average of 2.38%
  - Scenario 46 0.47% to 12.76%, with an average of 4.82%

- The expected total commodity cost intensity increases for **SR 10%** across all case studies and scenarios are:
  - Scenario 23 0.10% to 5.17%, with an average of 1.50%
  - Scenario 24 0.17% to 5.00%, with an average of 1.53%
  - Scenario 31 0.75% to 5.61%, with an average of 2.29%
  - Scenario 32 0.79% to 8.56%, with an average of 2.66%
  - Scenario 46 1.04% to 12.77%, with an average of 5.10%

- The expected total commodity cost intensity increases for **SR 20%** across all case studies and scenarios are:
  - Scenario 23 0.15% to 7.42%, with an average of 2.66%
  - Scenario 24 0.22% to 7.25%, with an average of 2.70%
  - Scenario 31 1.24% to 6.87%, with an average of 3.45%
  - Scenario 32 1.52% to 8.60%, with an average of 3.83%
  - Scenario 46 2.08% to 12.82%, with an average of 6.27%

- The expected total commodity cost intensity increases for **SR 30%** across all case studies and scenarios are:
  - Scenario 23 0.26% to 15.85%, with an average of 5.48%
  - Scenario 24 0.33% to 15.28%, with an average of 5.51%
  - Scenario 31 1.36% to 15.84%, with an average of 6.26%
  - Scenario 32 1.98% to 15.90%, with an average of 6.64%
  - Scenario 46 2.88% to 17.78%, with an average of 9.08%

2040

The 2040 Task 4 total commodity cost intensity results for all 39 case studies, by scenario and by SR groups are presented below.

- The expected total commodity cost intensity increases for **SR 0%** across all case studies and scenarios are:
  - Scenario 23 0.59% to 18.18%, with an average of 6.34%
  - Scenario 24 0.54% to 14.47%, with an average of 5.26%
  - Scenario 31 0.60% to 14.12%, with an average of 5.17%
  - Scenario 32 0.60% to 14.65%, with an average of 5.37%
  - Scenario 46 0.69% to 15.70%, with an average of 6.37%

- The expected total commodity cost intensity increases for **SR 10%** across all case studies and scenarios are:
  - Scenario 23 1.16% to 18.19%, with an average of 6.63%
  - Scenario 24 1.11% to 14.48%, with an average of 5.55%
  - Scenario 31 1.17% to 14.23%, with an average of 5.46%
  - Scenario 32 1.17% to 14.76%, with an average of 5.65%
  - Scenario 46 1.26% to 15.81%, with an average of 6.66%

- The expected total commodity cost intensity increases for **SR 20%** across all case studies and scenarios are:
  - Scenario 23 2.10% to 18.24%, with an average of 7.79%
  - Scenario 24 2.01% to 14.53%, with an average of 6.71%
  - Scenario 31 2.08% to 14.67%, with an average of 6.62%
  - Scenario 32 2.10% to 15.20%, with an average of 6.82%
  - Scenario 46 2.60% to 16.24%, with an average of 7.82%

- The expected total commodity cost intensity increases for **SR 30%** across all case studies and scenarios are:
  - Scenario 23 3.79% to 21.13%, with an average of 10.60%
  - Scenario 24 3.24% to 18.98%, with an average of 9.52%
  - Scenario 31 3.04% to 17.68%, with an average of 9.43%
  - Scenario 32 3.20% to 17.80%, with an average of 9.63%
  - Scenario 46 3.37% to 20.44%, with an average of 10.63%

2050

The 2050 Task 4 total commodity cost intensity results for all 39 case studies, by scenario and by SR groups are presented below.

- The expected total commodity cost intensity increases for **SR 0%** across all case studies and scenarios are:
  - Scenario 23 0.73% to 19.86%, with an average of 6.89%
  - Scenario 24 0.73% to 19.56%, with an average of 6.80%
  - Scenario 31 0.80% to 20.31%, with an average of 7.09%
  - Scenario 32 0.78% to 18.81%, with an average of 6.81%
  - Scenario 46 0.76% to 20.46%, with an average of 7.07%

- The expected total commodity cost intensity increases for **SR 10%** across all case studies and scenarios are:
  - Scenario 23 1.30% to 19.88%, with an average of 7.17%
  - Scenario 24 1.30% to 19.57%, with an average of 7.09%
  - Scenario 31 1.37% to 20.32%, with an average of 7.38%
  - Scenario 32 1.35% to 18.82%, with an average of 7.10%
  - Scenario 46 1.33% to 20.47%, with an average of 7.36%

- The expected total commodity cost intensity increases for **SR 20%** across all case studies and scenarios are:
  - Scenario 23 2.59% to 19.92%, with an average of 8.34%
  - Scenario 24 2.58% to 19.62%, with an average of 8.25%
  - Scenario 31 2.76% to 20.37%, with an average of 8.54%
  - Scenario 32 2.72% to 18.86%, with an average of 8.26%
  - Scenario 46 2.68% to 20.52%, with an average of 8.52%

- The expected total commodity cost intensity increases for **SR 30%** across all case studies and scenarios are:
  - Scenario 23 4.27% to 20.42%, with an average of 11.15%
  - Scenario 24 4.26% to 20.44%, with an average of 11.06%
  - Scenario 31 4.45% to 20.83%, with an average of 11.35%
  - Scenario 32 4.16% to 20.84%, with an average of 11.07%
  - Scenario 46 4.36% to 20.90%, with an average of 11.33%

1 Introduction

In accordance with the Revised procedure for assessing impacts on States of candidate measures (MEPC.1/Circ.885/Rev.1)) and the Terms of reference of the comprehensive impact assessment of the basket of candidate mid-term measures (MEPC/80/17/Add.1, annex 16), the Comprehensive impact assessment (CIA) of the basket of candidate mid-term measures (MTM), consists of five interlinked tasks:

- Task 1: Literature review, led by World Maritime University (WMU)
- Task 2: Assessment of impacts on the fleet, led by DNV[8]
- Task 3: Assessment of impacts on States, led by the United Nations Conference on Trade and Development (UNCTAD)
- Task 4: Complementary qualitative/quantitative stakeholders' analysis, led by Starcrest
- Task 5: Identification of areas of missing data, quality assurance and quality control (QA/AC), uncertainty, and sensitivity analyses and integration between various tasks, led by members of the Steering Committee (SC)

As noted in the Revised work plan for the conduct of the comprehensive impact assessment of the basket of candidate mid-term measures for Task 4 (Complementary qualitative/quantitative stakeholders' analysis), as provided in the annex to document MEPC 82/7, the primary focus of Task 4 is:

> 'To undertake complementary qualitative/quantitative stakeholders' analysis of potential negative impacts on specific States, including relevant illustrative case studies.'

This study comprises the Task 4 complementary qualitative and quantitative stakeholder analyses, which is one of five tasks of the Comprehensive Impact Assessment of the mid-term GHG reduction measures (CIA MTM). This portion of the CIA MTM is conducted by Starcrest Consulting Group, LLC (Starcrest). It assesses the possible impacts of certain policy combinations of candidate mid-term measures in 10 selected Member States, namely Argentina, Belize, Brazil, Chile, Cook Islands, Peru, South Africa, Togo, Tonga, and the United States, across 39 identified commodity case studies and specific trade routes (including ports of origin and ports of destination) selected by the participating Member States. Cook Islands and Tonga are Small Island Developing States (SIDS) and Togo is a Least Developed Countries (LDCs) in this study. The 39 commodity case studies include a mix of essential goods and trade commodities.

This study aligns with Step 4, paragraph 15 of the Revised procedure for assessing impacts on States of candidate measures, found in MEPC.1/Circ.885/Rev.1 and the Revised work plan for the conduct of the comprehensive impact assessment of the basket of candidate mid-term measures for Task 4 (MEPC 82/7, annex).

Each of the first four tasks of the CIA MTM provides different perspectives on the potential impacts of the various policy combinations of the MTM. Task 1 provides a systematic review of relevant literature related to CIA MTM (Literature Review). Tasks 2, 3, and 4 provide three different perspectives on understanding the potential impacts from the MTM. Task 2, conducted by DNV,[9] examines the impacts of the MTMs on the global fleet of vessels and their future costs. Task 3, conducted by

[8] DNV, *Comprehensive Impact Assessment of the basket of candidate mid-term GHG reduction measures – Task 2: Assessment of impacts on the fleet* (CIA Task 2 Report), June 2024 [DNV 2024]
[9] DNV 2024

UNCTAD,[10] focuses on economic impacts at the country and regional levels. Task 4 (this report) examines costs and timing impacts due to ship-side and ocean transit time and economic impact implications on 39 actual commodities shipped to or from 10 different countries on selected trade routes.

To use an analogy, Tasks 2 and 3 are global perspectives on the potential impacts of the fleet and countries from the various scenarios, similar to the view from the International Space Station. In these global analyses and results, there are aggregations that 'flatten' the 'topography' of what is seen below. Task 4 is taken from the local perspective, where aggregations are minimized, akin to flying through the landscape where features like mountains and valleys are more prominent. As such, Task 4 does not inform on what could happen globally, it provides context and informs what could happen to nationally important sectors. ***This is the purpose of this analysis.***

Task 2: Assessment of Impacts on the Fleet modeled the costs of transitioning the international fleet through the basket of mid-term measures – the ship-side cost intensity increases due to the various selected MTM scenarios for the three forecasted years of 2030, 2040, and 2050. It is assumed that the ship-side cost increase estimates are absorbed by the freight rates that the shipping line charges the commodity/cargo owner ***Ultimately these costs are borne by end consumers.***[11]

Task 3: Assessment of Impacts on States uses the modelled outputs from Task 2 to conduct global modeling simulations at the national and regional level to determine trade flow impacts and country/regional impacts. This is done by using an adapted Global Trade Analysis Project (GTAP) model, for which the underlying database is aggregated to 115 countries and 15 sectors. '***It is important to note that for most SIDS and LDCs, GTAP does not represent them as single economies, but are aggregated to part of a composite one.'***[12] For information on impacts on States, see UNCTAD 2024.

It is important to note that Task 4 was not able to discern how revenue is moved internally within a country to a specific segment or part of a segment within the overall economy. ***Therefore, the revenue disbursements associated with those scenarios that include revenue were not considered in Task 4.*** The Task 4 impacts shown ***do not take into account*** any future revenue disbursements. To understand potential country revenue disbursements by applicable scenario, see UNCTAD 2024.

Of the 10 participating Member States in the MTM stakeholder analysis, six participated previously and four new Member States were added to increase geographical coverage of the cohort. The original six included Argentina, Brazil, Chile, Cook Islands, Peru, and the United States (US). The new participating Member States include Belize, South Africa, Togo, and Tonga. It was agreed by the CIA Steering Committee that the original participating Member States in the CIA STM could continue with the same number of commodities as in the past, and due to time constraints and scope, the new Member States could choose a maximum of 3 each. In total 39 commodity case studies were identified. Similar to the stakeholders analysis in the CIA STM, the commodities selected by the Member States could be either:

[10] UNCTAD, *Comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures, Task 3 Assessment of Impacts on States, Final Report*, July 2024 [UNCTAD 2024]
[11] First, the additional cost is paid either by the importer or exporter, depending on the terms in the purchase/sale agreement. The extra cost is then passed to all the supply chain actors, who finally charge the costs to the final consumer (end consumer) who is the one paying for additional costs and inefficiencies.
[12] UNCTAD 2024

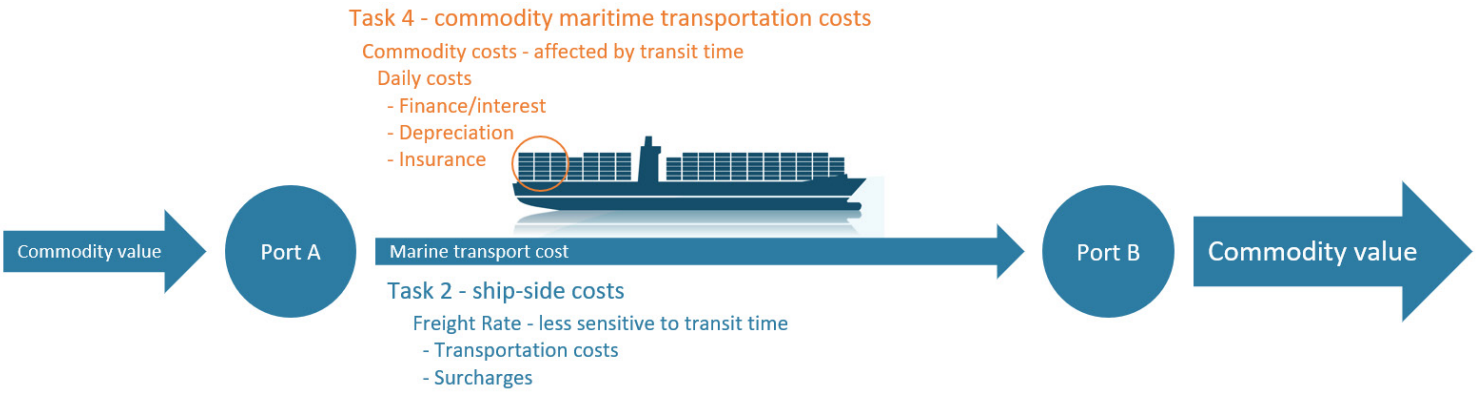
- **Essential goods -** those commodities needed to sustain life and society such as food, water, medicine, fuel, building materials, electronic equipment (communications, computers, etc.), and many others. Impacts from higher maritime transport costs and/or longer transits could include shortages, rationing, disruption to the society that depends on these goods.
- **Trade commodities -** a broad group of goods that are traded between countries and include everything from foods (perishables and nonperishables), raw materials, partial or finished products, animals, waste products, and fuels. Impacts from higher maritime transport costs and/or longer transits could include financial and employment disruption within the sector or portion of the national economy are associated with the trade commodity.

The differences between these types of goods lie in their fundamentally different potential for negative impacts. For people fully dependent on marine transportation to sustain life and society, potential negative impacts caused by port arrival delays of essential good imports could for example result in shortages for those essential goods or fuels that are not warehoused or stored in quantities sufficient to cover the delay period. In stark contrast, potential negative impacts from longer transit times for trade commodities generally affect only a specific sector of a country's greater economy; however, life will continue to be sustained and only a segment of society will be impacted. It is important to note that countries' selected commodities can include both essential goods imported, and trade commodities imported or exported. In this study all selected essential goods were imports, and the selected exports were all trade goods.

Note that one country's essential good is another country's trade commodity; it depends on the direction of trade.

Two key cost elements make up the total increases related to the MTM: ship-side cost increases and cargo-side cost increases due to longer transit times. The ship-side cost increases include everything modelled by DNV in Task 2, which includes the impacts of both the Short-Term Measures (STM) and MTM, as well as projecting the use of vessel speed reductions and other compliance measures over time. Increases in the cargo costs due to longer transit times are not modeled in Task 2. These cargo related increases are from daily costs that include finance/interest charges, depreciation, and insurance for additional vessel transit time to reach the destination. For each of the 39 commodity case studies, Task 4 provides the separate and combined ship-side and cargo-side cost changes. Together, these are the total commodity cost intensity increases. The concept described above is illustrated in Figure 1.1.

Figure 1.1: Illustration of maritime transport costs



These costs are added and are part of the landed costs of commodities upon arrival at the destination port, compared to business-as-usual (BAU) transit times. It is assumed in Task 4 that both cost intensity changes will ultimately be passed on to the final consumer as it is a common industry practice.

In cases where cargo is transshipped at intermediate ports (cargo is unloaded and transferred to another ship to continue its voyage to its destination port), our analysis covers all water transit times (only the ship navigational time), but not the port stays. For this analysis, the time the cargo spends within intermediate ports is assumed not to change and so is not included in maritime transport cost changes.

Task 4 does ***not*** prescribe nor estimate where speed reduction should be used for any commodity case study or ship segment. Task 4 does provide the projected commodity cost impacts should speed reductions be implemented by the ship operator due to cost, compliance needs or other timing criteria. This study should be seen as a 'sensitivity analysis' for the 10 participating Member States, and the ship type, size and age, market and commodity combinations. These analyses can be informative for other stakeholders with similar combinations of trade and fleet types.

To support the specific analyses, a broad range of data, contextual information, and insights/perspectives is captured by Task 4. This information was provided by participating Members States and their national stakeholders, as well as UNCTAD, DNV, and Marine Benchmark. National resources included a broad range of organizations including: industry representatives, trade associations, product/sector associations, institutes, government ministries, exporters, shipping lines, ports, customs departments, national statistic offices, and Chambers of Commerce.

Note that for this report, cost increases refer to commodity cost intensity increases and the terms are used interchangeably.

Inter-Task coordination efforts

Throughout the project timeline, coordination was conducted with the Member States, Tasks 2 and 3 project teams, and the Steering Committee.

During ISWG-GHG 16 and MEPC 81, Starcrest had a coordination meeting with DNV and UNCTAD to discuss the approaches, timelines, progress, and concepts as to how those tasks could be integrated into Task 4. In addition, Starcrest held various coordination meetings with the 10 Member States to inform them on the relevant data needs, process, and tight project timelines, as well as address questions and solicit feedback. These informative discussions led to the development of a way forward and approach to Task 4. Starcrest also emailed status updates and action item to the Member States throughout the project.

Starcrest presented a proposed path forward for Task 4 at the 4th Steering Committee (SC 4) Meeting on 30 to 31 January 2024. A more detailed presentation on the proposed approach was made at the 6th SC Meeting, 13-14 May 2024 and the approach document was posted to the SC on 15 May 2024. An update in response to comments received from the SC was posted on 14 June 2024. In addition, a note was circulated in conjunction with the approach document related to the selection of bracketing scenarios from Task 2 (these originally focused on one mean and one high impact scenario). This note was uploaded to IMO Space on 21 May 2024. The scenario selection note was updated and finalized based on input from the SC to include a total of five bracketing scenarios, including a 'strive' scenario, as described in the next section. Starcrest posted a Step 1 draft for SC review on 26 June 2024 for review prior to the 9th SC meeting and posted a full final draft for SC review on 8 July 2024 for review prior to the 10th SC meeting. Coordination with both the Task 2 and Task 3 project teams continued to the end of the project.

As Starcrest started to incorporate the outputs from Task 2 into the analysis of the case studies, coordination with DNV was conducted frequently to ensure understanding and proper use of the outputs. Similarly, a coordination call with UNCTAD and the IMO Secretariat was conducted in June to ensure alignment on key items between Tasks 2 and 4.

Key concepts

To understand the findings presented in this report, the following key concepts should be understood.

Maritime transport costs are one of the key elements of trade costs. As noted below, the transportation cost percentages of the commodities' prices were estimated using the UNCTAD Transport Cost Data webpage for each case study. Based on the *ad valorem* freight rates identified and used across the 39 commodity case studies, the maritime transport costs (freight rates) ranged from 1.3% to 32.1%, with an average of 11.0% of landed costs.

What variables drive maritime transport cost increases?

What drives the ultimate maritime transport cost increases for each of the 39 commodity case studies are their unique combination of the following variables:

- **Ship-side cost increases** – These are the cost increases modeled by DNV for Task 2 across the fleet for each MTM scenario and the forecast years (2030, 2040 and 2050). For each scenario, the cost impacts are dependent on the ship type, size, and age. ***These cost increases include all the ship-side estimated costs associated with the various MTM scenarios***. These costs vary widely for each ship type, size, and age combination based on the many assumptions and scenarios documented and referenced in Task 2 (DNV 2024). These include:
  - **CAPEX**– capital expenses associated with the ship, including newbuild ships, capital improvements on existing ships associated with the MTM, energy-efficiency retrofits on existing ships, etc.
  - **OPEX** – operational expenses including fuel, crew, provisions, maintenance, etc.
  - **Carbon capture and control** – carbon capture CAPEX and OPEX expenditures, as applicable.
  - **Regulatory costs** – costs associated with regulations including MTM, except joining compliance pools under the GFI flexibility mechanism.
- **Cargo-side cost increases** – These are elements on the cargo-side that result in cost increases, including
  - **Cargo value** – Higher value commodities are generally more sensitive to increases in time than they are to ship-side cost increases (maritime transport costs or freight rates) due to their typically lower *ad valorem* rates; generally higher value cargoes and time-sensitive commodities tend to incur higher freight rates. Lower value commodities are generally more ship-side cost sensitive than time sensitive and tend to have higher *ad valorem* rates.
  - ***Ad valorem* rate** – The *ad valorem* rate is the maritime transport cost as a percentage of the total landed commodity cost (ocean freight rate as a percentage of total landed commodity cost). For this study, the landed cost is the total value of the commodity at the receiving port including costs associated with maritime transport. Generally, the lower the *ad valorem* rate, the lower the sensitivity to ship-side cost increases, and the higher the sensitivity to time delays. The same is generally true in reverse. Generally, the higher the *ad valorem* rate the higher the sensitivity to ship-side costs (maritime transport costs/freight rates), and the lower sensitivity to time delays.

- **Longer transit times** – The longer transit time resulting from voluntarily reduced transit speeds may generally reduce ship-side energy consumption, but generally adds cargo-related daily costs such as finance/interest charges, depreciation, and insurance. In addition, for perishable commodities or commodities that have shelf life or expiration limitations, added time in transit can reduce cargo value due to reduced remaining shelf life, deterioration, spoilage, and expiration. This might impact Member States' competitive positions. Note that Tasks 2, 3, and 4 all incorporate potential longer transit times based on the speed reduction groups presented in Task 2.

- **Distance to market** – The distance to market is the total nautical miles to transport cargo from port of origin to port of destination. Many variable costs are distance-related across both ship-side and cargo-side. However significant differences in vessel size, age and efficiency can provide or reduce economies of scale, making the actual freight rate picture complex.

Freight rates and surcharges

- According to FREIGHTOS,[13] freight shipping rates, ocean freight rates, or freight rates are the costs associated with transporting goods via various freight shipping methods, such as ocean, air, rail, or road. These rates can vary significantly depending on factors such as the mode of transport, distance, volume, weight, and dimensions of the cargo, as well as market conditions and seasonal fluctuations. Several key components that make up the total costs including:
- **Base freight rate** - This is the basic cost of shipping goods from the port of origin to the port of destination. [14]
- **Surcharges** - These are additional fees not covered in the freight rates which apply to cargo transportation. The list of surcharges typically applied in the industry is long, and some of them include:
  - **Bunker Adjustment Factor (BAF)** - This is a surcharge that accounts for fluctuations in fuel prices.
  - **Currency Adjustment Factor (CAF)** - This surcharge compensates for exchange rate fluctuations.
  - **Terminal Handling Charges (THC)** - These are fees charged by the port authorities or marine terminals for handling containers at the origin and destination ports.
  - **Hazardous Materials or Dangerous Cargo** - Charge applies to the movement of hazardous or dangerous cargo.
  - **Peak season Surcharge (PSS)** - Surcharge added to cargo moving for the duration of a typical Peak Season.
  - **Panama Canal Surcharge (PCS)** - Surcharge applied to cargo transiting through the Panama Canal.
  - **Suez Canal Surcharge (SCZ)** - Surcharge applied to cargo transiting through the Suez Canal.
  - **Port Congestion Surcharge**: Charge added to the base rate ocean freight cost reflecting the additional expenses that the ship lines incur when calling at congested ports.
  - **Red Sea Diversion Surcharge**: Charge added for the extended voyages that bypass the Red Sea due to the current threats to commercial shipping (this is included to be representative of a variety of surcharges applied due to emergency situations).

[13] FREIGHTOS, *Ocean Freight Shipping,* 23 February 2023.
[14] In the "tramp" market freight rates and other terms are agreed in the Contract of Affreightment or COA

Maritime Economics, written by Martin Stopford, is an essential reading material for professionals related to the shipping industry. This book (now in its 3rd edition)[15] recognized the complexity of the shipping market. It explains that five variables impact the demand for sea transportation: the world economy, the seaborne commodity trade, the average haul, political events, and transport costs. On the other hand, the supply of shipping services depends on the world's active fleet, fleet productivity, shipbuilding orderbook and deliveries, the ship scrapping market and freight costs (for the purpose of this document, freight rates, freight costs, and transport costs are equivalent), among others. Maritime transportation responds to supply and demand factors by changing freight rates. There is no direct link between one of these variables and the freight rates; the total mix will determine freight rates.

Report structure

The remaining report consists of three main components:

- Section 2 – Approach
  - Appendix A – Detailed approach
- Section 3 – Case studies overview
- Sections 4 through 13 - Member State Stakeholders' analyses
- Section 14 – Stakeholder Analysis – Quantitative results, trends, and conclusions
- Section 15 – Summary of findings from the qualitative analysis

[15] Martin Stopford, Maritime Economics 3e, 2008.

2 Approach

Task 4 consists of two primary analyses:

- **Quantitative analysis** – provides a sensitivity analysis related to the 39 identified commodity case studies, and their potential cost impacts related to ship-side cost increases from the MTM as modelled by DNV and potential cargo-side cost impacts from the speed reductions defined by DNV and modelled by Starcrest.
- **Qualitative analysis** – gathered national level stakeholder contextual input for 16 questions focused on speed reduction, higher costs and other factors. Stakeholder responses were analyzed using a strength, weakness, opportunity, and threat (SWOT) framework adapted to focus on cost increases and longer transit times. Similar to the CIA STM, these responses were not validated as part of the project, but presented solely as stakeholder responses to provide contextual information that could not be determined in the modelling.

The quantitative analysis is composed of a vessel fleet analysis and an economic analysis, which are then combined with information from Task 2 to quantify the impact of landed cost increases on commodity cost. This section describes the approach used for conducting each of these analyses at a high level. A more detailed explanation of the approach, quality assurance, and control measures used to conduct this project is provided in Appendix A. An illustration of the overall approach for Task 4 is presented in Figure 2.1 on the next page. The approached used for Task 4 is described in this section.

Data collection

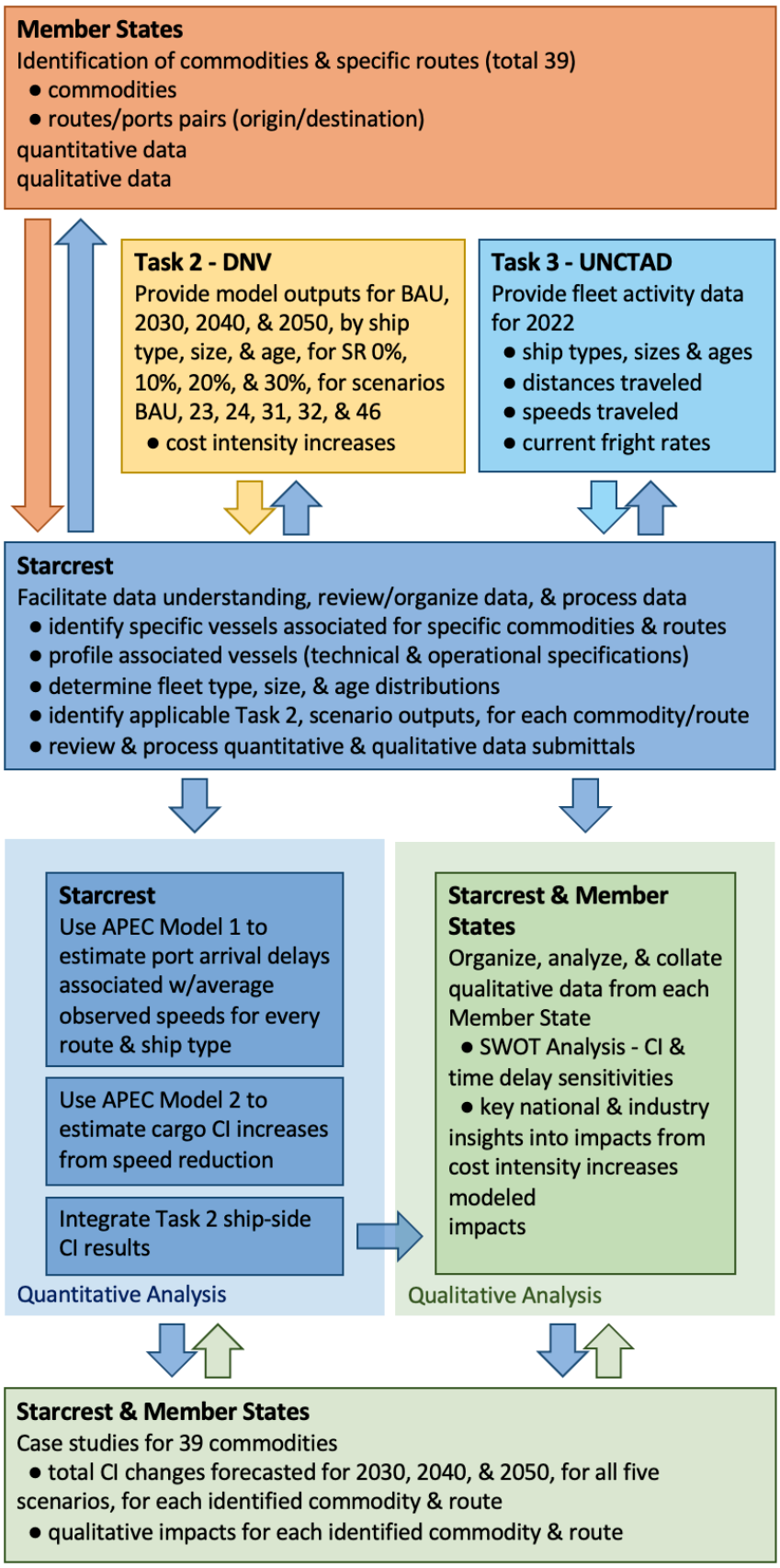
Unlike the other CIA MTM Tasks, Task 4 is dependent on Member States collecting the data for each Stakeholder Analysis. Seven key datasets are needed to complete Task 4 analyses for each participating Member State; these are listed in Table 2.1. Four of these datasets come directly from the Member States. For each commodity selected, a quantitative and a qualitative analysis were completed, building on the datasets compiled by the Member States for the project.

Task 4 is predicated on the modelling results from Task 2 and the ship activity data used in Task 3. Therefore, Task 4's timeline was linked to Member State data delivery, Task 2 results deliverable timelines, and Task 3 ship activity data availability.

Table 2.1: Task 4 Key datasets descriptions & data provider

	Key Task 4 Datasets descriptions	Data provider
1	For each commodity of interest, HS code, including ports of origin and departure (specific route)	Member State
2	Commodity economic & contextual data	Member State
3	Qualitative survey input from in-country resources (government, trade association, shippers, institutions, etc.)	Member State
4	Port call data associated with commodity (ships, associated commodity cargo throughput, port contextual data, etc.)	Member State
5	Fleet parameter data (physical characteristics)	Starcrest
6	Fleet operational data (ship port calls/routes, average speeds, etc.)	Task 3 UNCTAD (data provider)
7	Cost intensity changes for mean & high impact scenarios; by ship size, age; for 2023, 2030, 2040, 2050	Task 2 DNV

Figure 2.1: Illustrative flow chart of main efforts under Task 4



The participating Member States selected commodities and specific port-pair routes, and provided data needed to conduct the analyses. Two primary quantitative data questionnaire input files were provided to the Member States to facilitate the data collection. These were similar to the files used during the last CIA. These questionnaires provided the primary data inputs needed for the two APEC models used in the study, and the qualitative analyses. A third questionnaire requested qualitative information from knowledgeable stakeholders within the Member States on the impacts of increased maritime transport costs and longer vessel transit times. Data gaps were identified and noted. An illustration of the main efforts associated with Task 4, and the coordination points with Task 2, 3, and the participating Member States, is presented in Figure 2.1 on the next page.

A note for clarity: In this document the term "delay" is used to refer to a scheduled longer transit time, and not a one-time arrival reliability failure. This is consistent with the STM report and APEC usage.

Quantitative analysis

The quantitative analysis is made up of a fleet analysis, MTM scenario selection, and an economics analysis.

Fleet analysis

For the previous CIA STM, vessel speed reduction was a primary reduction option for meeting the various energy efficiency targets set out in the STM. For the CIA MTM, speed reduction plays a diminishing role into 2050 as new fuels are integrated into the fleet, additional efficiency improvements are incorporated through design of new ships, and improvements are made to existing ships. Further, Task 2 modelling no longer include a 50% speed reduction, which was a part of the STM study.

The Task 2 modelling results for each scenario are organized by the following:

- cost intensity (CI) estimates and associated data for baseline year 2023 (also referred to as business as usual, BAU) and 2030, 2040, and 2050, by
    - ship type, size, and age groups, and by
        - speed reduction groups: 0%, 10%, 20%, and 30%

Starcrest coordinated with UNCTAD and data provider, Marine Benchmark,[16] for ship activity metrics along the identified routes for the 39 case studies so that both analyses would be based on the same data. The datasets provided were for calendar year 2022. This data was processed in a manner similar to that used in the previous CIA STM to generate inputs for the APEC Models [APEC 2019].[17]

APEC Module 1 – Emission Impacts (APEC Module 1) was used to estimate increased transit time (delay). The average age across all the identified ships and trips identified was used for each type and size group. The following were derived for each ship type and size group combination:

- average age
- average distance sailed
- average speed

[16] *Marine Benchmark.*
[17] APEC, *Analysis of the Impacts of Slow Steaming for Distant Economies,* submitted by Chile, ISWG-GHG 7/2/17, 7/2/25, Starcrest, December 2021, [APEC 2019].

For each of the 39 commodity routes, the ship type and size group combinations were identified for the ships that operated on these routes in 2022. The average age distributions were kept constant in order to align with corresponding Task 2 cost intensity outputs that were provided in vessel age ranges (e.g., if the average age of the identified ship on a specific route is 20 years old, then this age was assumed for ships on this route in 2030, 2040, and 2050). This approach keeps the status quo and avoids numerous assumptions around specific route-focused fleet transitions, which would be highly speculative. This approach was confirmed in a meeting with DNV.

For each case study, one to many ship types and size groups were identified, resulting in a total of 87 combinations across all 39 case studies. For each of these groups, the average longer transit times were estimated for speed reduction (SR) 10%, 20%, and 30% groups applied to the average marine transit speeds. This data was then input into APEC Module 2 – Economic Impacts (APEC Module 2) for the economic analysis. Trip-weighted averages were used to produce one set of results for each case study, for each forecasted year.

Note that the emission elements of the model were not used in this analysis as they are not relevant to the greater analysis of the CIA MTM. Appendix B of APEC 2019 provides detailed documentation for both Module 1, used for the fleet analysis, and Module 2, used for the economic analysis.

The selection of scenarios to include in the quantitative analysis completed under Task 4

Due to time constraints, the scope of Task 4 does not include all the scenarios that DNV modeled in Task 2. Instead, a bracketing approach was approved by the CIA Steering Committee. A key consideration for the scenarios selected for Task 4 is the need to select from the group of scenarios UNCTAD modeled in Task 3, thus ensuring alignment between the tasks. For Task 3, UNCTAD modeled the following Task 2 scenarios:

- 21, 22, 23, 24, 26, 31, 32, 36, 43, and 46

For scenarios 26, 31, 32, and 46, UNCTAD also modeled four revenue distribution scenarios. Again, due to time and scope constraints, it was not feasible to model all of UNCTAD's scenarios in Task 4. Task 4 is intended to evaluate very specific Member State identified case studies.

It is important to note that Task 4 was not able to discern how revenue is moved internally within a country to a specific segment or part of a segment within the overall economy. ***Therefore, the revenue disbursements associated with those scenarios that include it, were not considered in Task 4.*** Some of the scenarios are designed to generate excess funds that are intended to be used to help offset impacts, among other expenditures, like research and development. Please see the Task 2 DNV 2024 and Task 3 UNCTAD 2024 reports for information related to revenue disbursements.

In consultation with DNV and UNCTAD, and with approval by the CIA Steering Committee, and in consideration of the discussions related to tank-to-wake (TtW) and well-to-wake (WtW) emissions, five MTM scenarios were selected for inclusion in Task 4, as presented in Table ES.2.

Table 2.2: Selected Task 2 Scenarios used for Task 4

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination						
			Policy code	GFI scope	GFI flexibility RU % of price	GFI flexibility SU % of price	Levy USD/tCO_2eq	Levy Reward % of cost gap	Feebate Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

Scenario pairs 23/24 and 31/32 differ only in TtW and WtW, and their differences are observed in the Task 2 modelling outputs. The business-as-usual low growth (BAULG) scenario was used as a benchmark to determine ship-side cost intensity changes for each of the forecasted scenarios.

While some Member States on the Steering Committee would have preferred to have additional scenarios considered, the above approach was ultimately approved. Note that from DNV's perspective, feebate-based scenarios were expected to fall between the selected scenarios for Task 4.

Economic analysis

The economic analysis aligns and builds on the CIA STM analysis. The analysis is informed by a wide range of sources, which are referenced in Appendix A and listed in the Bibliography in Appendix B.

In terms of potential impacts from the five selected MTM scenarios and the speed reduction groups, two key components were found to drive the total commodity cost intensity changes analyzed:

- **Ship-side cost intensity changes.** These cost changes include all cost elements associated with the ship (capital expenditures, operational costs, regulation costs, carbon capture costs, global fleet capacity associated with speed reduction, etc.) for the forecasted years 2030, 2040, and 2050. Ship-side cost intensity changes modeled by DNV were assumed to be fully reflected in freight rates over the low growth BAU cost intensity scenario.
- **Commodity cost intensity changes** due to speed reduction. These cost changes are associated with the cargo (commodities) and include the daily cost increases of finance/interest, depreciation, and insurance costs that increase with each additional day resulting from speed reduction.

These cost changes are independent and additive and make up portions of the landed costs of commodities upon arrival at the destination port compared to BAU transit times. It is assumed in Task 4 that both cost intensity changes will ultimately be passed on to the final consumer.

DNV in Task 2 modelled four speed reduction (SR) groups:

- **SR 0%** - ***this group assumed no speed reduction*** and the associated cost increases are ***solely*** from the ship-side cost intensity changes associated with the MTM, for each scenario and forecasted year by DNV in Task 2.
- **SR 10%** - this is a 10% reduction in the observed ship baseline speed. For Task 4, the average speeds for each of the specific ship type, size, and age combinations identified for each of the 39 commodity case studies were reduced by 10% and the days of increased transit time (delay) were determined.
- **SR 20%** - similar to SR 10%, except using a 20% reduction in speed.
- **SR 30%** - similar to the others, except a 30% reduction in speed. This is the highest level of speed reduction identified by DNV in this CIA.

Recall that speed reduction was a critical part of the STM and was one of the primary options for meeting the Carbon Intensity Indicator (CII). For the MTM, speed reduction is still a relevant element but diminished in that the SR 50% included in the STM study was not included in Task 2 or this task.

The ship-side cost intensities were derived by comparing the various scenario modelled outputs to the BAULG modelled outputs provided by DNV. There was close coordination between Starcrest and DNV throughout the Task 4 effort. Speed reduction was applied to identified ships associated with the 39 commodity case studies on identified illustrative routes based on information provided by UNCTAD and Marine Benchmark, which is the same data that Task 2 uses. There was also close coordination between Starcrest and Marine Benchmark throughout the Task 4 effort.

In order to combine ship-side and commodity-side cost impacts both needed to be converted to the same basis – in this case a total commodity cost basis. To do so, detailed *ad valorem* freight rates from UNCTAD were multiplied times the applicable Task 2 ship-side cost intensities. This resulted in 'freight rate adjusted commodity cost intensity' (FRACCI) which could then be added to the commodity cost intensity increases due to speed reduction, as applicable. This approach was coordinated and aligns with UNCTAD's modeling for Task 3. Due to the specific nature of the Task 4 commodity case studies, it was agreed between UNCTAD and Starcrest to use UNCTAD's specific (detailed) rates and not the aggregated rates used in the state level modeling in Task 3. The rates used in both tasks are 2021 basis rates, which are the latest rates from UNCTAD.

Note that *ad valorem* freight rates were identified for each country, with the exception of the Cook Islands and Tonga. For their commodity case studies, the Pacific Small Island Developing States (SIDS) *ad valorem* rates were used.

The Task 4 economic impact analysis evaluates the impacts of longer vessel transit times due to reduced speed on maritime transport cost and commodity cost for the specific ship types, sizes, and ages associated with each of the commodities and routes identified, for 2030, 2040, and 2050. This economic analysis builds on the APEC study and models and the CIA STM stakeholder analysis, and adds in maritime transport cost data used in Task 3 provided by UNCTAD. A review of specific literature and close coordination with DNV and UNCTAD were essential.

The main sources of data for the economic analysis were provided by Member States for each commodity in two quantitative spreadsheet templates developed for the CIA STM. The data provided ranges from commodity specific to macroeconomic data.

The APEC Module 2 was used to estimate the change in each commodity's costs due to longer transit times (without taking into account ship-side costs). For the ship-side impacts associated with the MTM, the cost intensity increases for that specific ship type, size, and age from Task 2 were used. Since DNV's Task 2 output looks only at the ship-side of the cost intensity increases due to speed reduction there is no double counting.

Member States organized national resources around each of their selected commodities. They organized the data packages and submitted them to the analysis team for review. Some necessary data could not be collected by all Member States due to tight timelines. For a limited number of case studies, missing data was sourced from:

- Trade related data – UN Comtrade database[18]
- Macroeconomic data – Member States official sources (central banks or national statistics offices) and/or the World Bank[19]
- Freight Rates – UNCTAD Transport Cost Data webpage[20]

[18] UN, *Comtrade database*.
[19] World Bank, *World Bank open data*.
[20] UNCTAD, *Transport Cost Data webpage*.

Global logistics networks are dictated by the needs of the shippers (cargo owners) who primarily value three metrics in designing their supply chains: cost, time, and reliability. These metrics are further influenced by a number of factors including market demand, port and inland infrastructure, availability of skilled labor, vessel and network capacity, transit times, government and regulatory issues, and environment and energy efficiency. These case studies focus on maritime transport only (port of origin to port of destination analysis), and not the entire or total supply chain costs. Shipments to some Member States require transshipment. In these instances the evaluation included navigation to the intermediate ports, but not the time spent in intermediate ports.

Most of the existing literature focuses on economic impacts from the ship operator's point of view; that is, the reduction in shipping cost due to the reduction of speed and the environmental impact of doing so. Several earlier papers (Hong Liang 2014,[21] Kalimeris 2015-2016)[22] considered slow steaming as strategy during periods of weak demand, lower freight rates, and/or higher fuel costs, and generally as a way to reduce vessel operating costs (Stopford 2009). The research focused on impacts to the cargo owner's total landed cost and the economic impact on economies. A bibliography of literature underlying this analysis is presented in Appendix B

Maritime transport costs are one of the key elements of trade costs. As noted below, the transportation cost percentage of a commodities price were estimated using the UNCTAD Transport Cost Data webpage for each case study. Based on the *ad valorem* freight rates identified and used across the 39 commodity case studies, the maritime transport costs (freight rates) ranged from 1.3% to 32.1%, with an average of 11.0% of landed costs.

Longer transit times due to vessel speed reduction can increase a shipper's logistics costs. One of the main components to be adjusted on a shipper's supply chain is inventory. Longer transit times require more inventory in the pipeline; that, in turn, creates additional capital expense, inventory carrying costs, storage fees, and the possible adjustment of a shipper's supply chain.[23] Surveys referenced in the literature indicate that shippers value the reliability of ocean transport more than transit times, implying an openness to slow steaming. On the contrary, ocean carriers report that cargo owners continue to request faster transit times.

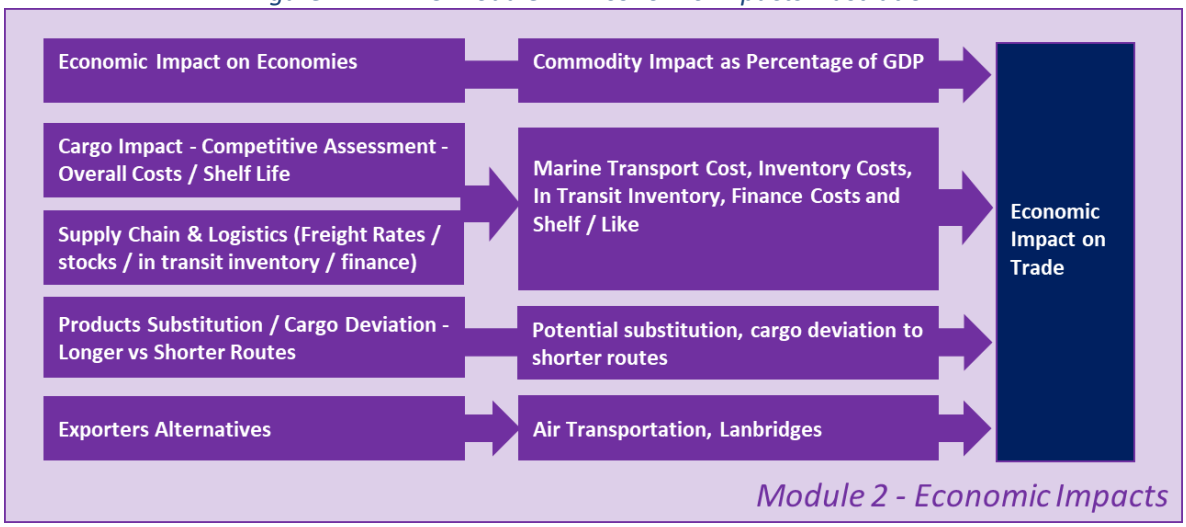
Some of the higher costs related to longer transit times include depreciation in the value of products, inventory holding costs, insurance cost, and interest/financing. Other technical literature also considers shippers' cash flow, lost sales, and production breakdown as additional potential impacts of slow steaming, as well as the impact on product shelf-life for commodities such as food, pharmaceuticals, chemicals, fashion, ephemeral products, electronics, etc. To counter some of these higher costs, transport in refrigerated containers can extend product storage life, but does add cost.[24]

Reviewed literature (Supply Chain Costs: A Definitive Guide for 2024)[25] on supply chain and logistics cost considers inventory costs to be determined by the value of the inventory, the interest rate, and the inventory and service levels. The inventory cost includes the inventory holding cost and pipeline costs.

[21] Hong Liang, Lee. (2014). *The Economics of Slow Steaming*. Seatrade Maritime News, and comments by Ma Shou, professor at World Maritime Univ., Sweden
[22] Kalimeris, George. (2015-2016). *The viability of slow steaming from a supply chain perspective though a break-even bunker price analysis. Master* Thesis - Erasmus University Rotterdam
[23] Supply chain perspective on slow steaming 2014 – Elzarka and Morsi
[24] Carson, J. K.; Kemp, R. M.; East, A. R.; Cleland, D. J. (2015). The Impact of Slow Steaming on Refrigerated Products from New Zealand. ICR 2015, August 16-22 - Yokohama, Japan.
[25] Throughput Inc., *Supply Chain Costs: A Definitive Guide for 2024, Anita Raj.*

The selection of transport mode becomes a trade-off between in-transit time and freight charges. When feasible, perishable shippers of high-value products may select air transport over sea transport because the value of the product can absorb the higher cost of air freight. Time sensitive products are also more likely to select air transport over sea transport, in order to meet their supply chain delivery deadlines. Other intermodal options such as sea-air and air-sea transportation are also used and considered by cargo owners as ways to meet delivery time and condition requirements.

Figure 2.2: APEC Module 2 – Economic impacts illustration



The economic impact analysis was based on total annual trade (full year volume) between the Member State selected port pairs (for both export and import economies), in both total volume (kilos or tons) and value (US Dollars or local currency) for the year provided by the Member State. Three different speed reductions levels were modeled: 10%, 20%, and 30% slower. The assumption is that the total volume of yearly trade will not change simply because of long transit time from vessel speed reduction.[26]

APEC Module 2 only captures ocean transit or time differentials from vessel speed reduction. No impact on the vessel or ship owner, or on inland transportation or warehousing is considered. The analysis is based on actual maritime distances for liners and bulk carriers, average vessel speed, and a range of slow steaming speed options to calculate the impact of delay on annual commodity trade. Shippers' costs include interest rate or financial cost associated to the commodity, commodity depreciation cost, and insurance costs. The key elements analyzed to measure the economic impact of slow steaming include: time delay, GDP impact, financial/interest costs, depreciation costs, and insurance costs. Note that GDP impacts were not analyzed in this study as there was not enough information provided to do so under the project timeline. GDP context is included in the participating Member State sections for those that provided information. These elements and relevant equations have been adapted from Appendix B of APEC 2021 to use nomenclature that is more specific to the CIA MTM, as described below. The purpose is to adapt the outputs of Task 2 such that they can be added to the outputs of Task 4 to estimate the total maritime transport cost intensity changes from speed reduction and MTM.

[26] Maritime Economics & Logistics, *Slow steaming impacts on ocean carriers and shippers, 2013*, Michael Maolni, Jomon Aliyas Paul and David M. Gigor.

- **Time delay –** number of hours or days that vessel speed reduction will add to the commodity arrival at the destination port compared with current observed speeds from the fleet analysis and speed reduction of 10%, 20%, and 30% using APEC Module 1.
- **GDP impact –** for each case study, the commodity is measured as to its sectorial importance on total economy GDP. In order to measure the relative importance of the commodity category, the analysis also compares the impact in its sector category of GDP. Data provided by Member States, as well as data from the World Bank's website, has been used as the source of information for total economy GDP and GDP sectors for the respective case studies. ***Due to lack of sectoral GDP data this was not estimated for this study.***
- **Finance/Interest cost –** the financial cost (interest rate) of capital invested in inventory over time. This measures the impact of each hour or day of delay in the cost of the product due to cost of money or interest rate (assumed to be 5% unless provided by the Member States).[27] Financial cost increases due to longer transit times from speed reduction were estimated using the equation below. This approach is based on common business practices based on the value of money, the proportion of a loan or a line of credit charged as interest to the borrower, expressed as an annual percentage of the loan outstanding. Interest rates vary between countries because countries have different inflation rates, interest rates also vary between banks.
- **Depreciation cost –** the cost allocation of a commodity, or reduction of the commodity value, over its useful life (for this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry and liquid bulk cargo).[28]
- **Insurance cost –** a cost paid by the cargo owner to protect their goods while in transit (the percentage used in the economic analysis is the one provided by MS, in case MS did not provide data, we assume it as 0.25% for container cargo (not reefer cargo), 0.50% for reefer container, 0.35% for dry bulk cargo, and 1% for fuel).[29]

For each case study, the total commodity cost intensity change was estimated by using a transit-weighted average of each of the ship type and size combinations identified. These are then added to the Task 2 outputs mentioned above. Further details on how this was done and associated equations are provided in Appendix A.

Qualitative analysis

The previous CIA STM Task 4 solicited contextual information and insights from participating Member State stakeholders that are connected to their selected case studies, and organized and documented that information to inform the development and implementation of the STM. The STM qualitative analysis focused on impacts from speed reduction as a means to comply with the CII.

[27] Lending Tree, *Assuming a line of credit 5%*.
[28] APEC 2019
[29] Interview with Luis Alberto Alvarado, insurance cargo broker, Probroker

The qualitative analysis is unique to Task 4 and provides insight and context from the Member State's national stakeholders. It illuminates contextual elements and insights not identified in the quantitative analysis, nor in the models and tools used in other tasks. This information is key to understanding decision-making processes at the individual sector levels and national and regional levels. It allows for the review of analytical modelling results and complements those findings with identified conditions that are not incorporated in the models, such as shelf life, spoilage, changes to products being transported, or other considerations that can have significant impacts on the commodity's value and use. In addition, for essential goods, it can provide insight into potential shortages and associated impacts, like a community's dependence on energy imports or perishables that may expire onboard ships while at sea due to longer transit times.

The original 12 questions (focusing on sensitivities due to longer transit times resulting from vessel speed reduction) were sent to the participating Member States, who were invited to submit additional questions related to MTM. A final set of 16 questions on the impacts of cost and time changes to commodity movements was developed in conjunction with the participating Member States.

The Member States then took these questions to their national resource teams to gather and provide input for each commodity. These stakeholders shared their knowledge and expertise through the questions related to their commodities of interest, and provided feedback through other materials, meetings, and correspondence. Similar to the CIA STM, Starcrest did not 'validate' or cross reference stakeholder responses provided by participating Member States; this was outside the Task 4 Work Plan and would be a project unto itself. The full qualitative question set is provided in Table A.3 in Appendix A.

The SWOT framework was suggested by the SC as a tool for undertaking the qualitative analysis and was then included in the Task 4 Work Plan. SWOT analyses were used to organize and present qualitative responses, data, and input in a way that is standardized, allows for comparisons across Member States, and is more accessible than the call out boxes used previously in the STM report.

SWOT analyses are normally presented in a 4-box structure like the one below, and were adapted for Task 4 in the following manner:

- **Strengths** – A strength is a resource or capacity the entity can use effectively to achieve its objectives.
- **Weaknesses** – A weakness is a limitation, fault, or defect that may keep the entity from achieving its objectives.
- **Opportunities** – An opportunity is any favorable situation in the entity's environment (in this case to adapt to or mitigate risks).
- **Threats** – A threat is a situation or event where the entity could lose business.

Two SWOT analyses were developed for each participating Member State. These focused on 1) sensitivities related to maritime transport cost increases, and 2) sensitives associated with potential longer transit times due to speed reduction. The stakeholder responses were typically aggregated by the participating Member State's focal point and sent to the Project Team to be reviewed for clarity and understanding, with the aim of identifying which information could be included in the two SWOTs and where to place each response within the framework. In addition, the responses were reviewed to identify which information could inform quantitative results like shelf life, spoilage, product value devaluation, and other related parameters.

The focus of each SWOT grid is to present how the MTM might impact the key issues that have been identified – costs and time. To accomplish this the opportunities section was defined as opportunities to mitigate weaknesses or risks related to the MTM and Threats (i.e., through planning or other operational improvements).

For each Member State, two SWOTs were used to compile responses across the selected commodities. For Argentina and the Cook Islands, which both had more than three commodities, commodities were either grouped by type or illustrative commodities were selected to highlight the range of findings. An example is provided in the table below.

Table 2.3: Example SWOT Analysis grid for qualitative responses

SWOT analysis: structure and definitions	
Strengths ➢ A strength is a resource or capacity the entity can use effectively to achieve its objectives.	**Weaknesses** ➢ A weakness is a limitation, fault, or defect that may keep the entity from achieving its objectives.
Opportunities to adapt/mitigate ➢ An opportunity is any favorable situation in the entity's environment. (In this case to adapt to the MTM or mitigate risks)	**Threats (Risks)** ➢ Threats are situations or events where the entity could lose business.

To provide consistency in data review, a structured process was followed. The results are presented in a streamlined way with the purpose being to inform the evaluation of the quantitative results on MTM impacts and selections. The qualitative information provided by the stakeholders was assessed based on commodity type (essential or trade goods), cost sensitivity, and time sensitivity. Within these three categories, the sensitivities expressed in the Member States' narratives were captured along with explanations as to how impacts will be felt economically, socially, and at an individual level. Risks, and opportunities to mitigate those risks, were identified.

For those responses where additional clarity was needed, the Project Team reached out to the participating Member State focal point to gather additional information through emails and online meetings. For each Member State, the SWOTs were completed by the Project Team along with identification of key findings from the materials submitted and shared with the Member States for review and feedback to ensure that the materials were interpreted correctly.

The overall report contains a section for each Member State which includes a qualitative subsection (designated as X.4, with X being the section number for each of the ten Member States). The qualitative sections begin with a leading paragraph, noting that the information has been provided by the Member State. This paragraph also lists organizations that contributed to the responses.

Where views expressed by stakeholders are reported, Starcrest is documenting the views provided. Starcrest has not sought to check the validity of these views.

The qualitative section of each Member State analysis includes the following:

- ***Transportation cost sensitivities***
  This section informs, for each country and their identified commodities, what the impacts are, and any concerns and level of severity expressed in comments related to increased transportation costs. A SWOT is provided to illustrate findings consistently.
- ***Transit time sensitivities***
  This section identifies the impacts, concerns and level of severity for each country and its commodities, as expressed in comments related to increased ship transit times. A SWOT is provided to illustrate findings consistently.
- ***Key findings***
  This section highlights the key findings collected from the Member State questionnaires and the analyses listed above. Key findings are those details that are critical in the understanding of issues, challenges, solutions and opportunities that are not found in any of the other CIA Tasks. These will be relevant and constructive to the conversations at IMO related to the MTM, their potential impacts, and other relevant conversations.

Note that some of the data submitted was deemed confidential by the data provider. The participating Member States worked with their cohorts to determine what information can be shared and what needed to remain confidential.

Uncertainties

The following are key uncertainties associated with this analysis:

- Since Task 4 integrates both the outputs of Task 2 and the data from Task 3, ***all the uncertainties with those two reports are applicable to this study*.**
- ***Ad valorem*** rates for each Member State were based on the detailed UNCTAD Trade and Development dataset that underlies Task 3's modelling of State impacts. There are no specific rates for Cook Islands nor Tonga, and an aggregated 'Pacific SIDS' rate was used. The uncertainty around those aggregated rates compared to the actual situation for each of those States is unknown.
- Related to Task 4, in Task 2 future ship-side cost impacts are aggregated by ship type, size, and age combinations. There are uncertainties associated with determining when to apply the ship-side impacts of an aggregated combination when analyzing a limited number of specific ships. This is especially true when ships have similar aspects to another ship type, size, and age combination. This becomes a '*boundary issue*.' For example, the two general cargo ships servicing the Cook Islands and Tonga are classified as general cargo 5,000 – 9,999 deadweight tonnes, that are 17 years old, hold just over 500 teus, design speed of 15 knots, and have cranes. In the Task 2 model there is also a category of container 0 – 999 teu with the same age group, which these ships also fit, with an average design speed of 15 knots, and may also have cranes. These ships operate solely in the Pacific, and in discussions with DNV, it was agreed that the impacts of the MTMs would likely be driven by compliance pooling options and the latter vessel group was more representative.
- Related to Task 4, again when trying to apply aggregated cost impacts for specific ships, one of the key cost impacts is related to whether the ship joins a compliance pool or not. At the global level this is not an issue, but when looking at specific ships, this becomes an uncertainty.

- As noted from the Task 2 Project Leader, "joining a ship pool to meet compliance of MTM. Compliance pools under the flexibility mechanism and while it is voluntary to join a pool, you must comply with the regulations. The modelling has shown that it is more cost effective to join a pool. DNV have not been able to ascertain the correct price."[30]
- There was no cross referencing/validation of stakeholder qualitative responses with publications, papers, or to confirm the response is consistent with economic or industrial theories. Similar to the CIA STM, the stakeholder input was to provide context from the national level from professionals and experts in the Member State that were associated/highly familiar with the trade. It was outside the scope of the Task 4 Work Plan to cross reference all the input received for the potential that respondent(s) might be trying to 'influence' policy decisions.

Data gaps

The following data gaps were identified:

- *Ad valorem* freight rates specific to the Cook Islands and Tonga were not available on the UNCTAD Transport Cost Data website, so the Pacific SIDS group of *ad valorem* rates were used.
- Sectoral GDP data was only reviewed for Member States that directly provided it, as the compressed project schedule proved prohibitive of additional data gathering.
- Arrival delay tolerances for commodities sensitive to time delays were provided by the Member States for some of the commodity case studies, but not for others.
- Updated information regarding commodity interest, depreciation, and insurance rates was not received in time for this publication. A sensitivity analysis will be conducted and presented to GHG EW-5.

Quality assurance and control

Starcrest implemented its multi-review quality assurance and control (QA/QC) approach for the conduct and completion of Task 4 deliverables. The approach ensures that information, data, calculations, results, and drafted sections of the analysis are reviewed multiple times from within the Drafting team, an internal team of QA/QC experts outside the Drafting team, from the Member States that provided input, and third-party external QA/QC reviewers including Task 5 reviewers from nominated by the United Kingdom UK and China, as well as both verbal and written comments from Steering Committee members. The necessary time and resources were used to ensure that the analysis was fully reviewed and is sound. While the report itself also went through numerous QA review cycles, due to project timeline constraints and the sheer size of the document, there may be some inconsistencies. Please see Appendix A for more details.

[30] Email exchange with Tore Longa, Project Manager Task 2, 18 July 2024

Discerning impacts from cost changes

As noted above, this analysis is a 'sensitivity analysis' that users can use to determine what drives the impacts of the 39 commodity case studies. It illustrates what the various magnitudes the cost increases are by MTM scenario, with and without speed reduction, and by forecasted year. There is no established IMO MEPC bright line that indicates severity of impact, nor does this report suggest any bright lines. In order to understand the forecasted numbers produced, one needs to take into account several contextual items including:

- Essential goods vs trade commodities. As noted above the impacts are fundamentally different.
  - Related to essential goods, Member State's GDP, GDP per capita, and income per capita to understand the capacity of the society to absorb higher costs.
  - Related to trade goods, the sectoral/sub sectoral contribution to the national GDP, the number of employees associated with the trade, and supporting/reliant in-country industries.
- Size of population to absorb costs and take advantage of economies of scale.
- Are there alternative competitive transportation modes available to move the commodity?
- The remoteness of the country from its trading partners.
- Are there trade agreements that reduce the cost impacts or amplify the cost impacts?

Refer to the individual Member State section in the report for more information and commodity specific results.

3 Case studies overview

As noted above similar to the stakeholder analysis for the CIA STM, the commodities selected by the Member States can be grouped into two types:

- **Essential goods** – those commodities needed to sustain life and society such as food, water, medicine, fuel, building materials, electronic equipment (communications, computers, etc.), and many others.
- **Trade commodities** – a broad group of goods that are traded between countries and include everything from foods (perishables and nonperishables), raw materials, partial or finished products, animals, waste products, and fuels.

The difference between the two groups are the nature of the commodities and their fundamentally different potential for negative impact. Essential goods sustain life and society, meaning port arrival delays can result in shortages if the goods are not warehoused in quantities to cover the delay period. In stark contrast, the potential negative impact from port arrival delays on trade commodities only affect certain segments of society and sectors of a country's greater economy. It is important to note that countries can have both essential goods imported and trade commodities imported or exported. For this CIA, countries did tend to select one or the other, but countries that have both types of commodities might consider selecting a mix of both in future CIAs.

The participating 10 Member States Identified 39 commodity case studies, as listed below:

Argentina	6 trade exports
Belize	3 trade exports
Brazil	3 trade exports
Chile	2 trade exports
	1 essential good import
Cook Islands	9 essential good imports
Peru	3 trade exports
South Africa	3 trade exports
Togo	3 essential good imports
Tonga	1 essential good import
	2 trade exports
United States (US)	3 trade exports

More specifically, each Member State provided a combination of specific port pair routes for each commodity, as presented in Table 3.1 on the following page. All the Member States that participated in Task 4 were also represented on the CIA Steering Committee.

Due to acute time constraints, and the reliance on output from other tasks as input for this task, the analysis should be viewed as a sensitivity analysis and not a comprehensive analysis for the trade commodities case studies. Not all ship type/size combinations were modeled at this time. The results are intended to be used in combination with and complementary to both DNV's Task 2 and UNCTAD's Task 3 analyses to indicate the potential magnitudes of cost intensity increases from both the ship and cargo-side.

Table 3.1: Summary overview of stakeholder assessments

Case Study	Country	Trade Direction	Cargo type	Ship Type	Trade Route	Country of Origin	Port of Origin	Country of Destination	Port of Destination
1a	Argentina	Export	Soybeans	Bulk carrier	East Coast South America - Asia	Argentina	San Lorenzo - Rosario	China	Huang Pu
1b	Argentina	Export	Soybean meal	Bulk carrier	East Coast South America - EU	Argentina	San Lorenzo - Rosario	The Netherlands	Rotterdam
1c	Argentina	Export	Chilled bovine meat	Container	East Coast South America - EU	Argentina	Buenos Aires	Germany	Hamburg
1d	Argentina	Export	Apples and pears	Container	East Coast South America - EU	Argentina	San Antonio Este	The Netherlands	Rotterdam
1e	Argentina	Export	Soy oil	Chemical tanker	East Coast South America - Asia	Argentina	San Lorenzo - Rosario	India	Haldia
1f	Argentina	Export	Corn	Bulk carrier	East Coast South America - Asia	Argentina	San Lorenzo - Rosario	Viet Nam	Phu Mei
2a	Belize	Export	Bananas	Container	Belize to UK	Belize	Port of Big Creek	United Kingdom	Port of London Authority
2b	Belize	Export	Sugar	Bulk carrier	Belize to UK	Belize	Port of Big Creek	United Kingdom	Port of London Authority
2c	Belize	Import	Steel	Container	China to Kingston, JA to Belize	China	Tianjin	Belize	Port of Belize
3a	Brazil	Export	Iron ore	Bulk carrier	East Coast South America - Asia	Brazil	Port of Ponta da Madeira	China	Qingdao Port
3b	Brazil	Export	Soybeans	Bulk carrier	East Coast South America - Asia	Brazil	Port of Santos	China	Shanghai
3c	Brazil	Export	Woodpulp (paper and paper products)	General cargo	East Coast South America - Asia	Brazil	Port of Barra do Riacho	China	Shanghai
4a	Chile	Export	Cherries	Container	West Coast South America - Asia	Chile	Valparaíso / San Antonio	China	Shanghai
4b	Chile	Import	Petroleum oils	Chemical tanker	United States - Chile	United States	Port Arthur	Chile	Quintero
4c	Chile	Export	Lithium carbonate	Container	WCSA - USWC	Chile	Puerto Angamos/Antofagasta	China	Shanghai
5a	Cook Islands	Import	Miscellaneous edible preparations	Container, General cargo	EU via Asia to Cook Islands	The Netherlands	Rotterdam	Cook Islands	Rarotonga/Aitutaki
5b	Cook Islands	Import	Pharmaceutical goods	General cargo	New Zealand to Cook Islands	New Zealand	Auckland	Cook Islands	Rarotonga/Aitutaki
5c	Cook Islands	Import	Fuels (LPG)	LPG tanker	Australia to Cook Islands	Australia	Westernport	Cook Islands	Rarotonga/Aitutaki
5d	Cook Islands	Import	Articles of iron and steel	General cargo	New Zealand to Cook Islands	New Zealand	Auckland	Cook Islands	Rarotonga/Aitutaki
5e	Cook Islands	Import	Edible vegetables, certain roots, & tubers	General cargo	New Zealand to Cook Islands	New Zealand	Auckland	Cook Islands	Rarotonga/Aitutaki
5f	Cook Islands	Import	Electrical machinery & equip	General cargo	New Zealand to Cook Islands	New Zealand	Auckland	Cook Islands	Rarotonga/Aitutaki
5g	Cook Islands	Import	Meat & edible meat offal	Container, General cargo	US West Coast to Cook Islands	United States	Seattle/Oakland/Long Beach	Cook Islands	Rarotonga/Aitutaki
5h	Cook Islands	Import	Dairy produce, birds eggs, natural honey+	General cargo	New Zealand to Cook Islands	New Zealand	Auckland	Cook Islands	Rarotonga/Aitutaki
5i	Cook Islands	Import	Products of the milling industry, etc.	General cargo	New Zealand to Cook Islands	New Zealand	Auckland	Cook Islands	Rarotonga/Aitutaki
6a	Peru	Export	Copper	Bulk carrier	West Coast South America - Asia	Peru	Matarani	China	Shanghai
6b	Peru	Export	Grapes	Container	West Coast South America - Asia	Peru	Callao	China	Hong Kong
6c	Peru	Export	Pota (squid)	Container	West Coast South America - Asia	Peru	Paita	South Korea	Busan
7a	South Africa	Export	Iron ore	Bulk carrier	South Africa - China	South Africa	Saldanha Bay	China	Tianjin
7b	South Africa	Export	Citrus foods	Container	South Africa - The Netherlands	South Africa	Durban	The Netherlands	Rotterdam
7c	South Africa	Export	Grapes	Container	South Africa - United Kingdom	South Africa	Cape Town	United Kingdom	London Gateway
8a	Togo	Import	Essence (LPG)	Container, Chemical tanker, Product tanker	Europe - Africa	Estonia	Tallinin	Togo	Port of Lomé
8b	Togo	Import	Iron and steel	Container	Asia - Africa	China	Tianjin	Togo	Port of Lomé
8c	Togo	Import	Palm oil	Chemical tanker	Asia - Africa	Malaysia	Port Klang	Togo	Port of Lomé
9a	Tonga	Import	Petroleum oils	Chemical tanker, Oil & product tanker	Singapore - Fiji - Tonga	Singapore	Lautoka	Tonga	Nuku'alofa/Neiafu
9b	Tonga	Export	Fish	General cargo	Tonga to New Zealand	Tonga	Nuku'alofa	Auckland	Port of Auckland
9c	Tonga	Export	Kava	General cargo	Tonga to New Zealand	Tonga	Nuku'alofa	Auckland	Port of Auckland
10a	United States	Export	Soybeans	Bulk carrier	US Gulf of Mexico - Asia	USA	Port of South Louisiana	China	Qingdao Port
10b	United States	Export	Wood and wood products	Bulk carrier	US West Coast - Asia	USA	Port of Longview, WA	Japan	Port of Kashima
10c	United States	Export	Automobiles	Vehicle carrier	US East Coast - Asia	USA	Port of Brunswick	South Korea	Port of Pyeongtaek

4 Stakeholders' analysis – Argentina

The Stakeholder Assessment for Argentina focuses on exports of soybean, soybean meal, chilled bovine meat, apples and pears, soy oil, and corn.

4.1 Geography, population, and economy

Geography

Argentina is located on the Southeast coast of South America and encompasses a wide array of physical features that significantly influence its socio-economic dynamics. The country is 2.8 million km^2 in area and is the second largest country in South America and eighth largest country in the world.[31] Argentina's extensive coastline supports port cities such as Buenos Aires, the capital of Argentina. It also hosts diverse ecosystems and important national parks, shaping Argentina's climate patterns and biodiversity, and also supporting its agricultural productivity and tourism industry.

Argentina is bounded on the west by Chile and on the east by Brazil, Uruguay and the Atlantic Ocean. This strategic geographical position has facilitated extensive maritime trade routes and has been pivotal to the country's economic growth and integration into global markets. The Port of Buenos Aires is one of South America's busiest ports, while the Port of Rosario serves as a hub for agricultural exports, particularly soybeans and grains. Representative distances to markets for the selected commodities and ports are presented in Section 4.2.

Population

Argentina's population is approximately 46 million as of 2022 and has a diverse demographic–a blend of European and indigenous ancestry.[32] Of that population, 92% live in urban areas and 8% live in rural areas.[33] The urban population is mostly concentrated in and around Buenos Aires, Rosario and Córdoba and the country's population density varies widely. It averages around 17 people per km^2 and is influenced by geographic features, economic opportunities and historical patterns. The population is growing faster in urban areas compared to the rest of the country. As Argentina ranks 3rd in South America and 33rd in the world by population, it makes up .5% of the world's population. Annual population growth declined in 2022. Ongoing efforts in infrastructure development and healthcare quality aim to foster inclusive domestic growth.

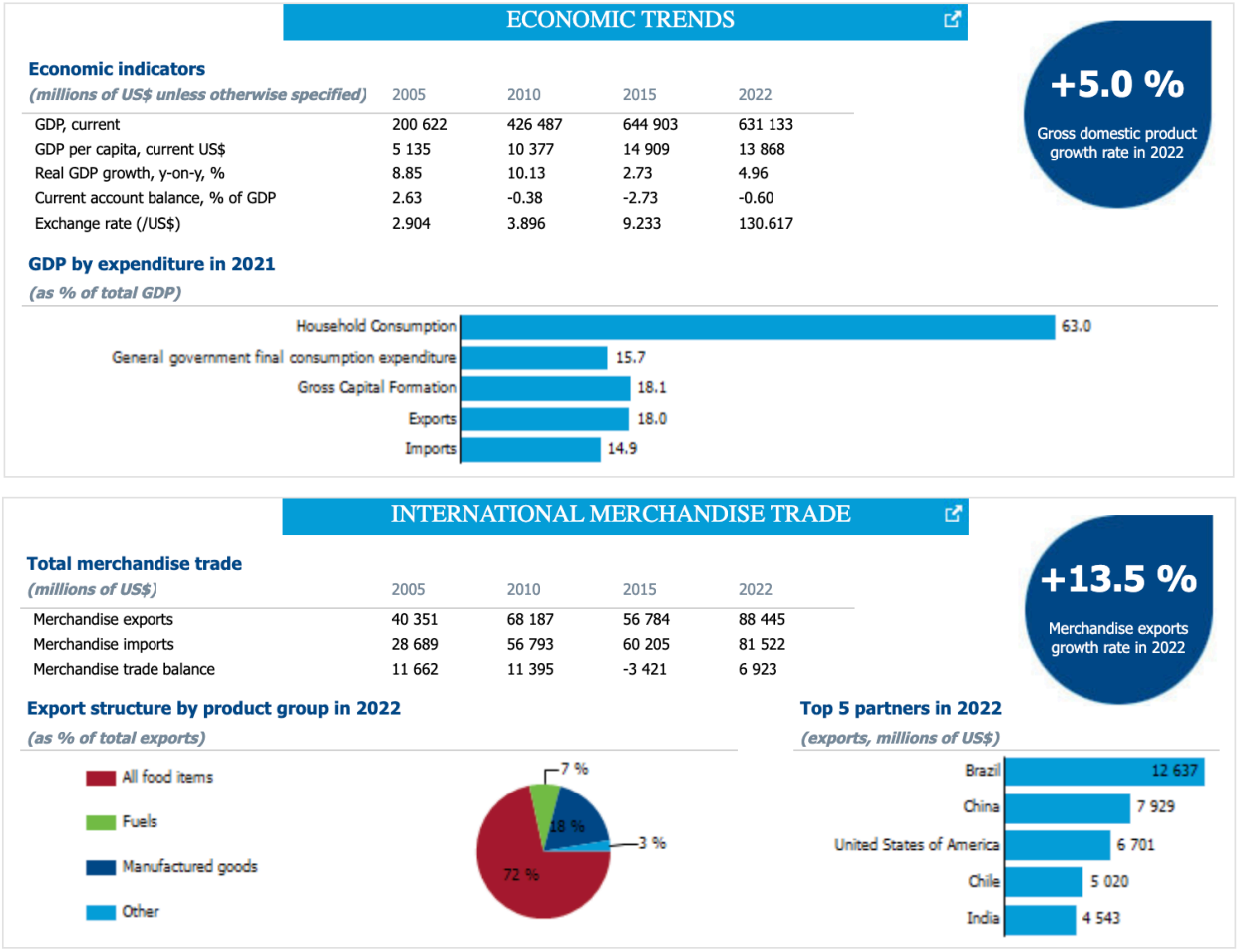
[31] Encyclopedia Britannica, *Argentina | History, Map, Flag, & Population*, Peter A.R. Calvert, Robert C. Eidt
[32] INDEC of Argentina, *Final results of the 2022 Census, Summary table*.
[33] UN-Habitat, *Argentina*.

Economy

Argentina is the 25th largest economy in the world by GDP at $631,133 million.[34] Argentina's GDP per capita has been steadily rising and in 2022, is $13,650. Argentina is the leading producer of grain in South America and has a well-developed industry sector. This includes motor vehicles and auto parts, food processing and beverages, and electronics. Services like tourism play a considerable role in the economy as well.

Argentina has also faced challenges including trade deficits and inflation. However, the economic measures adopted by the current Administration have resulted in a trade surplus of $8.8 billion in the first five months of 2024[35] and the inflation fell from 25.5% monthly in December 2023 to 4.2% in May 2024.[36] Argentina possesses significant potential for economic development.[37] Argentina's proximity to the Atlantic Ocean has bolstered maritime trade and, supported by UNCTAD, main ports across Argentina have set out to implement 10 of the 17 Sustainable Development Goals to support trade, competitiveness, and sustainability.[38] Key economic indicators are shown in Figure 4.1.[34]

Figure 4.1: Key economic indicators for Argentina



Source: UNCTAD, General and Maritime Profiles: Argentina, UNCTAD Statistics - General Profile.

[34] UNCTAD, General and Maritime Profiles: Argentina, *UNCTAD Statistics - General Profile*.
[35] Centre for International Economy - Ministry of Foreign Affairs, *International Trade and Worship, Argentine trade exchange – First five months of 2024*.
[36] INDEC (2024). *Índice de precios al consumidor. Cobertura nacional. Mayo. Índices de precios. Vol. 8, nº 18*.
[37] MFAITW, *Argentine trade exchange – First quarter of 2024*, CEI.
[38] UNCTAD, *Argentina: Transforming port management for sustainable development*.

4.2 Identified commodities and routes studied

The Stakeholder Assessment for Argentina focuses on exports of soybean, soybean meal, chilled bovine meat, apples and pears, soy oil, and corn.

The commodities selected by the Member State for focus and illustrative trade routes selected are shown in Table 4.1. All commodities selected for this study are exports.

Table 4.1: Shipping distances from Argentina to market for selected commodities

Case Study	Commodity	Illustrative identified routes, by country	Ship Type(s)	Route Distance Range, nm min	avg	max	Stops
1a	Soybeans	Argentina --> China	Bulk carrier	11,026	13,221	17,080	1-8
1b	Soybean meal	Argentina --> Brazil --> Netherlands	Bulk carrier	6,545	7,201	9,826	1-3
		Argentina --> Netherlands					
1c	Chilled bovine meat	Argentina --> Brazil --> Morocco --> England --> Germany	Container	7,119	7,552	8,343	4-12
		Argentina --> Brazil --> Morocco --> England --> Netherlands --> Germany					
		Argentina --> Brazil --> Morocco --> Netherlands --> Germany					
		Argentina --> Uruguay --> Brazil --> Morocco --> England --> Germany					
		Argentina --> Uruguay --> Brazil --> Morocco --> England --> Netherlands --> Germany					
		Argentina --> Uruguay --> Brazil --> Morocco --> Netherlands --> England --> Germany					
1d	Apples and pears	Argentina --> Brazil --> Netherlands	Container	6,919	7,464	8,168	na
		Regional routes					
		Argentina --> Brazil	Container	1,449	1,524	1,600	
		Long haul routes					
		Brazil --> Netherlands	Container	5,471	5,940	6,568	
1e	Soy oil	Argentina --> Bangladesh --> India	Chemical tanker	9,426	10,619	12,273	2-5
		Argentina --> Brazil --> Bangladesh --> India					
		Argentina --> Brazil --> India					
		Argentina --> India					
		Argentina --> Mozambique --> India					
		Argentina --> South Africa --> India					
1f	Corn	Argentina --> Brazil --> Vietnam	Bulk carrier	10,082	10,647	11,293	1-2
		Argentina --> Uruguay --> Vietnam					
		Argentina --> Vietnam					

Trade context

The Member State states the following on commodity selection:

"Argentina's exports are diversified in destination countries but concentrated at the product level. In 2022, exports to MERCOSUR countries accounted for 18% of the total, followed by 12% to the European Union, 10% to NAFTA, 9% to China, 9% to ASEAN, 5% to India and 37% to the rest of the world.[39] In terms of products, 62% are agri-food and fisheries, of which 9% are animal products, 25% vegetables products, 10% fats and oils and 18% foodstuffs, beverages and tobacco. In general, exports to neighboring countries are made by land transport. Therefore 86% of exports are made by ship.

"If these exports are reviewed by export complex, the main one is the soya complex (28% of total exports), made up of soymeal (13.6% of the total), soy oil (7.3%), soybeans (3.7%) and biodiesel (2.1%).[40] The main destinations of the complex are the European Union–particularly the Netherlands, whose port of Rotterdam is the main entry point to the economic zone–Vietnam, India and China. It should be noted that Argentina was the world's leading exporter of soybean oil (43% of the world total) and soybean meal (38% of the world total) in 2021.[41]

[39] Figures for 2022 are used because a major drought affected agricultural exports in 2023, causing total exports to fall by 24.5% - from USD 88.4 billion in 2022 to USD 66.7 billion in 2023.
[40] INDEC (2023). *Complejos exportadores. Año 2022. Informe Comercio Exterior vol. 7, n° 4*.
[41] According to UN Comtrade figures from Trade Map.

"The second largest export complex is maize (10.8% of total exports), of which 98% is maize grain. The main destinations are ASEAN, Korea and North Africa. In 2021, Argentina was the world's second largest exporter with 21% of exports.[42]

"A traditional exporter of Argentina is the beef complex, the country's sixth largest exporter with 4.8% of total exports. The main products are frozen meat (2.7% of the total) and chilled meat (1%). The main destination for frozen meat is China, while for chilled meat it is the EU (mainly Germany), Chile and Israel.

"Another traditional export complex is apples and pears with 0.3% of total exports, of which 73% corresponds to fresh pears and 16% to fresh apples. The main markets are Brazil, the United States, the European Union and Russia.

"This context allows us to understand the selection of products and export markets for the stakeholder analysis. The selection criteria were, i. product and complex with a significant share of the country's total exports; ii. product sold to the main destination markets (Europe and Asia), except for neighboring countries; iii. product in which most of its exports use maritime transport; iv. product whose sale may be affected by changes in the speed of navigation or cost of freight; v. products that are important for regional economies–such as apples and pears, which are a central sector in the north of Patagonia. Additionally, those same products were assessed with the stakeholder analysis for the short-term measure, which allows for comparability.

"An additional element is Argentina's macroeconomic context. A country with recurrent economic crises characterised by high inflation, recession and balance of payments problems, reflected in a shortage of foreign exchange reserves. This makes the volume of exports a central issue in all stabilisation policies that have been implemented in Argentina. Therefore, any measure that harms exports has important macroeconomic consequences, in addition to the sectoral impact."

4.3 Quantitative analysis

This section presents the quantitative analysis summary results and is organized by fleet analysis summary, total commodity cost intensity changes from speed reduction, Task 2 cost intensity changes due to MTM, total commodity cost intensity impacts, and GDP contexts. The quantitative analysis incorporates the findings of Task 2 related to the selected bracketing MTM scenarios as presented below:[43]

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination						
			Policy code	GFI scope	GFI flexibility RU % of price	GFI flexibility SU % of price	Levy Levy USD/tCO_2eq	Levy Reward % of cost gap	Feebate Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

The detailed approach for the below analysis is provided in Appendix A.

[42] According to UN Comtrade figures from Trade Map.
[43] DNV 2024

Fleet analysis summary

As part of the fleet analysis, routes and ship characteristics were identified for each case study. For the specific ship types identified with the case study and transiting on the identified route, the following were averaged to represent the fleet:

- Ship type and size
- Number of transits identified
- Route distances obtained from Marine Benchmark's 2022 AIS database were transit-weighted averaged and reported as minimum, average, and maximum distance sailed
- Transit-weighted average year of build, which was used to determine the average age in years

These characteristics for the case studies are presented in Table 4.2.

Table 4.2: Argentina – Fleet characteristics, by case study

Case Study	Commodity	2022 Transits	Ship Type(s)	Route Distance Range, nm min	avg	max	Avg Build
1a	Soybeans						
		1	Bulk carrier 10,000-34,999 dwt	14,456	**14,456**	14,456	2016
		9	Bulk carrier 35,000 - 59,999 dwt	11,026	**14,840**	17,080	2009
		19	Bulk carrier 60,000 - 99,999 dwt	11,120	**12,390**	16,355	2014
1b	Soybean meal						
		2	Bulk carrier 10,000-34,999 dwt	6,639	**7,257**	7,875	2009
		3	Bulk carrier 35,000 - 59,999 dwt	6,670	**7,253**	8,420	2009
		17	Bulk carrier 60,000 - 99,999 dwt	6,545	**7,185**	9,826	2013
1c	Chilled bovine meat						
		4	Container 5,000-7,999 teu	7,558	**7,757**	7,951	2011
		70	Container 8,000-11,999 teu	7,119	**7,540**	8,343	2014
1d	Apples and pears	**Regional routes**					
		12	Container 1,000-1,999 teu	1,449	**1,524**	1,600	2012
		Long haul routes					
		3	Container 5,000-7,999 teu	5,931	**5,892**	5,909	2011
		20	Container 8,000-11,999 teu	5,554	**5,947**	6,568	2014
1e	Soy oil						
		6	02 Chemical tanker / B 20,000 - 39,999 dwt	9,671	**10,285**	11,280	2013
		52	02 Chemical tanker / A 40,000 + dwt	9,426	**10,657**	12,273	2013
1f	Corn						
		9	Bulk carrier 35,000 - 59,999 dwt	9,975	**10,276**	11,051	2009
		99	Bulk carrier 60,000 - 99,999 dwt	10,078	**10,681**	11,293	2014

In addition, transit weighted average speeds and average route times were estimated, and the APEC Module 1 was used to estimate the longer transit times, in days of delay associated with the speed reduction groups of 10%, 20%, and 30%, as presented in Table 4.3.

Table 4.3: Average route distance, speed, & longer transit ,times, by speed reduction group

Country	Case Study	Commodity	Transits	Ship type & size	Avg Route Distance (nm)	Avg Route Speed (knots)	Avg Route Time (hours)	SR 10% Delay Delta (days)	SR 20% Delay Delta (days)	SR 30% Delay Delta (days)
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	14,456	11.0	1,312	6.1	13.7	23.4
			9	Bulk carrier 35,000 - 59,999 dwt	14,840	11.5	1,293	6.0	13.5	23.1
			19	Bulk carrier 60,000 - 99,999 dwt	12,390	11.6	1,067	4.9	11.1	19.1
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	7,257	11.3	640	3.0	6.7	11.4
			3	Bulk carrier 35,000 - 59,999 dwt	7,253	12.2	594	2.8	6.2	10.6
			17	Bulk carrier 60,000 - 99,999 dwt	7,185	11.7	615	2.8	6.4	11.0
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	7,757	15.5	501	2.3	5.2	8.9
			70	Container 8,000-11,999 teu	7,540	15.3	493	2.3	5.1	8.8
	1d	Apples and pears	12	Container 1,000-1,999 teu	1,524	14.3	106	0.5	1.1	1.9
			3	Container 5,000-7,999 teu	5,892	17.3	341	1.6	3.6	6.1
			20	Container 8,000-11,999 teu	5,947	16.4	362	1.7	3.8	6.5
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dw	10,285	12.3	834	3.9	8.7	14.9
			52	02 Chemical tanker / A 40,000 + dwt	10,657	11.9	893	4.1	9.3	15.9
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	10,276	11.0	931	4.3	9.7	16.6
			99	Bulk carrier 60,000 - 99,999 dwt	10,681	11.2	954	4.4	9.9	17.0

Total commodity cost intensity changes due to speed reduction

APEC Module 2 was used to estimate the commodity cost intensity increases due to potentially longer transit times resulting from the three speed reduction groups. The module estimates the daily cost increases, in percentage, associated with the following:

- Finance/interest costs – the financial cost of capital invested in inventory over time. This measures the impact of each hour or day of delay in the cost of the product due to cost of money or interest rate. A Member State rate was used when provided, otherwise, it was assumed to be 5%.[44]
- Depreciation costs – the cost allocation of a commodity, or reduction of the commodity value, over its useful life. For this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry bulk cargo.[45]
- Insurance costs – a cost paid by the cargo owner to protect their goods while in transit. The percentage used in the economic analysis is the one provided by the Member State. If the Member State did not provide data, we assumed it to be 2%.[46]

[44] Lending Tree, *Assuming a line of credit 5%*.
[45] APEC 2019
[46] APEC 2019

The total commodity cost intensity change related to the three speed reduction groups for the case studies is presented in Table 4.4. Note that these values remain constant across scenarios and forecasted year.

Table 4.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group.

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Commodity-side Task 4 TCCIsr Change, % SR 10%	SR 20%	SR 30%
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	7	1.21%	6.14%	18.04%
			9	Bulk carrier 35,000 - 59,999 dwt	13	1.18%	5.96%	17.51%
			19	Bulk carrier 60,000 - 99,999 dwt	9	0.80%	4.06%	11.93%
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	14	0.29%	1.46%	4.29%
			3	Bulk carrier 35,000 - 59,999 dwt	14	0.25%	1.26%	3.70%
			17	Bulk carrier 60,000 - 99,999 dwt	10	0.27%	1.35%	3.96%
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	12	0.18%	0.89%	2.63%
			70	Container 8,000-11,999 teu	9	0.17%	0.87%	2.55%
	1d	Apples and pears	12	Container 1,000-1,999 teu	11	0.01%	0.04%	0.12%
			3	Container 5,000-7,999 teu	12	0.08%	0.42%	1.22%
			20	Container 8,000-11,999 teu	9	0.09%	0.47%	1.37%
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dwt	10	0.49%	2.48%	7.28%
			52	02 Chemical tanker / A 40,000 + dwt	9	0.56%	2.84%	8.36%
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	14	0.61%	3.09%	9.08%
			99	Bulk carrier 60,000 - 99,999 dwt	9	0.64%	3.24%	9.53%

The commodity cost intensity changes due to speed reduction, ranges as follows:

- 1a – SR 10% → 0.8%-1.21% SR 20% → 4.06%-6.14% SR 30% → 11.93%-18.04%
- 1b – SR 10% → 0.25%-0.29% SR 20% → 1.26%-1.46% SR 30% → 3.70%-4.29%
- 1c – SR 10% →0.17%-0.18% SR 20% → 0.87%-0.89% SR 30% → 2.55%-2.63%
- 1d – SR 10% → negligible SR 20% → negligible-0.47% SR 30% → negligible-1.37%
- 1e – SR 10% → 0.49%-0.56% SR 20% → 2.48%-2.84% SR 30% → 7.28%-8.36%
- 1f – SR 10% → 0.61%-0.64% SR 20% → 3.09%-3.24% SR 30% → 9.08%-9.53%

Since the change in cost is per day, multiply by the delay in days to calculate the intensity cost for the delay. If the speed is reduced by 10%, the transport of Chinese soybeans would have a delay of between 4.9 and 6.1 days, and the total intensity cost for the delay would be between 3.9 USD (0.8 USD/day x 4.9 days) and 36.2 USD (1.21 USD/day x 6.1 days). If the speed is reduced by 30%, the total intensity cost would be between 356 and 539 USD.

Task 2 cost intensity changes due to MTM

Based on the ship type, size, and age combination for each case study, the applicable Task 2 ship-side commodity cost intensities due to the MTM were identified for the selected scenarios. In addition, in order to add these to the commodity cost intensity changes due to speed reduction, the a*d valorem* freight rate percentage was identified using the UNCTAD Trade-and-Transport Dataset.[47] The *ad valorem* freight rate percentage represents the transportation cost percentage of a commodity's total cost. These factors were multiplied to get the freight rate adjusted commodity cost intensity or FRACCI change for 2030, 2040, and 2050. Task 2 cost intensity change and FRACCI for each scenario are presented in Table 4.5.

[47] UNCTAD, *Trade-and-Transport Dataset*.

Table 4.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	7	6.0%	17.27%	45.03%	48.66%	1.04%	2.70%	2.92%
			9	Bulk carrier 35,000 - 59,999 dwt	13	6.0%	5.68%	51.22%	51.32%	0.34%	3.07%	3.08%
			19	Bulk carrier 60,000 - 99,999 dwt	9	6.0%	19.24%	42.69%	53.70%	1.15%	2.56%	3.22%
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	14	10.6%	9.93%	49.37%	46.01%	1.05%	5.23%	4.88%
			3	Bulk carrier 35,000 - 59,999 dwt	14	10.6%	5.68%	51.22%	51.32%	0.60%	5.43%	5.44%
			17	Bulk carrier 60,000 - 99,999 dwt	10	10.6%	19.24%	42.69%	53.70%	2.04%	4.53%	5.69%
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	12	2.7%	8.57%	70.19%	77.81%	0.23%	1.90%	2.10%
			70	Container 8,000-11,999 teu	9	2.7%	23.52%	44.39%	62.78%	0.64%	1.20%	1.70%
	1d	Apples and pears	12	Container 1,000-1,999 teu	11	10.3%	10.37%	64.23%	70.19%	1.07%	6.62%	7.23%
			3	Container 5,000-7,999 teu	12	10.3%	8.57%	70.19%	77.81%	0.88%	7.23%	8.01%
			20	Container 8,000-11,999 teu	9	10.3%	23.52%	44.39%	62.78%	2.42%	4.57%	6.47%
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dwt	10	19.0%	24.30%	53.32%	57.25%	4.62%	10.13%	10.88%
			52	02 Chemical tanker / A 40,000 + dwt	9	19.0%	24.30%	53.32%	57.25%	4.62%	10.13%	10.88%
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	14	12.0%	5.68%	51.22%	51.32%	0.68%	6.15%	6.16%
			99	Bulk carrier 60,000 - 99,999 dwt	9	12.0%	19.24%	42.69%	53.70%	2.31%	5.12%	6.44%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	7	6.0%	21.22%	44.21%	49.32%	1.27%	2.65%	2.96%
			9	Bulk carrier 35,000 - 59,999 dwt	13	6.0%	5.57%	43.06%	51.16%	0.33%	2.58%	3.07%
			19	Bulk carrier 60,000 - 99,999 dwt	9	6.0%	17.31%	40.02%	54.13%	1.04%	2.40%	3.25%
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	14	10.6%	8.34%	38.80%	44.53%	0.88%	4.11%	4.72%
			3	Bulk carrier 35,000 - 59,999 dwt	14	10.6%	5.57%	43.06%	51.16%	0.59%	4.56%	5.42%
			17	Bulk carrier 60,000 - 99,999 dwt	10	10.6%	17.31%	40.02%	54.13%	1.83%	4.24%	5.74%
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	12	2.7%	9.30%	53.92%	71.26%	0.25%	1.46%	1.92%
			70	Container 8,000-11,999 teu	9	2.7%	29.40%	41.82%	62.98%	0.79%	1.13%	1.70%
	1d	Apples and pears	12	Container 1,000-1,999 teu	11	10.3%	8.43%	53.62%	69.56%	0.87%	5.52%	7.16%
			3	Container 5,000-7,999 teu	12	10.3%	9.30%	53.92%	71.26%	0.96%	5.55%	7.34%
			20	Container 8,000-11,999 teu	9	10.3%	29.40%	41.82%	62.98%	3.03%	4.31%	6.49%
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dwt	10	19.0%	23.37%	46.05%	57.32%	4.44%	8.75%	10.89%
			52	02 Chemical tanker / A 40,000 + dwt	9	19.0%	23.37%	46.05%	57.32%	4.44%	8.75%	10.89%
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	14	12.0%	5.57%	43.06%	51.16%	0.67%	5.17%	6.14%
			99	Bulk carrier 60,000 - 99,999 dwt	9	12.0%	17.31%	40.02%	54.13%	2.08%	4.80%	6.50%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	7	6.0%	15.22%	40.12%	52.95%	0.91%	2.41%	3.18%
			9	Bulk carrier 35,000 - 59,999 dwt	13	6.0%	13.96%	45.74%	56.95%	0.84%	2.74%	3.42%
			19	Bulk carrier 60,000 - 99,999 dwt	9	6.0%	16.74%	44.14%	59.49%	1.00%	2.65%	3.57%
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	14	10.6%	13.45%	38.66%	49.40%	1.43%	4.10%	5.24%
			3	Bulk carrier 35,000 - 59,999 dwt	14	10.6%	13.96%	45.74%	56.95%	1.48%	4.85%	6.04%
			17	Bulk carrier 60,000 - 99,999 dwt	10	10.6%	16.74%	44.14%	59.49%	1.77%	4.68%	6.31%
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	12	2.7%	18.52%	52.42%	71.47%	0.50%	1.42%	1.93%
			70	Container 8,000-11,999 teu	9	2.7%	21.74%	44.33%	70.15%	0.59%	1.20%	1.89%
	1d	Apples and pears	12	Container 1,000-1,999 teu	11	10.3%	15.95%	52.44%	68.05%	1.64%	5.40%	7.01%
			3	Container 5,000-7,999 teu	12	10.3%	18.52%	52.42%	71.47%	1.91%	5.40%	7.36%
			20	Container 8,000-11,999 teu	9	10.3%	21.74%	44.33%	70.15%	2.24%	4.57%	7.22%
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dwt	10	19.0%	18.61%	44.44%	62.95%	3.54%	8.44%	11.96%
			52	02 Chemical tanker / A 40,000 + dwt	9	19.0%	18.61%	44.44%	62.95%	3.54%	8.44%	11.96%
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	14	12.0%	13.96%	45.74%	56.95%	1.68%	5.49%	6.83%
			99	Bulk carrier 60,000 - 99,999 dwt	9	12.0%	16.74%	44.14%	59.49%	2.01%	5.30%	7.14%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	Ship-side Task 2 CI Change, % 2040	Ship-side Task 2 CI Change, % 2050	Ship-side Task 2 FRACCI, % 2030	Ship-side Task 2 FRACCI, % 2040	Ship-side Task 2 FRACCI, % 2050
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	7	6.0%	17.93%	39.87%	52.54%	1.08%	2.39%	3.15%
			9	Bulk carrier 35,000 - 59,999 dwt	13	6.0%	13.52%	47.86%	54.71%	0.81%	2.87%	3.28%
			19	Bulk carrier 60,000 - 99,999 dwt	9	6.0%	16.75%	44.47%	58.06%	1.00%	2.67%	3.48%
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	14	10.6%	13.74%	40.22%	47.33%	1.46%	4.26%	5.02%
			3	Bulk carrier 35,000 - 59,999 dwt	14	10.6%	13.52%	47.86%	54.71%	1.43%	5.07%	5.80%
			17	Bulk carrier 60,000 - 99,999 dwt	10	10.6%	16.75%	44.47%	58.06%	1.78%	4.71%	6.15%
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	12	2.7%	20.15%	55.80%	67.84%	0.54%	1.51%	1.83%
			70	Container 8,000-11,999 teu	9	2.7%	24.44%	44.87%	68.45%	0.66%	1.21%	1.85%
	1d	Apples and pears	12	Container 1,000-1,999 teu	11	10.3%	14.72%	57.93%	67.35%	1.52%	5.97%	6.94%
			3	Container 5,000-7,999 teu	12	10.3%	20.15%	55.80%	67.84%	2.08%	5.75%	6.99%
			20	Container 8,000-11,999 teu	9	10.3%	24.44%	44.87%	68.45%	2.52%	4.62%	7.05%
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dwt	10	19.0%	18.83%	44.04%	60.55%	3.58%	8.37%	11.50%
			52	02 Chemical tanker / A 40,000 + dwt	9	19.0%	18.83%	44.04%	60.55%	3.58%	8.37%	11.50%
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	14	12.0%	13.52%	47.86%	54.71%	1.62%	5.74%	6.57%
			99	Bulk carrier 60,000 - 99,999 dwt	9	12.0%	16.75%	44.47%	58.06%	2.01%	5.34%	6.97%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	Ship-side Task 2 CI Change, % 2040	Ship-side Task 2 CI Change, % 2050	Ship-side Task 2 FRACCI, % 2030	Ship-side Task 2 FRACCI, % 2040	Ship-side Task 2 FRACCI, % 2050
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	7	6.0%	34.11%	50.13%	51.50%	2.05%	3.01%	3.09%
			9	Bulk carrier 35,000 - 59,999 dwt	13	6.0%	33.36%	49.90%	55.02%	2.00%	2.99%	3.30%
			19	Bulk carrier 60,000 - 99,999 dwt	9	6.0%	35.27%	49.89%	56.87%	2.12%	2.99%	3.41%
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	14	10.6%	28.23%	44.96%	47.30%	2.99%	4.77%	5.01%
			3	Bulk carrier 35,000 - 59,999 dwt	14	10.6%	33.36%	49.90%	55.02%	3.54%	5.29%	5.83%
			17	Bulk carrier 60,000 - 99,999 dwt	10	10.6%	35.27%	49.89%	56.87%	3.74%	5.29%	6.03%
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	12	2.7%	51.53%	65.50%	73.94%	1.39%	1.77%	2.00%
			70	Container 8,000-11,999 teu	9	2.7%	44.36%	64.06%	66.70%	1.20%	1.73%	1.80%
	1d	Apples and pears	12	Container 1,000-1,999 teu	11	10.3%	43.90%	69.28%	71.44%	4.52%	7.14%	7.36%
			3	Container 5,000-7,999 teu	12	10.3%	51.53%	65.50%	73.94%	5.31%	6.75%	7.62%
			20	Container 8,000-11,999 teu	9	10.3%	44.36%	64.06%	66.70%	4.57%	6.60%	6.87%
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dwt	10	19.0%	40.75%	58.62%	59.39%	7.74%	11.14%	11.28%
			52	02 Chemical tanker / A 40,000 + dwt	9	19.0%	40.75%	58.62%	59.39%	7.74%	11.14%	11.28%
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	14	12.0%	33.36%	49.90%	55.02%	4.00%	5.99%	6.60%
			99	Bulk carrier 60,000 - 99,999 dwt	9	12.0%	35.27%	49.89%	56.87%	4.23%	5.99%	6.82%

The *ad valorem* rates for the exported trade goods range significantly. Bovine meat, a relatively high-cost commodity, is the lowest at 2.7%. Soy oil, a relatively low-cost commodity, is the highest at 19.0%. The average is 10.1%. This means chilled bovine meat is the least sensitive to increases in ship-side cost intensity changes and soybean meal, apples and pears, corn, and soy oil are relatively much more sensitive to ship-side cost intensity changes compared to the other two.

Note that there are significant differences between ship type, size, and age groups between scenarios. As learned from our consultation with DNV, "It should be noted that scenarios 23 and 24, and to a lesser degree scenarios 31 and 32, show large differences in cost impacts in 2030 depending on the generation of ships deployed. Ships with 10 years or less of age – i.e. built in the period between 2020 and 2029 – have a significantly higher increase in costs compared to older vessels. In the scenarios with a GFI flexibility mechanism, the newer ships built in 2020-2029 take the brunt of the GHG intensity reductions, resulting in a higher cost increase compared to older ships when looking at all abatement costs. This is as expected, as the cost of reduction is relatively lower for new ships compared to existing ships.

"However, it should also be expected that there should be some compensation from the older ships to the newer ships when joining in a compliance pool under the GFI flexibility mechanism. DNV indicates in their report that the emission unit exchange price is set to the marginal cost of the last ship in the pool that was selected to implement an additional measure.

"However, when applying this price the results showed that the newer ships are overcompensated (i.e. the compensation led to a cost decrease), meaning that the marginal cost of the last ship is likely not a very good indicator for the exchange price in a pool as the many ships will have lower abatement costs. For this reason, the costs and incomes of joining a pool are not included in this analysis."[48]

Total commodity cost intensity due to speed reduction and MTM

For each case study, combining Task 2 and Task 4 results estimates the total commodity cost intensity[49] associated with potential speed reduction and the MTM ($TCCI_{mtm}$), for the forecasted years of 2030, 2040, and 2050, as presented in Table 4.6, on the following page. For each case study, the results were compiled into a transit-weighted average for each scenario and forecasted year. These results are presented in Table 4.7.

[48] Email exchange with Tore Longa, Project Manager Task 2, 1 June 2024.

[49] The term 'total commodity cost intensity' as used in this report is defined as the total 'landed cost' of the commodity.

Table 4.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	7	1.04%	2.25%	7.17%	19.07%	2.70%	3.91%	8.84%	20.74%	2.92%	4.13%	9.06%	20.96%
			9	Bulk carrier 35,000 - 59,999 dwt	13	0.34%	1.52%	6.30%	17.86%	3.07%	4.25%	9.03%	20.59%	3.08%	4.26%	9.04%	20.59%
			19	Bulk carrier 60,000 - 99,999 dwt	9	1.15%	1.96%	5.21%	13.08%	2.56%	3.36%	6.62%	14.49%	3.22%	4.02%	7.28%	15.15%
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	14	1.05%	1.34%	2.51%	5.34%	5.23%	5.52%	6.69%	9.53%	4.88%	5.17%	6.34%	9.17%
			3	Bulk carrier 35,000 - 59,999 dwt	14	0.60%	0.85%	1.86%	4.30%	5.43%	5.68%	6.69%	9.13%	5.44%	5.69%	6.70%	9.14%
			17	Bulk carrier 60,000 - 99,999 dwt	10	2.04%	2.31%	3.39%	6.00%	4.53%	4.79%	5.87%	8.49%	5.69%	5.96%	7.04%	9.65%
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	12	0.23%	0.41%	1.13%	2.86%	1.90%	2.07%	2.79%	4.52%	2.10%	2.28%	3.00%	4.73%
			70	Container 8,000-11,999 teu	9	0.64%	0.81%	1.50%	3.18%	1.20%	1.37%	2.07%	3.75%	1.70%	1.87%	2.56%	4.24%
	1d	Apples and pears	12	Container 1,000-1,999 teu	11	1.07%	1.08%	1.11%	1.19%	6.62%	6.62%	6.66%	6.73%	7.23%	7.24%	7.27%	7.35%
			3	Container 5,000-7,999 teu	12	0.88%	0.97%	1.30%	2.10%	7.23%	7.31%	7.64%	8.45%	8.01%	8.10%	8.43%	9.23%
			20	Container 8,000-11,999 teu	9	2.42%	2.52%	2.89%	3.80%	4.57%	4.66%	5.04%	5.95%	6.47%	6.56%	6.93%	7.84%
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dwt	10	4.62%	5.11%	7.09%	11.90%	10.13%	10.62%	12.61%	17.41%	10.88%	11.37%	13.36%	18.16%
			52	02 Chemical tanker / A 40,000 + dwt	9	4.62%	5.18%	7.46%	12.97%	10.13%	10.69%	12.97%	18.49%	10.88%	11.44%	13.72%	19.24%
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	14	0.68%	1.29%	3.77%	9.76%	6.15%	6.76%	9.24%	15.22%	6.16%	6.77%	9.25%	15.24%
			99	Bulk carrier 60,000 - 99,999 dwt	9	2.31%	2.95%	5.55%	11.84%	5.12%	5.76%	8.37%	14.65%	6.44%	7.08%	9.69%	15.98%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	7	1.27%	2.49%	7.41%	19.31%	2.65%	3.86%	8.79%	20.69%	2.96%	4.17%	9.10%	21.00%
			9	Bulk carrier 35,000 - 59,999 dwt	13	0.33%	1.51%	6.29%	17.85%	2.58%	3.76%	8.54%	20.10%	3.07%	4.25%	9.03%	20.58%
			19	Bulk carrier 60,000 - 99,999 dwt	9	1.04%	1.84%	5.10%	12.97%	2.40%	3.20%	6.46%	14.33%	3.25%	4.05%	7.31%	15.18%
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	14	0.88%	1.17%	2.34%	5.18%	4.11%	4.40%	5.57%	8.40%	4.72%	5.01%	6.18%	9.01%
			3	Bulk carrier 35,000 - 59,999 dwt	14	0.59%	0.84%	1.85%	4.29%	4.56%	4.81%	5.82%	8.26%	5.42%	5.67%	6.68%	9.12%
			17	Bulk carrier 60,000 - 99,999 dwt	10	1.83%	2.10%	3.18%	5.80%	4.24%	4.51%	5.59%	8.20%	5.74%	6.00%	7.09%	9.70%
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	12	0.25%	0.43%	1.15%	2.88%	1.46%	1.63%	2.35%	4.08%	1.92%	2.10%	2.82%	4.55%
			70	Container 8,000-11,999 teu	9	0.79%	0.97%	1.66%	3.34%	1.13%	1.30%	2.00%	3.68%	1.70%	1.87%	2.57%	4.25%
	1d	Apples and pears	12	Container 1,000-1,999 teu	11	0.87%	0.88%	0.91%	0.99%	5.52%	5.53%	5.56%	5.64%	7.16%	7.17%	7.21%	7.28%
			3	Container 5,000-7,999 teu	12	0.96%	1.04%	1.37%	2.18%	5.55%	5.64%	5.97%	6.77%	7.34%	7.42%	7.76%	8.56%
			20	Container 8,000-11,999 teu	9	3.03%	3.12%	3.50%	4.40%	4.31%	4.40%	4.77%	5.68%	6.49%	6.58%	6.95%	7.86%
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dwt	10	4.44%	4.93%	6.92%	11.72%	8.75%	9.24%	11.23%	16.03%	10.89%	11.38%	13.37%	18.17%
			52	02 Chemical tanker / A 40,000 + dwt	9	4.44%	5.00%	7.28%	12.80%	8.75%	9.31%	11.59%	17.11%	10.89%	11.45%	13.73%	19.25%
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	14	0.67%	1.28%	3.76%	9.75%	5.17%	5.78%	8.26%	14.24%	6.14%	6.75%	9.23%	15.22%
			99	Bulk carrier 60,000 - 99,999 dwt	9	2.08%	2.72%	5.32%	11.61%	4.80%	5.44%	8.05%	14.33%	6.50%	7.14%	9.74%	16.03%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	2030 SR 10%	2030 SR 20%	2030 SR 30%	2040 TCCImtm Change, % SR 0%	2040 SR 10%	2040 SR 20%	2040 SR 30%	2050 TCCImtm Change, % SR 0%	2050 SR 10%	2050 SR 20%	2050 SR 30%
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	7	0.91%	2.13%	7.05%	18.95%	2.41%	3.62%	8.54%	20.44%	3.18%	4.39%	9.31%	21.21%
			9	Bulk carrier 35,000 - 59,999 dwt	13	0.84%	2.01%	6.80%	18.35%	2.74%	3.92%	8.70%	20.26%	3.42%	4.59%	9.38%	20.93%
			19	Bulk carrier 60,000 - 99,999 dwt	9	1.00%	1.81%	5.06%	12.93%	2.65%	3.45%	6.71%	14.58%	3.57%	4.37%	7.63%	15.50%
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	14	1.43%	1.71%	2.89%	5.72%	4.10%	4.39%	5.56%	8.39%	5.24%	5.52%	6.70%	9.53%
			3	Bulk carrier 35,000 - 59,999 dwt	14	1.48%	1.73%	2.74%	5.18%	4.85%	5.10%	6.11%	8.54%	6.04%	6.29%	7.29%	9.73%
			17	Bulk carrier 60,000 - 99,999 dwt	10	1.77%	2.04%	3.12%	5.74%	4.68%	4.95%	6.03%	8.64%	6.31%	6.57%	7.65%	10.27%
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	12	0.50%	0.68%	1.39%	3.13%	1.42%	1.59%	2.31%	4.04%	1.93%	2.11%	2.82%	4.56%
			70	Container 8,000-11,999 teu	9	0.59%	0.76%	1.45%	3.13%	1.20%	1.37%	2.06%	3.74%	1.89%	2.07%	2.76%	4.44%
	1d	Apples and pears	12	Container 1,000-1,999 teu	11	1.64%	1.65%	1.68%	1.76%	5.40%	5.41%	5.44%	5.52%	7.01%	7.02%	7.05%	7.13%
			3	Container 5,000-7,999 teu	12	1.91%	1.99%	2.32%	3.13%	5.40%	5.48%	5.81%	6.62%	7.36%	7.44%	7.78%	8.58%
			20	Container 8,000-11,999 teu	9	2.24%	2.33%	2.71%	3.61%	4.57%	4.66%	5.03%	5.94%	7.22%	7.32%	7.69%	8.60%
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dwt	10	3.54%	4.03%	6.01%	10.82%	8.44%	8.93%	10.92%	15.73%	11.96%	12.45%	14.44%	19.24%
			52	02 Chemical tanker / A 40,000 + dwt	9	3.54%	4.10%	6.38%	11.89%	8.44%	9.00%	11.29%	16.80%	11.96%	12.52%	14.80%	20.32%
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	14	1.68%	2.29%	4.76%	10.75%	5.49%	6.10%	8.58%	14.57%	6.83%	7.44%	9.92%	15.91%
			99	Bulk carrier 60,000 - 99,999 dwt	9	2.01%	2.65%	5.25%	11.54%	5.30%	5.94%	8.54%	14.83%	7.14%	7.78%	10.38%	16.67%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	2030 SR 10%	2030 SR 20%	2030 SR 30%	2040 TCCImtm Change, % SR 0%	2040 SR 10%	2040 SR 20%	2040 SR 30%	2050 TCCImtm Change, % SR 0%	2050 SR 10%	2050 SR 20%	2050 SR 30%
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	7	1.08%	2.29%	7.21%	19.11%	2.39%	3.60%	8.53%	20.43%	3.15%	4.36%	9.29%	21.19%
			9	Bulk carrier 35,000 - 59,999 dwt	13	0.81%	1.99%	6.77%	18.33%	2.87%	4.05%	8.83%	20.39%	3.28%	4.46%	9.24%	20.80%
			19	Bulk carrier 60,000 - 99,999 dwt	9	1.00%	1.81%	5.06%	12.93%	2.67%	3.47%	6.73%	14.60%	3.48%	4.29%	7.54%	15.41%
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	14	1.46%	1.75%	2.92%	5.75%	4.26%	4.55%	5.72%	8.56%	5.02%	5.31%	6.48%	9.31%
			3	Bulk carrier 35,000 - 59,999 dwt	14	1.43%	1.68%	2.69%	5.13%	5.07%	5.32%	6.33%	8.77%	5.80%	6.05%	7.06%	9.50%
			17	Bulk carrier 60,000 - 99,999 dwt	10	1.78%	2.04%	3.12%	5.74%	4.71%	4.98%	6.06%	8.67%	6.15%	6.42%	7.50%	10.12%
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	12	0.54%	0.72%	1.44%	3.17%	1.51%	1.68%	2.40%	4.13%	1.83%	2.01%	2.73%	4.46%
			70	Container 8,000-11,999 teu	9	0.66%	0.83%	1.53%	3.21%	1.21%	1.38%	2.08%	3.76%	1.85%	2.02%	2.71%	4.39%
	1d	Apples and pears	12	Container 1,000-1,999 teu	11	1.52%	1.52%	1.56%	1.63%	5.97%	5.97%	6.01%	6.09%	6.94%	6.95%	6.98%	7.06%
			3	Container 5,000-7,999 teu	12	2.08%	2.16%	2.49%	3.30%	5.75%	5.83%	6.16%	6.97%	6.99%	7.07%	7.40%	8.21%
			20	Container 8,000-11,999 teu	9	2.52%	2.61%	2.98%	3.89%	4.62%	4.71%	5.09%	6.00%	7.05%	7.14%	7.52%	8.42%
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dwt	10	3.58%	4.07%	6.05%	10.86%	8.37%	8.86%	10.85%	15.65%	11.50%	11.99%	13.98%	18.79%
			52	02 Chemical tanker / A 40,000 + dwt	9	3.58%	4.14%	6.42%	11.93%	8.37%	8.93%	11.21%	16.73%	11.50%	12.07%	14.35%	19.86%
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	14	1.62%	2.23%	4.71%	10.70%	5.74%	6.35%	8.83%	14.82%	6.57%	7.18%	9.65%	15.64%
			99	Bulk carrier 60,000 - 99,999 dwt	9	2.01%	2.65%	5.25%	11.54%	5.34%	5.98%	8.58%	14.87%	6.97%	7.61%	10.21%	16.50%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	2030 SR 10%	2030 SR 20%	2030 SR 30%	2040 TCCImtm Change, % SR 0%	2040 SR 10%	2040 SR 20%	2040 SR 30%	2050 TCCImtm Change, % SR 0%	2050 SR 10%	2050 SR 20%	2050 SR 30%
Argentina	1a	Soybeans	1	Bulk carrier 10,000-34,999 dwt	7	2.05%	3.26%	8.18%	20.08%	3.01%	4.22%	9.15%	21.04%	3.09%	4.30%	9.23%	21.13%
			9	Bulk carrier 35,000 - 59,999 dwt	13	2.00%	3.18%	7.96%	19.52%	2.99%	4.17%	8.95%	20.51%	3.30%	4.48%	9.26%	20.82%
			19	Bulk carrier 60,000 - 99,999 dwt	9	2.12%	2.92%	6.18%	14.05%	2.99%	3.80%	7.05%	14.92%	3.41%	4.21%	7.47%	15.34%
	1b	Soybean meal	2	Bulk carrier 10,000-34,999 dwt	14	2.99%	3.28%	4.45%	7.28%	4.77%	5.05%	6.23%	9.06%	5.01%	5.30%	6.47%	9.31%
			3	Bulk carrier 35,000 - 59,999 dwt	14	3.54%	3.78%	4.79%	7.23%	5.29%	5.54%	6.55%	8.99%	5.83%	6.08%	7.09%	9.53%
			17	Bulk carrier 60,000 - 99,999 dwt	10	3.74%	4.00%	5.09%	7.70%	5.29%	5.55%	6.64%	9.25%	6.03%	6.29%	7.38%	9.99%
	1c	Chilled bovine meat	4	Container 5,000-7,999 teu	12	1.39%	1.57%	2.29%	4.02%	1.77%	1.95%	2.66%	4.40%	2.00%	2.17%	2.89%	4.62%
			70	Container 8,000-11,999 teu	9	1.20%	1.37%	2.06%	3.74%	1.73%	1.90%	2.60%	4.28%	1.80%	1.97%	2.67%	4.35%
	1d	Apples and pears	12	Container 1,000-1,999 teu	11	4.52%	4.53%	4.56%	4.64%	7.14%	7.14%	7.18%	7.25%	7.36%	7.37%	7.40%	7.48%
			3	Container 5,000-7,999 teu	12	5.31%	5.39%	5.72%	6.53%	6.75%	6.83%	7.16%	7.97%	7.62%	7.70%	8.03%	8.84%
			20	Container 8,000-11,999 teu	9	4.57%	4.66%	5.04%	5.94%	6.60%	6.69%	7.07%	7.97%	6.87%	6.96%	7.34%	8.24%
	1e	Soy oil	6	02 Chemical tanker / B 20,000 - 39,999 dwt	10	7.74%	8.23%	10.22%	15.03%	11.14%	11.63%	13.62%	18.42%	11.28%	11.77%	13.76%	18.57%
			52	02 Chemical tanker / A 40,000 + dwt	9	7.74%	8.30%	10.59%	16.10%	11.14%	11.70%	13.98%	19.50%	11.28%	11.85%	14.13%	19.64%
	1f	Corn	9	Bulk carrier 35,000 - 59,999 dwt	14	4.00%	4.61%	7.09%	13.08%	5.99%	6.60%	9.08%	15.06%	6.60%	7.21%	9.69%	15.68%
			99	Bulk carrier 60,000 - 99,999 dwt	9	4.23%	4.87%	7.48%	13.76%	5.99%	6.63%	9.23%	15.52%	6.82%	7.46%	10.07%	16.36%

Table 4.7: 2030, 2040, & 2050 case study transit-weighted average total commodity cost intensity, by scenario & forecasted year

2030

Country	Case Study	Case Study Commodity	Ship Type(s)	2030 Scenario 23 TCCImtm, % increase				2030 Scenario 24 TCCImtm, % increase				2030 Scenario 31 TCCImtm, % increase				2030 Scenario 32 TCCImtm, % increase				2030 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Argentina	1a	Soybeans	Bulk carrier	0.90%	1.83%	5.62%	14.77%	0.83%	1.76%	5.55%	14.70%	0.95%	1.88%	5.67%	14.82%	0.95%	1.88%	5.67%	14.82%	2.08%	3.01%	6.80%	15.95%
	1b	Soybean meal	Bulk carrier	1.75%	2.02%	3.10%	5.71%	1.58%	1.84%	2.92%	5.53%	1.70%	1.97%	3.05%	5.66%	1.70%	1.97%	3.05%	5.65%	3.64%	3.91%	4.99%	7.60%
	1c	Chilled bovine meat	Container	0.61%	0.78%	1.48%	3.16%	0.76%	0.94%	1.63%	3.32%	0.58%	0.75%	1.45%	3.13%	0.65%	0.83%	1.52%	3.20%	1.21%	1.38%	2.08%	3.76%
	1d	Apples and pears	Container	1.99%	2.06%	2.36%	3.09%	2.37%	2.45%	2.75%	3.47%	2.08%	2.16%	2.46%	3.18%	2.27%	2.34%	2.64%	3.37%	4.64%	4.71%	5.01%	5.74%
	1e	Soy oil	Chemical tanker	4.62%	5.17%	7.42%	12.86%	4.44%	5.00%	7.25%	12.69%	3.54%	4.09%	6.34%	11.78%	3.58%	4.13%	6.38%	11.82%	7.74%	8.30%	10.55%	15.99%
	1f	Corn	Bulk carrier	2.17%	2.81%	5.40%	11.67%	1.96%	2.60%	5.19%	11.45%	1.98%	2.62%	5.21%	11.47%	1.98%	2.62%	5.21%	11.47%	4.21%	4.85%	7.44%	13.71%

2040

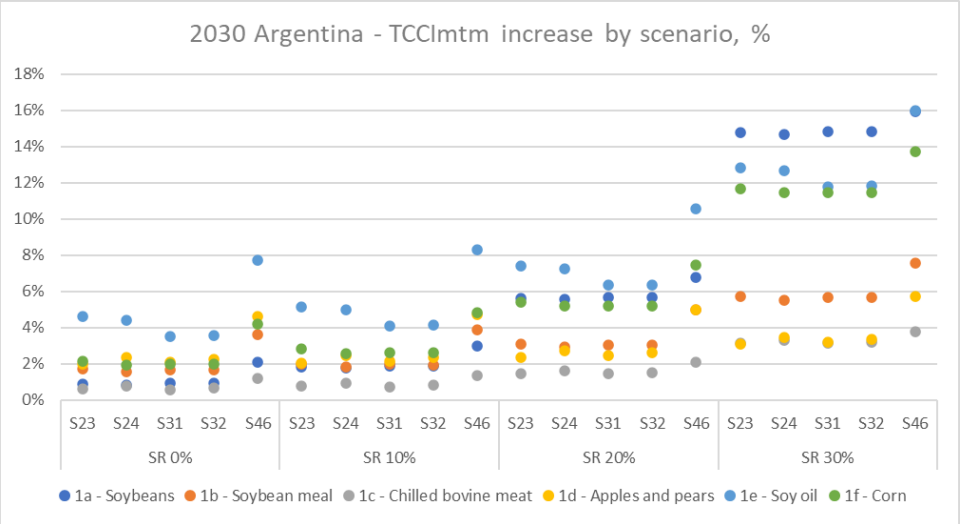
Country	Case Study	Case Study Commodity	Ship Type(s)	2040 Scenario 23 TCCImtm, % increase				2040 Scenario 24 TCCImtm, % increase				2040 Scenario 31 TCCImtm, % increase				2040 Scenario 32 TCCImtm, % increase				2040 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Argentina	1a	Soybeans	Bulk carrier	2.73%	3.66%	7.45%	16.60%	2.47%	3.40%	7.19%	16.34%	2.67%	3.60%	7.39%	16.54%	2.72%	3.65%	7.44%	16.59%	2.99%	3.93%	7.71%	16.87%
	1b	Soybean meal	Bulk carrier	4.71%	4.98%	6.06%	8.67%	4.27%	4.54%	5.62%	8.23%	4.65%	4.91%	5.99%	8.60%	4.72%	4.99%	6.07%	8.68%	5.24%	5.51%	6.59%	9.20%
	1c	Chilled bovine meat	Container	1.24%	1.41%	2.10%	3.79%	1.15%	1.32%	2.01%	3.70%	1.21%	1.38%	2.08%	3.76%	1.23%	1.40%	2.10%	3.78%	1.73%	1.90%	2.60%	4.28%
	1d	Apples and pears	Container	5.27%	5.34%	5.64%	6.37%	4.69%	4.76%	5.06%	5.79%	4.82%	4.90%	5.20%	5.92%	5.01%	5.09%	5.39%	6.11%	6.72%	6.80%	7.10%	7.82%
	1e	Soy oil	Chemical tanker	10.13%	10.68%	12.94%	18.38%	8.75%	9.30%	11.56%	17.00%	8.44%	9.00%	11.25%	16.69%	8.37%	8.92%	11.17%	16.61%	11.14%	11.69%	13.94%	19.39%
	1f	Corn	Bulk carrier	5.21%	5.85%	8.44%	14.70%	4.83%	5.47%	8.06%	14.33%	5.31%	5.95%	8.54%	14.81%	5.37%	6.01%	8.60%	14.86%	5.99%	6.62%	9.22%	15.48%

2050

Country	Case Study	Case Study Commodity	Ship Type(s)	2050 Scenario 23 TCCImtm, % increase				2050 Scenario 24 TCCImtm, % increase				2050 Scenario 31 TCCImtm, % increase				2050 Scenario 32 TCCImtm, % increase				2050 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Argentina	1a	Soybeans	Bulk carrier	3.17%	4.10%	7.89%	17.04%	3.18%	4.12%	7.90%	17.06%	3.51%	4.44%	8.23%	17.38%	3.41%	4.34%	8.13%	17.28%	3.37%	4.30%	8.09%	17.24%
	1b	Soybean meal	Bulk carrier	5.58%	5.85%	6.93%	9.54%	5.60%	5.87%	6.95%	9.56%	6.17%	6.44%	7.52%	10.13%	6.00%	6.27%	7.35%	9.96%	5.91%	6.17%	7.25%	9.86%
	1c	Chilled bovine meat	Container	1.72%	1.89%	2.59%	4.27%	1.71%	1.88%	2.58%	4.26%	1.90%	2.07%	2.76%	4.45%	1.85%	2.02%	2.72%	4.40%	1.81%	1.98%	2.68%	4.36%
	1d	Apples and pears	Container	6.78%	6.86%	7.16%	7.88%	6.71%	6.79%	7.09%	7.82%	7.19%	7.27%	7.57%	8.30%	7.02%	7.09%	7.40%	8.12%	7.05%	7.12%	7.42%	8.15%
	1e	Soy oil	Chemical tanker	10.88%	11.43%	13.68%	19.12%	10.89%	11.45%	13.70%	19.14%	11.96%	12.51%	14.77%	20.21%	11.50%	12.06%	14.31%	19.75%	11.28%	11.84%	14.09%	19.53%
	1f	Corn	Bulk carrier	6.42%	7.06%	9.65%	15.91%	6.47%	7.10%	9.70%	15.96%	7.11%	7.75%	10.34%	16.61%	6.93%	7.57%	10.16%	16.43%	6.81%	7.44%	10.04%	16.30%

The 2030, 2040, and 2050 transit-weighted averaged, total commodity cost intensity ranges across all scenarios, by speed reduction group is presented in Figures 4.2, 4.3, and 4.4, respectively.

Figure 4.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group

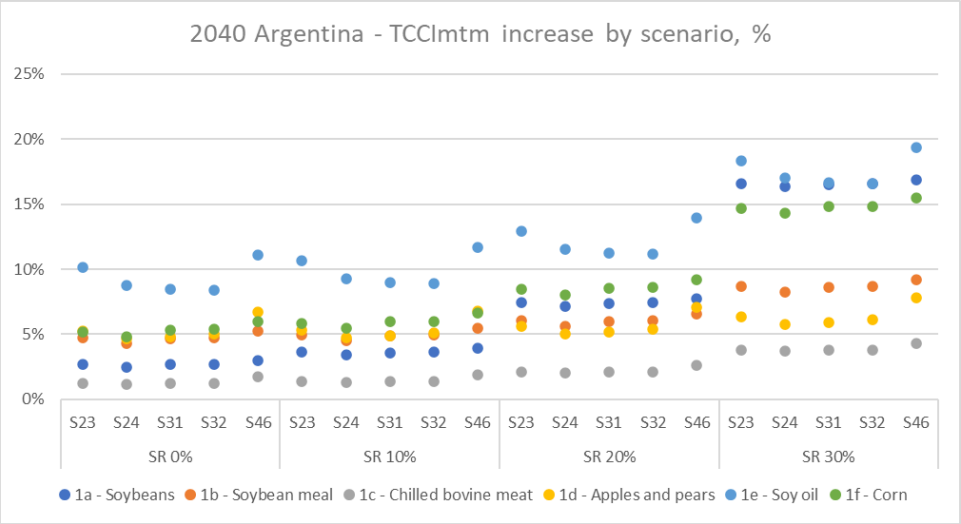


Note that in 2030, commodity cost intensity increases by category, with the key parameters ranging from:

- **TCCImtm** **0.58% to 15.99%, with an average of 4.62%**

One category (soybeans) is generally driven equally by ship-side and speed reduction. The other category (soybean meal, chilled bovine meat, apples, soy oil, and corn) is generally driven only by ship-side increases. Chilled meat has the lowest increases across all scenarios and speed reduction groups, driven by very low ship-side cost increases because of its 2.7% *ad valorem* rate. Soy oil generally has the highest increases due to its high *ad valorem* rate, and the fact that it has the longest transits—twice as far as soybean meal, chilled bovine meat, apples and pears, and nearly two-thirds longer than soy oil and corn. Scenario 46 is generally higher than the other scenarios across all speed reduction groups. Due to its distance to market, soybeans, soil oil, and corn have the highest sensitivities to speed reduction. Soybeans, while having a relatively low *ad valorem* freight rate also has the longest distance to market of all the commodity case studies (12,000 nm to nearly 15,000 nm depending on route). Soy oil and corn have relatively high *ad valorem* freight rates so they are impacted both by ship-side and speed reduction, speed side being due to the distance of the route (over 10,000 nm).

Figure 4.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group



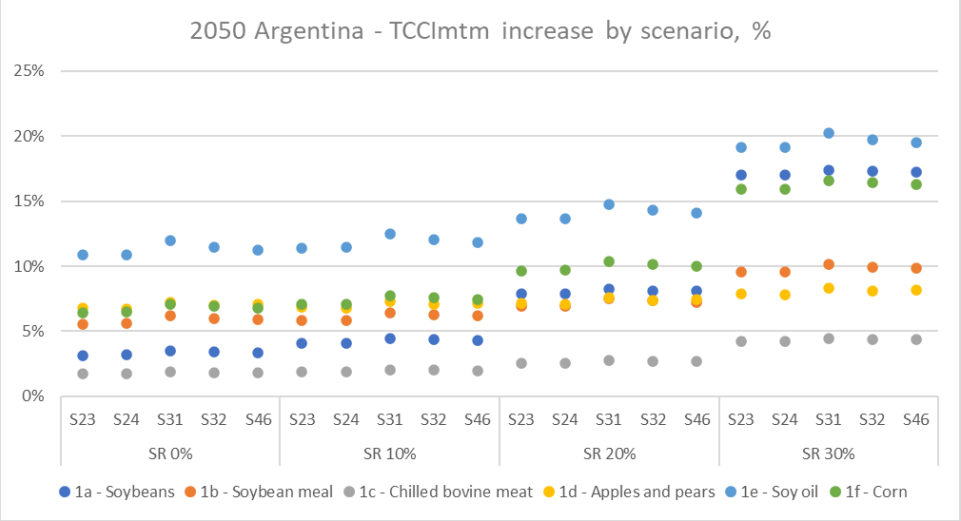
Note that in 2040, similar to 2030, there are two categories of commodities. However, this has shifted from the above, with the key parameters now ranging from:

- **TCCImtm** **1.15% to 19.39%, with an average of 7.09%**

For one category (soybeans) cost increases are generally driven equally by ship-side and speed reduction for all scenarios with the exception of Scenario 46, where ship-side cost increases are predominant at the SR 0% and SR 10% groups. The other category (soybean meal, chilled bovine meat, apples, soy oil, and corn) is generally driven only by ship-side increases.

Note that at SR 30%, corn cost increases are driven by speed reduction. For soybeans, Scenario 46 is no longer the highest scenario due to the increases in Scenario 23, with Scenarios 31 and 32 the least relative cost increases. Similar reshaping happens for all commodities across all scenarios and speed reduction categories. Soybeans, corn, and soy oil remain the most sensitive in the SR 30% group, while chilled bovine beef remains the least impacted commodity.

Figure 4.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2050, similar categories in 2040 exist with more distinct and tighter stratification of scenarios across all scenarios and speed reduction groups, with the key parameters ranging from:

- **TCCImtm** **1.71% to 20.21%, with an average of 8.30%**

Soybeans, corn, and soy oil remain the most sensitive in the SR 30% group, while chilled bovine beef remains the least impacted commodity.

GDP context

All commodities under evaluations form part of the agricultural sector and this sector shares 5.83% of the national GDP, according to the data provided by the Member States.

4.4 Qualitative analysis

Argentina provided detailed Qualitative information on all three of their commodities using input from global industry experts for each commodity. These are:

- Soybeans, soybean meal, soy oil and corn: Responses provided by Cámara de la Industria Aceitera de la República Argentina (CIARA) and Centro de Exportadores de Cereales (CEC)
- Chilled bovine meat: Responses provided by Instituto de Promoción de la Carne Vacuna Argentina (IPCVA) and Consorcio de Exportadores de Carnes Argentinas
- Apples and pears: Response provided by Cámara Argentina de Fruticultores Integrados (CAFI)

These stakeholders all showed strong awareness of the potential impacts of the IMO measures to decarbonize shipping, as well as related factors such as impacts on food and fuel prices.

Analyses of these responses are displayed on the following SWOT grids (Tables 4.8 and 4.9) showing sensitivities to freight costs and sensitivities to transit times. Key takeaways for each grid are reflected below the SWOT grids.

Table 4.8: SWOT analysis of Argentina's commodities and their sensitivity to cost changes

Sensitivity to freight shipment cost changes as reported by the stakeholders	
Country: Argentina Commodities: 1a Soybeans, 1b Soybean meal, 1c Chilled bovine meat, 1d Apples and pears, 1e Soy oil, 1f Corn	
Strengths ➢ Freight price is linked to the stipulated speed. ➢ Soybeans, soy oil, soy meal and corn commodities were not impacted by Covid-19. ➢ Apples and pears are not impacted by seasonal demand.	**Weaknesses** ➢ Air freight is not an option for large quantities of beef exports, as it could cost over 10x as much. ➢ Covid-19 had a terrible impact on beef exports, resulting in higher operation costs and thus higher costs for exporters and importers. ➢ Higher transport costs have severe implications as Argentina is located very far from countries which import their expensive beef cuts. ➢ It is almost impossible to export beef to the far east due to high freight costs. ➢ The apples and pears sectors are very sensitive to changes in freight rates, so paying for GHG emissions affects this. Major costs would be borne by the exporter. ➢ Refrigerated containers and bulkers use significantly more fuel and energy.
Opportunities to adapt/mitigate ➢ Trade agreements could perhaps push importing countries to make shipping lines that are owned by European countries to comply with zero emissions by 2050. ➢ Technological improvements could lower the cost of GHG emissions, and freight variation would be lower. ➢ Lower speeds could reduce bunker costs.	**Threats** ➢ Change in shipping speeds would affect freight costs for both importers and exporters. ➢ Paying for GHG emissions will affect freight costs. Importers and exporters/producers will bear these costs. ➢ Paying for GHG emissions would force exporters to charge less, the freight forwarder then has lower container turnover, the importer receives the goods later with less time to sell them. ➢ If there is an emissions tax, the importer pays more, ultimately impacting the exporter. Take note that Argentina is a price-taker in the commodities analyzed in this report. ➢ If green future fuels are not available in Argentina, freight rates could increase because of higher costing energy. ➢ Longer shipping times mean prolonged time under cooling, impacting shelf life, texture and resulting in additional waste.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- Soybeans, soy oil, soy meal and corn commodities were not impacted by Covid-19, though it did negatively impact beef exports. This resulted in higher costs for exporters and importers.
- Air freight is not a feasible alternative to maritime transport in relation to beef exports, as the large quantities of this export could cause transportation to cost over 10x as much.
- Higher transport costs have severe implications as Argentina is located far away from markets, making it almost impossible to ship to the far east.
- Major costs would be borne by the exporter, though all participants in the value chain would bear the costs of GHG emission charges. Take note that Argentina is a price-taker in the commodities analyzed in this report.
- Paying for GHG emissions would force exporters to charge less, the freight forwarder then has lower container turnover, the importer receives the goods later with less time to sell them because of their lower quality.
- Change in shipping speeds would affect freight costs and if there is an added emissions tax, the importer pays more, ultimately impacting the exporter.
- Lower speeds could reduce bunkers costs and technological improvements could also lower the cost of GHG emissions.

Table 4.9: SWOT analysis of Argentina's commodities and their sensitivity to transport time changes.

Sensitivity to increased transport times as reported by the stakeholders	
Country: Argentina Commodities: 1a Soybeans, 1b Soybean meal, 1c Chilled bovine meat, 1d Apples and pears, 1e Soy oil, 1f Corn	
Strengths ➢ For apples and pears, if they are delivered as agreed, speed reduction is not a major problem. ➢ With new preservation techniques for apples and pears, delay is not a problem. They also keep longer at destination. ➢ Covid-19 had no impacts in terms of delivery delays for soybeans, soy oil, soy meal and corn. ➢ Impact of lower speeds is not high for soy products and corn. ➢ Stakeholders note that some carriers have placed orders for over 200 dual-methanol vessels.	**Weaknesses** ➢ The problem is unforeseen delays – i.e., not planned. If a delay of over 7 days is not planned, containers pile up with no storage capacity. This applies for apples and pears. ➢ With apples and pears keeping longer at destinations, importers have no urgency to buy. ➢ The supply chain of apples and pears is impacted by delays in that wholesalers will lose their shelf space. The sale window is lost but the price remains the same. ➢ There is no possibility of changing the mode of transport from maritime transport to air transport for apples and pears. ➢ Covid-19 affected shipping routes. ➢ Speed reduction impacts beef exports negatively as shelf life is diminished, lowering value. ➢ Delays affect payments from importers to exporters in the beef sector. ➢ Stakeholders note that for some, zero-emission fuels are in short supply.
Opportunities to adapt/mitigate ➢ Stakeholders note that the shipping industry is moving to decarbonize, despite the scale of the challenge. ➢ Measures to encourage port developments and activities globally to facilitate reduction of GHG emissions from shipping, including ship and shoreside/onshore power supplies from renewable sources, infrastructure to support the supply of zero or near-zero GHG emission fuels and/or energy sources, and to further optimize the logistic chain.	**Threats** ➢ IMO GHG MTM may increase transport times. ➢ Speed reduction in transportation could lead to supplier substitution. ➢ If delays involve higher costs, someone has to pay for it as freight price is linked to speed. ➢ Possible lack of storage at destination following increased transport times. ➢ Supermarkets could charge beef importers because delivery dates are not met. ➢ Speed reduction could lead to distortions in terms of competitiveness, especially in the beef sector.

Key findings on shipment transport times derived from stakeholder input to the SWOT analysis:

- Because of new preservation techniques for apples and pears, delays and speed reductions are not major problems. They are also able to keep longer at destination, though this means importers have no urgency to buy.
- Though Covid-19 affected shipping routes, it had no impacts in terms of delivery delays for soy products and corn. The impact of lower speeds on soy products and corn is also not high.
- If delays are unexpected—i.e., not planned, containers can pile up with no available storage facilities. And, supermarkets could charge beef importers for late deliveries.
- The supply chain is impacted by delays in that wholesalers will lose their shelf space. The sale window is lost but the price remains the same.
- Speed reduction impacts beef exports negatively as shelf life is diminished, lowering value. Frozen beef shelf life is 720 days and chilled beef shelf life is 120 days. However, there are no acceptable delays.
- Delays affect payments from importers to exports. The more time a vessel takes to reach its destination, the more time that elapses until exporters receive payment.
- Speed reduction in transportation could lead to supplier substitution and thus loss of market. It could also lead to distortions in terms of competitiveness. For example, South Africa is a competitor of Argentina's pears. If Argentina takes longer, more production comes from South Africa.

In the stakeholder questionnaire we also asked the open-ended question: "What questions should we have asked to more fully understand the impacts of potential vessel greenhouse gas reduction requirements on shipping, your population and your economy?"

4.5 Findings

Quantitative findings

The key findings from the quantitative analysis include:

- Longer transit times from potential speed reduction range across the case studies, including:
  - Soybeans
    - SR 10% - 5 to 6 days
    - SR 20% - 11 to nearly 14 days
    - SR 30% - 19 to over 23 days
  - Soybean meal
    - SR 10% - 3 days
    - SR 20% - 6 to nearly 7 days
    - SR 30% - 10 to over 11 days
  - Chilled bovine meat
    - SR 10% - just over 2 days
    - SR 20% - just over 5 days
    - SR 30% - almost 9 days
  - Apples and pears
    - SR 10% - just over 2 days
    - SR 20% - just under 5 days
    - SR 30% - just over 8 days
  - Soy oil
    - SR 10% - 4 days
    - SR 20% - 8 to 9 days
    - SR 30% - 15 to 16 days

  - Corn
    - SR 10% - 4 days
    - SR 20% - just under 10 days
    - SR 30% - 16 to 17 days
- Total commodity cost intensity increases across all scenarios are more sensitive to commodity costs associated with the MTM than to the associated costs with speed reduction.
- The *ad valorem* rates for the exported trade goods range significantly with bovine meat, a relatively high-cost commodity, the lowest at 2.7%, and soy oil, a relatively low-cost commodity, the highest at 19.0%, with an average of 10.1%. This means chilled bovine meat is the least sensitive to increases in ship-side cost intensity changes, and soybean meal, apples and pears, corn, and soy oil are comparatively much more sensitive to ship-side cost intensity changes compared to the other two.
- Note that in 2030, commodity cost intensity increases by category. One category (soybeans) is generally driven equally by ship-side and speed reduction. The other category is generally driven only by ship-side increases (soybean meal, chilled bovine meat, apples, soy oil, and corn). Chilled meat has the lowest increases across all scenarios and speed reduction groups, driven by very low ship-side cost increases because of its 2.7% *ad valorem* rate. Soy oil generally has the highest increases due to its high *ad valorem* rates and it has the longest transits, twice as far as soybean meal, chilled bovine meat, apples and pears, and nearly two thirds longer transits than soy oil and corn. Scenario 46 generally dominates the other scenarios across all speed reduction groups. Due to its distance to market, soybeans have the highest sensitivity to speed reduction, jumping three times the SR 20% values across all scenarios. The three most sensitive commodities in the SR 30% bracket are soybeans, corn, and soy oil.
- Note that in 2040, similar to 2030, there are two categories of commodities, however, this has shifted from the above. For one category (soybeans) cost increases are generally driven equally by ship-side and speed reduction for all scenarios with the exception of Scenario 46, where ship-side cost increases are predominant at the SR 0% and SR 10% groups. The other category (soybean meal, chilled bovine meat, apples, soy oil, and corn) are generally driven only by ship-side increases (soybean meal, chilled bovine meat, apples, soy oil, and corn).
- Note that at SR 30%, corn cost increases are driven by speed reduction. For soybeans, Scenario 46 is no longer the highest scenario due to the increases in Scenario 23, with Scenarios 31 and 32 the least relative cost increases. Similar reshaping happens for all commodities across all scenarios and speed reduction categories. Soybeans, corn, and soy oil remain the most sensitive in the SR 30% group, while chilled bovine beef remains the least impacted commodity.
- Note that in 2050, similar categories to 2040 exist with more distinct tighter stratification of scenarios across all scenarios and speed reduction groups. Soybeans, corn, and soy oil remain the most sensitive in the SR 30% group, while chilled bovine beef remains the least impacted commodity.
- Total commodity cost intensity ranges across all scenarios and speed reduction groups, include:
  - Soybeans
    - 2030 – 0.83% to 15.95%, with an average of 6.02%
    - 2040 – 2.47% to 16.87%, with an average of 7.60%
    - 2050 – 3.17% to 17.38%, with an average of 8.21%
  - Soybean meal
    - 2030 – 1.58% to 7.60%, with an average of 3.47%
    - 2040 – 4.27% to 9.20%, with an average of 6.11%
    - 2050 – 5.58% to 10.13%, with an average of 7.25%

- Chilled bovine meat
  - 2030 – 0.58% to 3.76%, with an average of 1.66%
  - 2040 – 1.15% to 4.28%, with an average of 2.21%
  - 2050 – 1.71% to 4.45%, with an average of 2.69%
- Apples and pears
  - 2030 – 1.99% to 5.74%, with an average of 3.06%
  - 2040 – 4.69% to 7.82%, with an average of 5.69%
  - 2050 – 6.71% to 8.30%, with an average of 7.34%
- Soy oil
  - 2030 – 3.54% to 15.99%, with an average of 7.68%
  - 2040 – 8.37% to 19.39%, with an average of 12.27%
  - 2050 – 10.88% to 20.21%, with an average of 14.21%
- Corn
  - 2030 – 1.96% to 13.71%, with an average of 5.80%
  - 2040 – 4.83% to 15.48%, with an average of 8.68%
  - 2050 – 6.42% to 16.61%, with an average of 10.09%
- Soy oil
  - 2030 – 3.54% to 15.99%, with an average of 7.68%
  - 2040 – 8.37% to 19.39%, with an average of 12.27%
  - 2050 – 10.88% to 20.21%, with an average of 14.21%

- TCCImtm findings for the six export commodity case studies across all scenarios and speed reduction groups, by forecasted year:
  - 2030 0.58% to 15.99%, with an average of 4.62%
  - 2040 1.15% to 19.39%, with an average of 7.09%
  - 2050 1.71% to 20.21%, with an average of 8.30%

Qualitative findings

Argentina's stakeholders who took part in the qualitative analysis under Task 4 reported several key points during the discussion of freight shipment cost changes for Argentina's exports. Soy products were minimally affected by Covid-19, but beef exports faced significant disruptions. This led to increased costs for both exporters and importers. The implementation of GHG emission charges would impose financial burdens across the entire supply chain, forcing exporters to lower prices, reducing container turnover for freight forwarders, and delaying goods for importers, potentially affecting product quality and sales timelines. Reduced speeds could cut bunker costs and technological advancements to mitigate GHG emissions costs are considered by Argentina to be some potential solutions to these complex logistical and economic challenges.

In terms of increased transit times, advances in preservation techniques for apples and pears have minimized concerns over delays and speed reductions, extending their shelf life at destinations, albeit reducing urgency for importers to purchase. However, unexpected delays can lead to container congestion without adequate storage facilities, potentially resulting in additional charges for late deliveries. Delays also affect the supply chain by jeopardizing wholesalers' shelf space and sales windows, despite prices remaining the same. For beef exports, speed reductions are particularly detrimental due to reduced shelf life and any delays are unacceptable. Moreover, prolonged transit times defer payments from importers to exporters, impacting cash flow. Such delays could also prompt supplier substitution to maintain market share, potentially favoring competitors of Argentina.

Stakeholders suggested opportunities to mitigate impacts include a range of approaches:

- Costs:
  - Trade agreements could perhaps push importing countries to make shipping lines that are owned by European countries to comply with zero emissions by 2050.
  - Technological improvements could lower the cost of GHG emissions, and freight variation would be lower.
  - Lower speeds could reduce bunker costs.
- Longer transport times:
  - The shipping industry is moving to decarbonize, despite the scale of the challenge.
  - Measures to encourage port developments and activities globally to facilitate reduction of GHG emissions from shipping, including ship and shoreside/onshore power supplies from renewable sources, infrastructure to support the supply of zero or near-zero GHG emission fuels and/or energy sources, and to further optimize the logistic chain.

Summary of key points related to potential impacts

The following points are key to understanding the potential impacts of the MTM:

- Argentina is the 25th largest economy in the world by GDP at $631,133 million. Argentina's GDP per capita has been steadily rising and in 2022, is $13,650.
- The six commodities selected by Argentina for case studies are trade commodity exports of soybeans, soybean meal, chilled bovine meat, apples and pears, soy oil, and corn, all destined for markets in Europe and Asia. All six case studies are exported trade commodities, which means costs increases impact the sector/subsector of the economy associated with each commodity. In addition, associated employment, supporting industries, and taxes and revenues associated with the commodity will be impacted.
- All commodities under evaluations form part of the agricultural sector and this sector shares 5.83% of the national GDP, according to the data provided by the Member States.
- For these six case studies, the estimates indicate a range of total commodity cost intensity increases related to maritime transport. Scenarios 23/24 have higher cost impacts compare to Scenarios 31/32. These increases are estimated to be lower in 2030, but are estimated to significantly increase in 2040 and 2050. Scenario 46 brings forward the significant increase in costs to 2030. The least impacted commodity related to ship-side cost increases is chilled bovine meat and therefore its impact remains relatively low compared to the other commodities. That being said, chilled bovine meat does have an expiration window that could be sensitive to higher speed reductions (and therefore slower voyages). Soybeans, soy oil, and corn are the most sensitive to ship-side cost changes and most sensitive to the highest speed reduction group.
- Since these case studies represent export trade commodities only on particular routes, the entire economic sector/subsector is not captured. The full impact on the entire sector/subsector would need to be considered by the Member State and their national stakeholders to determine impacts to GDP, employment, and any collateral impacts on supporting industries.

5 Stakeholders' analysis – Belize

The Stakeholder Assessment for Belize focuses on exports of banana and sugar and imports of steel. Bananas and steel are shipped via containers to the United Kingdom and Belize, respectively. Sugar is sent through bulk carrier to the United Kingdom.

5.1 Geography, population, and economy

Geography

Belize is located on the east coast of Central America and is marked by its diverse and unique geography. It encompasses a range of ecosystems, including tropical rainforests, plains and the Belize Barrier Reef. A relatively small country, Belize is 22,966 km^2 and the only country in Central America without a Pacific coastline.[50] Belize is characterized by coastal plains in the north and the Maya Mountains in the south, a stark contrast in terrain. The country is also renowned for its major rivers and watersheds, including the Belize River which empties into the Caribbean Sea. Belize's coastline along the Caribbean Sea measures 366 km in length and hosts port cities like Belize City, the commercial capital and home to the largest seaport in Belize.[51] Belmopan is the capital city of Belize and is located inland.

Belize is bounded on the north by Mexico, Guatemala on the west and the Caribbean Sea to the east. The country has access to major maritime trade routes and despite its size, plays a significant role in international trade. This has been pivotal to Belize's economic growth and integration into global markets. Although vulnerable to natural disasters like hurricanes and flooding, Belize continues to leverage its location and resources to expand its role in trade. Representative distances to markets for the selected commodities and ports are presented in Section 5.2.

Population

Belize's population is approximately 397,483 as of 2022 and has a diverse demographic–a blend of Mestizo, Creole, African and European ancestry.[52] Of that population, 47% live in urban areas and 53% live in rural areas. The urban population is mostly concentrated in and around major cities like Belize City and Belmopan and the country's population density varies widely. It averages around 17 people km^2 and is influenced by geographic features and economic opportunities. Belize is the least populated and least densely populated country in Central America. Urbanization and immigration from neighboring countries has been steadily increasing, though population growth has declined. The total population in Belize was forecast to increase in the next couple of years but the birth rate remains nearly unchanged.

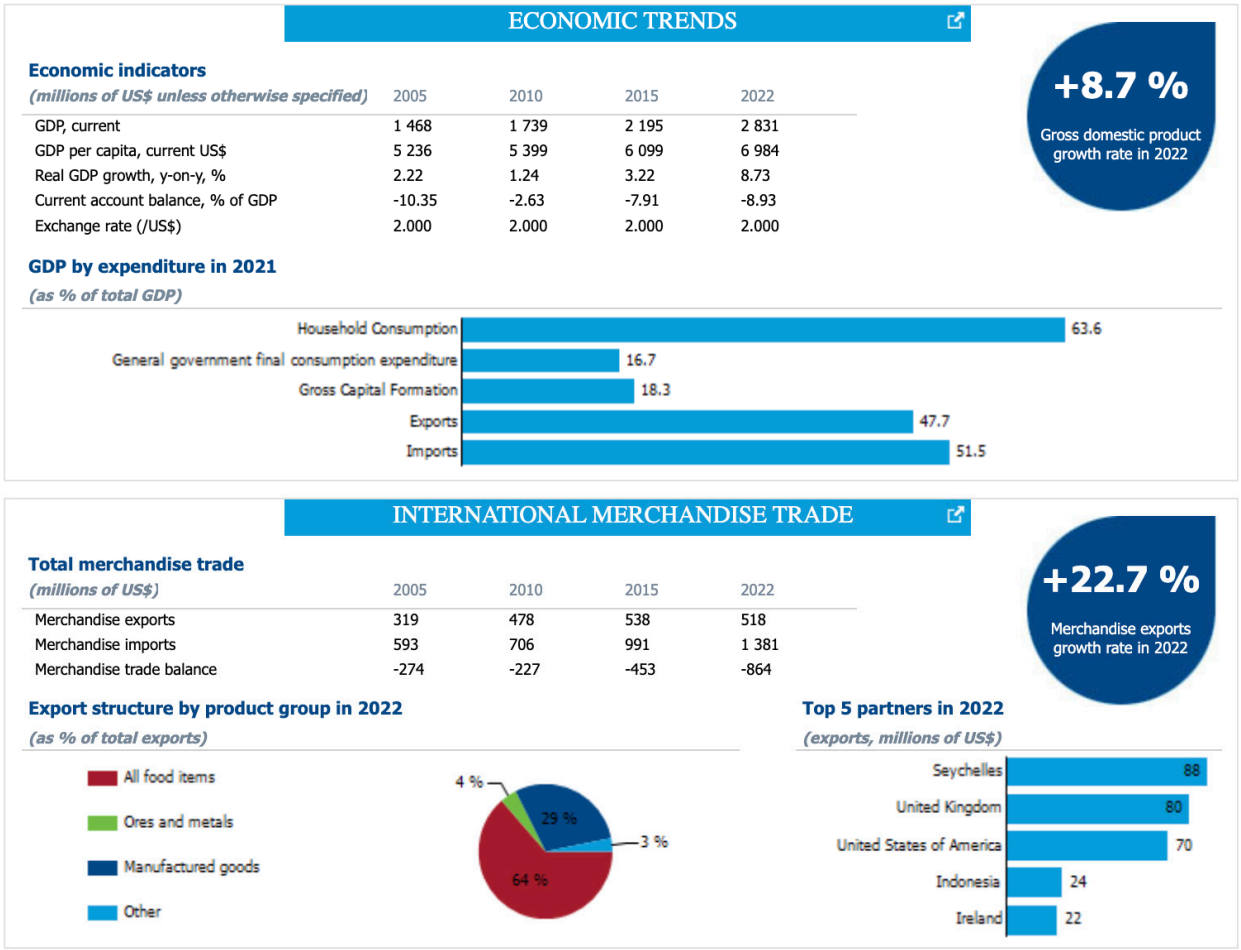
Economy

Belize's economy is diverse and relies on several sectors to drive its growth and development. Belize has benefitted from its agricultural production and the tourism industry.[53] Products like bananas and sugar play significant roles both domestically and in global markets. Belize has also made strides in renewable energy by harnessing its resources to generate hydroelectric power and solar and wind

[50] Encyclopedia Britannica at *Belize | History, Map, Flag, & Population*, O. Nigel Bolland, William J. Griffith.
[51] Port of Belize, *About Us*.
[52] SIB, *Key Findings of the 2022 Population and Housing Census*.
[53] World Bank Group, *The World Bank In Belize*.

energy.[54] The country's GDP per capita has continuously increased and is projected to continue that trend. In 2022, Belize's GDP was $2.831 million, with a GDP per capita of $6,984.[55]
Belize also faces challenges regarding trade deficits, though the country recently documented a record-low trade deficit.[56] Other challenges to Belize's economy include a reliance on foreign energy sources. This leaves Belize vulnerable to fluctuations in prices, geopolitical risks or supply disruptions.[57] Efforts to address these issues include energy investments and the sustainable development of infrastructure. Belize's proximity to the Caribbean Sea has bolstered maritime trade, enhancing its economic growth and integration into the global economy; its economy continues to evolve. Key economic indicators are shown in Figure 5.1.[58]

Figure 5.1: Key economic indicators for Belize



Source: UNCTAD, General and Maritime Profiles: Belize, UNCTAD Statistics - General Profile.

5.2 Identified commodities and routes studied

The case studies for Belize focuses on exports of banana and sugar and imports of steel. Bananas and steel are shipped via containers to the United Kingdom and Belize, respectively. Sugar is sent through bulk carrier to the United Kingdom and mainland Europe.

[54] Energy Unit, Ministry of Public Utilities, Energy, Logistics, and E-Governance, Belize, *Belize Annual Energy Report 2022 Edition*.
[55] UNCTAD, General and Maritime Profiles: *Belize, UNCTAD Statistics - General Profile*.
[56] DGFT, *Belize, Belize Trade Performance*, Trade Intelligence Unit.
[57] MPUELE, *Belize Annual Energy Report 2022 Edition,* Energy Unit.
[58] UNCTAD, General and Maritime Profiles: Belize, *UNCTAD Statistics - General Profile*.

The commodities selected by the Member State for focus and the illustrative trade routes selected are shown in Table 5.1. One commodity selected for this study is an import, and two commodities are exports.

Table 5.1: Shipping distances to and from Belize for selected commodities

Case Study	Commodity	Illustrative identified routes, by country	Ship Type(s)	Route Distance Range, nm min	avg	max	Stops
2a	Bananas	Belize --> Costa Rica --> Panama --> Columbia --> United Kingdom Belize --> Panama --> Costa Rica --> Ireland --> Belgium --> United Kingdom Belize --> Panama --> Costa Rica --> Ireland --> United Kingdom Belize --> Panama --> Ireland --> United Kingdom Belize --> Panama --> United Kingdom	Container	4,942	6,027	6,971	2-5
2b	Sugar	Belize --> Italy Belize --> Romania Belize --> Spain Belize --> Spain --> UK	Bulk carrier	4,523	5,610	6,728	1-2
2c	Steel	Tianjin --> Jamaica --> Belize	Container	10,246	11,863	13,178	5-11
		Long haul routes Tianjin --> Busan --> Hong Kong --> Thailand --> Singapore --> Brazil --> Panama --> United States --> Jamaica Tianjin --> Busan --> Mexico --> Jamaica Tianjin --> Busan --> Mexico --> Panama --> Columbia --> Jamaica Tianjin --> Busan --> Mexico --> Panama --> Jamaica Tianjin --> Busan --> Panama --> Columbia --> Dominican Republic --> Jamaica	Container	9,545	9,952	10,611	3-8
		Regional routes Jamaica --> Belize Jamaica --> Mexico --> Belize	Container	700	1,911	2,567	2-3

5.3 Quantitative analysis

This section presents the quantitative analysis summary results and is organized by fleet analysis summary, total commodity cost intensity changes from speed reduction, Task 2 cost intensity changes due to MTM, total commodity cost intensity impacts, and GDP contexts. The quantitative analysis incorporates the findings of Task 2 related to the selected bracketing MTM scenarios as presented below:[59]

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination: Policy code	GFI scope	GFI flexibility: RU % of price	SU % of price	Levy: Levy USD/tCO_2eq	Levy: Reward % of cost gap	Feebate Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

The detailed approach for the below analyses is provided in Appendix A.

[59] DNV 2024

Fleet analysis summary

As part of the fleet analysis, routes and ship characteristics were identified for each case study. For the specific ship types identified with the case study and transiting on the identified route the following were averaged to represent the fleet:

- Ship type and size
- Number of transits identified
- Route distances obtained from Marine Benchmark's 2022 AIS database were transit-weighted averaged and reported as minimum, average, and maximum distance sailed
- Transit-weighted average year of build, which was used to determine the average age in years

These characteristics for the case studies are presented on the next page in Table 5.2.

Table 5.2: Belize – Fleet characteristics, by case study

Case Study	Commodity	2022 Transits	Ship Type(s)	Route Distance Range, nm min	avg	max	Avg Build
2a	Bananas	47	Container 2,000-2,999 teu	4,942	**6,028**	6,971	2008
2b	Sugar	4	Bulk carrier 10,000-34,999 dwt	4,523	**5,610**	6,728	2011
2c	Steel		**Long haul routes**				
		1	Container 1,000-1,999 teu	9,854	**9,854**	9,854	2007
		5	Container 8,000-11,999 teu	9,545	**9,972**	10,611	2010
			Regional routes				
		5	Container 0-999 teu	767	**2,153**	2,567	2009
		1	Container 1,000-1,999 teu	700	**700**	700	2012

In addition, transit weighted average speeds and average route times were estimated and the APEC Module 1 was used to estimate the longer transit times associated with the speed reduction groups of 10%, 20%, and 30%, as presented in Table 5.3.

Table 5.3: Average route distance, speed, & longer transit ,times, by speed reduction group

Country	Case Study	Commodity	Transits	Ship type & size	Avg Route Distance (nm)	Avg Route Speed (knots)	Avg Route Time (hours)	SR 10% Delay Delta (days)	SR 20% Delay Delta (days)	SR 30% Delay Delta (days)
Belize	2a	Bananas	47	Container 2,000-2,999 teu	6,028	15.3	393	1.8	4.1	7.0
	2b	Sugar	4	Bulk carrier 10,000-34,999 dwt	5,610	11.0	511	2.4	5.3	9.1
	2c	Steel	5	Container 0-999 teu	2,153	12.5	173	0.8	1.8	3.1
			1	Container 1,000-1,999 teu	700	10.5	67	0.3	0.7	1.2
			1	Container 1,000-1,999 teu	9,854	12.2	806	3.7	8.4	14.4
			5	Container 8,000-11,999 teu	9,972	15.8	632	2.9	6.6	11.3

Note that for steel imports, there are two regional routes made up of container vessels with capacities less than 1,000 twenty-foot equivalent unit (teu), and two routes with container ships of less than 2,000 teu. In addition, another route is served by a less than 2,000 teu container ship and several 8,000 to less than 12,000 teu container ships. The long-haul and regional routes are added together in the analysis. The fleet characteristics are assumed to be consistent across the forecasted years of 2030, 2040, and 2050.

Total commodity cost intensity changes due to speed reduction

APEC Module 2 was used to estimate the commodity cost intensity increases due to potentially longer transit times resulting from the three speed reduction groups. The module estimates the daily cost increases, in percentage, associated with the following:

- Finance/interest costs – the financial cost of capital invested in inventory over time. This measures the impact of each hour or day of delay on the cost of the product due to cost of money or interest rate. A Member State rate was used when provided, otherwise, it was assumed to be 5%.[60]
- Depreciation costs – the cost allocation of a commodity, or reduction of the commodity value, over its useful life. For this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry bulk cargo.[61]
- Insurance costs – a cost paid by the cargo owner to protect their goods while in transit. The percentage used in the economic analysis is the one provided by the Member State. If the Member State did not provide data, we assumed it to be 2%.[62]

The total commodity cost intensity change related to the three speed reduction groups for the case studies is presented in Table 5.4. Note that these values remain constant across scenarios and forecasted year.

Table 5.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Commodity-side Task 4 TCCIsr Change, % SR 10%	SR 20%	SR 30%
Belize	2a	Bananas	47	Container 2,000-2,999 teu	15	0.11%	0.55%	1.62%
	2b	Sugar	4	Bulk carrier 10,000-34,999 dwt	12	0.18%	0.93%	2.74%
	2c	Steel	5	Container 0-999 teu	16	0.02%	0.11%	0.31%
			1	Container 1,000-1,999 teu	13	0.00%	0.02%	0.05%
			1	Container 1,000-1,999 teu	14	0.46%	2.32%	6.81%
			5	Container 8,000-11,999 teu	11	0.28%	1.43%	4.19%

The commodity cost intensity changes due to speed reduction, ranges as follows:

- 2a – SR 10% → negligible SR 20% → 0.55% SR 30% → 1.62%
- 2b – SR 10% → 0.18% SR 20% → 0.93% SR 30% → 2.74%
- 2c – SR 10% → negligible-0.46% SR 20% → negligible-2.32% SR 30% → negligible-6.81%

Task 2 cost intensity changes due to MTM

Based on the ship type, size, and age combination for each case study, the applicable Task 2 ship-side commodity cost intensities due to the MTM were identified for the selected scenarios. In addition, to be able to add these to the commodity cost intensity changes due to speed reduction, the a*d valorem* freight rate percentage was identified using the UNCTAD Trade-and-Transport Dataset.[63] The *ad valorem* freight rate percentage represents the transportation cost percentage of a commodity's total cost. These two were multiplied to get the freight rate adjusted commodity cost intensity or FRACCI change for 2030, 2040, and 2050. Task 2 cost intensity change and FRACCI for each scenario are presented in Table 5.5.

[60] Lending Tree, *Assuming a line of credit 5%.*
[61] APEC 2019.
[62] APEC 2019.
[63] UNCTAD, *Trade-and-Transport Dataset*.

Table 5.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Belize	2a	Bananas	47 Container 2,000-2,999 teu	15	10.4%	5.22%	60.95%	76.84%	0.54%	6.34%	7.99%
	2b	Sugar	4 Bulk carrier 10,000-34,999 dwt	12	10.2%	9.93%	49.37%	46.01%	1.01%	5.04%	4.69%
	2c	Steel	5 Container 0-999 teu	16	10.3%	6.90%	53.96%	52.70%	0.71%	5.56%	5.43%
			1 Container 1,000-1,999 teu	13	10.3%	10.37%	64.23%	70.19%	1.07%	6.62%	7.23%
			1 Container 1,000-1,999 teu	14	10.3%	10.37%	64.23%	70.19%	1.07%	6.62%	7.23%
			5 Container 8,000-11,999 teu	11	10.3%	16.71%	64.48%	65.89%	1.72%	6.64%	6.79%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Belize	2a	Bananas	47 Container 2,000-2,999 teu	15	10.4%	6.03%	50.07%	74.73%	0.63%	5.21%	7.77%
	2b	Sugar	4 Bulk carrier 10,000-34,999 dwt	12	10.2%	8.34%	38.80%	44.53%	0.85%	3.96%	4.54%
	2c	Steel	5 Container 0-999 teu	16	10.3%	7.71%	44.24%	51.69%	0.79%	4.56%	5.32%
			1 Container 1,000-1,999 teu	13	10.3%	8.43%	53.62%	69.56%	0.87%	5.52%	7.16%
			1 Container 1,000-1,999 teu	14	10.3%	8.43%	53.62%	69.56%	0.87%	5.52%	7.16%
			5 Container 8,000-11,999 teu	11	10.3%	14.18%	44.40%	61.66%	1.46%	4.57%	6.35%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Belize	2a	Bananas	47 Container 2,000-2,999 teu	15	10.4%	20.15%	54.45%	75.39%	2.10%	5.66%	7.84%
	2b	Sugar	4 Bulk carrier 10,000-34,999 dwt	12	10.2%	13.45%	38.66%	49.40%	1.37%	3.94%	5.04%
	2c	Steel	5 Container 0-999 teu	16	10.3%	18.11%	38.21%	54.54%	1.87%	3.94%	5.62%
			1 Container 1,000-1,999 teu	13	10.3%	15.95%	52.44%	68.05%	1.64%	5.40%	7.01%
			1 Container 1,000-1,999 teu	14	10.3%	15.95%	52.44%	68.05%	1.64%	5.40%	7.01%
			5 Container 8,000-11,999 teu	11	10.3%	22.77%	47.01%	61.89%	2.35%	4.84%	6.37%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Belize	2a	Bananas	47 Container 2,000-2,999 teu	15	10.4%	17.87%	58.30%	75.58%	1.86%	6.06%	7.86%
	2b	Sugar	4 Bulk carrier 10,000-34,999 dwt	12	10.2%	13.74%	40.22%	47.33%	1.40%	4.10%	4.83%
	2c	Steel	5 Container 0-999 teu	16	10.3%	25.87%	40.37%	48.95%	2.66%	4.16%	5.04%
			1 Container 1,000-1,999 teu	13	10.3%	14.72%	57.93%	67.35%	1.52%	5.97%	6.94%
			1 Container 1,000-1,999 teu	14	10.3%	14.72%	57.93%	67.35%	1.52%	5.97%	6.94%
			5 Container 8,000-11,999 teu	11	10.3%	24.49%	51.22%	59.89%	2.52%	5.28%	6.17%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Belize	2a	Bananas	47 Container 2,000-2,999 teu	15	10.4%	52.93%	71.39%	77.10%	5.50%	7.42%	8.02%
	2b	Sugar	4 Bulk carrier 10,000-34,999 dwt	12	10.2%	28.23%	44.96%	47.30%	2.88%	4.59%	4.82%
	2c	Steel	5 Container 0-999 teu	16	10.3%	40.06%	45.22%	53.77%	4.13%	4.66%	5.54%
			1 Container 1,000-1,999 teu	13	10.3%	43.90%	69.28%	71.44%	4.52%	7.14%	7.36%
			1 Container 1,000-1,999 teu	14	10.3%	43.90%	69.28%	71.44%	4.52%	7.14%	7.36%
			5 Container 8,000-11,999 teu	11	10.3%	58.81%	67.01%	63.19%	6.06%	6.90%	6.51%

The *ad valorem* rates of the exported trade goods ranged in a tight span between 10.2% to 10.4%.

Note that there are significant differences between ship type, size, and age groups between scenarios. As learned from our consultation with DNV, "It should be noted that scenarios 23 and 24, and to a lesser degree scenarios 31 and 32, show large differences in cost impacts in 2030 depending on the generation of ships deployed. Ships with 10 years or less of age – i.e. built in the period between 2020 and 2029 – have a significantly higher increase in costs compared to older vessels. In the scenarios with a GFI flexibility mechanism the newer ships built in 2020-2029 takes the brunt of the GHG intensity reductions, resulting in a higher cost increase compared to older ships when looking at all abatement costs. This is as expected, as the cost of reduction is relatively lower for new ships compared to existing ships.

"However, it should also be expected that there should be some compensation from the older ships to the newer ships when joining in a compliance pool under the GFI flexibility mechanism. DNV indicates in their report that the emission unit exchange price is set to the marginal cost of the last ship in the pool that was selected to implement an additional measure.

"However, when applying this price, the results showed that the newer ships are overcompensated (i.e. the compensation led to a cost decrease), meaning that the marginal cost of the last ship is likely not a very good indicator for the exchange price in a pool as many ships will have lower abatement costs. For this reason, the costs and incomes of joining a pool are not included in this analysis."[64]

Total commodity cost intensity due to speed reduction and MTM

For each case study, combining Task 2 and Task 4 results estimates the total commodity cost intensity[65] associated with potential speed reduction and the MTM ($TCCI_{mtm}$), for the forecasted years of 2030, 2040, and 2050, as presented in Table 5.6, on the following page. For each case study, the results were compiled into a transit-weighted average for each scenario and forecasted year. These results are presented in Table 5.7.

[64] Email exchange with Tore Longa, Project Manager Task 2, 1 June 2024.

[65] The term 'total commodity cost intensity' as used in this report is defined as the total 'landed cost' of the commodity.

Table 5.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Belize	2a	Bananas	47 Container 2,000-2,999 teu	15	0.54%	0.65%	1.09%	2.16%	6.34%	6.45%	6.89%	7.96%	7.99%	8.10%	8.54%	9.61%
	2b	Sugar	4 Bulk carrier 10,000-34,999 dwt	12	1.01%	1.20%	1.94%	3.75%	5.04%	5.22%	5.97%	7.77%	4.69%	4.88%	5.62%	7.43%
	2c	Steel	5 Container 0-999 teu	16	0.71%	0.73%	0.82%	1.02%	5.56%	5.58%	5.66%	5.87%	5.43%	5.45%	5.53%	5.74%
			1 Container 1,000-1,999 teu	13	1.07%	1.07%	1.08%	1.11%	6.62%	6.62%	6.63%	6.66%	7.23%	7.23%	7.25%	7.28%
			1 Container 1,000-1,999 teu	14	1.07%	1.53%	3.38%	7.88%	6.62%	7.07%	8.93%	13.42%	7.23%	7.69%	9.55%	14.04%
			5 Container 8,000-11,999 teu	11	1.72%	2.00%	3.15%	5.91%	6.64%	6.92%	8.07%	10.83%	6.79%	7.07%	8.21%	10.98%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Belize	2a	Bananas	47 Container 2,000-2,999 teu	15	0.63%	0.74%	1.18%	2.24%	5.21%	5.32%	5.76%	6.82%	7.77%	7.88%	8.32%	9.39%
	2b	Sugar	4 Bulk carrier 10,000-34,999 dwt	12	0.85%	1.03%	1.78%	3.59%	3.96%	4.14%	4.89%	6.70%	4.54%	4.73%	5.47%	7.28%
	2c	Steel	5 Container 0-999 teu	16	0.79%	0.81%	0.90%	1.11%	4.56%	4.58%	4.66%	4.87%	5.32%	5.35%	5.43%	5.64%
			1 Container 1,000-1,999 teu	13	0.87%	0.87%	0.88%	0.91%	5.52%	5.53%	5.54%	5.57%	7.16%	7.17%	7.18%	7.21%
			1 Container 1,000-1,999 teu	14	0.87%	1.33%	3.18%	7.68%	5.52%	5.98%	7.84%	12.33%	7.16%	7.62%	9.48%	13.97%
			5 Container 8,000-11,999 teu	11	1.46%	1.74%	2.89%	5.65%	4.57%	4.85%	6.00%	8.76%	6.35%	6.63%	7.78%	10.54%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Belize	2a	Bananas	47 Container 2,000-2,999 teu	15	2.10%	2.20%	2.65%	3.71%	5.66%	5.77%	6.21%	7.28%	7.84%	7.95%	8.39%	9.46%
	2b	Sugar	4 Bulk carrier 10,000-34,999 dwt	12	1.37%	1.56%	2.30%	4.11%	3.94%	4.13%	4.87%	6.68%	5.04%	5.22%	5.97%	7.78%
	2c	Steel	5 Container 0-999 teu	16	1.87%	1.89%	1.97%	2.18%	3.94%	3.96%	4.04%	4.25%	5.62%	5.64%	5.72%	5.93%
			1 Container 1,000-1,999 teu	13	1.64%	1.65%	1.66%	1.69%	5.40%	5.40%	5.42%	5.45%	7.01%	7.01%	7.02%	7.06%
			1 Container 1,000-1,999 teu	14	1.64%	2.10%	3.96%	8.45%	5.40%	5.86%	7.72%	12.21%	7.01%	7.47%	9.32%	13.82%
			5 Container 8,000-11,999 teu	11	2.35%	2.63%	3.77%	6.54%	4.84%	5.12%	6.27%	9.03%	6.37%	6.66%	7.80%	10.57%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Belize	2a	Bananas	47 Container 2,000-2,999 teu	15	1.86%	1.97%	2.41%	3.47%	6.06%	6.17%	6.61%	7.68%	7.86%	7.97%	8.41%	9.48%
	2b	Sugar	4 Bulk carrier 10,000-34,999 dwt	12	1.40%	1.59%	2.33%	4.14%	4.10%	4.29%	5.03%	6.84%	4.83%	5.01%	5.76%	7.57%
	2c	Steel	5 Container 0-999 teu	16	2.66%	2.69%	2.77%	2.98%	4.16%	4.18%	4.26%	4.47%	5.04%	5.06%	5.15%	5.35%
			1 Container 1,000-1,999 teu	13	1.52%	1.52%	1.53%	1.56%	5.97%	5.97%	5.98%	6.01%	6.94%	6.94%	6.95%	6.98%
			1 Container 1,000-1,999 teu	14	1.52%	1.97%	3.83%	8.32%	5.97%	6.42%	8.28%	12.77%	6.94%	7.39%	9.25%	13.74%
			5 Container 8,000-11,999 teu	11	2.52%	2.80%	3.95%	6.71%	5.28%	5.56%	6.70%	9.47%	6.17%	6.45%	7.59%	10.36%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Belize	2a	Bananas	47 Container 2,000-2,999 teu	15	5.50%	5.61%	6.05%	7.12%	7.42%	7.53%	7.97%	9.04%	8.02%	8.13%	8.57%	9.63%
	2b	Sugar	4 Bulk carrier 10,000-34,999 dwt	12	2.88%	3.06%	3.81%	5.62%	4.59%	4.77%	5.52%	7.32%	4.82%	5.01%	5.76%	7.56%
	2c	Steel	5 Container 0-999 teu	16	4.13%	4.15%	4.23%	4.44%	4.66%	4.68%	4.76%	4.97%	5.54%	5.56%	5.64%	5.85%
			1 Container 1,000-1,999 teu	13	4.52%	4.52%	4.54%	4.57%	7.14%	7.14%	7.15%	7.18%	7.36%	7.36%	7.37%	7.40%
			1 Container 1,000-1,999 teu	14	4.52%	4.98%	6.84%	11.33%	7.14%	7.59%	9.45%	13.94%	7.36%	7.82%	9.67%	14.17%
			5 Container 8,000-11,999 teu	11	6.06%	6.34%	7.48%	10.25%	6.90%	7.18%	8.33%	11.09%	6.51%	6.79%	7.93%	10.70%

Table 5.7: 2030, 2040, & 2050 case study transit-weighted average total commodity cost intensity, by scenario & forecasted year

2030

Country	Case Study	Case Study Commodity	Ship Type(s)	2030 Scenario 23 TCCImtm, % increase				2030 Scenario 24 TCCImtm, % increase				2030 Scenario 31 TCCImtm, % increase				2030 Scenario 32 TCCImtm, % increase				2030 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Belize	2a	Bananas	Container	0.54%	0.65%	1.09%	2.16%	0.63%	0.74%	1.18%	2.24%	2.10%	2.20%	2.65%	3.71%	1.86%	1.97%	2.41%	3.47%	5.50%	5.61%	6.05%	7.12%
	2b	Sugar	Bulk carrier	1.01%	1.20%	1.94%	3.75%	0.85%	1.03%	1.78%	3.59%	1.37%	1.56%	2.30%	4.11%	1.40%	1.59%	2.33%	4.14%	2.88%	3.06%	3.81%	5.62%
	2c	Steel	Container	1.48%	1.74%	2.81%	5.40%	1.27%	1.54%	2.61%	5.20%	2.16%	2.43%	3.50%	6.09%	2.37%	2.64%	3.71%	6.30%	5.54%	5.81%	6.88%	9.47%

2040

Country	Case Study	Case Study Commodity	Ship Type(s)	2040 Scenario 23 TCCImtm, % increase				2040 Scenario 24 TCCImtm, % increase				2040 Scenario 31 TCCImtm, % increase				2040 Scenario 32 TCCImtm, % increase				2040 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Belize	2a	Bananas	Container	6.34%	6.45%	6.89%	7.96%	5.21%	5.32%	5.76%	6.82%	.66%	5.77%	6.21%	7.28%	6.06%	6.17%	6.61%	7.68%	7.42%	7.53%	7.97%	9.04%
	2b	Sugar	Bulk carrier	5.04%	5.22%	5.97%	7.77%	3.96%	4.14%	4.89%	6.70%	3.94%	4.13%	4.87%	6.68%	4.10%	4.29%	5.03%	6.84%	4.59%	4.77%	5.52%	7.32%
	2c	Steel	Container	6.49%	6.76%	7.83%	10.42%	4.73%	4.99%	6.06%	8.65%	4.81%	5.08%	6.15%	8.74%	5.24%	5.50%	6.58%	9.17%	6.64%	6.90%	7.98%	10.56%

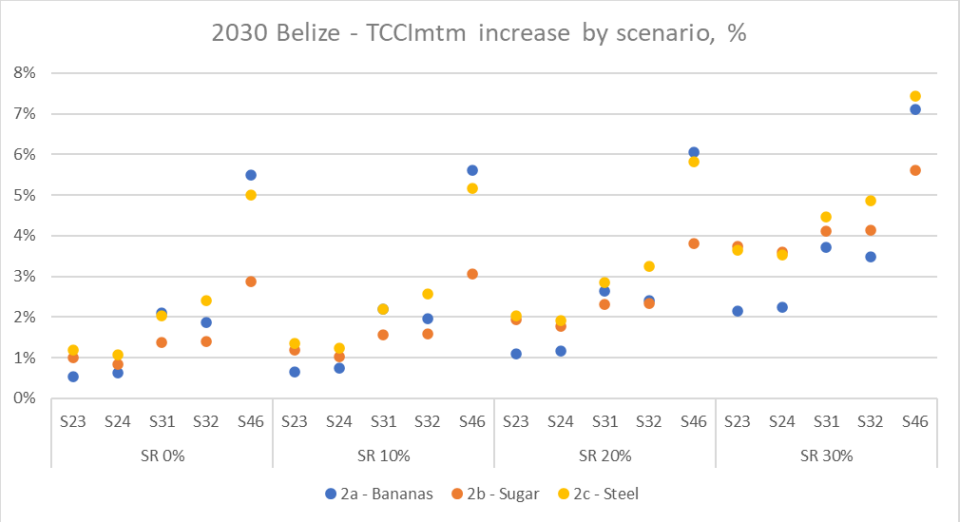
2050

Country	Case Study	Case Study Commodity	Ship Type(s)	2050 Scenario 23 TCCImtm, % increase				2050 Scenario 24 TCCImtm, % increase				2050 Scenario 31 TCCImtm, % increase				2050 Scenario 32 TCCImtm, % increase				2050 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Belize	2a	Bananas	Container	7.99%	8.10%	8.54%	9.61%	7.77%	7.88%	8.32%	9.39%	7.84%	7.95%	8.39%	9.46%	7.86%	7.97%	8.41%	9.48%	8.02%	8.13%	8.57%	9.63%
	2b	Sugar	Bulk carrier	4.69%	4.88%	5.62%	7.43%	4.54%	4.73%	5.47%	7.28%	5.04%	5.22%	5.97%	7.78%	4.83%	5.01%	5.76%	7.57%	4.82%	5.01%	5.76%	7.56%
	2c	Steel	Container	6.68%	6.94%	8.01%	10.60%	6.35%	6.61%	7.68%	10.27%	6.38%	6.64%	7.71%	10.30%	6.15%	6.41%	7.48%	10.07%	6.52%	6.78%	7.86%	10.44%

`

The 2030, 2040, and 2050 transit-weighted averaged, total commodity cost intensity ranges across all scenarios, by speed reduction group is presented in Figures 5.2, 5.3, and 5.4, respectively.

Figure 5.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group

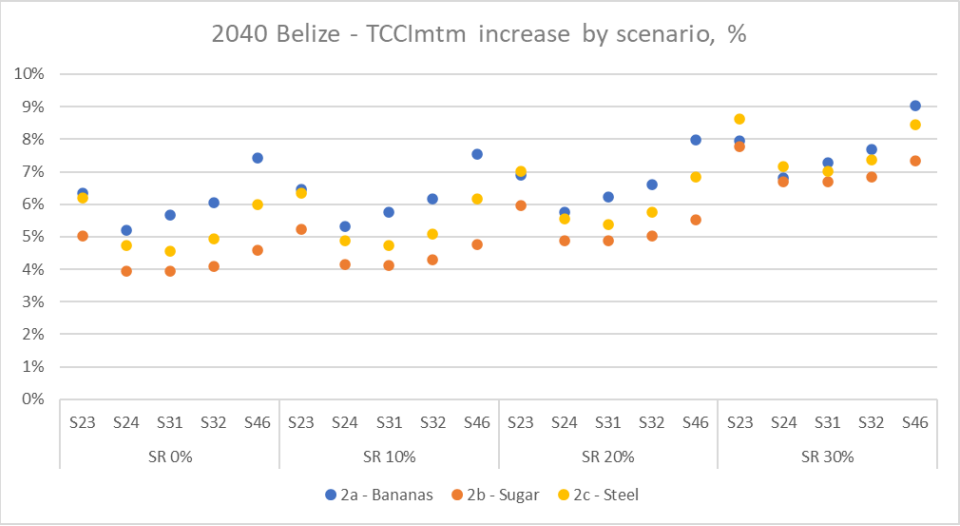


Note that in 2030, across all case studies and both ship types (container and bulk carrier), Scenario 23 and 24 indicate the lowest commodity cost intensity increase compared to the others, with the strive Scenario 46 indicating a near doubling for container ship-based commodities, bananas and steel. The key parameters range from:

- **TCCImtm** **0.54% to 9.47%, with an average of 3.04%**

Commodity cost intensity spreads for bananas and steel in Scenario 46 are significantly higher (two to three times) than the other scenarios across all speed reduction groups. For sugar, commodity cost intensity increases for Scenario 46 ranging from just below 3% to just under 6% across all speed reduction groups.

Figure 5.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group

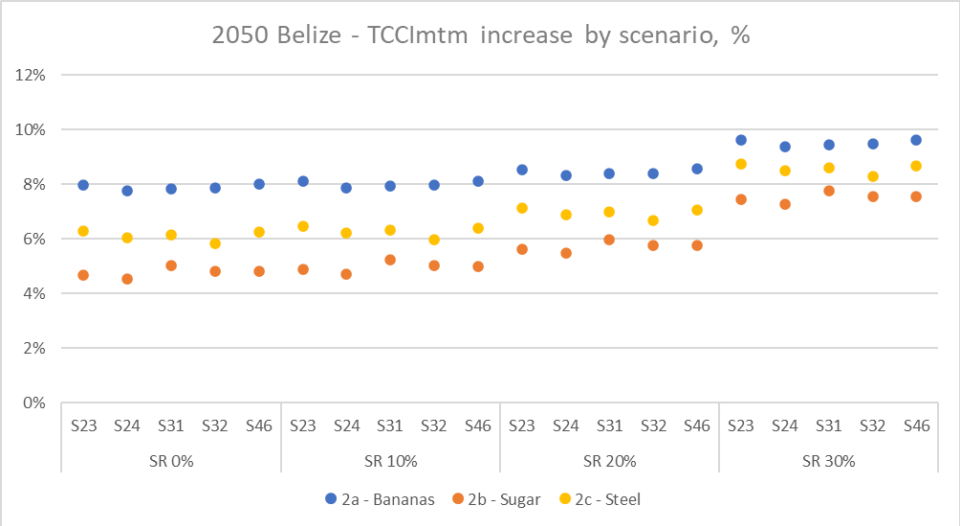


Note that in 2040, the commodity cost intensity increases across all case studies and speed reduction groups, with the key parameters ranging from:

- **TCCImtm** **3.94% to 10.56%, with an average of 6.32%**

Scenario 46 still tops the other scenarios, however the spreads against the other scenarios have significantly decreased. Bulk ships continue to be slightly less impacted than container ships.

Figure 5.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2050, the three case studies have stratified, with sugar being the least impacted, followed by steel, and then bananas. The key parameters range from:

- **TCCImtm** **4.54% to 10.60%, with an average of 7.34%**

The commodity cost intensity increases for all three case studies are relatively flat until the SR 30% group, where there is a step up. That being said, bananas have a spread of 2% across all scenarios and speed reduction groups. The other two case studies have a 3% spread across all scenarios and speed reduction groups.

GDP context

Bananas and sugar are both registered in Belize's national account as part of the "Agricultural, forestry and fishing sector". According to the Statistical Institute of Belize (SIB), this sector made up 8.27% of the country's GDP in 2023. In the case of bananas, this activity generates 1,638 employees, while sugar has 3,948 employees. Steel products, a part of the construction sector, shares 5.17% of the country's GDP, with 16,679 employees.

According to data provided by Belize, Sugar exports represent 38.66% of the country's total export, and bananas share 15.66%. Steel share of total country imports is 1.38%.

5.4 Qualitative analysis

Belize provided detailed Qualitative information on all three of their commodities using input from global industry experts for each commodity.

These stakeholders all showed strong awareness of the potential impacts of the IMO measures to decarbonize shipping, as well as related factors such as impacts on food and fuel prices.

Analyses of these responses are displayed on the following SWOT grids (Tables 5.8 and 5.9) showing sensitivities to freight costs and sensitivities to transit times. Key takeaways for each grid are reflected below the SWOT grids.

Table 5.8: SWOT analysis of Belize's commodities and their sensitivity to cost changes

Sensitivity to freight shipment cost changes as reported by the stakeholders	
Country: Belize Commodities: 2a Bananas, 2b Sugar, 2c Steel	
Strengths ➢ If perishable products require longer refrigeration, the freight rate should remain standard as the route and nautical miles do not change. ➢ Belize does not supply fuel; carriers attend to that. ➢ Belize is at an advantageous position due to its linear connectivity. ➢ Some ports in certain countries may not require green fuels in the future due to existing bunkering facilities along the supply chain. ➢ Belize uses short transits.	**Weaknesses** ➢ The high demand for sea transport and containers is driving up freight costs. ➢ Freight costs are always passed on to the end user (i.e. consumers). ➢ The parties liable for paying for GHG emissions are both the exporters and the importers. ➢ Refrigerated containers and refrigerated ships use significantly more fuel and energy. ➢ Change in shipping speeds would affect freight costs for both importers and exporters.
Opportunities to adapt/mitigate ➢ Lower speeds could reduce bunker costs. ➢ Belize's location may help alleviate the immediate need for large stocks of green future fuels. ➢ If all carriers adhere to higher transport costs tied to distance, no one has a competitive edge. ➢ Higher transport costs tied to distance could open markets to new countries.	**Threats** ➢ Paying for GHG emissions will affect freight costs. Importers and exporters/producers will bear these costs. ➢ Paying for GHG emissions will impact all products and services as the necessary infrastructure, ICT equipment, software, and employee training are all costly to implement. ➢ End consumers will bear the costs of any financial increases in the market. ➢ Reduced capacity ships due to the utilization of green future fuels will raise FOB (free on board) costs because of limited space on board. ➢ Countries without green fuels in the future could see an increase in the cost of moving commodities (exports and imports). ➢ High costs could drive demand down with time, especially if another supplier isn't located. Logistics and supply chains could fracture. ➢ Markets in some countries could be harmed by higher costs due to their distance from market in relation to the cost of the commodity.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- Major costs would be borne by the exporter, though all participants in the value chain would bear the costs of GHG emission charges.
- Change in shipping speeds would affect freight costs and if there is an added emissions tax, the importer pays more, ultimately impacting the exporter and consumers.
- Lower speeds could reduce bunker costs.
- If perishable products require longer refrigeration, the freight rate should remain standard since the route and nautical miles do not change. However, longer refrigeration affects the taste and texture of many perishables and, refrigerated containers and refrigerated ships use significantly more fuel and energy.
- Belize is at an advantageous position due to its linear connectivity, short transits and the fact that the Member State does not supply fuel, carriers do.
- Belize's location may also help alleviate the immediate need for large stocks of green future fuels. Some ports in certain countries might not require such fuels due to existing bunkering facilities.
- The high demand for sea transport and containers is driving up freight costs, though higher transport costs tied to distance could open markets to new countries. If all carriers adhere to these higher costs, no one will have a competitive edge.
- Paying for GHG emissions will impact all products and services as the necessary infrastructure, ICT equipment, software, and employee training are all costly to implement. End consumers will bear the costs of any financial increases in the market.
- Reduced capacity ships due to the utilization of green future fuels will raise FOB (free on board) costs because of limited space on board. Larger ships will have to be constructed, increasing the number of vessels. Countries could then experience heightened port traffic and congestion.
- Countries without green fuels in the future could see an increase in the cost of moving commodities (exports and imports). Higher costs could then drive down demand, fracturing supply chains.

Author's note: The questions asked of the stakeholders include a question specific to reduced cargo space on green fuel ships. An alternative is that some ships may choose to retain cargo space and bunker more frequently. We also note that cost impact is not yet clear, since countries with green fuels will also face higher costs associated with imports / exports. Countries without green fuels cannot be used for bunkering, unless they import green fuels (which should be feasible in principle).

Table 5.9: SWOT analysis of Belize's commodities and their sensitivity to transport time changes.

Sensitivity to increased transport times as reported by the stakeholders	
Country: Belize Commodities: 2a Bananas, 2b Sugar, 2c Steel	
Strengths ➢ Belize is only using shallow draught vessels for transshipment with nearby hub ports (Jamaica and Florida) so speed reduction from Belize would not have much of an impact on the first leg. ➢ Belize is using short transits, so slower speeds would not affect first legs, but layovers and transshipments may pose issues to perishables. ➢ Due to excellent logistics measures, Covid-19 had no impact on Belize's operations.	**Weaknesses** ➢ Delays affect payments from importers to exporters. ➢ Speed reduction would affect the ripening conditions and shelf life of bananas. ➢ The difference between an acceptable and critical delay could be only a few days. ➢ Longer steaming means more costs and a negative effect on schedule reliability. ➢ A delay will alter the taste and texture of a perishable product. ➢ Air transport is far more expensive than maritime transport. ➢ Demands during Covid-19 outweighed supplies ➢ Belize's market is small, and volumes are not high enough to see positive impacts of speed reduction requirements. ➢ There are no current plans to produce future maritime fuels in Belize.
Opportunities to adapt/mitigate ➢ Lightweight cargo could be transported via airfreight. ➢ From an exporter point of view, speed reductions could have positive effects like lower costs and lower consumption of fuel, improvements in industry management, reduced risk and perhaps higher customer satisfaction.	**Threats** ➢ IMO GHG MTM may increase transport times. ➢ Speed reduction in transportation could lead to supplier substitution. ➢ Speed reduction could lead to distortions in terms of competitiveness. ➢ If speed reduction caused products to arrive late to market, customer compliance and credit notes would be affected. In extreme cases, Belize could lose their market. ➢ If commodities are not available, then prices go up. ➢ If speed is reduced, it will affect the supply chain, causing accumulation along the chain, reducing its value and driving up costs. ➢ Increased transport times will affect all products without regard to demand peaks or their entrance into the market.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- Belize uses shorter transits and shallow draught vessels to nearby port hubs, so slower speeds would not have much of an impact on the first leg.
- Demands during Covid-19 outweighed supplies, however due to excellent logistics measures, the pandemic had no impact on Belize's operations.
- Lightweight cargo could be transported via airfreight, though air transport is much more expensive than maritime transport.
- Longer steaming means more costs and a negative effect on schedule reliability. This could also affect payments from importers to exporters.

- Speed reduction would affect the ripening conditions and shelf life of perishables like bananas. Delays would also alter the taste and texture of these products. A few days could mean the difference between an acceptable and critical delay.
- Belize's markets are small, and volumes are not high enough to see positive impacts of speed reduction requirement so there are no current plans to produce future maritime fuels in Belize.
- IMO GHG MTM may increase transport times by reducing speeds. This could lead to supplier substitutions and distortions in competitiveness. If speed reduction causes products to arrive late to market, in extreme cases, Belize could lose their market.
- If speed is reduced, it will affect the supply chain, causing accumulation along the chain, reducing its value and driving up costs without regard to peaks in demand for particular commodities.
- From an exporter's point of view however, speed reductions could have positive effects like lower costs and lower consumption of fuel, improvements in industry management, reduced risk and perhaps higher customer satisfaction.

Another insight to these stakeholders' awareness of and engagement in the decarbonization of shipping is the breadth of their responses to the final open-ended question "What questions should we have asked to more fully understand the impacts of potential vessel greenhouse gas reduction requirements on shipping, your population and your economy?" The additional question topics stakeholders from Belize suggested included the impacts on society and the economy.

5.5 Findings

Quantitative findings

The key findings from the quantitative analysis include:

- Longer transit times from potential speed reduction range across the case studies, including:
  - Bananas
    - SR 10% - less than 2 days
    - SR 20% - just over 4 days
    - SR 30% - 7 days
  - Sugar
    - SR 10% - less than 2.5 days
    - SR 20% - just over 5 days
    - SR 30% - just over 9 days
  - Steel
    - SR 10% - 3-5 days
    - SR 20% - 7-10 days
    - SR 30% - 13-18 days
- Total commodity cost intensity increases across all scenarios are more sensitive to commodity costs associated with the MTM than to the associated costs with speed reduction.
- The *ad valorem* rates of the exported trade goods ranged in a tight span between 10.2% to 10.4%.
- In 2030, across all case studies and both ship types (container and bulk carrier), Scenarios 23 and 24 indicate the lowest commodity cost intensity increase compared to the others, with the strive Scenario 46 indicating a near doubling for container ship-based commodities, bananas and steel. Commodity cost intensity spreads for bananas and steel, in Scenario 46 are significantly higher (two to three times) than the other scenarios across all speed reduction groups. For sugar, commodity cost intensity increases for Scenario 46 ranging from just below 3% to just under 6% across all speed reduction groups.

- In 2040, the commodity cost intensity increases across all case studies, speed reduction group, and scenarios ranges from just under 4% to just over 9%. Scenario 46 is still dominant, however the spreads against the other scenarios have significantly decreased. Bulk ships continue to be slightly less impacted than container ships.
- In 2050, the three case studies have stratified with sugar being the least impacted, follow by steel, and then bananas. The commodity cost intensity increases for all three case studies are relatively flat until the SR 30% group, and then there is a step up. That being said, bananas have a spread of 2% across all scenarios and speed reduction groups. The other two case studies have 3% spread across all scenarios and speed reduction groups.
- Total commodity cost intensity ranges across all scenarios and speed reduction groups, include:
    - Bananas
        - 2030 – 0.54% to 7.12%, with an average of 2.69%
        - 2040 – 5.21% to 9.04%, with an average of 6.71%
        - 2050 – 7.77% to 9.63%, with an average of 8.46%
    - Sugar
        - 2030 – 0.85% to 5.62%, with an average of 2.47%
        - 2040 – 3.94% to 7.77%, with an average of 5.29%
        - 2050 – 4.54% to 7.78%, with an average of 5.75%
    - Steel
        - 2030 – 1.08% to 7.44%, with an average of 3.20%
        - 2040 – 4.56% to 8.63%, with an average of 6.14%
        - 2050 – 5.83% to 8.74%, with an average of 6.98%
- TCCImtm findings for the three commodity case studies across all scenarios and speed reduction groups, by forecasted year:
    - 2030 0.54% to 9.47%, with an average of 3.04%
    - 2040 3.94% to 10.56%, with an average of 6.32%
    - 2050 4.54% to 10.60%, with an average of 7.34%

Qualitative findings

Belize's stakeholder input on shipment costs highlights several key insights. Changes in shipping speeds could raise freight expenses, with additional emissions taxes potentially burdening importers, thereby impacting both exporters and consumers. Slower speeds, however, might reduce bunker costs. Belize also benefits from its linear connectivity and short transits. This advantage may delay the need for the adoption of costly green future fuels. Nevertheless, high maritime transport demand and shortages elevate freight costs, potentially leveling the playing fields among carriers. GHG emission payments will affect all sectors, necessitating costly infrastructure and technologies. This would then be passed on to consumers through price increases. Furthermore, transitioning to green fuels may reduce ship capacity, increasing FOB costs due to limited space and potentially escalating port congestion in some countries. As such, regions without green fuel capabilities may face higher transportation expenses, posing risks to supply chain stability and market demand.

Belize's stakeholders' inputs provided key insights on increased transport time. Belize benefits from its shorter transits and vessel types, minimizing the impact of slower speeds on the initial legs. During the Covid-19 pandemic, Belize's operations remained unaffected due to robust logistics measures despite global supply chain disruptions. However, longer steaming times increase costs and jeopardize schedule reliability, potentially affecting payments by importers. Delays in shipping also directly impact perishable goods like bananas by affecting their shelf life, which could lead to significant quality degradation with just a few days' delay. Speed reductions could also further extend transport times, potentially prompting substitutions and competitive distortions. Though benefits of speed reductions could include lower costs, reduced fuel consumption, improved industry management, reduced risks, and potentially higher customer satisfaction from an exporter's perspective.

Stakeholders suggested opportunities to mitigate impacts include a range of approaches:

- Costs:
  - Lower speeds could reduce bunker costs.
  - Belize's location may help alleviate the immediate need for large stocks of green future fuels.
  - If all carriers adhere to higher transport costs tied to distance, no one has a competitive edge.
  - Higher transport costs tied to distance could open markets to new countries.
- Longer transport times:
  - Lightweight cargo could be transported via airfreight.

From an exporter's point of view, speed reductions could have positive effects like lower costs and lower consumption of fuel, improvements in industry management, reduced risk and perhaps higher customer satisfaction.

Summary of key points related to potential impacts

The following points are key to understanding the potential impacts of the MTM:

- In 2022, Belize's GDP was $2.831 million and it's GDP per capita was $6,984.38.
- The three commodities selected by Belize for case studies included one essential goods import of steel from China and two trade commodity exports of bananas and sugar to the UK and Europe.
- Bananas and sugar are both registered in Belize's national account as part of the "Agricultural, forestry and fishing sector". According to the Statistical Institute of Belize (SIB), this sector made up 8.27% of the country's GDP in 2023. In the case of bananas, this activity generates 1,638 employees, while sugar has 3,948 employees. Steel products, a part of the construction sector, shares 5.17% of the country's GDP, with 16,679 employees. According to data provided by Belize, Sugar exports represent 38.66% of the country's total export, and bananas share 15.66%. Steel share of total country imports is 1.38%.
- For these three case studies, the estimates indicate a range of total commodity cost intensity increases related to maritime transport.
- Imported steel is an essential good related to construction, which means cost increases impact the entire population, while the two trade commodities impact the sector/subsector of the economy associated with each commodity. In addition, the associated employment, supporting industries, and taxes and revenues associated with the commodity will be impacted.

- For all three commodities in 2030, Scenarios 23/24 estimate generally lower cost increases compare to Scenarios 31/32. These increases are estimated to be lower in 2030, but are estimated to significantly increase in 2040 and 2050. Scenario 46 brings forward the significant increase in costs to 2030. Steel and bananas are generally the most sensitive to ship-side cost increases.
- Since steel is an essential good, the impacts from delays weigh more heavily due to Belize's extremely limited GDP, limited population and infrastructure to provide economies of scale, extremely limited disposal incomes to absorb cost increases, limited alternative transportation options to import essential goods, and the country's remoteness to key trading partners.
- Since bananas and sugar are export trade commodities on particular routes, the entire economic sector/subsector is not captured. The full impact on the entire sector/subsector would need to be considered by the Member State and the national stakeholders to determine impacts to GDP, employment, and any collateral impacts on supporting industries.

6 Stakeholders' analysis – Brazil

The Stakeholder Assessment for Brazil focuses on exports of iron ore, soybeans, and woodpulp (paper and paper products). Iron ore and soybean are shipped to China via bulk carrier, while woodpulp is shipped to China via general cargo vessels.

6.1 Geography, population, and economy

Geography

Brazil is located on the east coast of South America and is marked by its vastness and diversity. It encompasses a range of ecosystems that significantly shape its socio-economic landscape. The country is 8.5 million km^2 in size, is the largest country in South America, and fifth largest country in the world.[66] The Amazon Rainforest occupies a large portion of northern Brazil and is the world's largest tropical rainforest, acting as a crucial force in global biodiversity and a key factor in moderating climate change. Brazil's extensive coastline along the Atlantic Ocean includes port cities like Rio de Janeiro and Santos. The diverseness of Brazil boosts its agricultural productivity and tourism industry. Brasília is the capital of Brazil and is located inland.

Brazil is bounded on the north and west by 10 countries, including Peru and Argentina, and on the east by the Atlantic Ocean. This strategic geographical position has facilitated maritime trade and has been pivotal to the country's economic growth and integration into global markets. The Port of Santos is one of South America's busiest ports. The Port of Açu and the company Vale recently signed an agreement to develop a hub for the decarbonization of steelmaking.[67] Representative distances to markets for the selected commodities and ports are presented in Section 6.2.

Population

Brazil's population is approximately 203 million as of 2022 and has a diverse demographic–a blend of European, African and indigenous ancestry.[68] Of that population, 88% live in urban areas and 12% live in rural areas. The urban population is mostly concentrated in and around the São Paulo and Minas Gerais regions and the country's population density varies widely. It averages around 23 people/km^2 and is influenced by geographic features and economic opportunities. Urbanization has increased dramatically, with population growth reaching 0.5% and migration contributing to the expansion of cities. Disparities in wealth and access to healthcare and education reflect ongoing socio-economic challenges as the population grows. Brazil ranks 1st in South America and 7th in the world by population, making up almost 3% of the world's population.

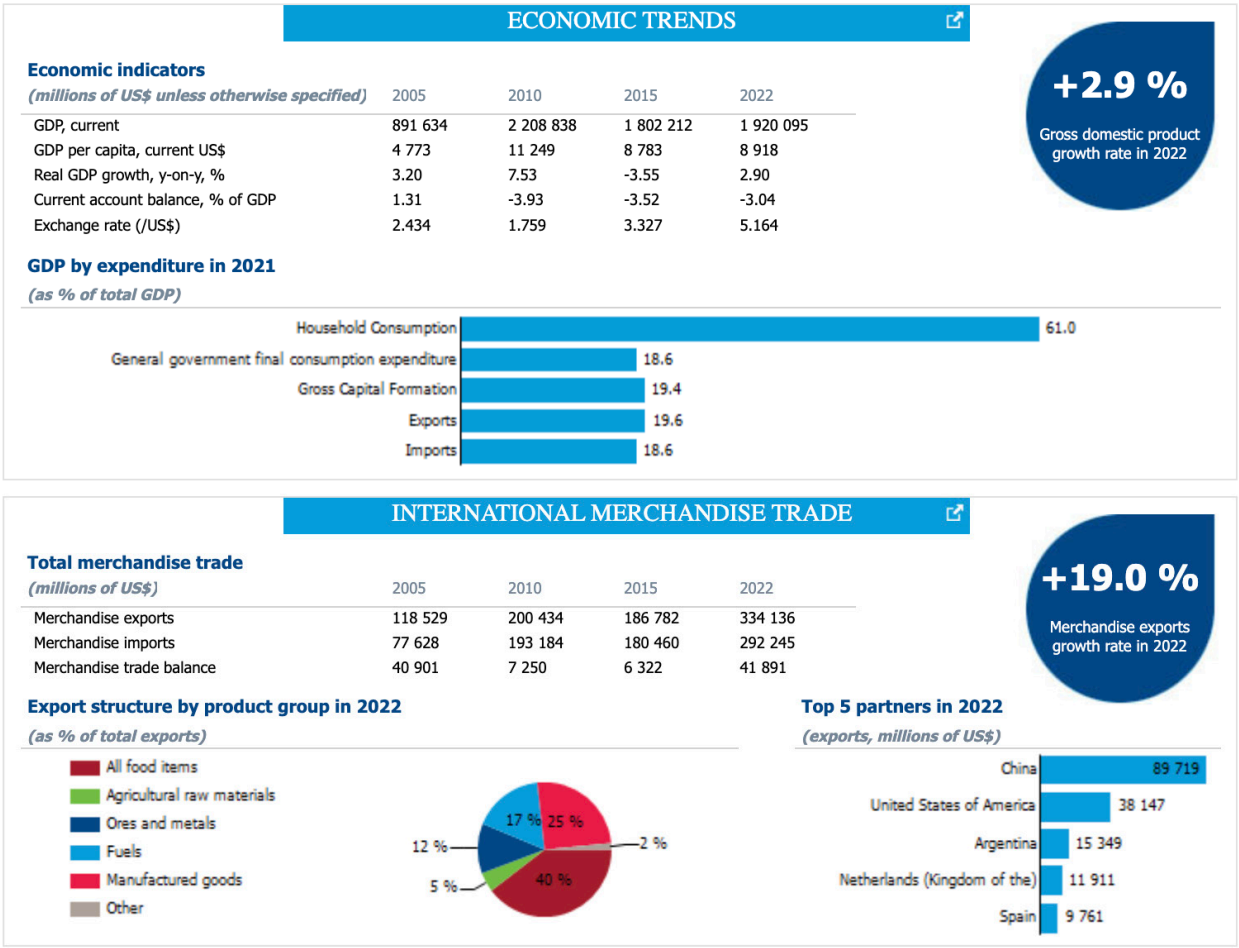
Economy

Brazil is the 8th largest economy in the world by GDP at $1,900,000 million. Brazil's GDP per capita has fluctuated in recent years and in 2022, was $8,918.[69] Brazil has a diverse economy with mining, agriculture, and manufacturing dominating. The country is a global leader in agricultural production, particularly in commodities like soybeans and coffee. Brazil is also a major producer of iron ore, manufactured goods, and fuels.

[66] Encyclopedia Britannica at *Brazil | History, Map, Flag, & Population*, Ronald Milton Schneider, Richard P. Momsen.
[67] Vale, *Vale and Port of Açu sign agreement to develop a Mega Hub for the decarbonization of steelmaking*, 26 September 2023.
[68] IBGE, *Censo 2022 Panorama*.
[69] UNCTAD, General and Maritime Profiles: Brazil, *UNCTAD Statistics - General Profile*.

Brazil faces challenges in income inequality, deficits, and inflation. However, Brazil possesses significant opportunities for economic development and diversification, as evident by a trade balance surplus of $2 billion in the fourth week of March 2024.[70] Brazil's proximity to the Atlantic Ocean has bolstered maritime trade, enhancing its economic growth and integration into the global economy. Brazilian ports like the Port of Santos, the largest in South America, support its export-oriented economy.[71] They also serve as links to key global destinations, connecting all of South America to worldwide markets. Key economic indicators are shown in Figure 6.1.[72]

Figure 6.1: Key economic indicators for Brazil



Source: UNCTAD, General and Maritime Profiles: Brazil, *UNCTAD Statistics - General Profile*.

6.2 Identified commodities and routes studied

The Stakeholder Assessment for Brazil focuses on exports of iron ore, soybeans, and woodpulp (paper and paper products). Iron ore and soybeans are shipped to China via bulk carrier, while woodpulp is sent through general cargo.

The commodities selected by the Member State for focus and illustrative trade routes selected are shown in Table 6.1. All commodities selected for this study are exports.

[70] Gov.br, *Brazil recorded a trade surplus of USD 2 billion in the fourth week of March*, Presidência da República.
[71] World Bank Group, *The World Bank in Brazil*.
[72] UNCTAD, General and Maritime Profiles: Brazil, *UNCTAD Statistics - General Profile*.

Table 6.1: Shipping distances from Brazil to market for selected commodities

Case Study	Commodity	Illustrative identified routes, by country	Ship Type(s)	Route Distance Range, nm min	avg	max	Stops
3a	Iron ore	Brazil --> China Brazil --> Japan --> China Brazil --> South Korea --> China	Bulk carrier	10,986	12,456	14,209	2-5
3b	Soybeans	Brazil --> China Brazil --> Japan --> China	Bulk carrier	11,027	11,891	13,512	1-3
3c	Woodpulp (paper and paper products)	Brazil --> China Brazil --> Indonesia --> China Brazil --> Singapore --> China	General cargo	10,529	11,534	12,907	1-3

Trade context

The Member State includes the following on commodity selection: "The selection of the trade routes to be analyzed in the study was as neutral and as straightforward as possible, as those three products were Brazil's largest export goods, by value, in 2023, and each of the three Chinese ports selected was its respective main destination in the same period. The fact that they also happen to all be commodities which need to be shipped to distant consuming markets just reiterates our long-held belief that the Brazilian economy stands to be one of the most affected overall by any kind of artificial increase in freight prices."

6.3 Quantitative analysis

This section presents the quantitative analysis summary results and is organized by fleet analysis summary, total commodity cost intensity changes from speed reduction, Task 2 cost intensity changes due to MTM, total commodity cost intensity impacts, and GDP contexts. The quantitative analysis incorporates the findings of Task 2 related to the selected bracketing MTM scenarios as presented below:[73]

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination: Policy code	GFI scope	GFI flexibility: RU % of price	SU % of price	Levy: Levy USD/tCO_2eq	Levy: Reward % of cost gap	Feebate Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

The detailed approach for the below analyses is provided in Appendix A.

Fleet analysis summary

As part of the fleet analysis, routes and ship characteristics were identified for each case study. For the specific ship types identified with the case study and transiting on the identified route the following were averaged to represent the fleet:

- Ship type and size
- Number of transits identified
- Route distances obtained from Marine Benchmark's 2022 AIS database were transit-weighted averaged and reported as minimum, average, and maximum distance sailed
- Transit-weighted average year of build, which was used to determine the average age in years

[73] DNV 2024

These characteristics for the case studies are presented in Table 6.2.

Table 6.2: Brazil – Fleet characteristics, by case study

Case Study	Commodity	2022 Transits	Ship Type(s)	Route Distance Range, nm min	avg	max	Avg Build
3a	Iron ore						
		4	Bulk carrier 60,000 - 99,999 dwt	12,183	**12,735**	14,209	2011
		86	Bulk carrier 200,000 + dwt	10,986	**12,444**	13,734	2016
3b	Soybeans						
		2	Bulk carrier 35,000 - 59,999 dwt	11,937	**12,725**	13,512	2009
		6	Bulk carrier 60,000 - 99,999 dwt	11,027	**11,613**	12,407	2013
3c	Woodpulp (paper and paper products)	26	General cargo 20,000+ dwt	10,529	**11,534**	12,907	2014

In addition, transit weighted average speeds and average route times were estimated and the APEC Module 1 was used to estimate the longer transit times associated with the speed reduction groups of 10%, 20%, and 30%, as presented in Table 6.3.

Table 6.3: Average route distance, speed, & longer transit ,times, by speed reduction group

Country	Case Study	Commodity	Transits	Ship type & size	Avg Route Distance (nm)	Avg Route Speed (knots)	Avg Route Time (hours)	SR 10% Delay Delta (days)	SR 20% Delay Delta (days)	SR 30% Delay Delta (days)
Brazil	3a	Iron ore	4	Bulk carrier 60,000 - 99,999 dwt	12,735	10.8	1,175	5.4	12.2	21.0
			86	Bulk carrier 200,000 + dwt	12,444	10.9	1,138	5.3	11.8	20.3
	3b	Soybeans	2	Bulk carrier 35,000 - 59,999 dwt	12,725	10.1	1,261	5.8	13.1	22.5
			6	Bulk carrier 60,000 - 99,999 dwt	11,613	10.5	1,103	5.1	11.5	19.7
	3c	Woodpulp (paper and paper products)	26	General cargo 20,000+ dwt	11,534	11.4	1,009	4.7	10.5	18.0

The fleet characteristics are assumed to be consistent across the forecasted years of 2030, 2040, and 2050.

Total commodity cost intensity changes due to speed reduction

APEC Module 2 was used to estimate the commodity cost intensity increases due to potentially longer transit times resulting from the three speed reduction groups. The module estimates the daily cost increases, in percentage, associated with the following:

- Finance/interest costs – the financial cost of capital invested in inventory over time. This measures the impact of each hour or day of delay in the cost of the product due to cost of money or interest rate. A Member State rate was used when provided, otherwise, it was assumed to be 5%.[74]
- Depreciation costs – the cost allocation of a commodity, or reduction of the commodity value, over its useful life. For this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry bulk cargo.[75]
- Insurance costs – a cost paid by the cargo owner to protect their goods while in transit. The percentage used in the economic analysis is the one provided by the Member State. If the Member State did not provide data, we assumed it to be 2%.[76]

[74] Lending Tree, *Assuming a line of credit 5%.*
[75] APEC 2019
[76] APEC 2019

The total commodity cost intensity change related to the three speed reduction groups for the case studies is presented in Table 6.4. Note that these values remain constant across scenarios and forecasted year.

Table 6.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Commodity-side Task 4 TCCIsr Change, % SR 10%	SR 20%	SR 30%
Brazil	3a	Iron ore	4	Bulk carrier 60,000 - 99,999 dwt	12	0.97%	4.92%	14.47%
			86	Bulk carrier 200,000 + dwt	7	0.91%	4.61%	13.56%
	3b	Soybeans	2	Bulk carrier 35,000 - 59,999 dwt	14	1.12%	5.67%	16.66%
			6	Bulk carrier 60,000 - 99,999 dwt	10	0.86%	4.34%	12.75%
	3c	Woodpulp (paper and paper products)	26	General cargo 20,000+ dwt	9	0.72%	3.63%	10.67%

The commodity cost intensity changes due to speed reduction, ranges as follows:

- 3a – SR 10% → 0.91%-0.97% SR 20% → 4.61%-4.92% SR 30% → 13.56%-14.47%
- 3b – SR 10% → 0.86%-1.12% SR 20% →4.34%-5.67% SR 30% → 12.75%-16.66%
- 3c – SR 10% → 0.72% SR 20% → 3.63% SR 30% → 10.67%

Task 2 cost intensity changes due to MTM

Based on the ship type, size, and age combination for each case study, the applicable Task 2 ship-side commodity cost intensities due to the MTM were identified for the selected scenarios. In addition, in order to be able to add these to the commodity cost intensity changes due to speed reduction, the a*d valorem* freight rate percentage was identified using the UNCTAD Trade-and-Transport Dataset.[77] The *ad valorem* freight rate percentage represents the transportation cost percentage of a commodity's total cost. These factors were multiplied to get the freight rate adjusted commodity cost intensity or FRACCI change for 2030, 2040, and 2050. Task 2 cost intensity change and FRACCI for each scenario are presented in Table 6.5.

[77] UNCTAD, *Trade-and-Transport Dataset*.

Table 6.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Brazil	3a	Iron ore	4	Bulk carrier 60,000 - 99,999 dwt	12	8.1%	6.68%	44.53%	46.16%	0.54%	3.61%	3.74%
			86	Bulk carrier 200,000 + dwt	7	8.1%	28.74%	45.72%	67.12%	2.33%	3.70%	5.44%
	3b	Soybeans	2	Bulk carrier 35,000 - 59,999 dwt	14	6.0%	5.68%	51.22%	51.32%	0.34%	3.07%	3.08%
			6	Bulk carrier 60,000 - 99,999 dwt	10	6.0%	19.24%	42.69%	53.70%	1.15%	2.56%	3.22%
	3c	Woodpulp (paper and paper products)	26	General cargo 20,000+ dwt	9	16.1%	18.02%	64.97%	60.56%	2.90%	10.46%	9.75%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Brazil	3a	Iron ore	4	Bulk carrier 60,000 - 99,999 dwt	12	8.1%	6.41%	39.12%	49.42%	0.52%	3.17%	4.00%
			86	Bulk carrier 200,000 + dwt	7	8.1%	21.46%	47.44%	67.63%	1.74%	3.84%	5.48%
	3b	Soybeans	2	Bulk carrier 35,000 - 59,999 dwt	14	6.0%	5.57%	43.06%	51.16%	0.33%	2.58%	3.07%
			6	Bulk carrier 60,000 - 99,999 dwt	10	6.0%	17.31%	40.02%	54.13%	1.04%	2.40%	3.25%
	3c	Woodpulp (paper and paper products)	26	General cargo 20,000+ dwt	9	16.1%	18.83%	51.61%	60.67%	3.03%	8.31%	9.77%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Brazil	3a	Iron ore	4	Bulk carrier 60,000 - 99,999 dwt	12	8.1%	13.39%	42.72%	51.24%	1.08%	3.46%	4.15%
			86	Bulk carrier 200,000 + dwt	7	8.1%	28.36%	49.10%	75.22%	2.30%	3.98%	6.09%
	3b	Soybeans	2	Bulk carrier 35,000 - 59,999 dwt	14	6.0%	13.96%	45.74%	56.95%	0.84%	2.74%	3.42%
			6	Bulk carrier 60,000 - 99,999 dwt	10	6.0%	16.74%	44.14%	59.49%	1.00%	2.65%	3.57%
	3c	Woodpulp (paper and paper products)	26	General cargo 20,000+ dwt	9	16.1%	15.55%	43.54%	63.10%	2.50%	7.01%	10.16%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Brazil	3a	Iron ore	4	Bulk carrier 60,000 - 99,999 dwt	12	8.1%	12.52%	43.66%	52.21%	1.01%	3.54%	4.23%
			86	Bulk carrier 200,000 + dwt	7	8.1%	29.19%	51.68%	70.22%	2.36%	4.19%	5.69%
	3b	Soybeans	2	Bulk carrier 35,000 - 59,999 dwt	14	6.0%	13.52%	47.86%	54.71%	0.81%	2.87%	3.28%
			6	Bulk carrier 60,000 - 99,999 dwt	10	6.0%	16.75%	44.47%	58.06%	1.00%	2.67%	3.48%
	3c	Woodpulp (paper and paper products)	26	General cargo 20,000+ dwt	9	16.1%	17.86%	44.29%	63.17%	2.88%	7.13%	10.17%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Brazil	3a	Iron ore	4	Bulk carrier 60,000 - 99,999 dwt	12	8.1%	32.28%	43.46%	54.34%	2.61%	3.52%	4.40%
			86	Bulk carrier 200,000 + dwt	7	8.1%	52.59%	57.80%	68.62%	4.26%	4.68%	5.56%
	3b	Soybeans	2	Bulk carrier 35,000 - 59,999 dwt	14	6.0%	33.36%	49.90%	55.02%	2.00%	2.99%	3.30%
			6	Bulk carrier 60,000 - 99,999 dwt	10	6.0%	35.27%	49.89%	56.87%	2.12%	2.99%	3.41%
	3c	Woodpulp (paper and paper products)	26	General cargo 20,000+ dwt	9	16.1%	40.48%	60.64%	63.52%	6.52%	9.76%	10.23%

The *ad valorem* rates of the exported trade goods ranged between 6.0% to 16.1%, with woodpulp having the highest rate. This means it is more sensitive to changes in ship-side costs relative to the other two commodity case studies.

Note that there are significant differences between ship type, size, and age groups between scenarios. As learned from our consultation with DNV, "It should be noted that scenarios 23 and 24, and to a lesser degree scenarios 31 and 32, show large differences in cost impacts in 2030 depending on the generation of ships deployed. Ships with 10 years or less of age – i.e. built in the period between 2020 and 2029 – have a significantly higher increase in costs compared to older vessels. In the scenarios with a GFI flexibility mechanism, the newer ships built in 2020-2029 take the brunt of the GHG intensity reductions, resulting in a higher cost increase compared to older ships when looking at all abatement costs. This is as expected, as the cost of reduction is relatively lower for new ships compared to existing ships.

"However, it should also be expected that there should be some compensation from the older ships to the newer ships when joining in a compliance pool under the GFI flexibility mechanism. DNV indicates in their report that the emission unit exchange price is set to the marginal cost of the last ship in the pool that was selected to implement an additional measure.

"However, when applying this price the results showed that the newer ships are overcompensated (i.e. the compensation led to a cost decrease), meaning that the marginal cost of the last ship is likely not a very good indicator for the exchange price in a pool as the many ships will have lower abatement costs. For this reason, the costs and incomes of joining a pool are not included in this analysis."[78]

Total commodity cost intensity due to speed reduction and MTM

For each case study, combining Task 2 and Task 4 results estimates the total commodity cost intensity[79] associated with potential speed reduction and the MTM ($TCCI_{mtm}$), for the forecasted years of 2030, 2040, and 2050, as presented in Table 6.6, on the following page. For each case study, the results were compiled into a transit-weighted average for each case study for each scenario and forecasted year. These results are presented as Table 6.7.

[78] Email exchange with Tore Longa, Project Manager Task 2, 1 June 2024.
[79] The term 'total commodity cost intensity' as used in this report is defined as the total 'landed cost' of the commodity.

Table 6.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Brazil	3a	Iron ore	4 Bulk carrier 60,000 - 99,999 dwt	12	0.54%	1.51%	5.47%	15.01%	3.61%	4.58%	8.53%	18.08%	3.74%	4.71%	8.66%	18.21%
			86 Bulk carrier 200,000 + dwt	7	2.33%	3.24%	6.94%	15.88%	3.70%	4.61%	8.32%	17.26%	5.44%	6.35%	10.05%	18.99%
	3b	Soybeans	2 Bulk carrier 35,000 - 59,999 dwt	14	0.34%	1.46%	6.01%	17.00%	3.07%	4.19%	8.74%	19.73%	3.08%	4.20%	8.75%	19.74%
			6 Bulk carrier 60,000 - 99,999 dwt	10	1.15%	2.01%	5.49%	13.90%	2.56%	3.42%	6.90%	15.31%	3.22%	4.08%	7.56%	15.97%
	3c	Woodpulp (paper and paper products)	26 General cargo 20,000+ dwt	9	2.90%	3.62%	6.53%	13.57%	10.46%	11.18%	14.09%	21.13%	9.75%	10.47%	13.38%	20.42%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Brazil	3a	Iron ore	4 Bulk carrier 60,000 - 99,999 dwt	12	0.52%	1.49%	5.44%	14.99%	3.17%	4.14%	8.09%	17.64%	4.00%	4.98%	8.93%	18.47%
			86 Bulk carrier 200,000 + dwt	7	1.74%	2.65%	6.35%	15.30%	3.84%	4.75%	8.46%	17.40%	5.48%	6.39%	10.09%	19.03%
	3b	Soybeans	2 Bulk carrier 35,000 - 59,999 dwt	14	0.33%	1.45%	6.00%	17.00%	2.58%	3.70%	8.25%	19.24%	3.07%	4.19%	8.74%	19.73%
			6 Bulk carrier 60,000 - 99,999 dwt	10	1.04%	1.90%	5.38%	13.79%	2.40%	3.26%	6.74%	15.15%	3.25%	4.11%	7.59%	16.00%
	3c	Woodpulp (paper and paper products)	26 General cargo 20,000+ dwt	9	3.03%	3.75%	6.66%	13.71%	8.31%	9.03%	11.94%	18.98%	9.77%	10.49%	13.40%	20.44%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Brazil	3a	Iron ore	4 Bulk carrier 60,000 - 99,999 dwt	12	1.08%	2.06%	6.01%	15.56%	3.46%	4.43%	8.38%	17.93%	4.15%	5.12%	9.07%	18.62%
			86 Bulk carrier 200,000 + dwt	7	2.30%	3.21%	6.91%	15.85%	3.98%	4.89%	8.59%	17.53%	6.09%	7.00%	10.71%	19.65%
	3b	Soybeans	2 Bulk carrier 35,000 - 59,999 dwt	14	0.84%	1.96%	6.51%	17.50%	2.74%	3.86%	8.41%	19.41%	3.42%	4.54%	9.09%	20.08%
			6 Bulk carrier 60,000 - 99,999 dwt	10	1.00%	1.86%	5.34%	13.75%	2.65%	3.51%	6.99%	15.40%	3.57%	4.43%	7.91%	16.32%
	3c	Woodpulp (paper and paper products)	26 General cargo 20,000+ dwt	9	2.50%	3.22%	6.14%	13.18%	7.01%	7.73%	10.64%	17.68%	10.16%	10.88%	13.79%	20.83%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Brazil	3a	Iron ore	4 Bulk carrier 60,000 - 99,999 dwt	12	1.01%	1.99%	5.94%	15.49%	3.54%	4.51%	8.46%	18.01%	4.23%	5.20%	9.15%	18.70%
			86 Bulk carrier 200,000 + dwt	7	2.36%	3.28%	6.98%	15.92%	4.19%	5.10%	8.80%	17.74%	5.69%	6.60%	10.30%	19.24%
	3b	Soybeans	2 Bulk carrier 35,000 - 59,999 dwt	14	0.81%	1.93%	6.48%	17.47%	2.87%	3.99%	8.54%	19.53%	3.28%	4.40%	8.95%	19.94%
			6 Bulk carrier 60,000 - 99,999 dwt	10	1.00%	1.86%	5.34%	13.75%	2.67%	3.52%	7.01%	15.42%	3.48%	4.34%	7.82%	16.23%
	3c	Woodpulp (paper and paper products)	26 General cargo 20,000+ dwt	9	2.88%	3.59%	6.51%	13.55%	7.13%	7.85%	10.76%	17.80%	10.17%	10.89%	13.80%	20.84%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Brazil	3a	Iron ore	4 Bulk carrier 60,000 - 99,999 dwt	12	2.61%	3.59%	7.54%	17.09%	3.52%	4.49%	8.44%	17.99%	4.40%	5.37%	9.33%	18.87%
			86 Bulk carrier 200,000 + dwt	7	4.26%	5.17%	8.87%	17.82%	4.68%	5.59%	9.29%	18.24%	5.56%	6.47%	10.17%	19.11%
	3b	Soybeans	2 Bulk carrier 35,000 - 59,999 dwt	14	2.00%	3.12%	7.67%	18.66%	2.99%	4.11%	8.66%	19.66%	3.30%	4.42%	8.97%	19.96%
			6 Bulk carrier 60,000 - 99,999 dwt	10	2.12%	2.97%	6.45%	14.87%	2.99%	3.85%	7.33%	15.74%	3.41%	4.27%	7.75%	16.16%
	3c	Woodpulp (paper and paper products)	26 General cargo 20,000+ dwt	9	6.52%	7.23%	10.15%	17.19%	9.76%	10.48%	13.40%	20.44%	10.23%	10.94%	13.86%	20.90%

Table 6.7: 2030, 2040, & 2050 case study transit-weighted average total commodity cost intensity, by scenario & forecasted year

2030

Country	Case Study	Case Study Commodity	Ship Type(s)	2030 TCCImtm, % increase Scenario 23				2030 TCCImtm, % increase Scenario 24				2030 TCCImtm, % increase Scenario 31				2030 TCCImtm, % increase Scenario 32				2030 TCCImtm, % increase Scenario 46			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Brazil	3a	Iron ore	Bulk carrier	2.25%	3.16%	6.88%	15.85%	1.69%	2.60%	6.31%	15.28%	2.24%	3.16%	6.87%	15.84%	2.31%	3.22%	6.93%	15.90%	4.19%	5.10%	8.81%	17.78%
	3b	Soybeans	Bulk carrier	0.95%	1.87%	5.62%	14.68%	0.86%	1.79%	5.53%	14.59%	0.96%	1.89%	5.63%	14.69%	0.96%	1.88%	5.63%	14.68%	2.09%	3.01%	6.76%	15.82%
	3c	Woodpulp (paper and paper products)	General cargo	2.90%	3.62%	6.53%	13.57%	3.03%	3.75%	6.66%	13.71%	2.50%	3.22%	6.14%	13.18%	2.88%	3.59%	6.51%	13.55%	6.52%	7.23%	10.15%	17.19%

2040

DRAFT

Country	Case Study	Case Study Commodity	Ship Type(s)	2040 Scenario 23 TCCImtm, % increase				2040 Scenario 24 TCCImtm, % increase				2040 Scenario 31 TCCImtm, % increase				2040 Scenario 32 TCCImtm, % increase				2040 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Brazil	3a	Iron ore	Bulk carrier	3.70%	4.61%	8.33%	17.30%	3.81%	4.73%	8.44%	17.41%	3.95%	4.87%	8.58%	17.55%	4.16%	5.07%	8.78%	17.75%	4.63%	5.55%	9.26%	18.23%
	3b	Soybeans	Bulk carrier	2.69%	3.61%	7.36%	16.42%	2.45%	3.37%	7.12%	16.17%	2.67%	3.60%	7.34%	16.40%	2.72%	3.64%	7.39%	16.45%	2.99%	3.92%	7.66%	16.72%
	3c	Woodpulp (paper and paper products)	General cargo	10.46%	11.18%	14.09%	21.13%	8.31%	9.03%	11.94%	18.98%	7.01%	7.73%	10.64%	17.68%	7.13%	7.85%	10.76%	17.80%	9.76%	10.48%	13.40%	20.44%

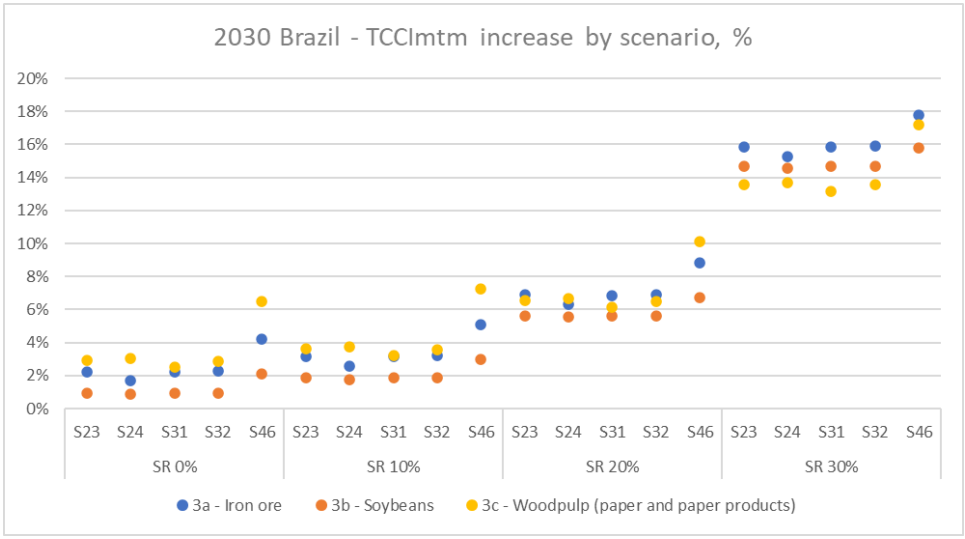
2050

DRAFT

Country	Case Study	Case Study Commodity	Ship Type(s)	2050 Scenario 23 TCCImtm, % increase				2050 Scenario 24 TCCImtm, % increase				2050 Scenario 31 TCCImtm, % increase				2050 Scenario 32 TCCImtm, % increase				2050 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Brazil	3a	Iron ore	Bulk carrier	5.36%	6.28%	9.99%	18.96%	5.41%	6.33%	10.04%	19.01%	6.01%	6.92%	10.64%	19.61%	5.62%	6.54%	10.25%	19.22%	5.51%	6.42%	10.13%	19.10%
	3b	Soybeans	Bulk carrier	3.19%	4.11%	7.86%	16.91%	3.20%	4.13%	7.87%	16.93%	3.53%	4.45%	8.20%	17.26%	3.43%	4.36%	8.10%	17.16%	3.38%	4.31%	8.06%	17.11%
	3c	Woodpulp (paper and paper products)	General cargo	9.75%	10.47%	13.38%	20.42%	9.77%	10.49%	13.40%	20.44%	10.16%	10.88%	13.79%	20.83%	10.17%	10.89%	13.80%	20.84%	10.23%	10.94%	13.86%	20.90%

The 2030, 2040, and 2050 transit-weighted averaged, total commodity cost intensity ranges across all scenarios, by speed reduction group is presented in Figures 6.2, 6.3, and 6.4, respectively.

Figure 6.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group

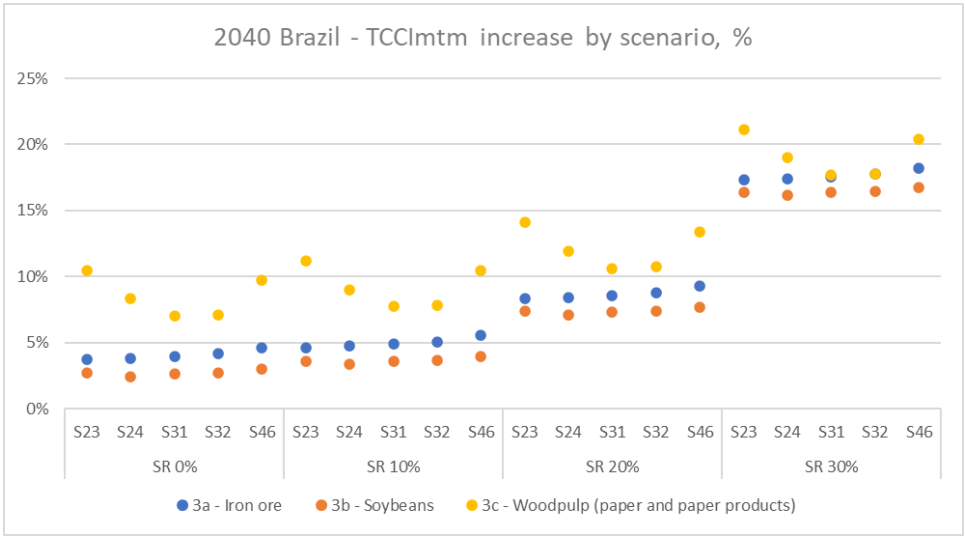


Note that in 2030, there are total commodity cost intensity increases as the speed reduction groups increase, with the key parameters ranging from:

- **TCCImtm** **0.86% to 17.78%, with an average of 6.85%**

Woodpulp (general cargo) has relatively less sensitivity than iron ore and soybeans (bulk carriers) at SR 30%. The strive scenario 46 does have the highest intensity increases across all ranges, while the other four scenarios are quite similar to each other (low variability).

Figure 6.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group

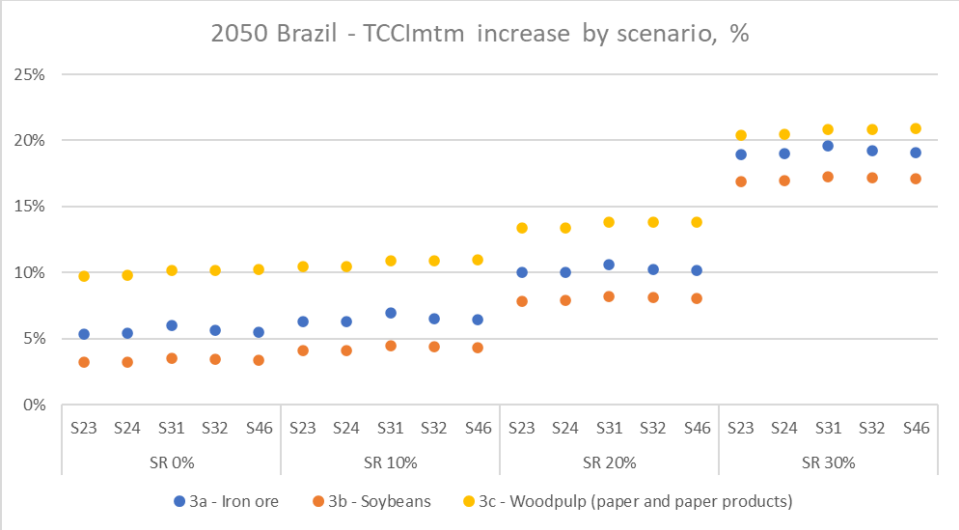


Note that in 2040, general cargo ships trading woodpulp have significantly higher cost intensities across 0%-20% SR groups over the other commodities, with the key parameters ranging from:

- **TCCImtm** **2.45% to 21.13%, with an average of 9.55%**

The bulk carriers moving iron ore and soybeans have cost intensities that track closely to each other across all five scenarios. Woodpulp Scenario 23 has the highest cost intensity increase across all scenarios and speed reduction groups.

Figure 6.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2050, the differences between the scenarios are minimal for each case study, with the key parameters ranging from:

- **TCCImtm** **3.19% to 20.90%, with an average of 10.77%**

The general cargo ships moving woodpulp have a range of nearly double to more than double cost intensity increases compared to the bulk ships through SR 0% and SR 10%. The spreads tighten as speed reduction group increase. This is consistent with the end of the transition and the fleets have mostly converted to the new fuels and all the measures are in effect.

GDP context

There was no data available to determine the sector share of GDP for any of the three commodities evaluated.

6.4 Qualitative analysis

Brazil provided detailed Qualitative information on all three of their commodities using input from global industry experts for each commodity. These are:

- Iron ore responses were provided by a representative from Vale, the largest producer and exporter in the world.
- Soybean responses were collated by from the contributions of two different companies within the sector.
- Woodpulp responses were provided by Suzano, Latin America's main pulp producer.

These stakeholders all showed strong awareness of the potential impacts of the IMO measures to decarbonize shipping, as well as related factors such as future fuels production and impacts on food prices.

Analyses of these responses are displayed on the following SWOT grids (Tables 6.8 and 6.9) showing sensitivities to freight costs and sensitivities to transit times. Key takeaways for each grid are reflected below the SWOT grids.

Table 6.8: SWOT analysis of Brazil's commodities and their sensitivity to cost changes

Sensitivity to freight shipment cost changes as reported by the stakeholders	
Country: Brazil Commodities: 3a iron ore, 3b soybeans, 3c woodpulp	
Strengths ➢ Brazil is well positioned as a leader in the global south for production of resources, intermediates, agriculturals and fuels. ➢ Brazil's marine fuels are recognized by the international community as one of the best qualities in the world, and they are investing to increase this availability. ➢ Final products for woodpulp are essential goods such as toilet paper, hygiene pads, diapers, printing and writing and biodegradable packaging.	**Weaknesses** ➢ The main consuming markets for all three commodities are located far from Brazil. ➢ The three commodities studied all are classified as commodities economically, with slim margins. ➢ The maritime transport costs are directly related to the distance sailed and quantity of fuel consumed. ➢ While developing new markets logistics costs are important, being very sensitive on the sales price and margin on product. ➢ The sector is already facing added cost for EU ETS, with the importer/exporter bearing the cost.
Opportunities to adapt/mitigate ➢ Trade agreements could help to solve this cost gap vs other countries. ➢ Biogenic CO_2 for biofuels can be obtained from woodpulp production in large scale, a possible a new business line for this sector. ➢ The woodpulp market is transitioning from softwood to hardwood input, favoring Global South (Brazil, Chile) vs northern countries (Canada, Finland) ➢ Lower speed reduces bunker costs. ➢ Petrobras, the Brazilian state oil company, is working to improve the quality and variety of fuels for bunkering, aiming to increase the share in this industry.	**Threats** ➢ IMO GHG MTM may increase shipping costs for all commodities. ➢ The consequence will be the increasing of food cost worldwide (related to soybeans) ➢ Clients would need to buy raw materials sooner. Working capital will increase, impacting the balance sheet negatively. ➢ Exporters may need to consider the GHG emission cost on their logistic cost to avoid deviation from market price. ➢ For iron ore miners, the fleet of vessels will have to increase to ship the same amount as before speed reduction, potentially increasing freight costs. ➢ More ships will be needed to ship the same volume of goods. In the short term, the capacity reduction of the spot fleet will push up freight rates for a number of years before the fleet adjusts via newbuilds.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis

- Brazil is well positioned as a leader in the global south for production of resources, intermediates, agriculturals and fuels.
- The main consuming markets for all three commodities are located far from Brazil.
- The three commodities studied all are classified as “commodities” economically, with slim margins.
- Brazil’s marine fuels are recognized by the international community as one of the best qualities in the world, and they are investing to increase this availability. This provides an opportunity to produce biogenic carbon dioxide as a feedstock for future low carbon fuels.
- Another opportunity is the move of the pulp industry to hardwoods sourced in the global south.
- Identified threats/risks of freight rate increases due to the MTM include increasing food costs worldwide. IMO GHG MTM may increase shipping costs for all commodities. Exporters may need to consider the GHG emission cost on their logistic cost to avoid deviation from market price.
- Clients would need to buy raw materials sooner, increasing working capital needs and impacting balance sheets negatively.
- A larger capacity fleet of vessels will be needed to ship the same quantity of goods as before speed reduction, potentially increasing freight costs.

Table 6.9: SWOT analysis of Brazil's commodities and their sensitivity to transport time changes

Sensitivity to increased transport times as reported by the stakeholders	
Country: Brazil Commodities: 3a iron ore, 3b soybeans, 3c woodpulp	
Strengths ➢ Iron ore, soy, and woodpulp are unlikely to degrade with longer transport time. ➢ Brazil managed Covid-19 well with little disruption. ➢ Grain and cereal crops like soy have specific dates to be planted, harvested, commercialized and shipped to meet processing windows. Location in Brazil is a strength due to the growing season.	**Weaknesses** ➢ Iron ore, soybeans, and woodpulp consumers demand timely arrivals for KPI and productivity reasons. ➢ The main consuming markets for all three commodities are located far from Brazil. ➢ Maritime transport costs are directly related to the distance sailed and quantity of fuel consumed.
Opportunities to adapt/mitigate ➢ If transit time will be affected, it will be necessary to adjust logistics to provide increased stock at destination. ➢ More frequent shipments or increased storage capacity at destination (However this may lead to higher emissions due to more frequent shipments or longer storage). ➢ Lower vessel speed should reduce fuel consumption. ➢ Potential to develop shipment and storage conditions to prolong the acceptable lifetime of agricultural products.	**Threats** ➢ IMO GHG MTM may increase transport times. ➢ Brazil is distant from the consuming market (mainly Asia, but also Europe and USA). ➢ Speed reduction would aggravate geographic disadvantage and worsen competitivity because of longer lead times and potentially more expensive freight costs. ➢ Stockpile management of our clients would be more challenging, requiring buying the raw materials sooner. Agricultural growing seasons may make this inflexible. ➢ Increased time for the sea passage increases the risk for agricultural cargo, increasing the risk of cargo quality claims. Temperature and changes are also an important factor.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- Commodities may be time-sensitive for a variety of reasons – product degradation, customer demands (KPIs, production efficiency), market forces and costs.
- Brazil is distant from the consuming market (mainly Asia, but also Europe and USA). Speed reduction would aggravate geographic disadvantage and worsen competitiveness due to longer lead times and potentially more expensive freight costs.
- Stockpile management of the clients would be more challenging, requiring buying the raw materials sooner. This flexibility may not exist for agricultural product with specific growing seasons.
- An opportunity to mitigate risks is to provide more frequent shipments or increased storage capacity at destination (However this may lead to higher emissions and longer storage with more costs).

- Potential to develop shipment and storage conditions to prolong the acceptable lifetime of agricultural products.
- Increased time for the sea passage increases the risk to preserve agricultural cargoes and some other goods, increasing the risk of cargo quality claims.

Another insight to these stakeholders' awareness of and engagement in the decarbonization of shipping is the breadth of their responses to the final open-ended question "What questions should we have asked to more fully understand the impacts of potential vessel greenhouse gas reduction requirements on shipping, your population and your economy?" The additional question topics stakeholders from Brazil suggested ranged from impacts on world food prices to future fuel needs.

6.5 Findings

Quantitative findings

The key findings from the quantitative analysis include:

- Longer transit times from potential speed reduction range across the case studies, including:
  - Iron ore
    - SR 10% - 5 days
    - SR 20% - 12 days
    - SR 30% - 20-21 days
  - Soybean
    - SR 10% - 5-6 days
    - SR 20% - 12-13 days
    - SR 30% - 20-23 days
  - Woodpulp (paper and paper products)
    - SR 10% - 5 days
    - SR 20% - 10-11 days
    - SR 30% - 18 days
- Total commodity cost intensity increases across all scenarios are sensitive to commodity costs associated with speed reductions of 20% and 30%.
- The *ad valorem* rates of the exported trade goods ranged between 6.0% to 16.1%, with woodpulp having the highest rate. This means it is more sensitive to changes in ship-side costs relative to the other two commodity case studies.
- In 2030, total commodity cost intensity increases build as the speed reduction groups increase. Woodpulp (general cargo) has relatively less sensitivity than iron ore and soybeans (bulk carriers) at SR 30%. The strive scenario 46 does have the highest intensity increases across all ranges, while the other four scenarios are quite similar to each other (low variability).
- In 2040, general cargo ships trading woodpulp have significantly higher cost intensities across 0%-20% SR groups over the other commodities. The bulk carriers moving iron ore and soybeans have cost intensities that track closely to each other across all five scenarios. Woodpulp Scenario 23 has the highest cost intensity across all scenarios and speed reduction groups.
- In 2050, the changes between scenarios are minimal for each case study. The general cargo ships moving woodpulp have nearly double to more than double cost intensity increase compared to the bulk ships through SR 0% and SR 10%. The gaps tighten as speed reduction group increase. This is consistent with the end of the transition and the fleets have mostly converted to the new fuels and all the measures are in effect.

- Total commodity cost intensity ranges across all scenarios and speed reduction groups, include:
  - Iron ore
    - 2030 – 1.69% to 17.78%, with an average of 7.32%
    - 2040 – 3.70% to 18.23%, with an average of 8.84%
    - 2050 – 5.36% to 19.61%, with an average of 10.37%
  - Soybeans
    - 2030 – 0.86% to 15.82%, with an average of 5.99%
    - 2040 – 2.45% to 16.72%, with an average of 7.53%
    - 2050 – 3.19% to 17.26%, with an average of 8.18%
  - Woodpulp (paper and paper products)
    - 2030 – 2.50% to 17.19%, with an average of 7.32%
    - 2040 – 7.10% to 21.13%, with an average of 12.29%
    - 2050 – 9.75% to 20.90%, with an average of 13.77%
- TCCImtm findings for the three commodity case studies across all scenarios and speed reduction groups, by forecasted year:
  - 2030 0.86% to 17.78%, with an average of 6.85%
  - 2040 2.45% to 21.13%, with an average of 9.55%
  - 2050 3.19% to 20.90%, with an average of 10.77%

Qualitative findings

Brazil is located in the global south and has significant production of mineral resources, intermediates, agriculturals and fuels. For all three commodities selected by Brazil, the main consumers are located far from Brazil. These commodities also are classified as "commodities" economically, with slim margins.

For soybeans, like other grains and cereals, Brazil's stakeholders who participated in the qualitative analysis reported that the effectiveness and efficiency of transport is of paramount importance. They stated that recent studies show that the time of voyage, moisture content, and temperature are of great importance to preserve cargo quality. Changes in cargo temperature may cause alteration in cargo characteristics. The alterations, and consequently the costs involved, will depend on the temperature and temperature variability.

Slower transit times for all commodities would mean that customer stockpile management would be more challenging, requiring buying the raw materials sooner. This flexibility may not exist for agricultural products with specific growing seasons. Mitigations of this situation could include additional storage, potentially with added environmental controls to extend shelf life and maintain quality.

In preparing for the future, Brazil's stakeholders report that Brazil's marine fuels are recognized by the international community as one of the best qualities in the world, and they are investing to increase this availability. This provides an opportunity to produce biogenic carbon dioxide as a feedstock for future low carbon fuels. Another evolving opportunity is the move of the pulp industry to hardwoods sourced in the global south.

Stakeholders suggested opportunities to mitigate impacts include a range of approaches:

- Costs:
  - Trade agreements could help to solve this cost gap vs other countries.
  - Biogenic CO_2 for biofuels can be obtained from woodpulp production in large scale, a possible a new business line for this sector.
  - The woodpulp market is transitioning from softwood to hardwood input, favoring Global South (Brazil, Chile) vs northern countries (Canada, Finland)
  - Lower speed reduces bunker costs.
    - Petrobras, the Brazilian state oil company, is working to improve the quality and variety of fuels for bunkering, aiming to increase the share in this industry.
- Longer transport times:
  - If transit time will be affected, it will be necessary to adjust logistics to provide increased stock storage capacity at destination.
  - More frequent shipments (However this may lead to higher emissions).
  - Lower vessel speed should reduce fuel consumption.
  - Potential to develop shipment and storage conditions to prolong the acceptable lifetime of agricultural products.

Summary of key points related to potential impacts

The following points are key to understanding the potential impacts of the MTM:

- Brazil is the 8th largest economy in the world by GDP at $1.9 trillion. Brazil's GDP per capita has fluctuated in recent years and in 2022 was $8,918.
- The three commodities selected by Brazil for case studies are trade commodity exports of iron ore, soybeans and woodpulp, all destined for distant markets in China. All three case studies are exported trade commodities, which means costs increases impact the sector/subsector of the economy associated with each commodity. In addition, the associated employment, supporting industries, and taxes and revenues associated with the commodity will be impacted.
- For these three case studies, the estimates indicate a range of total commodity cost intensity increases related to maritime transport. Across Scenarios 23/24 and 31/32, for all forecasted years, the estimates indicate a similar range total commodity cost intensity. These increases are estimated to be lower in 2030, but are estimated to significantly increase in 2040 and 2050. Scenario 46 brings forward the significant increase in costs to 2030. Woodpulp is the most sensitive commodity to ship-side cost increases.
- Since these case studies represent export trade commodities only on particular routes, the entire economic sector/subsector is not captured. The full impact on the entire sector/subsector would need to be considered by the Member State and their national stakeholders to determine impacts to GDP, employment, and any collateral impacts on supporting industries.

7 Stakeholders' analysis – Chile

The Stakeholder Assessment for Chile focuses on exports of cherries and lithium carbonate and imports of petroleum oils and oils obtained from bituminous minerals, other than crude. Cherries and lithium carbonate are shipped to China via containers. Petroleum oils and oils obtained from bituminous minerals are sent though tankers from the United States.

7.1 Geography, population, and economy

Geography

Chile is a long narrow country that stretches along the western edge of South America and is marked by its diverse and distinct geography. It encompasses a range of ecosystems, including the Atacama Desert in the north, the Andes Mountains to the east and temperate rainforests in the south. Chile is 756,102 km^2 in size, over 4,300 km long but only 350 km across at its widest point.[80] The country is also famous for its southernmost region, known as Patagonia. The Chilean side of Patagonia features glacial fjords and the aforementioned temperate rainforests. Chile's coastline along the Pacific Ocean stretches over 6,400 km long and hosts port cities like San Antonio and Valparaíso, some of the busiest ports on the western coastline.[81] Santiago is the capital of Chile and one of the largest cities in South America.

Chile is bounded on the east by Argentina, Peru and Bolivia in the north and the Pacific Ocean to the west. The country has access to major maritime trade routes and plays a significant role in international trade. This has been pivotal to Chile's economic growth and integration into global markets. Chile continues to leverage its resources and stable political environment to expand its role in trade. The case studies for Chile focuses on exports of cherries and lithium carbonate and imports of petroleum oils and oils obtained from bituminous minerals, other than crude. Cherries and lithium carbonate are shipped to China via containers. Petroleum oils and oils obtained from bituminous minerals are sent though tankers from the United States. Representative distances to markets for the selected commodities and ports are presented in Section 7.2.

Population

Chile's population is approximately 17.5 million as of 2017 with a demographic mix of European and indigenous ancestry.[82] Of that population, 88% live in urban areas and 12% live in rural areas. The urban population is mostly concentrated in and around major cities like Valparaíso and Concepción and the country's population density varies widely. It averages around 26 people per km^2 and is influenced by geographic features and economic opportunities. The capital, Santiago, is one of the most populated cities in South America and immigration from neighboring countries has been steadily increasing, as has population growth. The total population in Chile is forecast[3] to increase in the future but the birth rate is expected to decline.

Economy

Chile's economy is diverse and relies on several sectors to drive its growth and development. With a 2022 GDP of $300,686 million, Chile has benefitted from its mining sector, agriculture, and

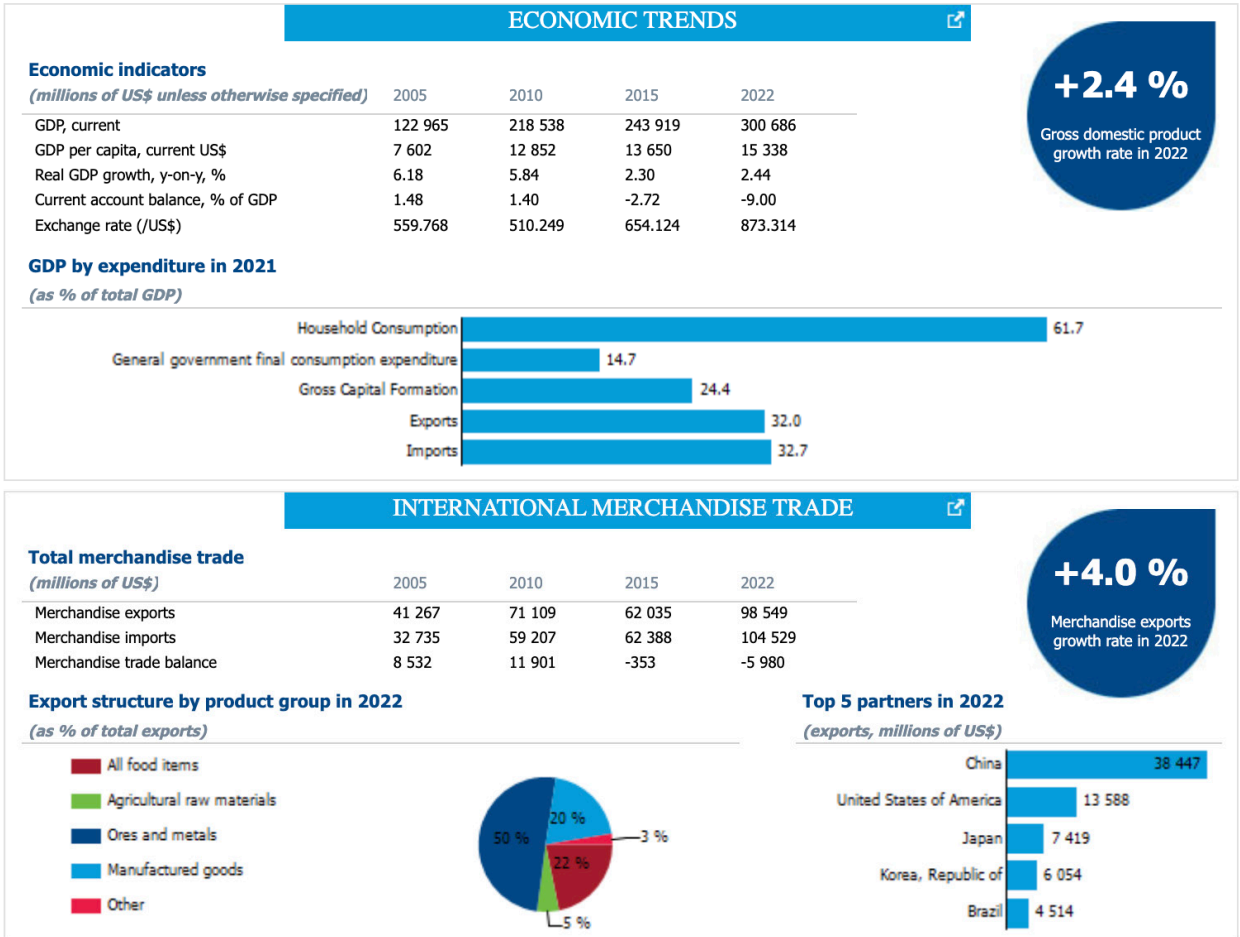
[80] Encyclopedia Britannica at *Chile | History, Map, Flag, & Population*, César N. Caviedes, Marcello A. Carmagnani.
[81] Marine Insight, *8 Major Ports in Chile*, 3 May 2022, Shilavadra Bhattacharjee.
[82] INE of Chile, *Population and Housing Censuses*.

tourism.[83] The country's GDP per capita has mostly increased and is projected to continue that trend. In 2022, Chile's GDP per capita was $15,338.[84]

Its economy has been bolstered by its abundant natural resources, made evident by Chile's position as the top copper producer in the world.[85] Chile's economy is also very much diversified across multiple sectors, including agriculture, forestry, and fishing thanks to the country's long coastline.[86]

Chile faces challenges regarding income inequality and environmental concerns related to mining and climate change. However, Chile also has competitive advantages in sustainability due to its geography and reputation for political stability. The copper industry in Chile ranks third in the world for sustainability and the lithium industry ranks second.[87] Chile's proximity to the Pacific Ocean has bolstered maritime trade, enhancing its economic growth and integration into the global economy; its economy continues to evolve. Key economic indicators are shown in Figure 7.1.[88]

Figure 7.1: Key economic indicators for Chile



Source: UNCTAD, General and Maritime Profiles: Chile, UNCTAD Statistics - General Profile.

[83] Luiza Antoun de Almeida, Si Guo and Andrea Schaechter, International Monetary Fund, *Making Chile's Economy More Dynamic, Greener, and Inclusive.*
[84] UNCTAD, General and Maritime Profiles: Chile, *UNCTAD Statistics - General Profile*, accessed June 2024.
[85] *Ibid.*
[86] World Bank Group, *Climate Risk Country Profile: Chile*, accessed July 2024.
[87] Science Direct, *Chile: On the road to global sustainable mining*, Juan Ignacio Guzmán.
[88] UNCTAD, General and Maritime Profiles: Chile, *UNCTAD Statistics - General Profile*.

7.2 Identified commodities and routes studied

The Stakeholder Assessment for Chile focuses on exports of cherries and lithium carbonate and imports of petroleum oils and oils obtained from bituminous minerals, other than crude. Cherries and lithium carbonate are shipped to China via containers. Petroleum oils and oils obtained from bituminous minerals are sent though tankers from the United States.

The commodities selected by the Member State for focus and illustrative trade routes selected are shown in Table 7.1. One commodity selected for this study is an import, and two commodities are exports.

Table 7.1: Shipping distances to and from Chile for selected commodities

Case Study	Commodity	Illustrative identified routes, by country	Ship Type(s)	Route Distance Range, nm min	avg	max	Stops
4a	Cherries	Chile --> China Chile --> Mexico --> China	Container	10,118	11,016	12,432	1-2
4b	Petroleum oils	United States --> Chile United States --> Panama --> Chile	Chemical tanker	4,184	4,347	4,923	1-3
4c	Lithium carbonate	Chile --> China Chile --> Ecuador --> China Chile --> New Zealand --> China Chile --> Philippines --> China	Container	10,519	12,189	13,911	1-4

Trade context

The Member State, states the following related to their commodity selection:

"In 2021, Chile participated in the first impact evaluation for short-term measures, analyzing the impact of exports of cherries, berries and grapes. In that occasion, the measure analyzed was a combined measure of a technical and an operational one. Thus, the products analyzed focused on those with short lifespan, thus could be affected by the speed reduction of ships, due to the increase in the days it takes to navigate to reach port destination.

Our previous analysis of Chilean cherries has explained the importance of the qualitative assessment we have conducted. This is one of the commodity examples that quantitative information won't necessarily reflect the impact of MTM. The current assessment has been conducted with vessels deployed in the "Cherries Express Services" which are direct services from Chile to China; there is a volume of Chilean cherries transported in longer liner shipping services (not cherries express services) which we have not analyzed, and the economic impact could be severe. For perishable products, such as fresh cherries, the impact due to the delay caused by slow steaming may be considerable. Our economic impact assessment was conducted on direct "cherries express services to China". The MS has indicated that the product tolerance to delay is "cero" due to the product shelf life. The impact of delay on fresh fruits' shelf life, like cherries, is considerable. Cherries are a very sensitive product to handle and transport. After harvest, the product is immediately fast-cooled to -0.5°C, and the pulp temperature should not exceed 0°C while handled or during transport. The product should be in the final retail market within 21 days after picking, as shelf life is very limited. Thus, cherries are one of the cases of a product whose shelf-life is affected by slow steaming.

Chile identified three trade commodities of concern related to the economic measures that could have negative impacts on the following important national exports and imports.

Cherries: Due to the fact that this product was considered in the previous analysis, it is important to evaluate both impacts to identify the total impact between both measures. In addition, Chile is the main world exporter of this product (53% of global exports approximately) and is the fourth largest export product in terms of values, being the main agricultural export.

Lithium carbonate: A significant number of ships are used for its transportation, all year round. Moreover, Chile is the main world exporter (80% of global exports). In addition, in 2023, lithium was Chile´s second largest exported product, with 6.6 billion dollars sold.

In relation to imports, Chile selected petroleum oils and oils obtained from bituminous minerals, other than crude, because it is the main imported product and also an essential one; in fact, Chile we imported 15,174 million dollars of this product in 2022.

In the last thirty years, Chile's total imports have grown at an average annual rate of 7.1%, going from US$ 11,820 million in 1994 to US$ 85,322 million in 2023. In the same period, Chile's total exports have grown at an average annual rate of 9.2%, going from US$ 7,362 million in 1994 to US$ 94,671 million in 2023.

In relation to exports, in 1960, Chile exported US$ 490 million, of which 87% corresponded to mining shipments, the country had a mono-export profile. In contrast, in 2023, non-copper products represent 54% of the country's exports, with shipments exceeding US$ 51 billion in 2023, made up of products and services as diverse as salmon, wine, olive oil, wooden furniture, software, video games, medicines, industrial robots, fresh fruits, animation, commercial filming, among others.

Chile is one of the main exporters of lithium as well as cherries. In fact, in 2023, Chile exported around US$ 4.9 billion of lithium carbonate, and cherries recorded shipments of more than US$ 2.3 billion in 2023."

7.3 Quantitative analysis

This section presents the quantitative analysis summary results and is organized by fleet analysis summary, total commodity cost intensity changes from speed reduction, Task 2 cost intensity changes due to MTM, total commodity cost intensity impacts, and GDP contexts. The quantitative analysis incorporates the findings of Task 2 related to the selected bracketing MTM scenarios as presented below:[89]

			Policy combination						
					GFI flexibility		Levy		Feebate
Scenario number	Emissions trajectory	Seaborne trade growth	Policy code	GFI scope	RU % of price	SU % of price	Levy USD/tCO_2eq	Reward % of cost gap	Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

The detailed approach for the below analyses is provided in Appendix A.

[89] DNV 2024

Fleet analysis summary

As part of the fleet analysis, routes and ship characteristics were identified for each case study. For the specific ship types identified with the case study and transiting on the identified route the following were averaged to represent the fleet:

- Ship type and size
- Number of transits identified
- Route distances obtained from Marine Benchmark's 2022 AIS database were transit-weighted averaged and reported as minimum, average, and maximum distance sailed
- Transit-weighted average year of build, which was used to determine the average age in years

These characteristics for the case studies are presented in Table 7.2, on the following page.

Table 7.2: Chile – Fleet characteristics, by case study

Case Study	Commodity	2022 Transits	Ship Type(s)	Route Distance Range, nm min	Route Distance Range, nm avg	Route Distance Range, nm max	Avg Build
4a	Cherries						
		8	Container 3,000-4,999 teu	10,118	**10,472**	11,276	2011
		23	Container 8,000-11,999 teu	10,125	**11,206**	12,432	2009
4b	Petroleum oils						
		20	Chemical tanker 40,000 + dwt	4,184	**4,347**	4,923	2014
4c	Lithium carbonate						
		5	Container 3,000-4,999 teu	10,519	**11,731**	12,361	2004
		66	Container 8,000-11,999 teu	10,898	**12,199**	13,911	2001

In addition, transit weighted average speeds and average route times were estimated and the APEC Module 1 was used to estimate the hours and longer transit times associated with the speed reduction groups of 10%, 20%, and 30%, as presented in Table 7.3.

Table 7.3: Average route distance, speed, & longer transit ,times, by speed reduction group

Country	Case Study	Commodity	Transits	Ship type & size	Avg Route Distance (nm)	Avg Route Speed (knots)	Avg Route Time (hours)	SR 10% Delay Delta (days)	SR 20% Delay Delta (days)	SR 30% Delay Delta (days)
Chile	4a	Cherries	8	Container 3,000-4,999 teu	10,472	18.4	570	2.6	5.9	10.2
			23	Container 8,000-11,999 teu	11,206	18.2	615	2.8	6.4	11.0
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	4,347	12.1	358	1.7	3.7	6.4
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	11,731	16.3	718	3.3	7.5	12.8
			66	Container 8,000-11,999 teu	12,199	17.3	705	3.3	7.3	12.6

The fleet characteristics are assumed to be consistent across the forecasted years of 2030, 2040, and 2050.

Total commodity cost intensity changes due to speed reduction

APEC Module 2 was used to estimate the commodity cost intensity increases due to potentially longer transit times resulting from the three speed reduction groups. The module estimates the daily cost increases, in percentage, associated with the following:

- Finance/interest costs - the financial cost of capital invested in inventory over time. This measures the impact of each hour or day of delay in the cost of the product due to cost of money or interest rate. A Member State rate was used when provided, otherwise, it was assumed to be 5%.[90]
- Depreciation costs - the cost allocation of a commodity, or reduction of the commodity value, over its useful life. For this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry bulk cargo.[91]
- Insurance costs - a cost paid by the cargo owner to protect their goods while in transit. The percentage used in the economic analysis is the one provided by the Member State. If the Member State did not provide data, we assumed it to be 2%.[92] In the particular case of petroleum oils, typical insurance cost is 0.12%, and in the case of lithium carbonate it has a 110% CIF rate. This information was provided by the Member State and applied to those commodities.

The total commodity cost intensity change related to the three speed reduction groups for the case studies is presented in Table 7.4. Note that these values remain constant across scenarios and forecasted year.

Table 7.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Commodity-side Task 4 TCIsr Change, % SR 10%	SR 20%	SR 30%
Chile	4a	Cherries	8	Container 3,000-4,999 teu	12	0.23%	1.16%	3.41%
			23	Container 8,000-11,999 teu	14	0.27%	1.35%	3.96%
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	9	0.09%	0.46%	1.34%
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	19	0.36%	1.84%	5.40%
			66	Container 8,000-11,999 teu	22	0.35%	1.77%	5.20%

The commodity cost intensity changes due to speed reduction, ranges as follows:

- 4a – SR 10% → 0.23%-0.27% SR 20% → 1.16%-1.35% SR 30% → 3.41%-3.96%
- 4b – SR 10% → negligible SR 20% → 0.46% SR 30% → 1.34%
- 4c – SR 10% → 0.35%-0.36% SR 20% → 1.77%-1.84% SR 30% → 5.20%-5.40%

Task 2 cost intensity changes due to MTM

Based on the ship type, size, and age combination for each case study, the applicable Task 2 ship-side commodity cost intensities due to the MTM were identified for the selected scenarios. In addition to add these to the commodity cost intensity changes due to speed reduction, the *ad valorem* freight rate percentage was identified using the UNCTAD Trade-and-Transport Dataset.[93] The *ad valorem* freight rate percentage represents the transportation cost percentage of a commodity's total cost. These values were multiplied to get the freight rate adjusted commodity cost intensity or FRACCI change for 2030, 2040, and 2050. Task 2 cost intensity change and FRACCI for each scenario are presented in Table 7.5.

[90] Lending Tree, *Assuming a line of credit 5%*.
[91] APEC 2019
[92] APEC 2019
[93] UNCTAD, *Trade-and-Transport Dataset*.

Table 7.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Chile	4a	Cherries	8	Container 3,000-4,999 teu	12	6.1%	9.16%	73.77%	67.78%	0.56%	4.50%	4.13%
			23	Container 8,000-11,999 teu	14	6.1%	16.71%	64.48%	65.89%	1.02%	3.93%	4.02%
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	9	5.7%	24.30%	53.32%	57.25%	1.38%	3.04%	3.26%
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	19	8.9%	9.16%	73.77%	67.78%	0.82%	6.57%	6.03%
			66	Container 8,000-11,999 teu	22	8.9%	5.97%	139.53%	97.33%	0.53%	12.42%	8.66%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Chile	4a	Cherries	8	Container 3,000-4,999 teu	12	6.1%	10.59%	52.66%	67.58%	0.65%	3.21%	4.12%
			23	Container 8,000-11,999 teu	14	6.1%	14.18%	44.40%	61.66%	0.87%	2.71%	3.76%
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	9	5.7%	23.37%	46.05%	57.32%	1.33%	2.63%	3.27%
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	19	8.9%	10.59%	52.66%	67.58%	0.94%	4.69%	6.01%
			66	Container 8,000-11,999 teu	22	8.9%	6.53%	135.66%	105.22%	0.58%	12.07%	9.36%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Chile	4a	Cherries	8	Container 3,000-4,999 teu	12	6.1%	18.51%	55.11%	64.54%	1.13%	3.36%	3.94%
			23	Container 8,000-11,999 teu	14	6.1%	22.77%	47.01%	61.89%	1.39%	2.87%	3.78%
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	9	5.7%	18.61%	44.44%	62.95%	1.06%	2.53%	3.59%
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	19	8.9%	18.51%	55.11%	64.54%	1.65%	4.91%	5.74%
			66	Container 8,000-11,999 teu	22	8.9%	24.14%	121.77%	88.54%	2.15%	10.84%	7.88%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Chile	4a	Cherries	8	Container 3,000-4,999 teu	12	6.1%	21.78%	60.14%	65.30%	1.33%	3.67%	3.98%
			23	Container 8,000-11,999 teu	14	6.1%	24.49%	51.22%	59.89%	1.49%	3.12%	3.65%
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	9	5.7%	18.83%	44.04%	60.55%	1.07%	2.51%	3.45%
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	19	8.9%	21.78%	60.14%	65.30%	1.94%	5.35%	5.81%
			66	Container 8,000-11,999 teu	22	8.9%	28.70%	115.29%	93.09%	2.55%	10.26%	8.29%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Chile	4a	Cherries	8	Container 3,000-4,999 teu	12	6.1%	59.80%	71.49%	68.04%	3.65%	4.36%	4.15%
			23	Container 8,000-11,999 teu	14	6.1%	58.81%	67.01%	63.19%	3.59%	4.09%	3.85%
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	9	5.7%	40.75%	58.62%	59.39%	2.32%	3.34%	3.39%
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	19	8.9%	59.80%	71.49%	68.04%	5.32%	6.36%	6.06%
			66	Container 8,000-11,999 teu	22	8.9%	107.93%	163.92%	96.72%	9.61%	14.59%	8.61%

The *ad valorem* rates of the one imported essential good and two exported trade goods ranged between 5.7% to 8.9%.

Note that there are significant differences between ship type, size, and age groups between scenarios. The container ships related to case study 4c, lithium carbonate, show significant ship-side cost intensity increases across all scenarios - greater than doubling, however when multiplied by the *ad valorem* freight rate, the commodity cost intensity is only increasing 8% to 15%.

As learned from our consultation with DNV, "It should be noted that scenarios 23 and 24, and to a lesser degree scenarios 31 and 32, show large differences in cost impacts in 2030 depending on the generation of ships deployed. Ships with 10 years or less of age - i.e. built in the period between 2020 and 2029 – have a significantly higher increase in costs compared to older vessels. In the scenarios with a GFI flexibility mechanism the newer ships built in 2020-2029 take the brunt of the GHG intensity reductions, resulting in a higher cost increase compared to older ships when looking at all abatement costs. This is as expected, as the cost of reduction is relatively lower for new ships compared to existing ships.

"However, it should also be expected that there should be some compensation from the older ships to the newer ships when joining in a compliance pool under the GFI flexibility mechanism. DNV indicates in their report that the emission unit exchange price is set to the marginal cost of the last ship in the pool that was selected to implement an additional measure.

"However, when applying this price the results showed that the newer ships are overcompensated (i.e. the compensation led to a cost decrease), meaning that the marginal cost of the last ship is likely not a very good indicator for the exchange price in a pool as the many ships will have lower abatement costs. For this reason, the costs and incomes of joining a pool are not included in this analysis."[94]

In an additional follow up, related to high container cost intensity changes estimate for container 8,000-11,999 teu, "There are two significant effects (happening): the fuel cost increase for the older vessels is larger – they tend to not retrofit to other fuel types and stick with more expensive drop-in fuels until scrapped. The capex is lower which means that also the BAU cost is lower than for the newer vessels in this segment.

"Note that this is the only segment in your analysis with ship above 20 years. In our model we assume a ship financing model where 70% of the capex is paid in annual terms over 20 year+ interest, followed by a balloon payment of the remaining 30%. This means that for 20+ years old ships the capex is almost eliminated and the fuel cost becomes even more dominating and impacts the total costs even more. The total cost intensity is about the same for the two segments – i.e. the increase fuelex is matched by the reduced capex."[95]

Total commodity cost intensity due to speed reduction and MTM

For each case study, combining Task 2 and Task 4 results estimates the total commodity cost intensity[96] associated with potential speed reduction and the MTM ($TCCI_{mtm}$), for the forecasted years of 2030, 2040, and 2050, as presented in Table 7.6, on the following page. For ease of comparison purposes, the results detailed results for each case study were compiled into a single transit-weighted average for each scenario and forecasted year, these results are presented as Table 7.7.

[94] Email exchange with Tore Longa, Project Manager Task 2, 1 June 2024.
[95] Email exchange with Tore Longa, Project Manager Task 3, 6 July 2024
[96] The term 'total commodity cost intensity' as used in this report is defined as the total 'landed cost' of the commodity.

Table 7.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Chile	4a	Cherries	8	Container 3,000-4,999 teu	12	6.1%	0.56%	0.79%	1.72%	3.97%	4.50%	4.73%	5.66%	7.91%	4.13%	4.36%	5.29%	7.54%
			23	Container 8,000-11,999 teu	14	6.1%	1.02%	1.29%	2.37%	4.98%	3.93%	4.20%	5.28%	7.89%	4.02%	4.29%	5.37%	7.98%
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	9	5.7%	1.38%	1.48%	1.84%	2.73%	3.04%	3.13%	3.50%	4.38%	3.26%	3.35%	3.72%	4.61%
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	19	8.9%	0.82%	1.18%	2.65%	6.21%	6.57%	6.93%	8.40%	11.96%	6.03%	6.40%	7.87%	11.43%
			66	Container 8,000-11,999 teu	22	8.9%	0.53%	0.88%	2.30%	5.74%	12.42%	12.77%	14.19%	17.62%	8.66%	9.01%	10.43%	13.87%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Chile	4a	Cherries	8	Container 3,000-4,999 teu	12	6.1%	0.65%	0.88%	1.81%	4.05%	3.21%	3.44%	4.37%	6.62%	4.12%	4.35%	5.28%	7.53%
			23	Container 8,000-11,999 teu	14	6.1%	0.87%	1.13%	2.21%	4.82%	2.71%	2.97%	4.05%	6.67%	3.76%	4.03%	5.11%	7.72%
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	9	5.7%	1.33%	1.42%	1.79%	2.67%	2.63%	2.72%	3.08%	3.97%	3.27%	3.36%	3.72%	4.61%
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	19	8.9%	0.94%	1.31%	2.78%	6.34%	4.69%	5.05%	6.52%	10.08%	6.01%	6.38%	7.85%	11.41%
			66	Container 8,000-11,999 teu	22	8.9%	0.58%	0.93%	2.35%	5.79%	12.07%	12.42%	13.84%	17.28%	9.36%	9.71%	11.14%	14.57%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Chile	4a	Cherries	8	Container 3,000-4,999 teu	12	6.1%	1.13%	1.36%	2.29%	4.54%	3.36%	3.59%	4.52%	6.77%	3.94%	4.17%	5.10%	7.35%
			23	Container 8,000-11,999 teu	14	6.1%	1.39%	1.66%	2.74%	5.35%	2.87%	3.13%	4.21%	6.82%	3.78%	4.04%	5.12%	7.73%
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	9	5.7%	1.06%	1.15%	1.52%	2.40%	2.53%	2.62%	2.99%	3.88%	3.59%	3.68%	4.04%	4.93%
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	19	8.9%	1.65%	2.01%	3.48%	7.04%	4.91%	5.27%	6.74%	10.30%	5.74%	6.11%	7.58%	11.14%
			66	Container 8,000-11,999 teu	22	8.9%	2.15%	2.50%	3.92%	7.35%	10.84%	11.19%	12.61%	16.04%	7.88%	8.23%	9.65%	13.08%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Chile	4a	Cherries	8	Container 3,000-4,999 teu	12	6.1%	1.33%	1.56%	2.49%	4.74%	3.67%	3.90%	4.83%	7.08%	3.98%	4.21%	5.14%	7.39%
			23	Container 8,000-11,999 teu	14	6.1%	1.49%	1.76%	2.84%	5.45%	3.12%	3.39%	4.47%	7.08%	3.65%	3.92%	5.00%	7.61%
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	9	5.7%	1.07%	1.16%	1.53%	2.42%	2.51%	2.60%	2.97%	3.85%	3.45%	3.54%	3.91%	4.79%
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	19	8.9%	1.94%	2.30%	3.77%	7.34%	5.35%	5.72%	7.19%	10.75%	5.81%	6.17%	7.65%	11.21%
			66	Container 8,000-11,999 teu	22	8.9%	2.55%	2.90%	4.33%	7.76%	10.26%	10.61%	12.03%	15.46%	8.29%	8.63%	10.06%	13.49%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Ad-valorem FR	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Chile	4a	Cherries	8	Container 3,000-4,999 teu	12	6.1%	3.65%	3.88%	4.81%	7.06%	4.36%	4.59%	5.52%	7.77%	4.15%	4.38%	5.31%	7.56%
			23	Container 8,000-11,999 teu	14	6.1%	3.59%	3.85%	4.93%	7.54%	4.09%	4.35%	5.43%	8.04%	3.85%	4.12%	5.20%	7.81%
	4b	Petroleum oils	20	Chemical tanker 40,000 + dwt	9	5.7%	2.32%	2.41%	2.78%	3.67%	3.34%	3.43%	3.80%	4.68%	3.39%	3.48%	3.84%	4.73%
	4c	Lithium carbonate	5	Container 3,000-4,999 teu	19	8.9%	5.32%	5.69%	7.16%	10.72%	6.36%	6.73%	8.20%	11.76%	6.06%	6.42%	7.89%	11.45%
			66	Container 8,000-11,999 teu	22	8.9%	9.61%	9.96%	11.38%	14.81%	14.59%	14.94%	16.36%	19.79%	8.61%	8.96%	10.38%	13.81%

Table 7.7: 2030, 2040, & 2050 case study transit-weighted average total commodity cost intensity, by scenario & forecasted year

2030

Country	Case Study	Case Study Commodity	Ship Type(s)	2030 Scenario 23 TCCImtm, % increase				2030 Scenario 24 TCCImtm, % increase				2030 Scenario 31 TCCImtm, % increase				2030 Scenario 32 TCCImtm, % increase				2030 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Chile	4a	Cherries	Container	0.90%	1.16%	2.20%	4.72%	0.81%	1.06%	2.11%	4.62%	1.32%	1.58%	2.62%	5.14%	1.45%	1.71%	2.75%	5.27%	3.60%	3.86%	4.90%	7.42%
	4b	Petroleum oils	Chemical tanker	1.38%	1.48%	1.84%	2.73%	1.33%	1.42%	1.79%	2.67%	1.06%	1.15%	1.52%	2.40%	1.07%	1.16%	1.53%	2.42%	2.32%	2.41%	2.78%	3.67%
	4c	Lithium carbonate	Container	0.55%	0.90%	2.33%	5.77%	0.61%	0.96%	2.38%	5.82%	2.11%	2.46%	3.89%	7.33%	2.51%	2.86%	4.29%	7.73%	9.30%	9.65%	11.08%	14.52%

2040

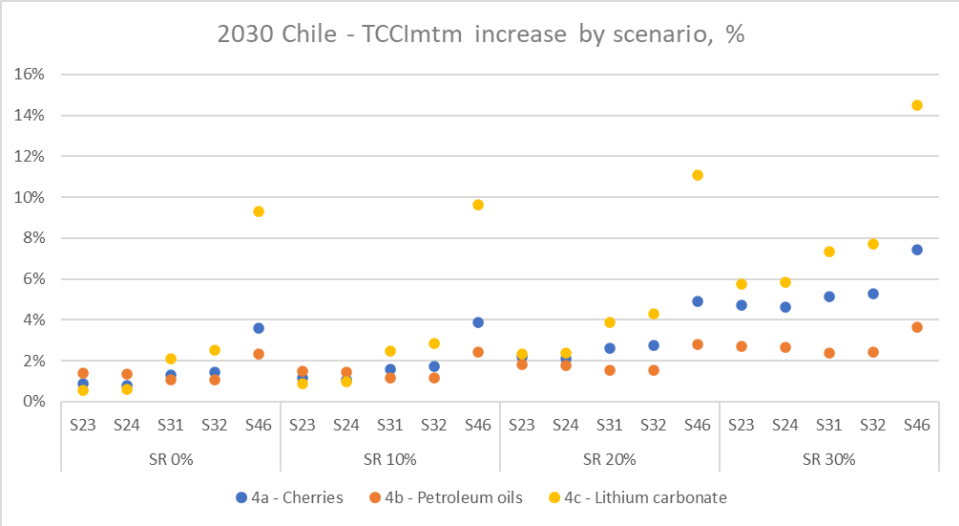
Country	Case Study	Case Study Commodity	Ship Type(s)	2040 Scenario 23 TCCImtm, % increase				2040 Scenario 24 TCCImtm, % increase				2040 Scenario 31 TCCImtm, % increase				2040 Scenario 32 TCCImtm, % increase				2040 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Chile	4a	Cherries	Container	4.08%	4.34%	5.38%	7.90%	2.84%	3.09%	4.14%	6.65%	3.00%	3.25%	4.29%	6.81%	3.26%	3.52%	4.56%	7.08%	4.16%	4.41%	5.46%	7.97%
	4b	Petroleum oils	Chemical tanker	3.04%	3.13%	3.50%	4.38%	2.63%	2.72%	3.08%	3.97%	2.53%	2.62%	2.99%	3.88%	2.51%	2.60%	2.97%	3.85%	3.34%	3.43%	3.80%	4.68%
	4c	Lithium carbonate	Container	12.01%	12.36%	13.78%	17.22%	11.55%	11.90%	13.33%	16.77%	10.42%	10.77%	12.19%	15.64%	9.91%	10.27%	11.69%	15.13%	14.01%	14.36%	15.79%	19.23%

2050

Country	Case Study	Case Study Commodity	Ship Type(s)	2050 Scenario 23 TCCImtm, % increase				2050 Scenario 24 TCCImtm, % increase				2050 Scenario 31 TCCImtm, % increase				2050 Scenario 32 TCCImtm, % increase				2050 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Chile	4a	Cherries	Container	4.05%	4.31%	5.35%	7.86%	3.85%	4.11%	5.15%	7.67%	3.82%	4.07%	5.12%	7.63%	3.74%	3.99%	5.04%	7.55%	3.93%	4.19%	5.23%	7.75%
	4b	Petroleum oils	Chemical tanker	3.26%	3.35%	3.72%	4.61%	3.27%	3.36%	3.72%	4.61%	3.59%	3.68%	4.04%	4.93%	3.45%	3.54%	3.91%	4.79%	3.39%	3.48%	3.84%	4.73%
	4c	Lithium carbonate	Container	8.48%	8.83%	10.25%	13.70%	9.13%	9.48%	10.90%	14.35%	7.73%	8.08%	9.51%	12.95%	8.11%	8.46%	9.89%	13.33%	8.43%	8.78%	10.20%	13.65%

The 2030, 2040, and 2050 transit-weighted averaged, total commodity cost intensity ranges across all scenarios, by speed reduction group is presented in Figures 7.2, 7.3, and 7.4, respectively.

Figure 7.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group

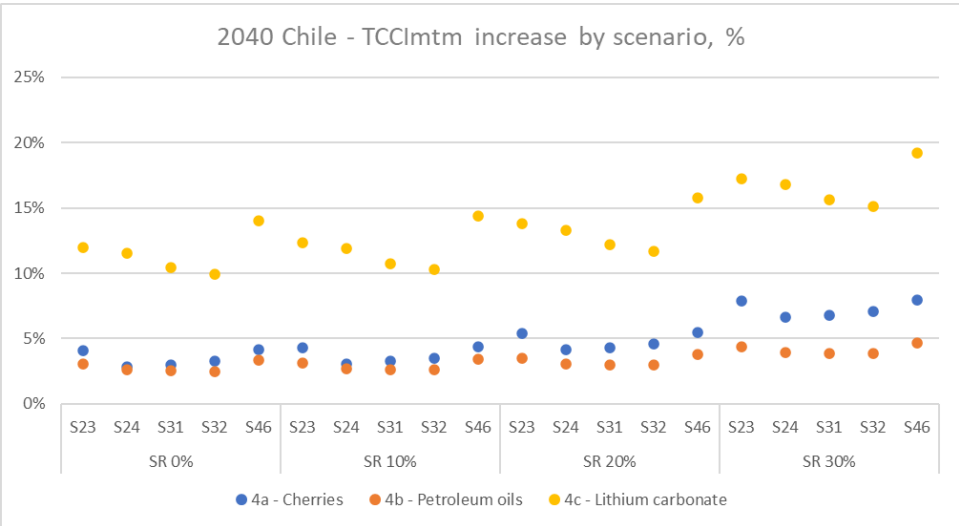


Note that in 2030, for petroleum oils transported by chemical tankers, total commodity cost intensity increases as the higher speed reduction groups are reached, however, across all scenarios and speed reduction groups, the increases range from under 2%, to just under 4%. The key parameters range from:

- **TCCImtm** **0.55% to 14.52%, with an average of 3.20%**

For container ships transporting cherries the commodity cost intensity across all scenarios and speed reduction groups ranges from 1% to nearly 8%, with the largest increases coming in the SR 30% group. For container ships moving lithium carbonate, scenario 46 shows significant increase compared to the other scenarios. In addition, scenarios 31 and 32 are higher than scenarios 23 and 24.

Figure 7.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group

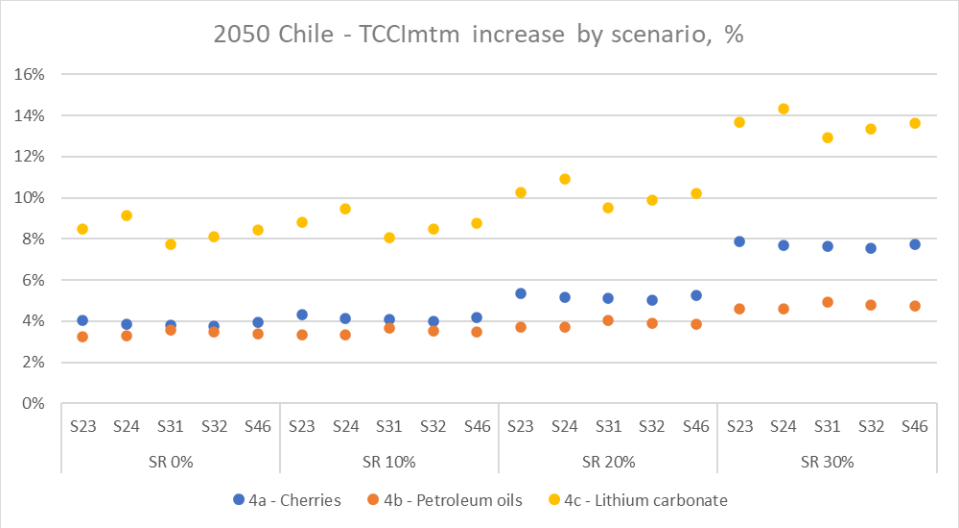


Note that in 2040, the commodity cost intensity increases for cherries and petroleum oils closely align and mirror each other across all scenarios and speed reduction groups, with the key parameters ranging from:

- **TCCImtm** **2.51% to 19.23%, with an average of 7.17%**

The lithium carbonate commodity cost intensity increases are nearly three times as high, with scenarios 23 and 46 coming much closer than in 2030, while scenarios 31 and 32 flip to represent the lowest increase.

Figure 7.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2050, similar to 2040 cherries and petroleum oils have closely aligned commodity cost intensity increase across all scenarios and speed reduction groups until through SR 20%. At SR 30% there is a pronounced separation, nearly a doubling of the increase associated with transporting the cherries and lithium carbonate. The key parameters range from:

- **TCCImtm** **3.26% to 14.35%, with an average of 6.43%**

GDP context

According to the Central Bank of Chile, the agricultural sector in Chile, which includes cherries, accounts for a 4.31% share of the total country's GDP. The Commerce sector, where petroleum oils are grouped, accounts for a 9.2% share; and the mining sector that includes lithium carbonate makes up an 8.9% share of the country's GDP.

Cherries exports represent 2.46% of total Chilean exports (in value terms), while lithium carbonate 4.32%. Petroleum oils share 6.35% of total Chilean imports.

7.4 Qualitative analysis

Chile provided detailed Qualitative information on all three of their commodities using input from experts for each commodity. These are:

- Cherries responses and a history of the development of the cherry trade were provided by Frutas de Chile.
- Petroleum fuels responses were provided by Empresa Nacional de Petróleo (ENAP).

- Lithium carbonate responses were provided by SQM Litio.

In these Qualitative responses, emails, and virtual meetings the stakeholders all showed awareness of the potential impacts of the IMO measures to decarbonize shipping on their businesses, as well as related factors such as the impact of changing vessel size on port facilities and impacts on markets and competitiveness.

Analyses of these responses are displayed on the following SWOT grids (Tables 7.8 and 7.9) showing sensitivities to freight costs and sensitivities to transit times. Key takeaways for each grid are reflected below the SWOT grids.

Table 7.8: SWOT analysis of Chile's commodities and their sensitivity to cost changes

Sensitivity to freight shipment cost changes as reported by the stakeholders	
Country: Chile Commodities: 4a Cherries, 4b Petroleum oils, 4c Lithium carbonate	
Strengths ➢ Cargo volumes and costs for air transport mean sea is the predominant mode. ➢ High speed Cherry Express shipping was a factor in the successful growth but does increase fuel consumption. ➢ For the cherry market product quality and timeliness are top considerations and more important than freight costs (as long as the freight cost is a competitive cost). This is a premium price high volume market.	**Weaknesses** ➢ The main markets and sources for all three commodities are located far from Chile. ➢ Delays in delivery during peak periods or holidays could lead to product deterioration, lower prices, missed sales opportunities and disruptions in market dynamics. ➢ Lithium carbonate is relatively stable. A related material Lithium hydroxide can shift in chemical composition and properties with time or moisture, impacting produce quality, pricing and competitiveness.
Opportunities to adapt/mitigate ➢ Stakeholders state that it is not feasible to develop reefer systems or new cherry variants to prolong shelf life. ➢ South American markets already receive fruit not suitable for the Asian market, but do not have the premium pricing seen in the Asian market. ➢ Trade agreements are in place for most cherries markets and can play a role in mitigating these costs.	**Threats** ➢ IMO GHG MTM may increase shipping costs for all commodities. ➢ For fuels, a reduction in speed will result in longer voyages and the need for more vessels to meet inventory replenishment cycles, increasing freight costs. Availability of the required MR tanker vessels for fuels is not guaranteed. ➢ Increased transportation costs linked to distance can have a significant impact on a company's export strategy, requiring adjustments in pricing, market strategy and the selection of trading partners. ➢ In the case of lithium materials, longer shipping times could negatively affect the delivery time of the product to our customer and the time he can store and dispose of his cargo. We would lose competitiveness with other companies located closer to our main sales markets, such as Asia.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- Increased transportation costs linked to distance can have a significant impact on a company's export strategy, requiring adjustments in pricing, market strategy and the selection of trading partners.
- Delays in delivery during peak periods or holidays could lead to product deterioration, lower prices, missed sales opportunities and disruptions in market dynamics.
- For the cherry market product quality and timeliness are top considerations and more important than freight costs (as long as the freight cost is a competitive cost). This is a premium price high volume market. High speed Cherry Express shipping was a factor in the successful growth of the Asian Lunar New Year market, but does increase fuel consumption.
- Stakeholders state that it is not feasible to develop reefer systems or new cherry variants to prolong shelf life.

Table 7.9: SWOT analysis of Chile's commodities and their sensitivity to transport time changes.

Sensitivity to increased transport times as reported by the stakeholders	
Country: Chile Commodities: 4a Cherries, 4b Petroleum oils, 4c Lithium carbonate	
Strengths ➢ Petroleum fuels are unlikely to degrade with longer transport time. ➢ Growing season in Chile is winter for the northern hemisphere and aligns with major holidays (especially the Chinese Lunar New Year) ➢ Development of Cherry Express maritime services have enabled significant growth – second fastest growing fruit import to China. ➢ Large percent of cherry production in So. Hemisphere is from Chile; Chile dominates the market for cherries to Asia.	**Weaknesses** ➢ All 3 commodities demand timely arrivals for market, KPI or productivity reasons. ➢ Cherries are perishable and must arrive in perfect condition before the Chinese New Year holiday, which changes in dates every year. Shipments made close to the holiday are particularly impacted by any delays in transit time. ➢ Additional transport time impacts the condition of the product and the market demand. Chile is in the global south. The main markets and suppliers for all three commodities are located far from Chile. Thus, Chile has longer shipping distances to markets (Asia, Europe) vs some potential competitors.
Opportunities to adapt/mitigate ➢ Lower vessel speed should reduce fuel consumption. ➢ Cherry color is attractive to many cultures, and expanded markets could expand acceptable delivery dates. However no other market can absorb the volumes that China imparts and pay the price that China pays. Cherry producers have developed a range of techniques to adapt to the changing dates of the Lunar New Year (which are known well in advance). ➢ Evaluate restrictions that could interfere with vessel and port implementation of IMO MTM, or prevent port development or flexibility in operations.	**Threats** ➢ IMO GHG criteria may increase shipping costs more for shippers with longer distance to market than some potential competitors. ➢ In the case of cherries, longer shipping times could negatively affect the delivery time of the product to our customer in a specific celebration period (Chinese New Year) and will affect the quality and condition of the fruit. ➢ Chinese New Year date changes yearly. ➢ El Niño periodic storms may impact production or shipping for all producing countries in some years. Last year China was the only market that did not decrease due to this effect. In the case of lithium materials, longer shipping times could negatively affect the delivery time of the product to customers, reducing the time he can store and dispose of his cargo. ➢ Fuel suppliers say that in Chile most marine fuel terminals can only receive tankers MR2 (and it is not possible to make modifications or develop new terminals due to the current restrictions). ➢ For future fuels implementation, there would be a risk of delay if the vessels had to load bunkers before arriving in Chile and this was not foreseen from the beginning.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- Commodities may be time-sensitive for a variety of reasons – product degradation, customer demands (KPIs, production efficiency, seasonal demand), market forces and costs. This was well demonstrated by Chile's chosen commodities.
- For perishable fruits (cherries), development of dedicated Cherry Express maritime services helped enabled significant growth. This specialty service is organized around Chinese New Year's changing dates and cherry ripening.
- Longer shipping times for Lithium materials could negatively affect the delivery time of the product to our customer and the time he can store and dispose of his cargo. This could cause a loss of competitiveness with other companies located closer to the main sales markets, such as Asia.

Another insight to these stakeholders' awareness of and engagement in the decarbonization of shipping is the breadth of their responses to the final open-ended question "What questions should we have asked to more fully understand the impacts of potential vessel greenhouse gas reduction requirements on shipping, your population and your economy?" The additional question topics stakeholders from Chile suggested ranged from supply chain resilience and technology solutions to impacts on human needs and affordability.

7.5 Findings

Quantitative findings

The key findings from the quantitative analysis include:

- Longer transit times from potential speed reduction range across the case studies, include:
  - Cherries
    - SR 10% - 2.5 days
    - SR 20% - 6 to 6.5 days
    - SR 30% - 10 to 11 days
  - Petroleum oils
    - SR 10% - just over 1.5 days
    - SR 20% - just under 4 days
    - SR 30% - just under 6.5 days
  - Lithium carbonate
    - SR 10% - just over 3 days
    - SR 20% - just under 7.5 days
    - SR 30% - nearly 13 days
- Total commodity cost intensity increases across all scenarios for cherries is nearly evenly split between speed reduction and MTM increase. Petroleum oils and lithium carbonate, the MTM commodity cost intensity changes dominate over the speed reduction commodity cost intensity changes.
- The *ad valorem* rates of the one imported essential good and two exported trade goods ranged between 5.7% to 8.9%.In 2030, for petroleum oils transported by chemical tankers, total commodity cost intensity increases as the higher speed reduction groups are reached, however, across all scenarios and speed reduction groups, the range is from just under 2% to just under 4% increases. For container ships transporting cherries, the commodity cost intensity across all scenarios and speed reduction groups ranges from 1% to nearly 8%, with the largest increases coming in the SR 30% group. For container ships moving lithium carbonate, scenario 46 is significant increase compared to the other scenarios. In addition, scenarios 31 and 32 are higher than scenarios 23 and 24.

- In 2040, In 2040, Note that in 2050, similar to 2040 cherries and petroleum oils have closely aligned commodity cost intensity increase across all scenarios and speed reduction groups until SR 30%, in which there is a pronounce separation, nearly a doubling associated with the container ships transporting the cherries.
- In 2050, similar to 2040 cherries and petroleum oils have closely aligned commodity cost intensity increase across all scenarios and speed reduction groups through SR 20%. At SR 30% there is a pronounced separation—nearly a doubling of the increase associated with transporting cherries and lithium carbonate.
- Total commodity cost intensity ranges across all scenarios and speed reduction groups, include:
    - Cherries
        - 2030 – 0.81% to 7.42%, with an average of 2.96%
        - 2040 – 2.84% to 7.97%, with an average of 4.81%
        - 2050 – 3.74% to 7.86%, with an average of 5.22%
    - Petroleum oils
        - 2030 – 1.06% to 3.67%, with an average of 1.91%
        - 2040 – 2.51% to 4.68%, with an average of 3.28%
        - 2050 – 3.26% to 4.93%, with an average of 4.93%
    - Lithium carbonate
        - 2030 – 0.55% to 14.52%, with an average of 4.85%
        - 2040 – 9.91% to 19.23%, with an average of 13.42%
        - 2050 – 7.73% to 14.35%, with an average of 10.21%
- TCCImtm findings for the three commodity case studies across all scenarios and speed reduction groups, by forecasted year:
    - 2030 0.55% to 14.52%, with an average of 3.20%
    - 2040 2.51% to 19.23%, with an average of 7.17%
    - 2050 3.26% to 14.35%, with an average of 6.43%

Qualitative findings

Chile selected three commodities covering the full range of time sensitivities: Cherries (perishable and delivery date sensitive), Lithium carbonate (relatively stable) and fuel oils (do not deteriorate but have other timing demands and are carried in tankers that call ports limited to specific vessel sizes and designs). While time and cost sensitivities varied by commodity, Chile's Stakeholders who participated in the qualitative analysis shared common concerns for vessel speed or capacity reductions, efficient and timely deliveries and increased costs.

Commodities may be time-sensitive for a variety of reasons – product degradation, customer demands (KPIs, production efficiency, seasonal demand), market forces, and costs. For all three commodities selected by Chile, the main suppliers are located far from Chile, and timely delivery is important.

Chile's stakeholders reported that the effectiveness and efficiency of transport is of paramount importance for all three commodities.

Vessel speed reduction would aggravate geographic disadvantage and worsen competitivity because of longer lead times and potentially more expensive freight costs.

Slower transit times for all commodities would mean increased costs to consumers.

Chile is located in the global south and has significant production of mineral resources, intermediates, and agriculturals.

Opportunities to mitigate impacts include a range of approaches recommended by the stakeholders from Chile:

- Costs:
  - Stakeholders state that it is not feasible to develop reefer systems or new cherry variants to prolong shelf life.
  - South American markets already receive fruit not suitable for the Asian market, but do not have the premium pricing seen in the Asian market.
  - Trade agreements are in place for most cherries markets and can play a role in mitigating these costs.
- Longer transport times:
  - Lower vessel speed should reduce fuel consumption.
  - Cherry color is attractive to many cultures, and expanded markets could expand acceptable delivery dates. However no other market can absorb the volumes that China imparts and pay the price that China pays. Cherry producers have developed a range of techniques to adapt to the changing dates of the Lunar New Year (which are known well in advance).
  - Evaluate restrictions that could interfere with vessel and port implementation of IMO MTM, or prevent port development or flexibility in operations.

Summary of key points related to potential impacts

The following points are key to understanding the potential impacts of the MTM:

- In 2022, Chile's GDP was $300,686 million and it's GDP per capita was $15,339.
- The three commodities selected by Chile for case studies include the trade commodity exports of cherries and lithium carbonate, both to China, and the essential goods imports of petroleum oils from the US.
- Since cherries and lithium carbonate are exported trade commodities, cost increases impact the sector/subsector of the economy associated with each commodity. In addition, the associated employment, supporting industries, and taxes and revenues associated with the commodity will be impacted.
- According to the Central Bank of Chile, the agricultural sector in Chile, which includes cherries, accounts for a 4.31% share of the total country's GDP. The Commerce sector, where petroleum oils are grouped, accounts for a 9.2% share; and the mining sector that includes lithium carbonate makes up an 8.9% share of the country's GDP. Cherries exports represent 2.46% of total Chilean exports (in value terms), while lithium carbonate 4.32%. Petroleum oils share 6.35% of total Chilean imports.

- For these three case studies, the estimates indicate a range of commodity cost intensity increases related to maritime transport. Across all three trade commodities in 2030, Scenarios 23/24 estimate generally lower cost increases compared to Scenarios 31/32, while Scenario 46 bring forward significant cost increases seen in the other scenarios in 2040 and 2050. Lithium carbonate is the most sensitive to Scenario 46 in 2030. In 2040 and 2050 differences between the scenarios close, with lithium still significantly higher than the other two commodities due to its sensitivity to ship-side cost increases.
- Since imports of petroleum oils from the US are essential goods, the impacts from delays weigh more heavily due to GDP, limited population and infrastructure to provide economies of scale, extremely limited disposal incomes to absorb cost increases, limited alternative transportation options to import essential goods, and the country's remoteness to key trading partners.
- Since the cherries and lithium carbonate case studies represent export trade commodities only on particular routes, the entire economic sector/subsector is not captured. The full impact on the entire sector/subsector would need to be considered by the Member State and their national stakeholders to determine impacts to GDP, employment, and any collateral impacts on supporting industries. That being said, cherries make up approximately 8% of the Chilean GDP, so cost impacts to cherries will have ripple effects across greater Chile.

8 Stakeholders' analysis – Cook Islands

The Stakeholder Assessment for the Cook Islands focuses on imports of miscellaneous edible preparations; pharmaceutical goods; fuels (LPG); articles of iron and steel; edible vegetables and certain roots and tubers; electrical machinery and equipment; meat & edible meat offal; dairy produce, birds eggs, natural honey and edible products of animal origin (honey+); and products of the milling industry.

8.1 Geography, population, and economy

Geography

The Cook Islands is a Polynesian island nation and Small Island Developing State (SIDS) located midway between French Polynesia and Fiji in the South Pacific, shown in Figure 8.1.[97] It is comprised of 15 islands with a total land area of about 240 km^2 scattered over 2.2 million km^2 of the Pacific Ocean. The Cook Islands is broadly divided into the Southern Group, and Northern Group (also known as the Pa Enua or Outer Islands) with Rarotonga recognized as the main island and administrative center. The two island groups are markedly different in their social, cultural and economic activities and are separated by over 1,000 km. The Northern Group remains relatively isolated from the Southern Group with infrequent and expensive transportation links. The Cook Islands is a self-governing country in free association with New Zealand.[98]

Figure 8.1: Map of the Cook Islands



Source: Government of the Cook Islands, *Census of Population and Dwellings 2021*, CISO.

The Cook Island's remote geography places the islands away from major trade routes, creating a significant distance from where essential goods are sourced, and the primary transportation mode is by sea. Representative distances to markets for the selected commodities are presented in Section 8.2. Air transport is expensive and used sparingly. The closest main export hub for the islands is

[97] Map from: Government of the Cook Islands, *Census of Population and Dwellings 2021*, CISO.
[98] Government of the Cook Islands*, Cook Islands Economic Development Strategy 2030,* MFEM.

Auckland, New Zealand, which is some 1,600+ nautical miles (nm) or nearly 3,000 km to the south-southwest.

The Southern Group of islands receives most imported international goods primarily in Rarotonga. Two to three small general cargo ships serve two islands of the Southern Group with international links on a loop based out of Auckland, New Zealand. Both ports are limited: Rarotonga's port has limited ship accessibility due to the narrow entrance through the reef and small harbor. The only other island that takes international cargoes is Aitutaki which is some 140 nm or 260 km north of Rarotonga. Ships to Aitutaki must transload to a barge outside the reef as they cannot access the island directly. Schedules are delayed at both ports when rough weather prevents ships from passing through the reef in Rarotonga or from transloading in Aitutaki, pushing arrivals back.

The Northern Group lies 540 to 740 nm or 1,000 to 1,365 km north of Rarotonga and is served by aged domestic vessels operating on variable schedules. Delays and costs of imported essential goods to the Southern Group are magnified when considering the distribution of those essential goods to the Northern Group.

Population

The 2021 Population Census indicated that the resident population of the Cook Islands was 15,040, of which 85% are Cook Islands Māori or part Cook Islands Māori. Nearly 72% of the population lives on Rarotonga, 20% in the Southern Group beyond Rarotonga, and 7% in the Northern Group. The total population has been declining since the 1970s. The tourist trade stopped in March 2020 due to the Covid-19 pandemic and associated jobs disappeared. There has been strong migration out of the Cook Islands through 2021 to primarily New Zealand where they are seeking employment in the meat packing and fruit picking/packaging industries,[99] and some migrating further on, to Australia to work in the mines.

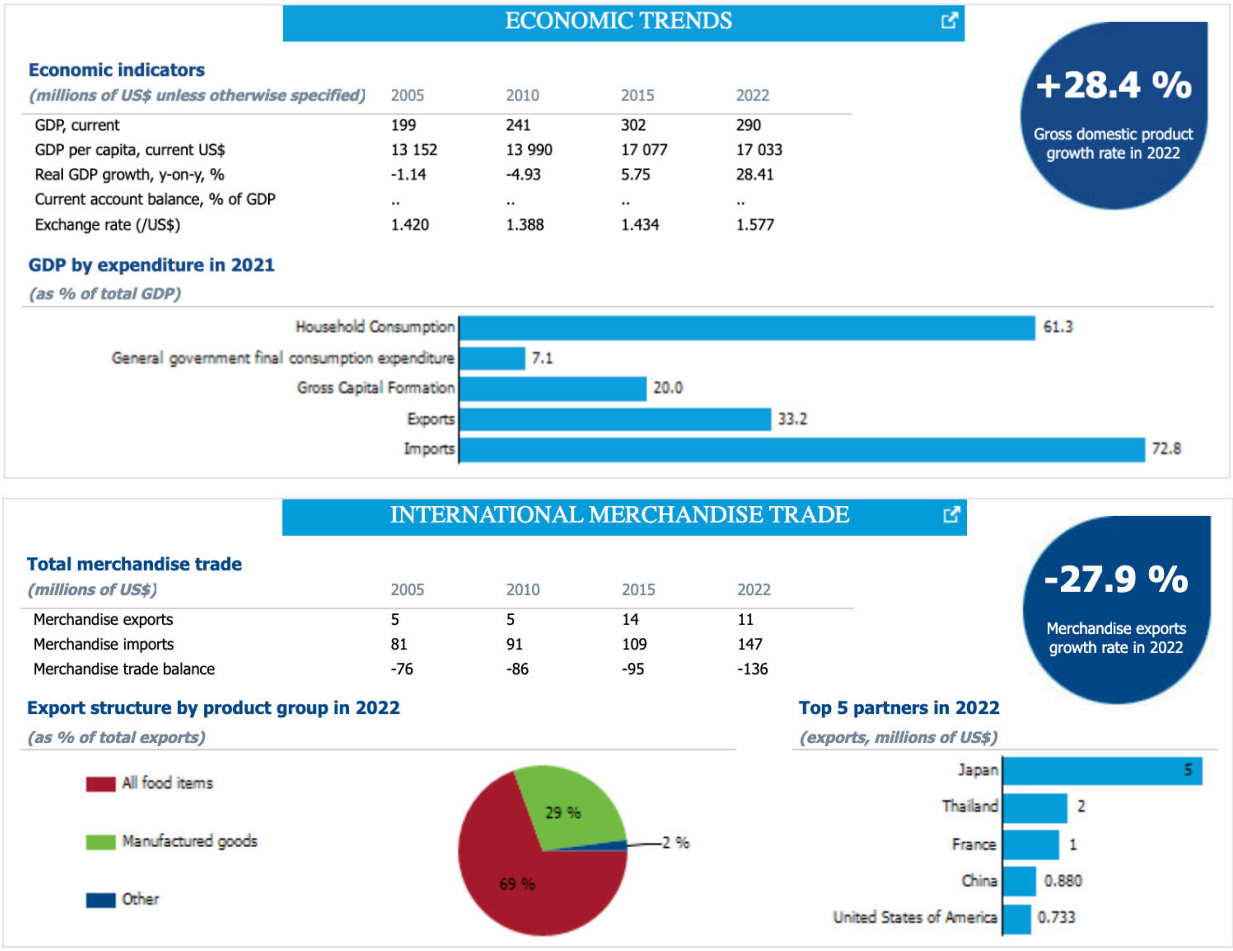
Economy

The Cook Islands is a small, open economy dependent on the import of essentials good and whose economic growth is heavily reliant on the export of services to a number of key partner countries: Japan, New Zealand, and the United States of America in particular. Tourism accounts for around 60% of the GDP and drives other industries like construction which ranges from essential infrastructure to various tourist accommodation construction (including holiday homes). With a limited tourism sector, the other Southern Group islands rely more on subsistence agriculture and fishing than Rarotonga does, while the Northern Group's largely subsistence economy is driven by fisheries, limited mariculture (pearls) and handicrafts. Key economic indicators are shown on the next page in Table 8.2.[100]

As described by the Member State, "As we are at the end of a long supply chain, with imports constituting the majority of our consumption, any increase in costs will have a compounding effect. This is especially concerning considering the already high cost of goods and visitor complaints about the cost of goods and services. For a country whose economy relies largely on Tourism, further inflation could severely impact our market. The negative flow on effects could cripple critical sectors i.e. healthcare, education and lead to an increase in the number of people leaving the island for better paid work and a lower cost of living."[101]

[99] Cook Islands News, Article: *People are Leaving the country and not coming back,* 20 February 2021, Caleb Fotheringham.
[100] UNCTAD, General and Maritime Profiles: Cook Islands, *UNCTAD Statistics - General Profile*.
[101] Email with Sandria Thondoo, Director of Multilaterals, Ocean and Treaties Division, Ministry of Foreign Affairs & Immigration, Government of Cook Islands.

Figure 8.2: Key economic indicators for Cook Islands



UNCTAD, General and Maritime Profiles: Cook Islands, *UNCTAD Statistics - General Profile*.

The Covid-19 pandemic set the country's economy back and caused significant drops in GDP for the years 2020 and 2021. With travel restrictions uplifted and borders opening the country is now slowly returning to normal.[102] The GDP of the Cook Islands in 2022 reached $290 million, with total exports in the month of February 2024 reaching $17 thousands, and total imports exceeding $14 million in the same month. The total revenue from these imports generated $2.5 million.[103]

8.2 Identified commodities and routes studied

In the first CIA, nine commodities classed as essential goods were selected for analysis. Due to the country's heavy reliance on imports, these commodities experience high consumption rates to meet the population's needs.

For the current Cook Islands case studies, the same essentials goods are included, focusing on imports of miscellaneous edible preparations; pharmaceutical goods; fuels (LPG); articles of iron and steel; edible vegetables, certain roots, and tubers; electrical machinery and equipment; meat & edible meat offal; dairy produce, birds eggs, natural honey+; and products of the milling industry, etc.

[102] Government of the Cook Islands, *Census of Population and Dwellings 2021 - 2022*, CISO.
[103] Government of the Cook Islands, *International Merchandised Trade Statistics*, CISO.

The commodities selected by the Member State for focus and illustrative trade routes selected are shown in Table 8.1. All commodities selected for this study are imported essential goods.

Table 8.1: Shipping distances to and from Cook Islands for selected commodities

Case Study	Commodity	Illustrative identified routes, by country	Ship Type(s)	Route Distance Range, nm min	avg	max	Stops
5a	Miscellaneous edible preparations	The Netherlands --> Singapore --> Fiji --> Samoa --> Cook Islands The Netherlands --> Singapore --> Fiji --> Samoa --> Niue --> Cook Islands The Netherlands --> Singapore --> Fiji --> Samoa --> Tonga --> Cook Islands	Container & General cargo	14,516	15,436	20,689	4-5
5b 5d 5e 5f 5h 5i	Pharmaceutical goods Articles of iron and steel Edible vegetables, certain roots, & tubers Electrical machinery & equip Dairy produce, birds eggs, natural honey+ Products of the milling industry, etc.	New Zealand --> Fiji --> Samoa --> Cook Islands New Zealand --> Fiji --> Samoa --> Niue --> Cook Islands New Zealand --> Fiji --> Samoa --> Tonga --> Cook Islands New Zealand --> Samoa --> Tonga --> Cook Islands New Zealand --> Tonga --> Fiji --> Samoa --> Niue --> Cook Islands	General cargo	2,567	2,821	3,356	3-5
5c	Fuels (LPG)	Austrailia --> Cook Island Australia --> Fiji --> New Caledonia --> Tahiti --> Cook Island Australia --> Tahiti --> Cook Island	LPG tanker	2,651	4,418	6,875	1-4
5g	Meat & edible meat offal	**Long haul routes** United States --> Fiji United States --> Samoa **Regional direct routes** Fiji --> Cook Islands Somoa --> Cook Islands **Regional indirect routes** Fiji --> Samoa --> Cook Islands Samoa --> Fiji --> Cook Islands	Container & General cargo	6,058	7,174	9,198	2-4

8.3 Quantitative analysis

This section presents the quantitative analysis summary results and is organized by fleet analysis summary, total commodity cost intensity changes from speed reduction, Task 2 cost intensity changes due to MTM, total commodity cost intensity impacts, and GDP contexts. The quantitative analysis incorporates the findings of Task 2 related to the selected bracketing MTM scenarios as presented below:[104]

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination: Policy code	GFI scope	GFI flexibility: RU % of price	SU % of price	Levy: Levy USD/tCO_2eq	Levy: Reward % of cost gap	Feebate Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

The detailed approach for the below analyses is provided in Appendix A.

[104] DNV 2024

Fleet analysis summary

As part of the fleet analysis, routes and ship characteristics were identified for each case study. For the specific ship types identified with the case study and transiting on the identified route the following were averaged to represent the fleet:

- Ship type and size
- Number of transits identified
- Route distances from 2022 AIS were transit-weighted averaged to determine minimum, average, and maximum distance sailed
- Transit-weighted average year of build, which was used to determine the average age in years

These characteristics for the case studies are presented in Table 8.2.

Table 8.2: Cook Islands – Fleet characteristics, by case study

Case Study	Commodity	2022 Transits	Ship Type(s)	Route Distance Range, nm min	avg	max	Avg Build
5a	Miscellaneous edible preparations	**Long haul route**					
		17	Container 8,000-11,999 teu	8,598	**9,056**	9,203	2008
		12	Container 12,000-14,499 teu	8,388	**8,758**	9,326	2012
		30	Container 14,500-19,999 teu	8,306	**8,467**	9,362	2015
		43	Container 20,000+ teu	8,377	**8,516**	11,909	2019
		Regional route					
		12	Container 2,000-2,999 teu	4,792	**5,059**	5,504	2013
		15	General cargo 5,000-9,999 dwt	1,418	**1,672**	2,257	2006
5b	Pharmaceutical goods						
5d	Articles of iron and steel						
5e	Edible vegetables, certain roots, & tubers	23	General cargo 5,000-9,999 dwt	2,567	**2,821**	3,356	2006
5f	Electrical machinery & equip						
5h	Dairy produce, birds eggs, natural honey+						
5i	Products of the milling industry, etc.						
5c	Fuels (LPG)	4	Liquefied gas tanker 0-49,999 cbm	3,683	**5,117**	6,875	2006
5g	Meat & edible meat offal	**Long haul routes**					
		14	Container 1,000-1,999 teu	4,932	**5,592**	6,803	2013
		Regional direct/indirect routes					
		5	General cargo 5,000-9,999 dwt	1,442	**1,530**	1,625	2006
		8	General cargo 5,000-9,999 dwt	807	**832**	900	2006
		2	Container 0 - 999 teu	820	**869**	918	2018
		10	Container 1,000-1,999 teu	638	**722**	908	2014
		12	General cargo 5,000-9,999 dwt	806	**1,315**	2,257	2006

In addition, transit weighted average speeds and average route times were estimated and the APEC Module 1 was used to estimate the longer transit times associated with the speed reduction groups of 10%, 20%, and 30%, as presented in Table 8.3.

Table 8.3: Average route distance, speed, & longer transit times by speed reduction group

Country	Case Study	Commodity	Transits	Ship type & size	Avg Route Distance (nm)	Avg Route Speed (knots)	Avg Route Time (hours)	SR 10% Delay Delta (days)	SR 20% Delay Delta (days)	SR 30% Delay Delta (days)
Cook Islands	5a	Miscellaneous edible preparations	17	Container 8,000-11,999 teu	9,056	17.0	534	2.5	5.6	9.5
			12	Container 12,000-14,499 teu	8,758	15.3	572	2.6	6.0	10.2
			30	Container 14,500-19,999 teu	8,467	17.2	493	2.3	5.1	8.8
			43	Container 20,000+ teu	8,516	17.1	498	2.3	5.2	8.9
			12	Container 2,000-2,999 teu	5,049	15.4	328	1.5	3.4	5.9
			15	General cargo 5,000-9,999 dwt	1,672	11.0	152	0.7	1.6	2.7
	5b	Pharmaceutical goods	23	General cargo 5,000-9,999 dwt	2,821	11.1	255	1.2	2.7	4.6
	5c	Fuels (LPG)	4	Liquified gas tanker 0-49,999 cbm	5,117	10.4	491	2.3	5.1	8.8
	5d	Articles of iron and steel	23	General cargo 5,000-9,999 dwt	2,821	11.1	255	1.2	2.7	4.6
	5e	Edible vegetables, certain roots, & tubers	23	General cargo 5,000-9,999 dwt	2,821	11.1	255	1.2	2.7	4.6
	5f	Electrical machinery & equip	23	General cargo 5,000-9,999 dwt	2,821	11.1	255	1.2	2.7	4.6
	5g	Meat & edible meat offal	14	Container 1,000-1,999 teu	5,592	14.7	381	1.8	4.0	6.8
			8	General cargo 5,000-9,999 dwt	832	10.8	77	0.4	0.8	1.4
			5	General cargo 5,000-9,999 dwt	1,530	10.6	145	0.7	1.5	2.6
			2	Container 0 - 999 teu	869	12.3	70	0.3	0.7	1.3
			10	Container 1,000-1,999 teu	722	13.9	52	0.2	0.5	0.9
			12	General cargo 5,000-9,999 dwt	1,315	10.4	126	0.6	1.3	2.2
	5h	Dairy produce, birds eggs, natural honey	23	General cargo 5,000-9,999 dwt	2,821	11.1	255	1.2	2.7	4.6
	5i	Products of the milling industry, etc.	23	General cargo 5,000-9,999 dwt	2,821	11.1	255	1.2	2.7	4.6

In 2022, most of the imported essential goods came via two general cargo ships that brought goods via container. These ships are connected with all the commodity case studies either as the primary transport or the last leg transport to Cook Islands, with the exception of 5c, which is a liquid propane gas (LPG) tanker. Based on the Marine Benchmark data, presented in Table 8.3, these ships travel an average voyage speed of 11.1 knots. Note that in CIA STM, these same general cargo ships had an average voyage speed of 12.4 knots. Based on that information, the average voyage SR 10% speed would be 10.0 knots, the average voyage SR 20% speed would be 8.9 knots, and the average voyage SR 30% would be 7.7 knots. With an average rated speed of 15 knots, the potential benefit from additional speed reduction beyond SR 10% is limited. Similarly, the LPG tanker had an average voyage speed of 10.4 knots. Additional voyage speed reduction would have limited benefits.

Note that there are two commodities that require multiple legs to reach the Cook Islands. For case study 5a, large container ships come from The Netherlands to Singapore on a long-haul route, where the containers are transloaded to smaller Pacific regional ships that travel on a regional route to Fiji where the cargo is again transloaded for distribution to the Cook Islands. For case study 5g, small to medium sized container ships leave the United States west coast and arrive in Hawaii on a long-haul route, where containers are transloaded onto small container ships that go to either Fiji or Samoa where they are transloaded for distribution to the Cook Islands on either a regional direct or regional indirect route.

Total commodity cost intensity changes due to speed reduction

APEC Module 2 was used to estimate the commodity cost intensity increases due to potentially longer transit times resulting from the three speed reduction groups. The module estimates the daily cost increases, in percentage, associated with the following:

- Finance/interest costs - the financial cost of capital invested in inventory over time. This measures the impact of each hour or day of delay on the cost of the product due to cost of money or interest rate. A Member State rate was used when provided, otherwise, it was assumed to be 5%.[105] The rate provided by the Cook Islands was 10% for all commodities under evaluation.

[105] Lending Tree, *Assuming a line of credit 5%*.

- Depreciation costs - the cost allocation of a commodity, or reduction of the commodity value, over its useful life. For this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry bulk cargo.[106]
- Insurance costs - a cost paid by the cargo owner to protect their goods while in transit. The percentage used in the economic analysis is the one provided by the Member State. If the Member State did not provide data, we assumed it to be 2%.[107] Cook Islands provided insurance cost rates of 1% for all commodities under evaluation.

The total commodity cost intensity change related to the three speed reduction groups for the case studies is presented in Table 8.4. Note that these values remain constant across scenarios and forecasted year.

Table 8.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Commodity-side Task 4 TCCIsr Change, % SR 10%	SR 20%	SR 30%
Cook Islands	5a	Miscellaneous edible preparations	17	Container 8,000-11,999 teu	16	0.20%	1.02%	2.99%
			12	Container 12,000-14,499 teu	11	0.23%	1.17%	3.43%
			30	Container 14,500-19,999 teu	8	0.17%	0.87%	2.54%
			43	Container 20,000+ teu	4	0.17%	0.89%	2.60%
			12	Container 2,000-2,999 teu	10	0.08%	0.38%	1.13%
			15	General cargo 5,000-9,999 dwt	17	0.02%	0.08%	0.24%
	5b	Pharmaceutical goods	23	General cargo 5,000-9,999 dwt	17	0.05%	0.23%	0.68%
	5c	Fuels (LPG)	4	Liquified gas tanker 0-49,999 cbm	17	0.17%	0.86%	2.52%
	5d	Articles of iron and steel	23	General cargo 5,000-9,999 dwt	17	0.05%	0.23%	0.68%
	5e	Edible vegetables, certain roots, & tub	23	General cargo 5,000-9,999 dwt	17	0.05%	0.23%	0.68%
	5f	Electrical machinery & equip	23	General cargo 5,000-9,999 dwt	17	0.05%	0.23%	0.68%
	5g	Meat & edible meat offal	14	Container 1,000-1,999 teu	9	0.10%	0.52%	1.52%
			8	General cargo 5,000-9,999 dwt	17	0.00%	0.02%	0.06%
			5	General cargo 5,000-9,999 dwt	11	0.01%	0.07%	0.22%
			2	Container 0 - 999 teu	10	0.00%	0.02%	0.05%
			10	Container 1,000-1,999 teu	10	0.00%	0.01%	0.03%
			12	General cargo 5,000-9,999 dwt	17	0.01%	0.06%	0.17%
	5h	Dairy produce, birds eggs, natural hone	23	General cargo 5,000-9,999 dwt	17	0.05%	0.23%	0.68%
	5i	Products of the milling industry, etc.	23	General cargo 5,000-9,999 dwt	17	0.05%	0.23%	0.68%

The commodity cost intensity changes due to speed reduction, ranges as follows:

- 5a – SR 10% negligible to 0.23%, SR 20% negligible to 1.17%, SR 30% 0.24% to 3.43%
- 5b – less than 1% across all speed reduction groups
- 5c – SR 10% less than 1%, SR 20% 0.86%, SR 30% 2.52%
- 5d – less than 1% across all speed reduction groups
- 5e – less than 1% across all speed reduction groups
- 5f – less than 1% across all speed reduction groups
- 5g – SR 10% negligible, SR 20% negligible to 0.52%, SR 30% negligible to 1.52%
- 5h – less than 1% across all speed reduction groups; note that delays of 2.7 to 4.5 days at SR 20% and SR 30%, respectively, could mean loss of product due to expiration
- 5i – less than 1% across all speed reduction groups

As noted above, there is limited benefits from speed reduction beyond SR 10%.

[106] APEC 2019
[107] APEC 2019

For commodities like eggs where shelf-life durations are very tight even delays related to SR 10% could render the product expired with full loss of value resulting in a country-wide shortage of eggs for the month, until the next ship call.

Task 2 cost intensity changes due to MTM

Based on the ship type, size, and age combination for each case study the applicable Task 2 ship-side commodity cost intensities due to the MTM were identified for the selected scenarios. In addition, in order to be able to add these to the commodity cost intensity changes due to speed reduction, the a*d valorem* freight rate percentage was identified using the UNCTAD Trade-and-Transport Dataset.[108] The *ad valorem* freight rate percentage represents the transportation cost percentage of a commodity's total cost. These factors were multiplied to get the freight rate adjusted commodity cost intensity or FRACCI change for 2030, 2040, and 2050. Task 2 cost intensity change and FRACCI for each scenario are presented in Table 8.5.

Table 8.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Cook Islands	5a	Miscellaneous edible preparations	17	Container 8,000-11,999 teu	16	9.1%	16.71%	64.48%	65.89%	1.52%	5.87%	6.00%
			12	Container 12,000-14,499 teu	11	9.1%	4.23%	76.22%	78.92%	0.38%	6.94%	7.18%
			30	Container 14,500-19,999 teu	8	9.1%	9.38%	44.67%	56.18%	0.85%	4.07%	5.11%
			43	Container 20,000+ teu	4	9.1%	15.45%	33.00%	45.42%	1.41%	3.00%	4.13%
			12	Container 2,000-2,999 teu	10	9.1%	30.91%	56.91%	75.55%	2.81%	5.18%	6.87%
			15	General cargo 5,000-9,999 dwt	17	9.1%	1.40%	60.20%	65.77%	0.13%	5.48%	5.99%
	5b	Pharmaceutical goods	23	General cargo 5,000-9,999 dwt	17	14.6%	1.40%	60.20%	65.77%	0.20%	8.79%	9.60%
	5c	Fuels (LPG)	4	Liquified gas tanker 0-49,999 cbm	17	7.5%	12.63%	34.60%	57.18%	0.95%	2.59%	4.29%
	5d	Articles of iron and steel	23	General cargo 5,000-9,999 dwt	17	17.8%	1.40%	60.20%	65.77%	0.25%	10.72%	11.71%
	5e	Edible vegetables, certain roots, & tub	23	General cargo 5,000-9,999 dwt	17	16.6%	1.40%	60.20%	65.77%	0.23%	9.99%	10.92%
	5f	Electrical machinery & equip	23	General cargo 5,000-9,999 dwt	17	17.0%	1.40%	60.20%	65.77%	0.24%	10.23%	11.18%
	5g	Meat & edible meat offal	14	Container 1,000-1,999 teu	9	9.0%	22.47%	60.61%	75.56%	2.02%	5.46%	6.80%
			8	General cargo 5,000-9,999 dwt	17	9.0%	1.40%	60.20%	65.77%	0.13%	5.42%	5.92%
			5	General cargo 5,000-9,999 dwt	11	9.0%	1.40%	60.20%	65.77%	0.13%	5.42%	5.92%
			2	Container 0 - 999 teu	10	9.0%	8.47%	52.63%	66.15%	0.76%	4.74%	5.95%
			10	Container 1,000-1,999 teu	10	9.0%	22.47%	60.61%	75.56%	2.02%	5.46%	6.80%
			12	General cargo 5,000-9,999 dwt	17	9.0%	1.40%	60.20%	65.77%	0.13%	5.42%	5.92%
	5h	Dairy produce, birds eggs, natural hone	23	General cargo 5,000-9,999 dwt	17	6.9%	1.40%	60.20%	65.77%	0.10%	4.15%	4.54%
	5i	Products of the milling industry, etc.	23	General cargo 5,000-9,999 dwt	17	13.1%	1.40%	60.20%	65.77%	0.18%	7.89%	8.62%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Cook Islands	5a	Miscellaneous edible preparations	17	Container 8,000-11,999 teu	16	9.1%	14.18%	44.40%	61.66%	1.29%	4.04%	5.61%
			12	Container 12,000-14,499 teu	11	9.1%	7.96%	61.14%	74.62%	0.72%	5.56%	6.79%
			30	Container 14,500-19,999 teu	8	9.1%	12.82%	42.67%	56.39%	1.17%	3.88%	5.13%
			43	Container 20,000+ teu	4	9.1%	20.92%	34.86%	44.12%	1.90%	3.17%	4.01%
			12	Container 2,000-2,999 teu	10	9.1%	36.86%	59.79%	76.26%	3.35%	5.44%	6.94%
			15	General cargo 5,000-9,999 dwt	17	9.1%	2.47%	47.92%	64.77%	0.22%	4.36%	5.89%
	5b	Pharmaceutical goods	23	General cargo 5,000-9,999 dwt	17	14.6%	2.47%	47.92%	64.77%	0.36%	7.00%	9.46%
	5c	Fuels (LPG)	4	Liquified gas tanker 0-49,999 cbm	17	7.5%	7.31%	31.07%	38.15%	0.55%	2.33%	2.86%
	5d	Articles of iron and steel	23	General cargo 5,000-9,999 dwt	17	17.8%	2.47%	47.92%	64.77%	0.44%	8.53%	11.53%
	5e	Edible vegetables, certain roots, & tub	23	General cargo 5,000-9,999 dwt	17	16.6%	2.47%	47.92%	64.77%	0.41%	7.95%	10.75%
	5f	Electrical machinery & equip	23	General cargo 5,000-9,999 dwt	17	17.0%	2.47%	47.92%	64.77%	0.42%	8.15%	11.01%
	5g	Meat & edible meat offal	14	Container 1,000-1,999 teu	9	9.0%	25.97%	58.52%	76.57%	2.34%	5.27%	6.89%
			8	General cargo 5,000-9,999 dwt	17	9.0%	2.47%	47.92%	64.77%	0.22%	4.31%	5.83%
			5	General cargo 5,000-9,999 dwt	11	9.0%	2.47%	47.92%	64.77%	0.22%	4.31%	5.83%
			2	Container 0 - 999 teu	10	9.0%	21.28%	54.36%	66.05%	1.92%	4.89%	5.94%
			10	Container 1,000-1,999 teu	10	9.0%	25.97%	58.52%	76.57%	2.34%	5.27%	6.89%
			12	General cargo 5,000-9,999 dwt	17	9.0%	2.47%	47.92%	64.77%	0.22%	4.31%	5.83%
	5h	Dairy produce, birds eggs, natural hone	23	General cargo 5,000-9,999 dwt	17	6.9%	2.47%	47.92%	64.77%	0.17%	3.31%	4.47%
	5i	Products of the milling industry, etc.	23	General cargo 5,000-9,999 dwt	17	13.1%	2.47%	47.92%	64.77%	0.32%	6.28%	8.48%

[108] UNCTAD, *Trade-and-Transport Dataset*.

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Cook Islands	5a	Miscellaneous edible preparations	17	Container 8,000-11,999 teu	16	9.1%	22.77%	47.01%	61.89%	2.07%	4.28%	5.63%
			12	Container 12,000-14,499 teu	11	9.1%	16.02%	61.94%	68.50%	1.46%	5.64%	6.23%
			30	Container 14,500-19,999 teu	8	9.1%	19.35%	38.43%	62.03%	1.76%	3.50%	5.64%
			43	Container 20,000+ teu	4	9.1%	16.64%	34.41%	51.94%	1.51%	3.13%	4.73%
			12	Container 2,000-2,999 teu	10	9.1%	27.40%	55.12%	82.50%	2.49%	5.02%	7.51%
			15	General cargo 5,000-9,999 dwt	17	9.1%	18.54%	44.76%	67.26%	1.69%	4.07%	6.12%
	5b	Pharmaceutical goods	23	General cargo 5,000-9,999 dwt	17	14.6%	18.54%	44.76%	67.26%	2.71%	6.53%	9.82%
	5c	Fuels (LPG)	4	Liquified gas tanker 0-49,999 cbm	17	7.5%	12.76%	31.39%	43.82%	0.96%	2.35%	3.29%
	5d	Articles of iron and steel	23	General cargo 5,000-9,999 dwt	17	17.8%	18.54%	44.76%	67.26%	3.30%	7.97%	11.97%
	5e	Edible vegetables, certain roots, & tub	23	General cargo 5,000-9,999 dwt	17	16.6%	18.54%	44.76%	67.26%	3.08%	7.43%	11.16%
	5f	Electrical machinery & equip	23	General cargo 5,000-9,999 dwt	17	17.0%	18.54%	44.76%	67.26%	3.15%	7.61%	11.43%
	5g	Meat & edible meat offal	14	Container 1,000-1,999 teu	9	9.0%	22.82%	54.69%	80.73%	2.05%	4.92%	7.27%
			8	General cargo 5,000-9,999 dwt	17	9.0%	18.54%	44.76%	67.26%	1.67%	4.03%	6.05%
			5	General cargo 5,000-9,999 dwt	17	9.0%	18.54%	44.76%	67.26%	1.67%	4.03%	6.05%
			2	Container 0 - 999 teu	10	9.0%	16.45%	48.83%	73.63%	1.48%	4.39%	6.63%
			10	Container 1,000-1,999 teu	10	9.0%	22.82%	54.69%	80.73%	2.05%	4.92%	7.27%
			12	General cargo 5,000-9,999 dwt	17	9.0%	18.54%	44.76%	67.26%	1.67%	4.03%	6.05%
	5h	Dairy produce, birds eggs, natural hone	23	General cargo 5,000-9,999 dwt	17	6.9%	18.54%	44.76%	67.26%	1.28%	3.09%	4.64%
	5i	Products of the milling industry, etc.	23	General cargo 5,000-9,999 dwt	17	13.1%	18.54%	44.76%	67.26%	2.43%	5.86%	8.81%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Cook Islands	5a	Miscellaneous edible preparations	17	Container 8,000-11,999 teu	16	9.1%	24.49%	51.22%	59.89%	2.23%	4.66%	5.45%
			12	Container 12,000-14,499 teu	11	9.1%	18.32%	63.71%	68.88%	1.67%	5.80%	6.27%
			30	Container 14,500-19,999 teu	8	9.1%	21.43%	40.74%	58.34%	1.95%	3.71%	5.31%
			43	Container 20,000+ teu	4	9.1%	23.78%	35.44%	47.24%	2.16%	3.22%	4.30%
			12	Container 2,000-2,999 teu	10	9.1%	27.68%	54.64%	79.89%	2.52%	4.97%	7.27%
			15	General cargo 5,000-9,999 dwt	17	9.1%	28.29%	47.30%	62.27%	2.57%	4.30%	5.67%
	5b	Pharmaceutical goods	23	General cargo 5,000-9,999 dwt	17	14.6%	28.29%	47.30%	62.27%	4.13%	6.91%	9.09%
	5c	Fuels (LPG)	4	Liquified gas tanker 0-49,999 cbm	17	7.5%	11.03%	32.39%	43.20%	0.83%	2.43%	3.24%
	5d	Articles of iron and steel	23	General cargo 5,000-9,999 dwt	17	17.8%	28.29%	47.30%	62.27%	5.04%	8.42%	11.08%
	5e	Edible vegetables, certain roots, & tub	23	General cargo 5,000-9,999 dwt	17	16.6%	28.29%	47.30%	62.27%	4.70%	7.85%	10.34%
	5f	Electrical machinery & equip	23	General cargo 5,000-9,999 dwt	17	17.0%	28.29%	47.30%	62.27%	4.81%	8.04%	10.59%
	5g	Meat & edible meat offal	14	Container 1,000-1,999 teu	9	9.0%	19.19%	55.19%	76.49%	1.73%	4.97%	6.88%
			8	General cargo 5,000-9,999 dwt	17	9.0%	28.29%	47.30%	62.27%	2.55%	4.26%	5.60%
			5	General cargo 5,000-9,999 dwt	11	9.0%	28.29%	47.30%	62.27%	2.55%	4.26%	5.60%
			2	Container 0 - 999 teu	10	9.0%	18.60%	47.82%	72.83%	1.67%	4.30%	6.55%
			10	Container 1,000-1,999 teu	10	9.0%	19.19%	55.19%	76.49%	1.73%	4.97%	6.88%
			12	General cargo 5,000-9,999 dwt	17	9.0%	28.29%	47.30%	62.27%	2.55%	4.26%	5.60%
	5h	Dairy produce, birds eggs, natural hone	23	General cargo 5,000-9,999 dwt	17	6.9%	28.29%	47.30%	62.27%	1.95%	3.26%	4.30%
	5i	Products of the milling industry, etc.	23	General cargo 5,000-9,999 dwt	17	13.1%	28.29%	47.30%	62.27%	3.71%	6.20%	8.16%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Cook Islands	5a	Miscellaneous edible preparations	17	Container 8,000-11,999 teu	16	9.1%	58.81%	67.01%	63.19%	5.35%	6.10%	5.75%
			12	Container 12,000-14,499 teu	11	9.1%	57.16%	85.14%	71.38%	5.20%	7.75%	6.50%
			30	Container 14,500-19,999 teu	8	9.1%	45.10%	58.21%	58.76%	4.10%	5.30%	5.35%
			43	Container 20,000+ teu	4	9.1%	40.01%	51.78%	44.50%	3.64%	4.71%	4.05%
			12	Container 2,000-2,999 teu	10	9.1%	50.52%	71.36%	77.40%	4.60%	6.49%	7.04%
			15	General cargo 5,000-9,999 dwt	17	9.1%	42.25%	50.00%	67.75%	3.85%	4.55%	6.17%
	5b	Pharmaceutical goods	23	General cargo 5,000-9,999 dwt	17	14.6%	42.25%	50.00%	67.75%	6.17%	7.30%	9.89%
	5c	Fuels (LPG)	4	Liquified gas tanker 0-49,999 cbm	17	7.5%	31.53%	37.65%	57.40%	2.36%	2.82%	4.30%
	5d	Articles of iron and steel	23	General cargo 5,000-9,999 dwt	17	17.8%	42.25%	50.00%	67.75%	7.52%	8.90%	12.06%
	5e	Edible vegetables, certain roots, & tub	23	General cargo 5,000-9,999 dwt	17	16.6%	42.25%	50.00%	67.75%	7.01%	8.30%	11.25%
	5f	Electrical machinery & equip	23	General cargo 5,000-9,999 dwt	17	17.0%	42.25%	50.00%	67.75%	7.18%	8.50%	11.52%
	5g	Meat & edible meat offal	14	Container 1,000-1,999 teu	9	9.0%	46.63%	71.86%	73.00%	4.20%	6.47%	6.57%
			8	General cargo 5,000-9,999 dwt	17	9.0%	42.25%	50.00%	67.75%	3.80%	4.50%	6.10%
			5	General cargo 5,000-9,999 dwt	11	9.0%	42.25%	50.00%	67.75%	3.80%	4.50%	6.10%
			2	Container 0 - 999 teu	10	9.0%	41.27%	64.98%	67.97%	3.71%	5.85%	6.12%
			10	Container 1,000-1,999 teu	10	9.0%	46.63%	71.86%	73.00%	4.20%	6.47%	6.57%
			12	General cargo 5,000-9,999 dwt	17	9.0%	42.25%	50.00%	67.75%	3.80%	4.50%	6.10%
	5h	Dairy produce, birds eggs, natural hone	23	General cargo 5,000-9,999 dwt	17	6.9%	42.25%	50.00%	67.75%	2.92%	3.45%	4.67%
	5i	Products of the milling industry, etc.	23	General cargo 5,000-9,999 dwt	17	13.1%	42.25%	50.00%	67.75%	5.54%	6.55%	8.88%

The *ad valorem* rates of the imported essential goods ranged from 6.9% to 17.8%, with an average of 10.6%. Note that UNCTAD does not have Cook Island specific *ad valorem* rates, and that the 6.9% to 9.1% rates appear lower than anticipated.

Note that there are differences in the business-as-usual (BAU) within the DNV model that was used for Task 2. As learned from our consultation with DNV, "…that ships in the model that called the European Union (EU), will have a higher BAU because of the EU's regulatory requirements. Ships not calling the EU will have a lower BAU, which implies that their changes in ship-side cost intensity should be higher for the forecasted years compared to those calling the EU and the average of the entire ship size, type, and age category."[109] The non-EU BAU was used for ships regionally servicing the Cook Islands, which includes all ship types except:

- Container 8,000-11,999 teu
- Container 12,000-14,499 teu
- Container 14,500-19,999 teu
- Container 20,000+ teu

For the ship type, size, and age combinations listed above, there were no EU BAU, so the aggregated BAU was used.

In further email correspondence with Task 2 Project Manager, Starcrest asked about the outputs for Cook Islands, he noted the following: "[looking] at 5c for scenario 46 and the large increase for container ships built in 2010-2019. What happens here is that these ships do not reduce that much (joining pools instead) and combined with a very high levy in 2040 (300 USD), this results in a 164% cost intensity increase. The newer ships reduce emissions more and the cost increase is less, although higher compared to other ship types, likely due to relatively higher fuel cost compared to other expenses."[110]

Further review into the relatively low Task 2 cost intensities based on the general cargo ship, size, and age range, Tore noted, "Looking into the profiles of the GC 5-10kdwt segment it looks like the ships operate closer to design speed compared to other segments. This means that there is a higher potential for energy efficiency and cost improvements (but not GHG intensity). But this is a very diverse segments of many different sub-types – from heavy load carriers, small bulk carriers and container vessels with some GC carrying capability. Matson's GC vessels are in many aspects more similar to container ships (0-999 teu). The GC 5-10k dwt segment's average design speed is about 12 knots. The average design speed of container ships (0-999 teu) is 16 knots. Matsons vessels operating on these routes are 15-16 knots [less than 999 teus]. It also looks like Matson's vessel already operate at closer to 12-13 knots and the additional speed reduction potential is not that great."[111]

A further review was made of the cost intensity increases from the suggested very small container ships (0-999 teu) group, noted above. These showed a higher impact, which for two ships operating in the Pacific, seemed more anticipated.[112] The results presented in this report are based on the impacts on the applicable very small container ship grouping.

Because these two ships also service Tonga, the change was made there as well to keep the two stakeholder analyses consistent.

[109] Email exchange with Tore Longa, Project Manager Task 2, 17 June 2024.
[110] Email exchange with Tore Longa, Project Manager Task 2, 5 July 2024.
[111] Email exchange with Tore Longa, Project Manager Task 2, 13 July 2024
[112] Email exchange with Tore Longa, Project Manager Task 2, 14 July 2024

Total commodity cost intensity due to speed reduction and MTM

For each commodity case study, combining Task 2 and Task 4 results estimates the total commodity cost intensity[113] associated with potential speed reduction and the MTM ($TCCI_{mtm}$), for the forecasted years of 2030, 2040, and 2050, as presented in Table 8.6, on the following page. For each commodity case study, the results were compiled into a transit-weighted average for each scenario and forecasted year. These results are presented in Table 8.7.

[113] The term 'total commodity cost intensity' as used in this report is defined as the total 'landed cost' of the commodity.

Table 8.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Cook Islands	5a	Miscellaneous edible preparations	17 Container 8,000-11,999 teu	16	1.52%	1.72%	2.54%	4.51%	5.87%	6.07%	6.88%	8.85%	6.00%	6.20%	7.01%	8.98%
			12 Container 12,000-14,499 teu	11	0.38%	0.61%	1.55%	3.81%	6.94%	7.17%	8.10%	10.36%	7.18%	7.41%	8.35%	10.61%
			30 Container 14,500-19,999 teu	8	0.85%	1.02%	1.72%	3.40%	4.07%	4.24%	4.93%	6.61%	5.11%	5.28%	5.98%	7.65%
			43 Container 20,000+ teu	4	1.41%	1.58%	2.29%	4.01%	3.00%	3.18%	3.89%	5.60%	4.13%	4.31%	5.02%	6.73%
			12 Container 2,000-2,999 teu	10	2.81%	2.89%	3.20%	3.94%	5.18%	5.25%	5.56%	6.31%	6.87%	6.95%	7.26%	8.00%
			15 General cargo 5,000-9,999 dwt	17	0.13%	0.14%	0.21%	0.37%	5.48%	5.49%	5.56%	5.72%	5.99%	6.00%	6.07%	6.23%
	5b	Pharmaceutical goods	23 General cargo 5,000-9,999 dwt	17	0.20%	0.25%	0.44%	0.88%	8.79%	8.83%	9.02%	9.47%	9.60%	9.65%	9.83%	10.28%
	5c	Fuels (LPG)	4 Liquified gas tanker 0-49,999 cbm	17	0.95%	1.12%	1.81%	3.47%	2.59%	2.76%	3.45%	5.12%	4.29%	4.46%	5.15%	6.81%
	5d	Articles of iron and steel	23 General cargo 5,000-9,999 dwt	17	0.25%	0.29%	0.48%	0.93%	10.72%	10.76%	10.95%	11.40%	11.71%	11.75%	11.94%	12.39%
	5e	Edible vegetables, certain roots, & tub	23 General cargo 5,000-9,999 dwt	17	0.23%	0.28%	0.46%	0.91%	9.99%	10.04%	10.22%	10.67%	10.92%	10.96%	11.15%	11.60%
	5f	Electrical machinery & equip	23 General cargo 5,000-9,999 dwt	17	0.24%	0.28%	0.47%	0.92%	10.23%	10.28%	10.47%	10.91%	11.18%	11.23%	11.41%	11.86%
	5g	Meat & edible meat offal	14 Container 1,000-1,999 teu	9	2.02%	2.12%	2.54%	3.54%	5.46%	5.56%	5.97%	6.98%	6.80%	6.90%	7.32%	8.32%
			8 General cargo 5,000-9,999 dwt	17	0.13%	0.13%	0.15%	0.19%	5.42%	5.42%	5.44%	5.48%	5.92%	5.92%	5.94%	5.98%
			5 General cargo 5,000-9,999 dwt	11	0.13%	0.14%	0.20%	0.35%	5.42%	5.43%	5.49%	5.64%	5.92%	5.93%	5.99%	6.14%
			2 Container 0 - 999 teu	10	0.76%	0.77%	0.78%	0.81%	4.74%	4.74%	4.75%	4.79%	5.95%	5.96%	5.97%	6.01%
			10 Container 1,000-1,999 teu	10	2.02%	2.02%	2.03%	2.05%	5.46%	5.46%	5.46%	5.48%	6.80%	6.80%	6.81%	6.83%
			12 General cargo 5,000-9,999 dwt	17	0.13%	0.14%	0.18%	0.29%	5.42%	5.43%	5.47%	5.58%	5.92%	5.93%	5.98%	6.09%
	5h	Dairy produce, birds eggs, natural hone	23 General cargo 5,000-9,999 dwt	17	0.10%	0.14%	0.33%	0.78%	4.15%	4.20%	4.39%	4.83%	4.54%	4.58%	4.77%	5.22%
	5i	Products of the milling industry, etc.	23 General cargo 5,000-9,999 dwt	17	0.18%	0.23%	0.41%	0.86%	7.89%	7.93%	8.12%	8.57%	8.62%	8.66%	8.85%	9.30%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Cook Islands	5a	Miscellaneous edible preparations	17 Container 8,000-11,999 teu	16	1.29%	1.49%	2.31%	4.28%	4.04%	4.24%	5.06%	7.03%	5.61%	5.81%	6.63%	8.60%
			12 Container 12,000-14,499 teu	11	0.72%	0.95%	1.89%	4.15%	5.56%	5.79%	6.73%	8.99%	6.79%	7.02%	7.96%	10.22%
			30 Container 14,500-19,999 teu	8	1.17%	1.34%	2.03%	3.71%	3.88%	4.05%	4.75%	6.43%	5.13%	5.30%	6.00%	7.67%
			43 Container 20,000+ teu	4	1.90%	2.08%	2.79%	4.50%	3.17%	3.35%	4.06%	5.77%	4.01%	4.19%	4.90%	6.62%
			12 Container 2,000-2,999 teu	10	3.35%	3.43%	3.74%	4.48%	5.44%	5.52%	5.82%	6.57%	6.94%	7.02%	7.32%	8.07%
			15 General cargo 5,000-9,999 dwt	17	0.22%	0.24%	0.31%	0.47%	4.36%	4.38%	4.44%	4.60%	5.89%	5.91%	5.98%	6.13%
	5b	Pharmaceutical goods	23 General cargo 5,000-9,999 dwt	17	0.36%	0.41%	0.59%	1.04%	7.00%	7.04%	7.23%	7.68%	9.46%	9.50%	9.69%	10.14%
	5c	Fuels (LPG)	4 Liquified gas tanker 0-49,999 cbm	17	0.55%	0.72%	1.41%	3.07%	2.33%	2.50%	3.19%	4.85%	2.86%	3.03%	3.72%	5.38%
	5d	Articles of iron and steel	23 General cargo 5,000-9,999 dwt	17	0.44%	0.49%	0.67%	1.12%	8.53%	8.58%	8.76%	9.21%	11.53%	11.57%	11.76%	12.21%
	5e	Edible vegetables, certain roots, & tub	23 General cargo 5,000-9,999 dwt	17	0.41%	0.46%	0.64%	1.09%	7.95%	8.00%	8.19%	8.63%	10.75%	10.80%	10.98%	11.43%
	5f	Electrical machinery & equip	23 General cargo 5,000-9,999 dwt	17	0.42%	0.47%	0.65%	1.10%	8.15%	8.19%	8.38%	8.83%	11.01%	11.06%	11.24%	11.69%
	5g	Meat & edible meat offal	14 Container 1,000-1,999 teu	9	2.34%	2.44%	2.86%	3.86%	5.27%	5.37%	5.78%	6.79%	6.89%	6.99%	7.41%	8.41%
			8 General cargo 5,000-9,999 dwt	17	0.22%	0.23%	0.24%	0.28%	4.31%	4.32%	4.33%	4.37%	5.83%	5.83%	5.85%	5.89%
			5 General cargo 5,000-9,999 dwt	11	0.22%	0.24%	0.30%	0.44%	4.31%	4.33%	4.39%	4.53%	5.83%	5.84%	5.90%	6.05%
			2 Container 0 - 999 teu	10	1.92%	1.92%	1.93%	1.97%	4.89%	4.90%	4.91%	4.94%	5.94%	5.95%	5.96%	6.00%
			10 Container 1,000-1,999 teu	10	2.34%	2.34%	2.35%	2.37%	5.27%	5.27%	5.28%	5.30%	6.89%	6.89%	6.90%	6.92%
			12 General cargo 5,000-9,999 dwt	17	0.22%	0.23%	0.28%	0.39%	4.31%	4.32%	4.37%	4.48%	5.83%	5.84%	5.89%	5.99%
	5h	Dairy produce, birds eggs, natural hone	23 General cargo 5,000-9,999 dwt	17	0.17%	0.22%	0.40%	0.85%	3.31%	3.35%	3.54%	3.99%	4.47%	4.51%	4.70%	5.15%
	5i	Products of the milling industry, etc.	23 General cargo 5,000-9,999 dwt	17	0.32%	0.37%	0.56%	1.00%	6.28%	6.32%	6.51%	6.96%	8.48%	8.53%	8.72%	9.16%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Cook Islands	5a	Miscellaneous edible preparations	17 Container 8,000-11,999 teu	16	2.07%	2.27%	3.09%	5.06%	4.28%	4.48%	5.29%	7.26%	5.63%	5.83%	6.65%	8.62%
			12 Container 12,000-14,499 teu	11	1.46%	1.69%	2.62%	4.88%	5.64%	5.87%	6.80%	9.06%	6.23%	6.46%	7.40%	9.66%
			30 Container 14,500-19,999 teu	8	1.76%	1.93%	2.63%	4.30%	3.50%	3.67%	4.36%	6.04%	5.64%	5.82%	6.51%	8.19%
			43 Container 20,000+ teu	4	1.51%	1.69%	2.40%	4.12%	3.13%	3.31%	4.02%	5.73%	4.73%	4.90%	5.61%	7.33%
			12 Container 2,000-2,999 teu	10	2.49%	2.57%	2.88%	3.62%	5.02%	5.09%	5.40%	6.14%	7.51%	7.58%	7.89%	8.63%
			15 General cargo 5,000-9,999 dwt	17	1.69%	1.70%	1.77%	1.93%	4.07%	4.09%	4.15%	4.31%	6.12%	6.14%	6.20%	6.36%
	5b	Pharmaceutical goods	23 General cargo 5,000-9,999 dwt	17	2.71%	2.75%	2.94%	3.39%	6.53%	6.58%	6.77%	7.21%	9.82%	9.87%	10.05%	10.50%
	5c	Fuels (LPG)	4 Liquified gas tanker 0-49,999 cbm	17	0.96%	1.13%	1.82%	3.48%	2.35%	2.52%	3.21%	4.88%	3.29%	3.46%	4.14%	5.81%
	5d	Articles of iron and steel	23 General cargo 5,000-9,999 dwt	17	3.30%	3.35%	3.53%	3.98%	7.97%	8.01%	8.20%	8.65%	11.97%	12.02%	12.20%	12.65%
	5e	Edible vegetables, certain roots, & tub	23 General cargo 5,000-9,999 dwt	17	3.08%	3.12%	3.31%	3.76%	7.43%	7.48%	7.66%	8.11%	11.16%	11.21%	11.40%	11.85%
	5f	Electrical machinery & equip	23 General cargo 5,000-9,999 dwt	17	3.15%	3.20%	3.38%	3.83%	7.61%	7.65%	7.84%	8.29%	11.43%	11.48%	11.67%	12.11%
	5g	Meat & edible meat offal	14 Container 1,000-1,999 teu	9	2.05%	2.16%	2.57%	3.58%	4.92%	5.02%	5.44%	6.44%	7.27%	7.37%	7.78%	8.79%
			8 General cargo 5,000-9,999 dwt	17	1.67%	1.67%	1.69%	1.73%	4.03%	4.03%	4.05%	4.09%	6.05%	6.06%	6.07%	6.11%
			5 General cargo 5,000-9,999 dwt	17	1.67%	1.68%	1.74%	1.89%	4.03%	4.04%	4.10%	4.25%	6.05%	6.07%	6.13%	6.27%
			2 Container 0 - 999 teu	10	1.48%	1.48%	1.50%	1.53%	4.39%	4.40%	4.41%	4.45%	6.63%	6.63%	6.64%	6.68%
			10 Container 1,000-1,999 teu	10	2.05%	2.06%	2.06%	2.08%	4.92%	4.92%	4.93%	4.95%	7.27%	7.27%	7.28%	7.29%
			12 General cargo 5,000-9,999 dwt	17	1.67%	1.68%	1.73%	1.83%	4.03%	4.04%	4.08%	4.19%	6.05%	6.06%	6.11%	6.22%
	5h	Dairy produce, birds eggs, natural hone	23 General cargo 5,000-9,999 dwt	17	1.28%	1.33%	1.51%	1.96%	3.09%	3.13%	3.32%	3.77%	4.64%	4.69%	4.87%	5.32%
	5i	Products of the milling industry, etc.	23 General cargo 5,000-9,999 dwt	17	2.43%	2.47%	2.66%	3.11%	5.86%	5.91%	6.09%	6.54%	8.81%	8.86%	9.04%	9.49%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Cook Islands	5a	Miscellaneous edible preparations	17 Container 8,000-11,999 teu	16	2.23%	2.43%	3.24%	5.22%	4.66%	4.86%	5.68%	7.65%	5.45%	5.65%	6.47%	8.44%
			12 Container 12,000-14,499 teu	11	1.67%	1.90%	2.83%	5.09%	5.80%	6.03%	6.96%	9.22%	6.27%	6.50%	7.43%	9.69%
			30 Container 14,500-19,999 teu	8	1.95%	2.12%	2.82%	4.49%	3.71%	3.88%	4.57%	6.25%	5.31%	5.48%	6.17%	7.85%
			43 Container 20,000+ teu	4	2.16%	2.34%	3.05%	4.76%	3.22%	3.40%	4.11%	5.83%	4.30%	4.47%	5.18%	6.90%
			12 Container 2,000-2,999 teu	10	2.52%	2.59%	2.90%	3.65%	4.97%	5.05%	5.36%	6.10%	7.27%	7.35%	7.65%	8.40%
			15 General cargo 5,000-9,999 dwt	17	2.57%	2.59%	2.66%	2.82%	4.30%	4.32%	4.39%	4.54%	5.67%	5.68%	5.75%	5.91%
	5b	Pharmaceutical goods	23 General cargo 5,000-9,999 dwt	17	4.13%	4.18%	4.36%	4.81%	6.91%	6.95%	7.14%	7.59%	9.09%	9.14%	9.32%	9.77%
	5c	Fuels (LPG)	4 Liquified gas tanker 0-49,999 cbm	17	0.83%	1.00%	1.69%	3.35%	2.43%	2.60%	3.29%	4.95%	3.24%	3.41%	4.10%	5.76%
	5d	Articles of iron and steel	23 General cargo 5,000-9,999 dwt	17	5.04%	5.08%	5.27%	5.72%	8.42%	8.46%	8.65%	9.10%	11.08%	11.13%	11.32%	11.77%
	5e	Edible vegetables, certain roots, & tub	23 General cargo 5,000-9,999 dwt	17	4.70%	4.74%	4.93%	5.38%	7.85%	7.90%	8.08%	8.53%	10.34%	10.38%	10.57%	11.02%
	5f	Electrical machinery & equip	23 General cargo 5,000-9,999 dwt	17	4.81%	4.86%	5.04%	5.49%	8.04%	8.09%	8.27%	8.72%	10.59%	10.63%	10.82%	11.27%
	5g	Meat & edible meat offal	14 Container 1,000-1,999 teu	9	1.73%	1.83%	2.25%	3.25%	4.97%	5.07%	5.49%	6.49%	6.88%	6.99%	7.40%	8.41%
			8 General cargo 5,000-9,999 dwt	17	2.55%	2.55%	2.57%	2.61%	4.26%	4.26%	4.28%	4.32%	5.60%	5.61%	5.63%	5.67%
			5 General cargo 5,000-9,999 dwt	11	2.55%	2.56%	2.62%	2.77%	4.26%	4.27%	4.33%	4.48%	5.60%	5.62%	5.68%	5.82%
			2 Container 0 - 999 teu	10	1.67%	1.68%	1.69%	1.73%	4.30%	4.31%	4.32%	4.36%	6.55%	6.56%	6.57%	6.61%
			10 Container 1,000-1,999 teu	10	1.73%	1.73%	1.74%	1.76%	4.97%	4.97%	4.98%	5.00%	6.88%	6.89%	6.89%	6.91%
			12 General cargo 5,000-9,999 dwt	17	2.55%	2.56%	2.60%	2.71%	4.26%	4.27%	4.31%	4.42%	5.60%	5.62%	5.66%	5.77%
	5h	Dairy produce, birds eggs, natural hone	23 General cargo 5,000-9,999 dwt	17	1.95%	2.00%	2.18%	2.63%	3.26%	3.31%	3.50%	3.94%	4.30%	4.34%	4.53%	4.98%
	5i	Products of the milling industry, etc.	23 General cargo 5,000-9,999 dwt	17	3.71%	3.75%	3.94%	4.39%	6.20%	6.24%	6.43%	6.88%	8.16%	8.20%	8.39%	8.84%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Cook Islands	5a	Miscellaneous edible preparations	17 Container 8,000-11,999 teu	16	5.35%	5.55%	6.37%	8.34%	6.10%	6.30%	7.11%	9.08%	5.75%	5.95%	6.77%	8.74%
			12 Container 12,000-14,499 teu	11	5.20%	5.43%	6.37%	8.63%	7.75%	7.98%	8.91%	11.17%	6.50%	6.73%	7.66%	9.92%
			30 Container 14,500-19,999 teu	8	4.10%	4.27%	4.97%	6.65%	5.30%	5.47%	6.16%	7.84%	5.35%	5.52%	6.21%	7.89%
			43 Container 20,000+ teu	4	3.64%	3.82%	4.53%	6.24%	4.71%	4.89%	5.60%	7.31%	4.05%	4.22%	4.93%	6.65%
			12 Container 2,000-2,999 teu	10	4.60%	4.67%	4.98%	5.72%	6.49%	6.57%	6.88%	7.62%	7.04%	7.12%	7.43%	8.17%
			15 General cargo 5,000-9,999 dwt	17	3.85%	3.86%	3.93%	4.09%	4.55%	4.57%	4.63%	4.79%	6.17%	6.18%	6.25%	6.41%
	5b	Pharmaceutical goods	23 General cargo 5,000-9,999 dwt	17	6.17%	6.21%	6.40%	6.85%	7.30%	7.35%	7.53%	7.98%	9.89%	9.94%	10.12%	10.57%
	5c	Fuels (LPG)	4 Liquified gas tanker 0-49,999 cbm	17	2.36%	2.53%	3.22%	4.89%	2.82%	2.99%	3.68%	5.35%	4.30%	4.47%	5.16%	6.83%
	5d	Articles of iron and steel	23 General cargo 5,000-9,999 dwt	17	7.52%	7.57%	7.75%	8.20%	8.90%	8.95%	9.13%	9.58%	12.06%	12.11%	12.29%	12.74%
	5e	Edible vegetables, certain roots, & tub	23 General cargo 5,000-9,999 dwt	17	7.01%	7.06%	7.25%	7.69%	8.30%	8.35%	8.53%	8.98%	11.25%	11.29%	11.48%	11.93%
	5f	Electrical machinery & equip	23 General cargo 5,000-9,999 dwt	17	7.18%	7.23%	7.41%	7.86%	8.50%	8.55%	8.73%	9.18%	11.52%	11.56%	11.75%	12.20%
	5g	Meat & edible meat offal	14 Container 1,000-1,999 teu	9	4.20%	4.30%	4.71%	5.72%	6.47%	6.57%	6.99%	7.99%	6.57%	6.67%	7.09%	8.09%
			8 General cargo 5,000-9,999 dwt	17	3.80%	3.81%	3.82%	3.86%	4.50%	4.50%	4.52%	4.56%	6.10%	6.10%	6.12%	6.16%
			5 General cargo 5,000-9,999 dwt	11	3.80%	3.82%	3.88%	4.02%	4.50%	4.51%	4.57%	4.72%	6.10%	6.11%	6.17%	6.32%
			2 Container 0 - 999 teu	10	3.71%	3.72%	3.73%	3.77%	5.85%	5.85%	5.87%	5.90%	6.12%	6.12%	6.14%	6.17%
			10 Container 1,000-1,999 teu	10	4.20%	4.20%	4.21%	4.23%	6.47%	6.47%	6.48%	6.50%	6.57%	6.57%	6.58%	6.60%
			12 General cargo 5,000-9,999 dwt	17	3.80%	3.81%	3.86%	3.97%	4.50%	4.51%	4.56%	4.67%	6.10%	6.11%	6.15%	6.26%
	5h	Dairy produce, birds eggs, natural hone	23 General cargo 5,000-9,999 dwt	17	2.92%	2.96%	3.15%	3.60%	3.45%	3.50%	3.68%	4.13%	4.67%	4.72%	4.91%	5.36%
	5i	Products of the milling industry, etc.	23 General cargo 5,000-9,999 dwt	17	5.54%	5.58%	5.77%	6.22%	6.55%	6.60%	6.78%	7.23%	8.88%	8.92%	9.11%	9.56%

Table 8.7: 2030, 2040, & 2050 commodity case study transit-weighted average total commodity cost intensity, by scenario and forecasted year

2030

Country	Case Study	Case Study Commodity	Ship Type(s)	2030 Scenario 23 TCCImtm, % increase				2030 Scenario 24 TCCImtm, % increase				2030 Scenario 31 TCCImtm, % increase				2030 Scenario 32 TCCImtm, % increase				2030 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Cook Islands	5a	Miscellaneous edible preparations	Container	1.58%	1.71%	2.24%	3.52%	1.94%	2.07%	2.60%	3.88%	1.94%	2.07%	2.60%	3.88%	2.26%	2.39%	2.92%	4.20%	4.32%	4.45%	4.98%	6.26%
	5b	Pharmaceutical goods	General cargo	0.20%	0.25%	0.44%	0.88%	0.36%	0.41%	0.59%	1.04%	2.71%	2.75%	2.94%	3.39%	4.13%	4.18%	4.36%	4.81%	6.17%	6.21%	6.40%	6.85%
	5c	Fuels (LPG)	LPG tanker	0.83%	1.00%	1.69%	3.35%	0.83%	1.00%	1.69%	3.35%	0.83%	1.00%	1.69%	3.35%	0.83%	1.00%	1.69%	3.35%	2.36%	2.53%	3.22%	4.89%
	5d	Articles of iron and steel	General cargo	0.25%	0.29%	0.48%	0.93%	0.44%	0.49%	0.67%	1.12%	3.30%	3.35%	3.53%	3.98%	5.04%	5.08%	5.27%	5.72%	7.52%	7.57%	7.75%	8.20%
	5e	Edible vegetables, certain roots, & tubers	General cargo	0.23%	0.28%	0.46%	0.91%	0.41%	0.46%	0.64%	1.09%	3.08%	3.12%	3.31%	3.76%	4.70%	4.74%	4.93%	5.38%	7.01%	7.06%	7.25%	7.69%
	5f	Electrical machinery & equip	General cargo	0.24%	0.28%	0.47%	0.92%	0.42%	0.47%	0.65%	1.10%	3.15%	3.20%	3.38%	3.83%	4.81%	4.86%	5.04%	5.49%	7.18%	7.23%	7.41%	7.86%
	5g	Meat & edible meat offal	Container, General cargo	1.71%	1.80%	2.13%	2.93%	2.00%	2.08%	2.42%	3.22%	1.99%	2.07%	2.40%	3.20%	1.85%	1.94%	2.27%	3.07%	4.13%	4.21%	4.54%	5.35%
	5h	Dairy produce, birds eggs, natural honey+	General cargo	0.10%	0.14%	0.33%	0.78%	0.17%	0.22%	0.40%	0.85%	1.28%	1.33%	1.51%	1.96%	1.95%	2.00%	2.18%	2.63%	2.92%	2.96%	3.15%	3.60%
	5i	Products of the milling industry, etc.	General cargo	0.18%	0.23%	0.41%	0.86%	0.32%	0.37%	0.56%	1.00%	2.43%	2.47%	2.66%	3.11%	3.71%	3.75%	3.94%	4.39%	5.54%	5.58%	5.77%	6.22%

2040

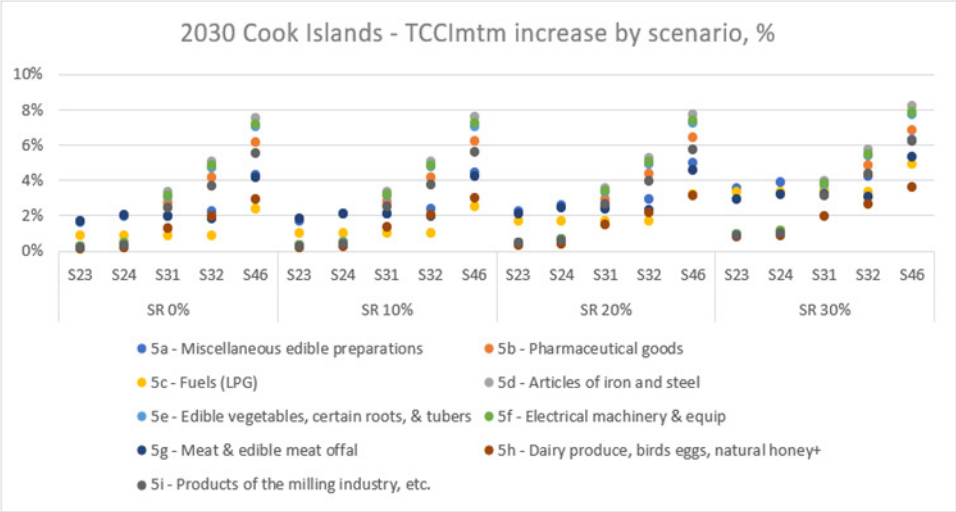
Country	Case Study	Case Study Commodity	Ship Type(s)	2040 Scenario 23 TCCImtm, % increase				2040 Scenario 24 TCCImtm, % increase				2040 Scenario 31 TCCImtm, % increase				2040 Scenario 32 TCCImtm, % increase				2040 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Cook Islands	5a	Miscellaneous edible preparations	Container	4.69%	4.82%	5.35%	6.63%	4.41%	4.54%	5.07%	6.34%	4.19%	4.32%	4.85%	6.13%	4.30%	4.43%	4.96%	6.24%	5.71%	5.84%	6.37%	7.65%
	5b	Pharmaceutical goods	General cargo	8.79%	8.83%	9.02%	9.47%	7.00%	7.04%	7.23%	7.68%	6.53%	6.58%	6.77%	7.21%	6.91%	6.95%	7.14%	7.59%	7.30%	7.35%	7.53%	7.98%
	5c	Fuels (LPG)	LPG tanker	2.43%	2.60%	3.29%	4.95%	2.43%	2.60%	3.29%	4.95%	2.43%	2.60%	3.29%	4.95%	2.43%	2.60%	3.29%	4.95%	2.82%	2.99%	3.68%	5.35%
	5d	Articles of iron and steel	General cargo	10.72%	10.76%	10.95%	11.40%	8.53%	8.58%	8.76%	9.21%	7.97%	8.01%	8.20%	8.65%	8.42%	8.46%	8.65%	9.10%	8.90%	8.95%	9.13%	9.58%
	5e	Edible vegetables, certain roots, & tubers	General cargo	9.99%	10.04%	10.22%	10.67%	7.95%	8.00%	8.19%	8.63%	7.43%	7.48%	7.66%	8.11%	7.85%	7.90%	8.08%	8.53%	8.30%	8.35%	8.53%	8.98%
	5f	Electrical machinery & equip	General cargo	10.23%	10.28%	10.47%	10.91%	8.15%	8.19%	8.38%	8.83%	7.61%	7.65%	7.84%	8.29%	8.04%	8.09%	8.27%	8.72%	8.50%	8.55%	8.73%	9.18%
	5g	Meat & edible meat offal	Container, General cargo	5.44%	5.52%	5.86%	6.66%	5.11%	5.20%	5.53%	6.33%	4.78%	4.86%	5.19%	5.99%	4.85%	4.93%	5.26%	6.06%	6.15%	6.24%	6.57%	7.37%
	5h	Dairy produce, birds eggs, natural honey+	General cargo	4.15%	4.20%	4.39%	4.83%	3.31%	3.35%	3.54%	3.99%	3.09%	3.13%	3.32%	3.77%	3.26%	3.31%	3.50%	3.94%	3.45%	3.50%	3.68%	4.13%
	5i	Products of the milling industry, etc.	General cargo	7.89%	7.93%	8.12%	8.57%	6.28%	6.32%	6.51%	6.96%	5.86%	5.91%	6.09%	6.54%	6.20%	6.24%	6.43%	6.88%	6.55%	6.60%	6.78%	7.23%

2050

Country	Case Study	Case Study Commodity	Ship Type(s)	2050 Scenario 23 TCCImtm, % increase				2050 Scenario 24 TCCImtm, % increase				2050 Scenario 31 TCCImtm, % increase				2050 Scenario 32 TCCImtm, % increase				2050 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Cook Islands	5a	Miscellaneous edible preparations	Container	5.78%	5.91%	6.44%	7.71%	5.70%	5.83%	6.36%	7.64%	6.13%	6.26%	6.79%	8.07%	5.83%	5.96%	6.49%	7.77%	5.80%	5.93%	6.46%	7.74%
	5b	Pharmaceutical goods	General cargo	9.60%	9.65%	9.83%	10.28%	9.46%	9.50%	9.69%	10.14%	9.82%	9.87%	10.05%	10.50%	9.09%	9.14%	9.32%	9.77%	9.89%	9.94%	10.12%	10.57%
	5c	Fuels (LPG)	LPG tanker	3.24%	3.41%	4.10%	5.76%	3.24%	3.41%	4.10%	5.76%	3.24%	3.41%	4.10%	5.76%	3.24%	3.41%	4.10%	5.76%	4.30%	4.47%	5.16%	6.83%
	5d	Articles of iron and steel	General cargo	11.71%	11.75%	11.94%	12.39%	11.53%	11.57%	11.76%	12.21%	11.97%	12.02%	12.20%	12.65%	11.08%	11.13%	11.32%	11.77%	12.06%	12.11%	12.29%	12.74%
	5e	Edible vegetables, certain roots, & tubers	General cargo	10.92%	10.96%	11.15%	11.60%	10.75%	10.80%	10.98%	11.43%	11.16%	11.21%	11.40%	11.85%	10.34%	10.38%	10.57%	11.02%	11.25%	11.29%	11.48%	11.93%
	5f	Electrical machinery & equip	General cargo	11.18%	11.23%	11.41%	11.86%	11.01%	11.06%	11.24%	11.69%	11.43%	11.48%	11.67%	12.11%	10.59%	10.63%	10.82%	11.27%	11.52%	11.56%	11.75%	12.20%
	5g	Meat & edible meat offal	Container, General cargo	6.65%	6.74%	7.07%	7.87%	6.72%	6.80%	7.13%	7.93%	7.07%	7.15%	7.48%	8.28%	6.68%	6.76%	7.09%	7.90%	6.49%	6.57%	6.91%	7.71%
	5h	Dairy produce, birds eggs, natural honey+	General cargo	4.54%	4.58%	4.77%	5.22%	4.47%	4.51%	4.70%	5.15%	4.64%	4.69%	4.87%	5.32%	4.30%	4.34%	4.53%	4.98%	4.67%	4.72%	4.91%	5.36%
	5i	Products of the milling industry, etc.	General cargo	8.62%	8.66%	8.85%	9.30%	8.48%	8.53%	8.72%	9.16%	8.81%	8.86%	9.04%	9.49%	8.16%	8.20%	8.39%	8.84%	8.88%	8.92%	9.11%	9.56%

The 2030, 2040, and 2050 transit-weighted averaged, total commodity cost intensity ranges across all scenarios, by speed reduction group is presented in Figures 8.3, 8.4, and 8.5, respectively.

Figure 8.3: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group

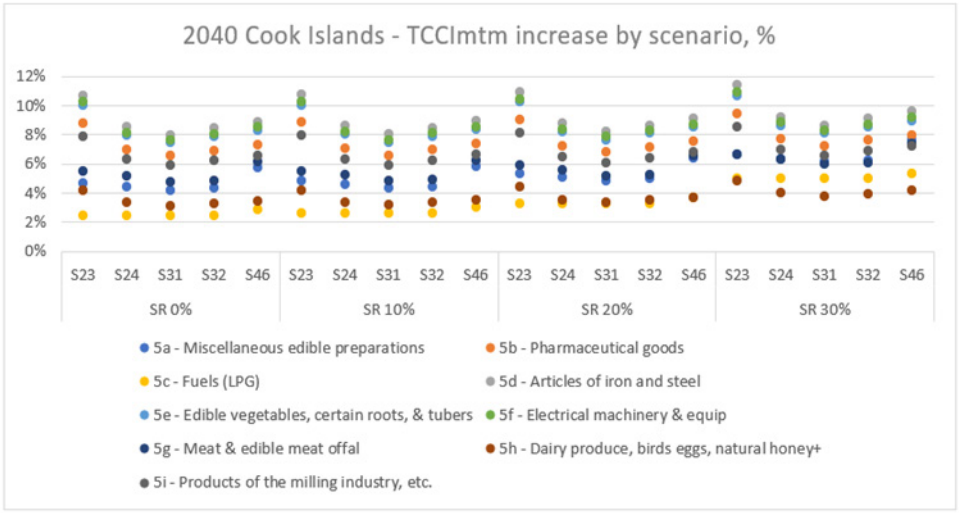


Note that in 2030, ship-side cost intensity increases are the primary driver across all scenarios and speed reduction groups SR 0% and SR 10%, with the key parameters ranging from:

- **TCCImtm** **0.10% to 7.57%, with an average of 2.47%**

In general, there is only a slight increase in costs from SR 10% compared to no speed reduction. Fuels, steel, edible vegetables, electrical machinery, and products of milling have the highest *ad valorem* rates. Miscellaneous edible perishables from Europe have the longest distance. Case studies that had the highest ship-side cost intensity increases included articles of iron and steel, miscellaneous edible preparations, electrical machinery, fuels, meat, and products of milling. Scenario 46 has the highest total commodity cost intensity increases across all speed reduction ranges, while the other scenarios aren't really affected until SR 30%. As noted above, SR 20% and SR 30% are probably not practicable.

Figure 8.4: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group

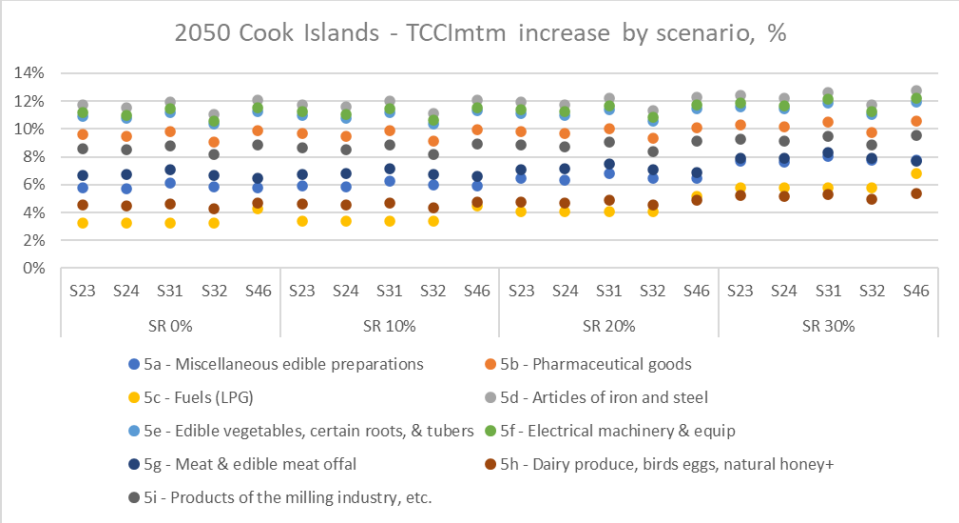


Note that in 2040, ship-side cost intensity increases are the primary driver across all scenarios and speed reduction groups SR 0% and SR 10%, with the key parameters, ranging from:

- **TCCImtm** **2.43% to 10.76%, with an average of 6.20%**

Fuels, steel, edible vegetables, electrical machinery, and products of milling have the highest *ad valorem* rates. Case studies that had the highest ship-side cost intensity increases are the same as 2030. Scenario 46 continues to have high commodity cost intensity increases and is joined by Scenario 23 across all speed reduction ranges, but the spread is diminished.

Figure 8.5: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2050, ship-side cost intensity increases are the primary driver across all scenarios and speed reduction groups SR 0% and SR 10%, with the key parameters, ranging from:

- **TCCImtm** **3.24% to 12.11%, with an average of 8.08%**

The commodity cost intensities for all commodities have stratified, with spans narrowing across all scenarios and speed reduction groups.

As noted previously and not shown in the figures above, SR 20% and SR 30% can have critically significant impacts for commodities like eggs, where shelf-life durations are extremely tight. This is applicable across all forecasted years and scenarios. These delays could render the product expired and full loss of value, resulting in no eggs in the country until the next ship call in a month.

In email correspondence with Task 2 Project Manager Tore Longva of DNV about the outputs for Cook Islands, he noted the following: "[looking] at 5c for scenario 46 and the large increase for container ships built in 2010-2019. What happens here is that these ships do not reduce that much (joining pools instead) and combined with a very high levy in 2040 (300 USD), this results in a 164% cost intensity increase. The newer ships reduce emissions more and the cost increase is less, although higher compared to other ship types, likely due to relatively higher fuel cost compared to other expenses."[114]

[114] Email exchange with Tore Longa, Project Manager Task 2, 5 July 2024.

GDP context

According to information provided by the Cook Islands, the trade sector (where miscellaneous edible, pharmaceutical, goods, fuel, editable vegetables, meat and edible meat, dairy produce, and products of the milling industry are part of) share 14.96% of the national GDP; the construction sector where electrical machinery and articles of iron and steel are part of) shares 2.37% of total GDP.

8.4 Qualitative analysis

The Cook Islands provided detailed Qualitative information on all of their multiple commodities using input from local industry experts for each commodity. These are:

- Miscellaneous edible preparations; Pharmaceutical goods; Fuels (LPG); Articles of iron and steel; Edible vegetables, certain roots, & tubers; Electrical machinery & equip; Meat & edible meat offal; Dairy produce, birds eggs, natural honey+; Products of the milling industry, etc.

Responses were provided by CITC (Cook Islands Trading Corporation Ltd), the largest and longest-serving business enterprise in the Cook Islands. CITC is an importer, distributor, wholesaler, and retailer of a variety of products and is based in Rarotonga. Responses were also provided by Prime Foods, a supermarket and food service distributor that sources products from Rarotonga and the outer Cook Islands as well as imported goods from around the globe.

These stakeholders all showed strong awareness of the potential impacts of the IMO measures to decarbonize shipping, as well as related factors such as impacts on food and fuel prices.

Analyses of these responses are displayed on the following SWOT grids (Tables 8.8 and 8.9) showing sensitivities to freight costs and sensitivities to transit times. Key takeaways for each grid are reflected below the SWOT grids.

Table 8.8: SWOT analysis of the Cook Islands' commodities and their sensitivity to cost changes

Sensitivity to freight shipment cost changes as reported by the stakeholders	
Country: Cook Islands Commodities: 5a Miscellaneous edible preparations, 5b Pharmaceutical goods, 5c Fuels (LPG), 5d Articles of iron and steel, 5e Edible vegetables, certain roots, & tubers, 5f Electrical machinery & equip, 5g Meat & edible meat offal, 5h Dairy produce, birds eggs, natural honey+, 5i Products of the milling industry, etc.	
Strengths ➢ Have expanded their purchases to Europe and other markets. ➢ Are buying directly from manufacturers in an effort to reduce costs to consumers. ➢ Markets like New Zealand and Australia import and re-export products to the Cook Islands. ➢ Added expenses due to temporary disruptions in shipping rotations are covered by the stakeholder, rather than consumers.	**Weaknesses** ➢ Costs of goods are already expensive. ➢ Because of space issues on the airlines, maritime transport is the only real option. ➢ Imports make up over 90% of consumption. ➢ Covid-19 increased costs of freight and it has not come down to pre-Covid levels. ➢ The Cook Islands is an isolated SIDS in the Pacific Ocean, and freight shipment costs are directly related to the distance sailed and the amount of fuel used. ➢ Low priced commodity items reflect freight costs the most. ➢ Any price increases for food-based commodities are reflected in all manufactured food products. ➢ Freight rate increases following Covid-19 have drastically affected other costs on land. And the imminent increases in freight rates now being sought by shipping companies will have a detrimental impact on costs and competitiveness of our tourist industry
Opportunities to adapt/mitigate ➢ Could move more cargo to air transport, especially with a sea/air price discount. ➢ Continue to seek an airfreight link in addition to the current one through New Zealand. ➢ Trade agreements could help to solve cost gaps vs. other countries. ➢ Lower speeds reduce bunker costs.	**Threats** ➢ IMO GHG MTM may increase shipping costs for all commodities. ➢ Higher transport costs could result in higher logistics costs and higher overall prices paid by importers. ➢ Higher transport costs will increase the cost of goods for consumers and increase inflation. ➢ Speed reduction could affect freight costs. ➢ Costs of goods are already expensive, and visitors often complain about the cost of groceries so further increases would have a negative impact on the important tourist market. ➢ Certain goods may no longer be imported at all due to increased costs and timeframes.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- The Cook Islands has expanded their purchases to Europe and other markets and are buying directly from manufacturers to reduce costs to consumers.
- Costs of goods are already expensive, so higher transport costs will increase inflation and costs for consumers even more so.
- Though some commodities could be shipped via airfreight, space issues on planes leave maritime transport as the best option.
- As imports make up over 90% of consumption, trade agreements could help solve cost gaps vs. other countries. Exporters may need to consider the GHG emissions cost on their logistic cost to avoid deviation from market price.
- Covid-19 increased the costs of freight and it has yet to returned to pre-Covid levels. Another dramatic increase in freight shipment costs could be detrimental. Freight costs due to Covid-19 also drastically affected land costs.
- The Cook Islands is an isolated SIDS in the Pacific Ocean and freight shipment costs are directly related to the distance sailed and amount of fuel used. Higher transport costs could result in higher logistics costs and higher overall prices paid by importers.
- Speed reduction threatens freight costs, so certain goods may no longer be imported at all due to increased costs and timeframes.
- Lower priced commodities reflect freight costs the most and any price increases for food-based commodities are reflected in all manufactured food products.
- Costs of goods are already expensive, and visitors often complain about the cost of groceries so further increases could have negative impacts on the tourism industry, a large contributor to the Cook Islands' GDP.
- IMO GHG MTM may increase shipping costs. However, lower speeds also reduce bunker costs.
- Identified threats/risks of freight rate increases due to the MTM include increasing food costs worldwide.

Table 8.9: SWOT analysis of the Cook Islands' commodities and their sensitivity to transport time changes

Sensitivity to increased transport times as reported by the stakeholders	
Country: Cook Islands Commodities: 5a Miscellaneous edible preparations, 5b Pharmaceutical goods, 5c Fuels (LPG), 5d Articles of iron and steel, 5e Edible vegetables, certain roots, & tubers, 5f Electrical machinery & equip, 5g Meat & edible meat offal, 5h Dairy produce, birds eggs, natural honey+, 5i Products of the milling industry, etc.	
Strengths ➢ Since Covid-19, things have improved in relation to logistics, availability of containers, port and cargo delivery delays. ➢ Current cargo loads are high. ➢ Stakeholders account for shipping delays by adding on a week of stock hold for most purchases. ➢ Are able to allow 4-5 weeks buffer to avoid shortages. ➢ Frozen products generally have good 'best by' dates. ➢ If stocks run out, competitors will most likely run out too.	**Weaknesses** ➢ Longer durations for perishable commodities are critical and any delays or longer trips would heavily impact a SIDS. ➢ More expensive to transport goods by air. ➢ Shipping schedules and delays are already a constant issue, especially for perishable goods. ➢ Stakeholders are forced to air freight perishable goods due to long shipping times. ➢ Chilled goods have significantly less time until expiration vs. frozen goods. ➢ If stock is received late, stakeholders often receive shipments back-to-back, making them overstocked. ➢ The Cook Islands are at the end of the supply chain. ➢ Currently paying 4-5 times more for airfreight vs. maritime transport.
Opportunities to adapt/mitigate ➢ Stock holdings will need to increase if shipping rotations are affected. ➢ If transit time are affected, it will be necessary to adjust logistics to provide increased stock at destination. ➢ More frequent shipments or increased storage capacity at destination. However, this may lead to higher emissions due to more frequent shipments or longer storage. ➢ Lower vessel speed should reduce fuel consumption. ➢ More products could be airfreighted, though this would reflect as higher prices to consumers.	**Threats** ➢ IMO GHG MTM may increase transport times. ➢ The longer that goods are refrigerated, the less shelf life a product will have. ➢ Speed reduction will require higher holding stock needed, putting pressure on warehousing. ➢ Certain goods may no longer be imported at all due to increased costs and timeframes. ➢ Reduced capacity ships would severely impact the supply chain. Container shortages have also meant major shipping delays. ➢ Timing of transshipping goods across various shipping lines is already difficult. Slowing shipping speeds would aggravate this. ➢ Having larger stock holdings is a major expense for frozen or chilled products. ➢ Speed reduction would aggravate geographic disadvantages because of longer lead times and potentially more expensive freight costs.

Key findings on transport time derived from stakeholder input to the SWOT analysis:

- IMO GHG MTM may increase transit times. The Cook Islands is at the end of the supply chain so the timing of transshipping goods across various shipping lines is already difficult. Slowing shipping speeds would aggravate this.
- Since Covid-19, things have improved in relation to logistics, availability of containers, port and cargo delivery delays and current cargo loads are high.
- Stakeholders account for shipping delays by adding on a week of stock to be held for most purchases and are sometimes able to allow 4-5 weeks buffer to avoid shortages.
- Although frozen products generally have good 'best by' dates, chilled goods have significantly less time until expiration. To avoid this, the Cook Islands would need to have larger stock holdings. This would be a major expense and would put pressure on warehousing.
- Shipping schedules and delays are already a constant issue, especially for perishable goods, so stakeholders are forced to air freight perishable goods due to long shipping times.
- To avoid increased transit times or delays, goods could be transported by air. However, airfreight currently costs 4 to 5 times as much as ocean shipping.
- Certain goods may no longer be imported at all due to increased costs and timeframes. Container shortages have already meant major shipping delays, so any added pressure is detrimental.
- An opportunity to mitigate risks is to provide more frequent shipments or increased storage capacity at destinations. This could lead to higher emissions and longer storage with more costs.
- Potential to develop shipment and storage conditions to prolong the acceptable lifetime of agricultural products.
- The Cook Islands' remote location could lead to disadvantages if transport times are increased.

8.5 Findings

Quantitative findings

The key findings from the quantitative analysis include:

- ***All nine*** commodity case studies cost increases are ***driven by ship-side cost increases***. The exception could be the loss of eggs due to even short delays of 1 or more days.
- The *ad valorem* rates of the imported essential goods ranged from 6.9% to 17.9%, with an average of 10.6%. Note that UNCTAD does not have Cook Island specific *ad valorem* rates, and that the 6.9% to 9.1% rates appear lower than anticipated.
- In 2022, all of the imported essential goods came via two general cargo ships that bring goods via container or two liquid propane gas (LPG) tankers. Both types of ships had generally low average voyage speeds of 11.1 and 10.4 knots, respectively in 2022. In the CIA STM, these ships had average voyage speeds of 12.4 and 11.9 knots, respectively in 2019. So speed reduction appears to have been implemented. Due to the existing low average voyage speeds, benefits beyond SR 10% would be anticipated to be limited.
- Longer transit times from potential speed reduction across the case studies for SR 0% and SR 10% range from 1 to 4 days.
- As noted previously even SR 10% can have critically significant impacts for commodities like eggs, where shelf-life durations are tight. This is applicable across all forecasted years and scenarios. These delays could render the product expired and full loss of value, resulting in no eggs in the country until the next ship call in a month.

- Note that in 2030, in general there is only a slight increase in SR 10% compared to no speed reduction. Fuels, steel, edible vegetables, electrical machinery, and products of milling have the highest *ad valorem* rates. Miscellaneous edible perishables from Europe have the longest distance. Case studies that had the highest ship-side cost intensity increases included articles of iron and steel, miscellaneous edible preparations, electrical machinery, fuels, meat, and products of milling. Scenario 46 has the highest total commodity cost intensity increases across all speed reduction ranges, while the other scenarios aren't really affected until SR 30%.
- Note that in 2040, there is a noticeable jump in the ship-side cost intensity across all commodity cases studies and the highest ship-side cost intensity increases are the same as 2030. Scenario 46 continues to have higher total commodity cost intensity increases across all speed reduction ranges, but the spread is diminished.
- Note that in 2050, The commodity cost intensity spans are narrower across all scenarios and speed reduction groups.
- The *ad valorem* rates of the imported essential goods ranged from 6.9% to 17.9%, with an average of 10.6%. Note that UNCTAD does not have Cook Island specific *ad valorem* rates.
- Total commodity cost intensity ranges across all scenarios and speed reduction groups for case studies, include:
    - Miscellaneous edible preparations
        - 2030 – 1.58% to 6.26%, with an average of 3.09%
        - 2040 – 4.19% to 7.65%, with an average of 5.34%
        - 2050 – 5.70% to 8.07%, with an average of 6.53%
    - Fuels (LPG)
        - 2030 – 0.83% to 4.89%, with an average of 2.02%
        - 2040 – 2.43% to 5.35%, with an average of 3.40%
        - 2050 – 3.24% to 6.83%, with an average of 4.34%
    - Pharmaceutical goods, articles of iron and steel, edible vegetables, electrical machinery, diary, and milling
        - 2030 – 0.10% to 8.20%, with an average of 2.90%
        - 2040 – 3.09% to 11.40%, with an average of 7.41%
        - 2050 – 4.30% to 12.74%, with an average of 9.64%
    - Meat & edible meat offal
        - 2030 – 1.71% to 5.35%, with an average of 2.77%
        - 2040 – 4.78% to 7.37%, with an average of 5.69%
        - 2050 – 6.49% to 8.28%, with an average of 7.15%
- TCCImtm findings for the nine imported essential goods commodity case studies across all scenarios and across SR 0% and SR10% speed reduction groups, by forecasted year:
    - 2030 0.10% to 7.57%, with an average of 2.47%
    - 2040 2.43% to 10.76%, with an average of 6.20%
    - 2050 3.24% to 12.11%, with an average of 8.08%

Qualitative findings

The Cook Islands face significant challenges regarding transport and trade dynamics. Cook Islands stakeholders' views expressed as part of the qualitative analysis on freight shipment cost changes highlighted several issues. The Cook Islands have expanded their purchasing strategies to include direct purchases from manufacturers in order to lower costs for consumers. Goods are already expensive and any increases in transport costs, exacerbated by Covid-19-related inflation, threatens to further inflate prices. The Cook Islands heavily rely on imports, which constitute over 90% of consumption. Freight costs, directly tied to distance and fuel usage, pose substantial economic risks for such an isolated country. Potential speed reductions in shipping could further complicate import logistics and raise overall prices, impacting both local residents and the tourism industry. The IMO

GHG MTM may increase shipping expenses, though slower speeds could mitigate bunker costs. This highlights the complex balance between environmental recommendations and economic impacts on global commodity costs.

According to Cook Islands stakeholders, IMO GHG MTM may increase transit times as well, which is already a challenge due to the Cook Islands' position at the end of the supply chain. Although logistics and container availability have improved since Covid-19, shipping schedules remain a concern. Stakeholders compensate by adding extra stock hold time and buffer periods to prevent shortages. Perishable goods or those with limited shelf lives often already require air transport due to long shipping times, despite the higher costs involved. Developing improved shipment and storage conditions could enhance the longevity of agricultural products, although this presents logistical and financial challenges. The Cook Islands' remote location exacerbates these issues, potentially disadvantaging them further if transport times increase.

Stakeholders suggested opportunities to mitigate impacts include a range of approaches identified by the stakeholders from the Cook Islands:

- Costs
  - Air freight is only an option when absolutely necessary due to much higher costs.
  - Continue to seek an airfreight link in addition to the current one through New Zealand.
  - Trade agreements could help to solve cost gaps vs. other countries.
  - Lower speeds reduce bunker costs.
- Longer transport times
  - Stock holdings will need to increase if shipping rotations are affected.
  - If transit time are affected, it will be necessary to adjust logistics to provide increased stock at destination.
  - More frequent shipments or increased storage capacity at destination. However, this may lead to higher emissions due to more frequent shipments or longer storage.
  - Lower vessel speed should reduce fuel consumption.
  - More products could be airfreighted, though this would reflect as higher prices to consumers.

Summary of key points related to potential impacts

The following points are key to understanding the potential impacts of the MTM:

- Cook Island is a SIDS
- UNCTAD's 2022 data shows the Cook Islands GDP is $290 million USD, with a GDP per capita of $17,033.
- The nine commodities selected by Cook Islands for case studies are essential goods imports of miscellaneous edible preparations from Europe; pharmaceutical goods, articles of iron and steel, edible vegetables, certain roots & tubers, electrical machinery & equipment, diary produce, birds eggs, natural honey, products of the milling industry, all from New Zealand; fuels (LPG) from Australia; and meat and edible meat offal from the US. All nine commodity case studies are imported essential goods, which means cost increases impact the entire population. These impacts are significantly amplified when the essential goods are moved to the outer islands.

- According to information provided by the Cook Islands, the trade sector (where miscellaneous edible, pharmaceutical, goods, fuel, editable vegetables, meat and edible meat, dairy produce, and products of the milling industry are part of) share 14.96% of the national GDP; the construction sector where electrical machinery and articles of iron and steel are part of) shares 2.37% of total GDP.
- For these nine case studies, the estimates indicate a range total commodity cost intensity increases related to maritime transport. Across Scenarios 23/24 and 31/32, for all forecasted years, the cost increases with Scenarios 23/24 generally run higher than 31/32. These increases are estimated to be relatively low in 2030, but are estimated to significantly increase in 2040 and 2050. For strive Scenario 46, as expected, the significant increases in total commodity cost intensity increases are shifted forward to 2030, with future forecasted years seeing modest increases.
- Since these are essential goods, the impacts of delays weigh more heavily due to limited GDP, limited population and infrastructure to provide economies of scale, limited disposal incomes to absorb cost increases, limited alternative transportation options to import essential goods, and country's remoteness to key trading partners.

9 Stakeholders' analysis – Peru

The Stakeholder Assessment for Peru focuses on exports of copper, grapes and pota (squid). Copper represents the economically critical mining industry and is exported by bulk carrier to Asia. Grapes and pota (squid) are perishable food products and are exported to Asia in refrigerated containers.

9.1 Geography, population, and economy

Geography

The Republic of Peru (Peru) is located on the west coast of South America, with ports on the Pacific Ocean. Although located in the tropics, Peru's topography ranges from coastal to mountainous, resulting in a variety of climate areas, agricultural production and natural resources.

Peru is located in the global south, which is characterized by long trading distances and shipping times to market and resulting higher trading costs. Representative distances to markets for the selected commodities and ports are presented in Section 9.2.

Population

Peru had about 34 million inhabitants in 2022, with 79% living in urban areas and 21.7% in rural areas.[115] The capitol city Lima's metropolitan area is home to over 9.8 million people. Most of the population resides along the coast where Lima is located.

Economy

Peru's economy is the 48th largest in the world, with significant mining, industrial fisheries, agriculture, livestock production, and tourism. It is one of the fastest-growing economies in the region, with a GDP of $242,632 million. In 2022, Peru's GDP per capita was $7,126.[116]

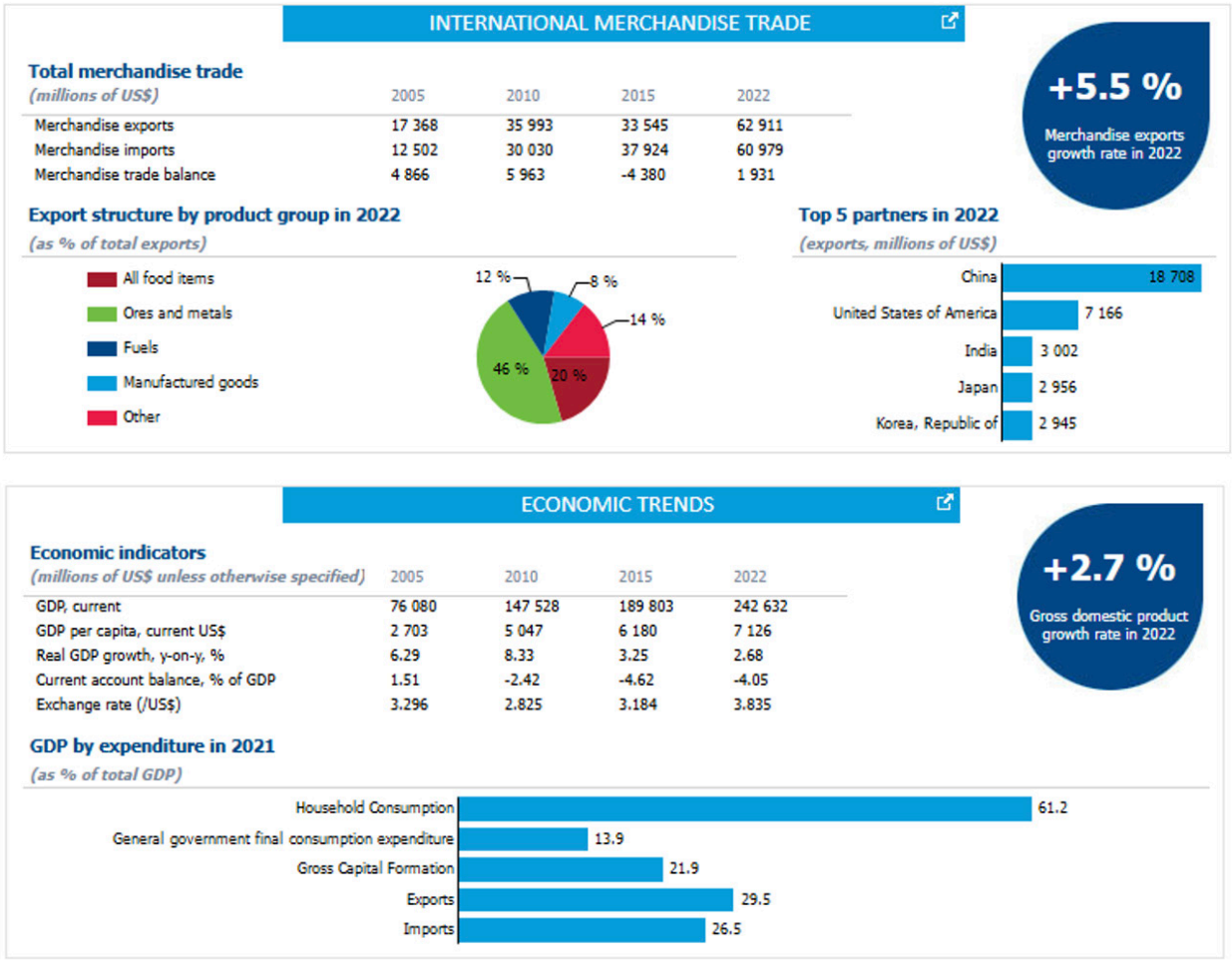
Mining is the primary economic activity of Peru, contributing nearly 60% of foreign exchange earnings in the country.[117] Peru is among the top global producers of copper, silver, zinc, tin, gold, boron, molybdenum, gas, and oil. This strong global position in mining creates economic sensitivity to variation in international commodity prices.

The fishing industry is the secondary source of income, accounting for 18% of exports. Peru is the world's largest producer and exporter of fishmeal and fish.

Peru's agricultural sector plays a crucial role in its economy and is also a significant source of exports. While agriculture represents only 6 percent of Peru's total GDP, it employs about 26 percent of the population and is an important factor in reducing poverty in the country. Peru is the country of origin for several essential crops, including potatoes, tomatoes, quinoa, beans, and cassava. After significant growth in recent decades—from just $645 million in 2000 to an estimated $10.5 billion in 2023-4—the export of agricultural products is now the third-largest economic sector.[118] The country has quadrupled its high-value export farmland to nearly 200,000 hectares, creating at least 1 million jobs. Key economic indicators are on the next page in Figure 9.1.[119]

[115] UNCTAD, General and Maritime Profiles: Peru, *UNCTAD Statistics – General Profile*.
[116] UNCTAD, General and Maritime Profiles: Peru, *UNCTAD Statistics – General Profile*.
[117] Peru Information, *Mineral Industry of Peru*.
[118] Peru Information, *Agriculture*.
[119] UNCTAD, General and Maritime Profiles: Peru, *UNCTAD Statistics – General Profile*.

Figure 9.1: Key economic indicators for Peru



Source: UNCTAD, General and Maritime Profiles: Peru, UNCTAD Statistics – General Profile.

9.2 Identified commodities and routes studied

The Stakeholder Assessment for Peru focuses on exports of copper, grapes and pota (squid). Copper represents the economically critical mining industry and is exported by bulk carrier to Asia. Grapes and pota (squid) are perishable food products and are exported to Asia in containers. Pota are normally shipped frozen.

The commodities selected by the Member State for focus and illustrative trade routes selected are shown in Table 9.1. All commodities selected for this study are trade exports.

Table 9.1: Shipping distances from Peru to market for selected commodities

Case Study	Commodity	Illustrative identified routes, by country	Ship Type(s)	Route Distance Range, nm min	avg	max	Stops
6a	Copper	Peru --> China	Bulk carrier	9,838	10,943	12,157	2-5
6b	Grapes	Peru --> Ecuador --> Mexico --> Taiwan --> China --> Hong Kong	Container	10,081	11,583	13,748	1-3
		Peru --> Chile --> Hong Kong					
		Peru --> Chile --> New Zealand --> Hong Kong					
		Peru --> Mexico --> Taiwan --> China --> Hong Kong					
		Peru --> Mexico --> Japan --> China --> Hong Kong					
		Peru --> Chile --> China --> Hong Kong					
		Peru --> Chile --> Guatemala --> Hong Kong					
6c	Pota (squid)	Peru --> Chile --> China --> South Korea	Container	9,306	11,054	14,231	5-11
		Peru --> Chile --> Hong Kong --> China --> South Korea					
		Peru --> Chile --> Mexico --> Japan --> South Korea					
		Peru --> Ecuador --> Colombia --> Guatemala --> Mexico --> Japan --> South Korea					
		Peru --> Ecuador --> Colombia --> Mexico --> Japan --> South Korea					
		Peru --> Ecuador --> Colombia --> Panama --> Mexico --> Japan --> South Korea					
		Peru --> Ecuador --> Mexico --> Japan --> South Korea					
		Peru --> Mexico --> Japan --> China --> Hong Kong --> China --> South Korea					
		Peru --> Mexico --> Japan --> South Korea					

For this commodity case study, Peru selected three traded commodities which are all exported to Asia. The selection criteria were based on classifying Peruvian exports into three categories: perishable, non-perishable, and frozen/canned products, and selecting the products with the highest contribution in each category. Thus, grapes were identified as the main export product in the perishable category, copper in the non-perishable category, and squid in the frozen/canned category.

To determine the most relevant maritime routes to the Asian market, frequent export routes for non-mineral-energy products were analyzed using 2022 data. The following key routes were highlighted: Callao - Hong Kong for grapes, Paita - Pusan (South Korea) for squid, and various routes to China for copper. This selection allows for an accurate assessment of the impact of the proposed measures on reducing emissions in the international transport of Peruvian foreign trade and the associated logistics routes, providing a solid basis for strategic decision-making.

Trade context

In 2023, Peruvian goods exports reached a historical record for the third consecutive year, totaling US$ 64,582 million, which is 1.5% higher than in 2022. In contrast, imports decreased by 10.8%. As a result, the trade in goods fell by 4.2% in 2023 compared to the previous year.

The growth in export value in 2023 was mainly driven by higher exports of fruits (+15.5%) and minerals (+12%). Notable increases were seen in the export value of grapes (+31.7%), lead (+40.1%), and molybdenum (+22%)

Copper exports, the main good exported by Peru (35.8% of the total export value), reached US$ 23,104 million, a record value equivalent to 25 times the export value recorded at the beginning of this century. This has solidified Peru's position as the world's second-largest copper exporter.

Agricultural exports in 2023 reached US$ 10,483 million, a record value. Alongside higher fruit sales, there were increases in sales of cocoa/derivatives (+22.5%) and ginger (+82.9%). The higher sales of these goods compensated for the decline in the export value of coffee (-32.9%).

The value of goods imports decreased in 2023 due, among other factors, to the stabilization of fuel prices and their derivatives, as well as lower export volumes. The main import category—intermediate goods and inputs—registered a decline of 18.5% in 2023.

Meanwhile, the import value of capital goods and construction materials fell by 2.3% in 2023 due to lower investment spending in the economy. Finally, the import of consumer goods decreased by 0.5%, mainly due to reduced purchases of clothing and household appliances.

9.3 Quantitative analysis

This section presents the quantitative analysis summary results and is organized by fleet analysis summary, total commodity cost intensity changes from speed reduction, Task 2 cost intensity changes due to MTM, total commodity cost intensity impacts, and GDP contexts. The quantitative analysis incorporates the findings of Task 2 related to the selected bracketing MTM scenarios as presented below:[120]

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination						
			Policy code	GFI scope	GFI flexibility RU % of price	GFI flexibility SU % of price	Levy USD/tCO_2eq	Levy Reward % of cost gap	Feebate Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

The detailed approach for the below analyses is provided in Appendix A.

Fleet analysis summary

As part of the fleet analysis, routes and ship characteristics were identified for each commodity case study. For the specific ship types identified with the commodity case study and transiting on the identified route the following were averaged to represent the fleet:

- Ship type and size
- Number of transits identified
- Route distances obtained from Marine Benchmark's 2022 AIS database were transit-weighted averaged and reported as minimum, average, and maximum distance sailed
- Transit-weighted average year of build, which was used to determine the average age in years

These characteristics for this study are presented in Table 9.2, on the following page.

[120] DNV 2024

Table 9.2: Peru – Fleet characteristics, by commodity case study

Case Study	Commodity	2022 Transits	Ship Type(s)	Route Distance Range, nm min	avg	max	Avg Build
6a	Copper						
		8	Bulk carrier 35,000 - 59,999 dwt	9,838	**10,834**	12,157	2014
		8	Bulk carrier 60,000 - 99,999 dwt	10,592	**11,052**	11,522	2018
6b	Grapes						
		3	Container 3,000-4,999 teu	10,116	**10,852**	11,991	2007
		38	Container 5,000-7,999 teu	10,192	**10,917**	12,882	2007
		114	Container 8,000-11,999 teu	10,077	**11,929**	13,748	2010
		10	Container 12,000-14,499 teu	10,199	**10,393**	10,635	2013
6c	Pota (squid)						
		4	08 Container / E 5,000 - 7,999 teu	9,643	**11,469**	13,041	2008
		64	08 Container / D 8,000 - 11,999 teu	9,447	**11,457**	14,231	2012
		40	08 Container / C 12,000 - 14,499 teu	9,306	**10,441**	12,942	2012
		3	08 Container / B 14,500 - 19,999 teu	9,926	**10,061**	10,306	2019

In addition, transit weighted average speeds and average route times were estimated and the APEC Module 1 was used to estimate the longer transit times associated with the speed reduction groups of 10%, 20%, and 30%, as presented in Table 9.3.

Table 9.3: Average route distance, speed, & longer transit ,times, by speed reduction group

Country	Case Study	Commodity	Transits	Ship type & size	Avg Route Distance (nm)	Avg Route Speed (knots)	Avg Route Time (hours)	SR 10% Delay Delta (days)	SR 20% Delay Delta (days)	SR 30% Delay Delta (days)
Peru	6a	Copper	8	Bulk carrier 35,000 - 59,999 dwt	10,834	11.9	911	4.2	9.5	16.3
			8	Bulk carrier 60,000 - 99,999 dwt	11,052	12.4	891	4.1	9.3	15.9
	6b	Grapes	3	Container 3,000-4,999 teu	10,852	15.6	696	3.2	7.3	12.4
			38	Container 5,000-7,999 teu	10,917	16.8	650	3.0	6.8	11.6
			114	Container 8,000-11,999 teu	11,929	17.9	668	3.1	7.0	11.9
			10	Container 12,000-14,499 teu	10,393	17.8	584	2.7	6.1	10.4
	6c	Pota (squid)	4	08 Container / E 5,000 - 7,999 teu	11,469	16.6	693	3.2	7.2	12.4
			64	08 Container / D 8,000 - 11,999 teu	11,457	16.5	693	3.2	7.2	12.4
			40	08 Container / C 12,000 - 14,499 teu	10,441	17.0	614	2.8	6.4	11.0
			3	08 Container / B 14,500 - 19,999 teu	10,061	17.9	562	2.6	5.9	10.0

The distances to market for all three commodities range from an average of 10,000 to nearly 12,000 nautical miles.

Total commodity cost intensity changes due to speed reduction

APEC Module 2 was used to estimate the commodity cost intensity increases due to potentially longer transit times resulting from the three speed reduction groups. The module estimates the daily cost increases, in percentage, associated with the following

- Finance/interest costs – the financial cost of capital invested in inventory over time. This measures the impact of each hour or day of delay in the cost of the product due to cost of money or interest rate. A Member State rate was used when provided, otherwise, it was assumed to be 5%.[121]

[121] Lending Tree, *Assuming a line of credit 5%*.

- Depreciation costs – the cost allocation of a commodity, or reduction of the commodity value, over its useful life. For this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry bulk cargo.[122]
- Insurance costs – a cost paid by the cargo owner to protect their goods while in transit. The percentage used in the economic analysis is the one provided by the Member State. In the case of Peru, insurance cost rates provided were as follows: 1% for cooper and grapes, and 0.47% for pota. These rates were applied in the economic impact model during analysis.

The total commodity cost intensity change related to the three speed reduction groups for the case studies is presented in Table 9.4. Note that these values remain constant across scenarios and forecasted year.

Table 9.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Commodity-side Task 4 TCCIsr Change, % SR 10%	SR 20%	SR 30%
Peru	6a	Copper	8	Bulk carrier 35,000 - 59,999 dwt	11	0.58%	2.96%	8.70%
			8	Bulk carrier 60,000 - 99,999 dwt	6	0.56%	2.83%	8.32%
	6b	Grapes	3	Container 3,000-4,999 teu	16	0.34%	1.73%	5.08%
			38	Container 5,000-7,999 teu	16	0.30%	1.51%	4.43%
			114	Container 8,000-11,999 teu	14	0.31%	1.59%	4.67%
			10	Container 12,000-14,499 teu	10	0.24%	1.21%	3.57%
	6c	Pota (squid)	4	08 Container / E 5,000 - 7,999 teu	15	0.34%	1.71%	5.03%
			64	08 Container / D 8,000 - 11,999 teu	13	0.34%	1.71%	5.03%
			40	08 Container / C 12,000 - 14,499 teu	11	0.27%	1.34%	3.95%
			3	08 Container / B 14,500 - 19,999 teu	4	0.22%	1.13%	3.31%

The commodity cost intensity changes due to speed reduction, ranges as follows:

- 6a – SR 10% → 0.56%-0.58% SR 20% → 2.83%-2.96% SR 30% → 8.32%-8.70%
- 6b – SR 10% → 0.24%-0.34% SR 20% → 1.21%-1.73% SR 30% → 3.57%-5.08%
- 6c – SR 10% → 0.22%-0.34% SR 20% → 1.13%-1.71% SR 30% → 3.31%-5.03%

Task 2 cost intensity changes due to MTM

Based on the ship type, size, and age combination for each commodity case study, the applicable Task 2 ship-side commodity cost intensities due to the MTM were identified for the selected scenarios. In addition, in order to be able to add these to the commodity cost intensity changes due to speed reduction, the a*d valorem* freight rate percentage was identified using the UNCTAD Trade-and-Transport Dataset.[123] The *ad valorem* freight rate percentage represents the transportation cost percentage of a commodity's total cost. These factors were multiplied to get the freight rate adjusted commodity cost intensity or FRACCI change for 2030, 2040, and 2050. Task 2 cost intensity change and FRACCI for each scenario are presented in Table 9.5.

[122] APEC 2019
[123] UNCTAD, *Trade-and-Transport Dataset*.

Table 9.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Peru	6a	Copper	8	Bulk carrier 35,000 - 59,999 dwt	11	1.3%	14.83%	48.40%	57.89%	0.19%	0.63%	0.75%
			8	Bulk carrier 60,000 - 99,999 dwt	6	1.3%	19.24%	42.69%	53.70%	0.25%	0.55%	0.70%
	6b	Grapes	3	Container 3,000-4,999 teu	16	7.5%	9.16%	73.77%	67.78%	0.69%	5.53%	5.08%
			38	Container 5,000-7,999 teu	16	7.5%	8.57%	70.19%	77.81%	0.64%	5.26%	5.84%
			114	Container 8,000-11,999 teu	14	7.5%	16.71%	64.48%	65.89%	1.25%	4.84%	4.94%
			10	Container 12,000-14,499 teu	10	7.5%	29.28%	49.18%	74.70%	2.20%	3.69%	5.60%
	6c	Pota (squid)	4	08 Container / E 5,000 - 7,999 teu	15	6.7%	8.57%	70.19%	77.81%	0.57%	4.70%	5.21%
			64	08 Container / D 8,000 - 11,999 teu	13	6.7%	16.71%	64.48%	65.89%	1.12%	4.32%	4.41%
			40	08 Container / C 12,000 - 14,499 teu	11	6.7%	4.23%	76.22%	78.92%	0.28%	5.11%	5.29%
			3	08 Container / B 14,500 - 19,999 teu	4	6.7%	9.38%	44.67%	56.18%	0.63%	2.99%	3.76%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Peru	6a	Copper	8	Bulk carrier 35,000 - 59,999 dwt	11	1.3%	16.97%	42.72%	58.36%	0.22%	0.56%	0.76%
			8	Bulk carrier 60,000 - 99,999 dwt	6	1.3%	17.31%	40.02%	54.13%	0.22%	0.52%	0.70%
	6b	Grapes	3	Container 3,000-4,999 teu	16	7.5%	10.59%	52.66%	67.58%	0.79%	3.95%	5.07%
			38	Container 5,000-7,999 teu	16	7.5%	9.30%	53.92%	71.26%	0.70%	4.04%	5.34%
			114	Container 8,000-11,999 teu	14	7.5%	14.18%	44.40%	61.66%	1.06%	3.33%	4.62%
			10	Container 12,000-14,499 teu	10	7.5%	25.31%	41.43%	75.63%	1.90%	3.11%	5.67%
	6c	Pota (squid)	4	08 Container / E 5,000 - 7,999 teu	15	6.7%	9.30%	53.92%	71.26%	0.62%	3.61%	4.77%
			64	08 Container / D 8,000 - 11,999 teu	13	6.7%	14.18%	44.40%	61.66%	0.95%	2.97%	4.13%
			40	08 Container / C 12,000 - 14,499 teu	11	6.7%	7.96%	61.14%	74.62%	0.53%	4.10%	5.00%
			3	08 Container / B 14,500 - 19,999 teu	4	6.7%	12.82%	42.67%	56.39%	0.86%	2.86%	3.78%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Peru	6a	Copper	8	Bulk carrier 35,000 - 59,999 dwt	11	1.3%	16.51%	47.79%	63.97%	0.21%	0.62%	0.83%
			8	Bulk carrier 60,000 - 99,999 dwt	6	1.3%	16.74%	44.14%	59.49%	0.22%	0.57%	0.77%
	6b	Grapes	3	Container 3,000-4,999 teu	16	7.5%	18.51%	55.11%	64.54%	1.39%	4.13%	4.84%
			38	Container 5,000-7,999 teu	16	7.5%	18.52%	52.42%	71.47%	1.39%	3.93%	5.36%
			114	Container 8,000-11,999 teu	14	7.5%	22.77%	47.01%	61.89%	1.71%	3.53%	4.64%
			10	Container 12,000-14,499 teu	10	7.5%	23.66%	45.71%	81.59%	1.77%	3.43%	6.12%
	6c	Pota (squid)	4	08 Container / E 5,000 - 7,999 teu	15	6.7%	18.52%	52.42%	71.47%	1.24%	3.51%	4.79%
			64	08 Container / D 8,000 - 11,999 teu	13	6.7%	22.77%	47.01%	61.89%	1.53%	3.15%	4.15%
			40	08 Container / C 12,000 - 14,499 teu	11	6.7%	16.02%	61.94%	68.50%	1.07%	4.15%	4.59%
			3	08 Container / B 14,500 - 19,999 teu	4	6.7%	19.35%	38.43%	62.03%	1.30%	2.57%	4.16%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Peru	6a	Copper	8	Bulk carrier 35,000 - 59,999 dwt	11	1.3%	16.35%	48.12%	62.08%	0.21%	0.63%	0.81%
			8	Bulk carrier 60,000 - 99,999 dwt	6	1.3%	16.75%	44.47%	58.06%	0.22%	0.58%	0.75%
	6b	Grapes	3	Container 3,000-4,999 teu	16	7.5%	21.78%	60.14%	65.30%	1.63%	4.51%	4.90%
			38	Container 5,000-7,999 teu	16	7.5%	20.15%	55.80%	67.84%	1.51%	4.18%	5.09%
			114	Container 8,000-11,999 teu	14	7.5%	24.49%	51.22%	59.89%	1.84%	3.84%	4.49%
			10	Container 12,000-14,499 teu	10	7.5%	21.78%	47.86%	83.90%	1.63%	3.59%	6.29%
	6c	Pota (squid)	4	08 Container / E 5,000 - 7,999 teu	15	6.7%	20.15%	55.80%	67.84%	1.35%	3.74%	4.55%
			64	08 Container / D 8,000 - 11,999 teu	13	6.7%	24.49%	51.22%	59.89%	1.64%	3.43%	4.01%
			40	08 Container / C 12,000 - 14,499 teu	11	6.7%	18.32%	63.71%	68.88%	1.23%	4.27%	4.61%
			3	08 Container / B 14,500 - 19,999 teu	4	6.7%	21.43%	40.74%	58.34%	1.44%	2.73%	3.91%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Peru	6a	Copper	8	Bulk carrier 35,000 - 59,999 dwt	11	1.3%	37.32%	55.72%	59.96%	0.49%	0.72%	0.78%
			8	Bulk carrier 60,000 - 99,999 dwt	6	1.3%	35.27%	49.89%	56.87%	0.46%	0.65%	0.74%
	6b	Grapes	3	Container 3,000-4,999 teu	16	7.5%	59.80%	71.49%	68.04%	4.49%	5.36%	5.10%
			38	Container 5,000-7,999 teu	16	7.5%	51.53%	65.50%	73.94%	3.86%	4.91%	5.55%
			114	Container 8,000-11,999 teu	14	7.5%	58.81%	67.01%	63.19%	4.41%	5.03%	4.74%
			10	Container 12,000-14,499 teu	10	7.5%	48.08%	66.50%	79.43%	3.61%	4.99%	5.96%
	6c	Pota (squid)	4	08 Container / E 5,000 - 7,999 teu	15	6.7%	51.53%	65.50%	73.94%	3.45%	4.39%	4.95%
			64	08 Container / D 8,000 - 11,999 teu	13	6.7%	58.81%	67.01%	63.19%	3.94%	4.49%	4.23%
			40	08 Container / C 12,000 - 14,499 teu	11	6.7%	57.16%	85.14%	71.38%	3.83%	5.70%	4.78%
			3	08 Container / B 14,500 - 19,999 teu	4	6.7%	45.10%	58.21%	58.76%	3.02%	3.90%	3.94%

Copper, a high-cost export commodity, has an *ad valorem* rate of 1.3%, meaning the impacts from any ship-side changes are very limited. Grapes and squid have an *ad valorem* rate of 7.5% and 6.7% respectively, and are comparatively more sensitive to ship-side cost intensity increases.

Note that there are significant differences between ship type, size, and age groups between scenarios. As learned from our consultation with DNV, "It should be noted that scenarios 23 and 24, and to a lesser degree scenarios 31 and 32, show large differences in cost impacts in 2030 depending on the generation of ships deployed. Ships with 10 years or less of age – i.e. built in the period between 2020 and 2029 – have a significantly higher increase in costs compared to older vessels. In the scenarios with a GFI flexibility mechanism the newer ships built in 2020-2029 takes the brunt of the GHG intensity reductions, resulting in a higher cost increase compared to older ships when looking at all abatement costs. This is as expected, as the cost of reduction is relatively lower for new ships compared to existing ships.

"However, it should also be expected that there should be some compensation from the older ships to the newer ships when joining in a compliance pool under the GFI flexibility mechanism. DNV indicates in their report that the emission unit exchange price is set to the marginal cost of the last ship in the pool that was selected to implement an additional measure.

"However, when applying this price the results showed that the newer ships are overcompensated (i.e. the compensation led to a cost decrease), meaning that the marginal cost of the last ship is likely not a very good indicator for the exchange price in a pool as the many ships will have lower abatement costs. For this reason the costs and incomes of joining a pool are not included in this analysis."[124]

Total commodity cost intensity due to speed reduction and MTM

For each commodity case study, combining Task 2 and Task 4 results estimates the total commodity cost intensity[125] associated with potential speed reduction and the MTM ($TCCI_{mtm}$), for the forecasted years of 2030, 2040, and 2050, as presented in Table 9.6, on the following page. For each case study, the results were compiled into a transit-weighted average for each scenario and forecasted year. These results are presented as Table 9.7.

[124] Email exchange with Tore Longa, Project Manager Task 2, 1 June 2024.
[125] The term 'total commodity cost intensity' as used in this report is defined as the total 'landed cost' of the commodity.

Table 9.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Peru	6a	Copper	8 Bulk carrier 35,000 - 59,999 dwt	11	0.19%	0.78%	3.15%	8.89%	0.63%	1.21%	3.59%	9.32%	0.75%	1.34%	3.71%	9.45%
			8 Bulk carrier 60,000 - 99,999 dwt	6	0.25%	0.81%	3.08%	8.57%	0.55%	1.11%	3.39%	8.88%	0.70%	1.26%	3.53%	9.02%
	6b	Grapes	3 Container 3,000-4,999 teu	16	0.69%	1.03%	2.42%	5.77%	5.53%	5.87%	7.26%	10.61%	5.08%	5.42%	6.81%	10.16%
			38 Container 5,000-7,999 teu	16	0.64%	0.94%	2.15%	5.08%	5.26%	5.56%	6.77%	9.70%	5.84%	6.13%	7.34%	10.27%
			114 Container 8,000-11,999 teu	14	1.25%	1.57%	2.84%	5.92%	4.84%	5.15%	6.43%	9.51%	4.94%	5.26%	6.53%	9.61%
			10 Container 12,000-14,499 teu	10	2.20%	2.44%	3.41%	5.76%	3.69%	3.93%	4.90%	7.26%	5.60%	5.84%	6.82%	9.17%
	6c	Pota (squid)	4 08 Container / E 5,000 - 7,999 teu	15	0.57%	0.91%	2.29%	5.61%	4.70%	5.04%	6.41%	9.73%	5.21%	5.55%	6.93%	10.24%
			64 08 Container / D 8,000 - 11,999 teu	13	1.12%	1.46%	2.83%	6.15%	4.32%	4.66%	6.03%	9.35%	4.41%	4.75%	6.13%	9.45%
			40 08 Container / C 12,000 - 14,499 teu	11	0.28%	0.55%	1.63%	4.23%	5.11%	5.37%	6.45%	9.05%	5.29%	5.55%	6.63%	9.24%
			3 08 Container / B 14,500 - 19,999 teu	4	0.63%	0.85%	1.75%	3.94%	2.99%	3.22%	4.12%	6.30%	3.76%	3.99%	4.89%	7.07%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Peru	6a	Copper	8 Bulk carrier 35,000 - 59,999 dwt	11	0.22%	0.81%	3.18%	8.92%	0.56%	1.14%	3.51%	9.25%	0.76%	1.34%	3.72%	9.45%
			8 Bulk carrier 60,000 - 99,999 dwt	6	0.22%	0.78%	3.06%	8.55%	0.52%	1.08%	3.35%	8.84%	0.70%	1.26%	3.54%	9.03%
	6b	Grapes	3 Container 3,000-4,999 teu	16	0.79%	1.14%	2.52%	5.87%	3.95%	4.29%	5.68%	9.03%	5.07%	5.41%	6.80%	10.15%
			38 Container 5,000-7,999 teu	16	0.70%	1.00%	2.21%	5.13%	4.04%	4.34%	5.55%	8.48%	5.34%	5.64%	6.85%	9.78%
			114 Container 8,000-11,999 teu	14	1.06%	1.38%	2.65%	5.73%	3.33%	3.64%	4.92%	8.00%	4.62%	4.94%	6.21%	9.30%
			10 Container 12,000-14,499 teu	10	1.90%	2.14%	3.11%	5.47%	3.11%	3.35%	4.32%	6.67%	5.67%	5.91%	6.89%	9.24%
	6c	Pota (squid)	4 08 Container / E 5,000 - 7,999 teu	15	0.62%	0.96%	2.34%	5.65%	3.61%	3.95%	5.32%	8.64%	4.77%	5.11%	6.49%	9.81%
			64 08 Container / D 8,000 - 11,999 teu	13	0.95%	1.29%	2.66%	5.98%	2.97%	3.31%	4.69%	8.01%	4.13%	4.47%	5.84%	9.17%
			40 08 Container / C 12,000 - 14,499 teu	11	0.53%	0.80%	1.88%	4.48%	4.10%	4.36%	5.44%	8.04%	5.00%	5.26%	6.34%	8.95%
			3 08 Container / B 14,500 - 19,999 teu	4	0.86%	1.08%	1.98%	4.17%	2.86%	3.08%	3.98%	6.17%	3.78%	4.00%	4.90%	7.09%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Peru	6a	Copper	8 Bulk carrier 35,000 - 59,999 dwt	11	0.21%	0.80%	3.17%	8.91%	0.62%	1.21%	3.58%	9.32%	0.83%	1.42%	3.79%	9.53%
			8 Bulk carrier 60,000 - 99,999 dwt	6	0.22%	0.78%	3.05%	8.54%	0.57%	1.13%	3.41%	8.90%	0.77%	1.33%	3.61%	9.10%
	6b	Grapes	3 Container 3,000-4,999 teu	16	1.39%	1.73%	3.12%	6.47%	4.13%	4.47%	5.86%	9.21%	4.84%	5.18%	6.57%	9.92%
			38 Container 5,000-7,999 teu	16	1.39%	1.69%	2.90%	5.82%	3.93%	4.23%	5.44%	8.36%	5.36%	5.66%	6.87%	9.79%
			114 Container 8,000-11,999 teu	14	1.71%	2.02%	3.30%	6.38%	3.53%	3.84%	5.11%	8.20%	4.64%	4.96%	6.23%	9.31%
			10 Container 12,000-14,499 teu	10	1.77%	2.01%	2.99%	5.34%	3.43%	3.67%	4.64%	7.00%	6.12%	6.36%	7.33%	9.69%
	6c	Pota (squid)	4 08 Container / E 5,000 - 7,999 teu	15	1.24%	1.58%	2.95%	6.27%	3.51%	3.85%	5.22%	8.54%	4.79%	5.13%	6.50%	9.82%
			64 08 Container / D 8,000 - 11,999 teu	13	1.53%	1.86%	3.24%	6.56%	3.15%	3.49%	4.86%	8.18%	4.15%	4.48%	5.86%	9.18%
			40 08 Container / C 12,000 - 14,499 teu	11	1.07%	1.34%	2.42%	5.02%	4.15%	4.42%	5.49%	8.10%	4.59%	4.85%	5.93%	8.54%
			3 08 Container / B 14,500 - 19,999 teu	4	1.30%	1.52%	2.42%	4.60%	2.57%	2.80%	3.70%	5.88%	4.16%	4.38%	5.28%	7.46%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	2030 SR 10%	2030 SR 20%	2030 SR 30%	2040 TCCImtm Change, % SR 0%	2040 SR 10%	2040 SR 20%	2040 SR 30%	2050 TCCImtm Change, % SR 0%	2050 SR 10%	2050 SR 20%	2050 SR 30%
Peru	6a	Copper	8	Bulk carrier 35,000 - 59,999 dwt	11	0.21%	0.80%	3.17%	8.91%	0.63%	1.21%	3.58%	9.32%	0.81%	1.39%	3.77%	9.50%
			8	Bulk carrier 60,000 - 99,999 dwt	6	0.22%	0.78%	3.05%	8.54%	0.58%	1.14%	3.41%	8.90%	0.75%	1.31%	3.59%	9.08%
	6b	Grapes	3	Container 3,000-4,999 teu	16	1.63%	1.97%	3.36%	6.71%	4.51%	4.85%	6.24%	9.59%	4.90%	5.24%	6.63%	9.98%
			38	Container 5,000-7,999 teu	16	1.51%	1.81%	3.02%	5.94%	4.18%	4.48%	5.69%	8.62%	5.09%	5.39%	6.60%	9.52%
			114	Container 8,000-11,999 teu	14	1.84%	2.15%	3.43%	6.51%	3.84%	4.16%	5.43%	8.51%	4.49%	4.81%	6.08%	9.16%
			10	Container 12,000-14,499 teu	10	1.63%	1.87%	2.85%	5.20%	3.59%	3.83%	4.80%	7.16%	6.29%	6.53%	7.51%	9.86%
	6c	Pota (squid)	4	08 Container / E 5,000 - 7,999 teu	15	1.35%	1.69%	3.06%	6.38%	3.74%	4.08%	5.45%	8.77%	4.55%	4.88%	6.26%	9.58%
			64	08 Container / D 8,000 - 11,999 teu	13	1.64%	1.98%	3.35%	6.68%	3.43%	3.77%	5.14%	8.47%	4.01%	4.35%	5.73%	9.05%
			40	08 Container / C 12,000 - 14,499 teu	11	1.23%	1.49%	2.57%	5.18%	4.27%	4.53%	5.61%	8.22%	4.61%	4.88%	5.96%	8.56%
			3	08 Container / B 14,500 - 19,999 teu	4	1.44%	1.66%	2.56%	4.74%	2.73%	2.95%	3.86%	6.04%	3.91%	4.13%	5.03%	7.22%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	2030 SR 10%	2030 SR 20%	2030 SR 30%	2040 TCCImtm Change, % SR 0%	2040 SR 10%	2040 SR 20%	2040 SR 30%	2050 TCCImtm Change, % SR 0%	2050 SR 10%	2050 SR 20%	2050 SR 30%
Peru	6a	Copper	8	Bulk carrier 35,000 - 59,999 dwt	11	0.49%	1.07%	3.44%	9.18%	0.72%	1.31%	3.68%	9.42%	0.78%	1.36%	3.74%	9.47%
			8	Bulk carrier 60,000 - 99,999 dwt	6	0.46%	1.02%	3.29%	8.78%	0.65%	1.21%	3.48%	8.97%	0.74%	1.30%	3.57%	9.06%
	6b	Grapes	3	Container 3,000-4,999 teu	16	4.49%	4.83%	6.21%	9.56%	5.36%	5.70%	7.09%	10.44%	5.10%	5.44%	6.83%	10.18%
			38	Container 5,000-7,999 teu	16	3.86%	4.16%	5.37%	8.30%	4.91%	5.21%	6.42%	9.35%	5.55%	5.84%	7.05%	9.98%
			114	Container 8,000-11,999 teu	14	4.41%	4.72%	6.00%	9.08%	5.03%	5.34%	6.62%	9.70%	4.74%	5.05%	6.33%	9.41%
			10	Container 12,000-14,499 teu	10	3.61%	3.85%	4.82%	7.17%	4.99%	5.23%	6.20%	8.55%	5.96%	6.20%	7.17%	9.52%
	6c	Pota (squid)	4	08 Container / E 5,000 - 7,999 teu	15	3.45%	3.79%	5.16%	8.48%	4.39%	4.73%	6.10%	9.42%	4.95%	5.29%	6.67%	9.99%
			64	08 Container / D 8,000 - 11,999 teu	13	3.94%	4.28%	5.65%	8.97%	4.49%	4.83%	6.20%	9.52%	4.23%	4.57%	5.95%	9.27%
			40	08 Container / C 12,000 - 14,499 teu	11	3.83%	4.10%	5.17%	7.78%	5.70%	5.97%	7.05%	9.65%	4.78%	5.05%	6.13%	8.73%
			3	08 Container / B 14,500 - 19,999 teu	4	3.02%	3.24%	4.15%	6.33%	3.90%	4.12%	5.03%	7.21%	3.94%	4.16%	5.06%	7.25%

Table 9.7: 2030, 2040, & 2050 commodity case study transit-weighted average total commodity cost intensity, by scenario and forecasted year

2030

Country	Case Study	Case Study Commodity	Ship Type(s)	2030 Scenario 23 TCCImtm, % increase				2030 Scenario 24 TCCImtm, % increase				2030 Scenario 31 TCCImtm, % increase				2030 Scenario 32 TCCImtm, % increase				2030 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Peru	6a	Copper	Bulk carrier	0.22%	0.79%	3.12%	8.73%	0.22%	0.79%	3.12%	8.73%	0.22%	0.79%	3.11%	8.73%	0.22%	0.79%	3.11%	8.72%	0.47%	1.04%	3.37%	8.98%
	6b	Grapes	Container	1.16%	1.47%	2.71%	5.72%	1.03%	1.33%	2.58%	5.58%	1.63%	1.94%	3.18%	6.19%	1.75%	2.05%	3.30%	6.30%	4.24%	4.54%	5.79%	8.79%
	6c	Pota (squid)	Container	0.79%	1.09%	2.35%	5.38%	0.79%	1.09%	2.35%	5.38%	1.35%	1.66%	2.91%	5.94%	1.48%	1.78%	3.04%	6.07%	3.86%	4.17%	5.42%	8.45%

2040

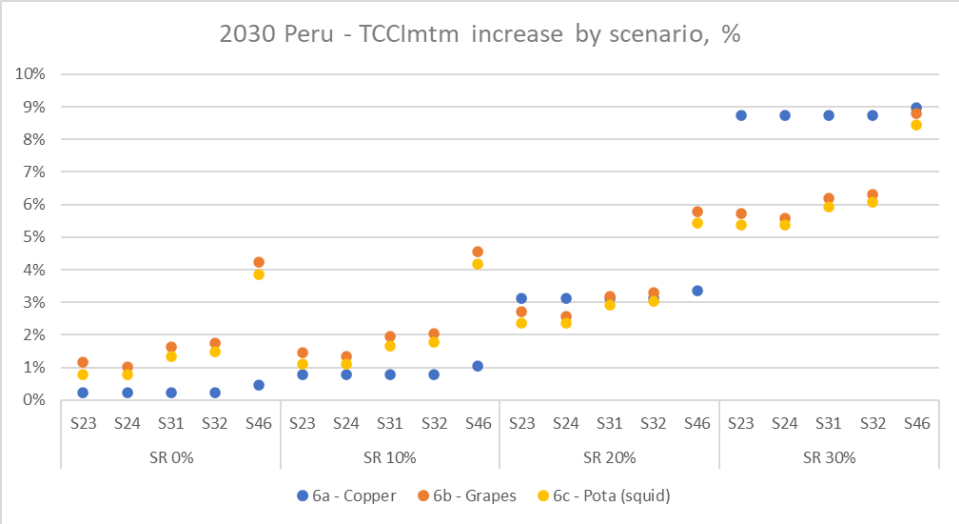
Country	Case Study	Case Study Commodity	Ship Type(s)	2040 Scenario 23 TCCImtm, % increase				2040 Scenario 24 TCCImtm, % increase				2040 Scenario 31 TCCImtm, % increase				2040 Scenario 32 TCCImtm, % increase				2040 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Peru	6a	Copper	Bulk carrier	0.59%	1.16%	3.49%	9.10%	0.54%	1.11%	3.43%	9.05%	0.60%	1.17%	3.49%	9.11%	0.60%	1.17%	3.50%	9.11%	0.69%	1.26%	3.58%	9.20%
	6b	Grapes	Container	4.88%	5.18%	6.43%	9.43%	3.49%	3.80%	5.04%	8.05%	3.62%	3.93%	5.17%	8.18%	3.92%	4.22%	5.47%	8.47%	5.00%	5.31%	6.55%	9.56%
	6c	Pota (squid)	Container	4.58%	4.89%	6.15%	9.18%	3.40%	3.71%	4.96%	7.99%	3.51%	3.82%	5.07%	8.10%	3.73%	4.03%	5.29%	8.32%	4.91%	5.22%	6.47%	9.50%

2050

Country	Case Study	Case Study Commodity	Ship Type(s)	2050 Scenario 23 TCCImtm, % increase				2050 Scenario 24 TCCImtm, % increase				2050 Scenario 31 TCCImtm, % increase				2050 Scenario 32 TCCImtm, % increase				2050 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Peru	6a	Copper	Bulk carrier	0.73%	1.30%	3.62%	9.23%	0.73%	1.30%	3.63%	9.24%	0.80%	1.37%	3.70%	9.31%	0.78%	1.35%	3.68%	9.29%	0.76%	1.33%	3.65%	9.27%
	6b	Grapes	Container	5.19%	5.50%	6.74%	9.75%	4.86%	5.17%	6.41%	9.42%	4.90%	5.21%	6.45%	9.46%	4.75%	5.05%	6.30%	9.30%	5.01%	5.31%	6.56%	9.56%
	6c	Pota (squid)	Container	4.74%	5.05%	6.30%	9.34%	4.46%	4.77%	6.02%	9.05%	4.33%	4.64%	5.89%	8.93%	4.25%	4.55%	5.81%	8.84%	4.45%	4.76%	6.01%	9.05%

The 2030, 2040, and 2050 transit-weighted averaged, total commodity cost intensity ranges across all scenarios, by speed reduction group is presented in Figures 9.2, 9.3, and 9.4, respectively.

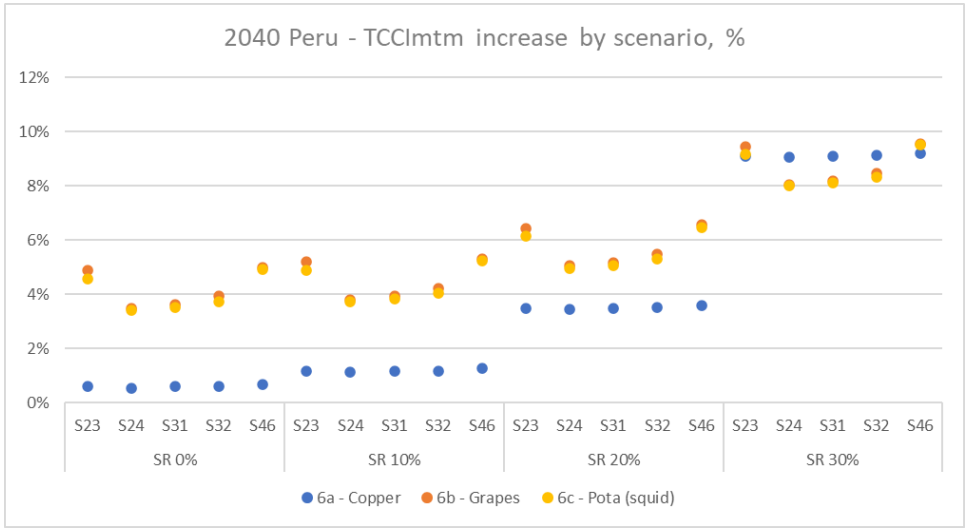
Figure 9.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2030, copper exports transported by bulk ships are extremely sensitive to speed reduction due to their extremely low *ad valorem* rate. For copper, there is no significant cost intensity increase spread between scenarios within a speed reduction group. With changes in speed reduction groups, the commodity cost intensity for copper generally doubles at SR 10%, triples at SR 20%, and triples again at SR 30%. Grapes and squid, have similar cost intensity spreads between scenarios within a speed reduction group, and their highest sensitivity is to Scenario 46. In regards to speed reduction, they are more sensitive at SR 20%, where they double, and SR 30%, where they double again. The key parameters range from:

- **TCCImtm** **0.22% to 8.98%, with an average of 3.35%**

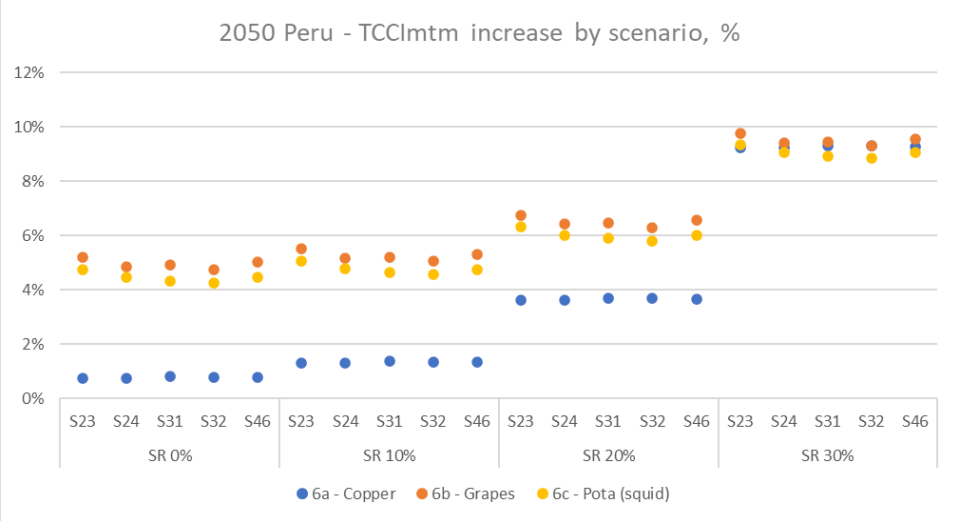
Figure 9.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2040, copper continues to be extremely sensitive to speed reductions, generally doubling at SR 10%, tripling at SR 20%, and then nearly tripling again at SR 30%. Grapes and squid continue to have similar cost intensities, but have a pronounced increase of nearly two to three times across SR 0% and SR 10% compared to 2030. This is because these commodities are more sensitive to ship-side costs compared to cooper. In SR 30%, all three commodities are generally in a narrow band of increases, but 2 to 3 times greater than SR 0%. The key parameters range from:

- **TCCImtm** **0.54% to 9.56%, with an average of 5.01%**

Figure 9.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2050, copper remains close to 2030 and 2040 levels across all speed reduction groups, again showing only a mild sensitivity to ship-side costs. Grapes and squid generally track at the 2030 levels with commodity cost intensity increases of grapes slightly higher than squid. The value oscillations between scenarios within a speed reduction group are less variable. The key parameters range from:

- **TCCImtm** **0.73% to 9.75%, with an average of 5.45%**

GDP context

Per the information provided by Instituto Nacional de Estadística e Informática de Peru (INEI),[126] the mining sector, where copper is part of, shares 6.98% of the total country GDP; the agricultural sector (grapes) shares 3.62%, and fishery (pota) 0.23%.

[126] INEI, *Información estadística.*

9.4 Qualitative analysis

Peru provided detailed Qualitative information on all three of their commodities using input from experts for each commodity. These are:

- Copper responses were provided by Dirección General de Investigación y Estudios sobre Comercio Exterior (DGIECE).
- Grapes and pota (squid) responses were provided as one document by Dirección General de Investigación y Estudios sobre Comercio Exterior (DGIECE).

In these Qualitative responses, emails and virtual meetings the stakeholders all showed awareness of the potential impacts of the IMO measures to decarbonize shipping on their businesses, as well as related factors such as the impact of changing vessel size on port facilities and impacts on markets and competitiveness.

Analyses of these responses are displayed on the following SWOT grids (Tables 9.8 and 9.9) showing sensitivities to freight costs and sensitivities to transit times. Key takeaways for each grid are reflected below the SWOT grids.

Table 9.8: SWOT analysis of Peru's commodities and their sensitivity to cost changes

Sensitivity to freight shipment cost changes as reported by the stakeholders	
Country: Peru Commodities: 6a Copper, 6b Grapes, 6c Pota (squid)	
Strengths ➢ Cargo volumes and costs for air transport mean sea is the predominant mode. ➢ Pota (squid) is normally shipped frozen, making it less sensitive to longer transportation times. ➢ The country will soon have the capacity to receive larger ships as well as a greater number of ships.	**Weaknesses** ➢ The main markets for all three commodities are located far from Peru. ➢ Grapes and pota transport have the added cost of refrigeration during transport and storage. ➢ Frozen products such as squid could withstand a slower journey without quality loss, however, the refrigeration costs of the cargo would increase.
Opportunities to adapt/mitigate ➢ Develop specialty Reefer systems or new grape variants to prolong growing season or shelf life. ➢ The country will soon have the capacity to receive larger ships as well as a greater number of ships.	**Threats** ➢ IMO GHG MTM may increase shipping costs for all commodities. ➢ Importers would face an increase in their acquisition costs for the products. Exporters revenues would experience a downward trend due to the decreased selling prices. Producers would witness a reduction in their overall income generated from product sales. The ultimate cost burden falls upon the consumer. As a result, the price of grapes and squid would experience an upward adjustment in the target market, diminishing their competitive edge. ➢ Increased transportation costs would mean loss -- loss of competitiveness, higher prices for our products due to higher transportation costs.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- Importers would face an increase in their acquisition costs for the products. Exporters' revenues would experience a downward trend due to the decreased selling prices. Producers would witness a reduction in their overall income generated from product sales.
- Grapes and pota transport have the added cost of refrigeration during transport and storage. Frozen products such as squid could withstand a slower journey without quality loss, however, grapes do deteriorate with longer chilling times. The refrigeration costs of both commodities would increase.
- The ultimate cost burden falls upon the consumer. As a result, the price of grapes and squid would experience an upward adjustment in the target market, diminishing their competitive edge.
- If shipping rates do not increase, this measure would not affect copper exports. However, coordination efforts would be necessary to avoid material shortages when shipments with longer durations begin.

The potential adverse repercussions of our increased exports encompass:

- Disrupted Market Entry: Our products may encounter delays or even barriers to entry in Asian markets due to the implementation of more stringent environmental regulations and evolving consumer preferences in those regions.
- Erosion of Competitiveness: Our products could lose their competitive advantage in the global marketplace due to concerns associated with their environmental impact and the associated costs of implementing mitigation measures.
- Escalating Product Prices: The adoption of stricter environmental standards and the increase in transportation costs could lead to an overall price hike for our products, potentially diminishing their appeal to consumers.

Table 9.9: SWOT analysis of Peru's commodities and their sensitivity to transport time changes.

Sensitivity to increased transport times as reported by the stakeholders	
Country: Peru Commodities: 6a Copper, 6b Grapes, 6c Pota (squid)	
Strengths ➢ Copper does not degrade with longer transport time. ➢ Frozen products such as squid could withstand a slower journey without quality loss.	**Weaknesses** ➢ All 3 commodities demand timely arrivals for KPI and productivity reasons. ➢ Grapes are a fresh product that must be shipped under refrigeration. A longer transit time could increase product loss. ➢ A longer transport time would mean longer refrigeration time for grapes and pota, increasing costs and energy usage. ➢ Peru is in the global south. The main markets for all three commodities are located far from Peru. Thus, Peru has longer shipping distances to markets (Asia) vs some potential competitors.
Opportunities to adapt/mitigate ➢ The port's infrastructure will be enhanced in the near future to enable the berthing of larger ships and the efficient handling of an increased number of vessels.	**Threats** ➢ Grapes are characterized by their seasonal nature, with a harvesting period restricted to a few months annually. Consequently, any delays in delivery will inevitably have a detrimental effect on market participation and competitiveness. ➢ The ultimate cost burden falls upon the consumer. As a result, the price of grapes and squid would experience an upward adjustment in the target market, diminishing their competitive edge. ➢ An increase in shipping times would affect the entire chain related to copper, as it is a raw material used in various productive sectors. Any changes would need to be made well in advance to cover the necessary stocks. If the measure only affects one country and there is another source of copper with faster shipping and at least the same prices, the demand could shift to other suppliers.

Key findings on shipment transport times derived from stakeholder input to the SWOT analysis:

- Commodities may be time-sensitive for a variety of reasons – product degradation, customer demands (KPIs, production efficiency, seasonal demand), market forces and costs. This was well demonstrated by Peru's chosen commodities.
- The ultimate cost burden falls upon the consumer. As a result, the price of grapes and squid would experience an upward adjustment in the target market, diminishing their competitive edge.
- Grapes are characterized by their seasonal nature, with a harvesting period restricted to a few months annually. Consequently, any delays in delivery will inevitably have a detrimental effect on market participation and competitiveness.

- A longer transport time would mean longer refrigeration time for grapes and pota, increasing costs and energy usage.
- An increase in shipping times would affect the entire chain related to copper, as it is a raw material used in various productive sectors. Any changes would need to be made well in advance to cover the necessary stocks.

Another insight to these stakeholders' awareness of and engagement in the decarbonization of shipping is the breadth of their responses to the final open-ended question "What questions should we have asked to more fully understand the impacts of potential vessel greenhouse gas reduction requirements on shipping, your population and your economy?" The additional question topics stakeholders from Peru suggested ranged from supply chain resilience and technology solutions to impacts on human needs and affordability.

9.5 Findings

Quantitative findings

The key findings from the quantitative analysis include:

- Longer transit times from potential speed reduction range across the case studies, including:
  - Copper
    - SR 10% - just over 4 days
    - SR 20% - just under 10 days
    - SR 30% - just over 16 days
  - Grapes
    - SR 10% - 3 days
    - SR 20% - 6 to 7 days
    - SR 30% - 10 to 12 days
  - Squid
    - SR 10% - 2 to 3 days
    - SR 20% - 6 to 7 days
    - SR 30% - 12 to 14 days
- Total commodity cost intensity increases for copper are extremely sensitive to speed reduction, while grapes and squid are more sensitive to ship-side costs.
- The *ad valorem* rate for copper, a high-cost export commodity is 1.3% which means that the impacts from any ship-side changes are very limited, while grapes and squid 7.5% and 6.7% respectively, are relatively more sensitive to increases to ship-side cost intensity increases.
- Note that in 2030, copper exports transported by bulk ships are extremely sensitive to speed reduction due to their extremely low *ad valorem* rate. For copper, there is no significant cost intensity increase spread between scenarios within a speed reduction group. With changes in speed reduction groups, the commodity cost intensity for copper generally doubles at SR 10%, triples at SR 20%, and triples again at SR 30%. Grapes and squid, have similar cost intensity spreads between scenarios within a speed reduction group, with their highest sensitivity to Scenario 46. With changes in speed reduction groups, they are more sensitive to speed reduction at SR 20% where they double, and double again at SR 30%.
- In 2040, copper continues to be extremely sensitive to speed reductions, generally doubling at SR 10%, then tripling at SR 20% and then nearly tripling again at SR 30%. Grapes and squid continue to have similar cost intensities but have a pronounced increase of nearly two to three times across SR 0% and SR 10% compared to 2030. This is because these commodities are more sensitive to ship-side costs compared to cooper. In SR 30%, all three commodities are in generally in a narrow band of increases, but 2 to 3 times greater than SR 0%.

- In 2050, copper remains close to 2030 and 2040 levels across all speed reduction groups, again not being too sensitive to ship-side costs. Grapes and squid generally track at the 2030 levels with commodity cost intensity increases of grapes slightly higher than squid. The value oscillations between scenarios within a speed reduction group are less variable.
- Total commodity cost intensity ranges across all scenarios and speed reduction groups, include:
  - Copper
    - 2030 – 0.22% to 8.98%, with an average of 3.26%
    - 2040 – 0.54% to 9.20%, with an average of 3.60%
    - 2050 – 0.73% to 9.31%, with an average of 3.75%
  - Grapes
    - 2030 – 1.03% to 8.79%, with an average of 3.56%
    - 2040 – 3.49% to 9.56%, with an average of 5.79%
    - 2050 – 4.75% to 9.75%, with an average of 6.54%
  - Squid
    - 2030 – 0.79% to 8.45%, with an average of 3.27%
    - 2040 – 3.40% to 9.50%, with an average of 5.64%
    - 2050 – 4.25% to 9.34%, with an average of 6.06%
- TCCImtm findings for the three commodity case studies across all scenarios and speed reduction groups, by forecasted year:
  - 2030 0.22% to 8.98%, with an average of 3.35%
  - 2040 0.54% to 9.56%, with an average of 5.01%
  - 2050 0.73% to 9.75%, with an average of 5.45%

Qualitative findings

Peru selected three commodities covering a range of time sensitivities: Copper does not deteriorate with time. Grapes are seasonal and perishable, bear refrigeration costs, and the quality deteriorates with time. Pota (squid) is shipped frozen so could withstand a longer journey but with higher costs and energy consumption for refrigeration. While time and cost sensitivities varied by commodity, they shared common concerns for vessel speed or capacity reductions, efficient and timely deliveries and increased costs.

Commodities may be time-sensitive for a variety of reasons – product degradation, customer demands (KPIs, production efficiency, seasonal demand), market forces and costs. For all three commodities selected by Peru, the main customers are located far from Peru, and timely delivery is important.

Peru's stakeholders reported that if green fuels are not available in the country increased exports could inadvertently contribute to environmental pollution.

- Loss of Competitiveness: Our products may become less attractive in the global market due to concerns about their environmental impact.
- Higher Logistics Costs: We may incur additional expenses related to implementing stricter environmental regulations and mitigating the environmental impact of our exports.
- Delayed Market Entry: Our products may face delays in entering Asian markets due to stricter environmental standards and regulations in those regions.

The Peru stakeholders also mentioned that higher transport costs would have these potential adverse repercussions for increased exports:

- Disrupted Market Entry: Our products may encounter delays or even barriers to entry in Asian markets due to the implementation of more stringent environmental regulations and evolving consumer preferences in those regions.
- Erosion of Competitiveness: Our products could lose their competitive advantage in the global marketplace due to concerns associated with their environmental impact and the associated costs of implementing mitigation measures.
- Escalating Product Prices: The adoption of stricter environmental standards and the increase in transportation costs could lead to an overall price hike for our products, potentially diminishing their appeal to consumers.

Opportunities to mitigate impacts identified by Peru's stakeholders during the qualitative analysis seemed limited.

- The port's infrastructure will be enhanced in the near future to enable the berthing of larger ships and the efficient handling of an increased number of vessels. This will impact costs, timeliness and the volumes that can be processed (so waiting time will be reduced).
- Develop Reefer systems or new grape variants to prolong shelf life.

Summary of key points related to potential impacts

The following points are key to understanding the potential impacts of the MTM:

- Peru is one of the fastest growing economies in the region with a GDP of $242,632 million. In 2022, Peru's GDP per capita was $7,126.
- The three commodities selected by Peru for case studies are trade commodity exports of copper, grapes and pota (squid), all destined for distant markets in China and South Korea. All three case studies are exported trade commodities, which means costs increases impact the sector/subsector of the economy associated with each commodity. In addition, the associated employment, supporting industries, and taxes and revenues associated with the commodity will be impacted.
- For these three case studies, the estimates indicate a range of total commodity cost intensity increases related to maritime transport. For grapes and squid across Scenarios 23/24 and 31/32, for all forecasted years, the estimates indicate a range of total commodity cost intensity increases. These increases are estimated to be lower in 2030, but are estimated to significantly increase in 2040 and 2050. Scenario 46 brings forward the significant increase in costs to 2030.
- For copper, due to its high cargo value and extremely low *ad valorem* rate, the average impact is relatively small and does not significantly increase across scenarios and all forecasted years.
- Since these case studies represent export trade commodities only on particular routes, the entire economic sector/subsector is not captured. The full impact on the entire sector/subsector would need to be considered by the Member State and their national stakeholders to determine impacts to GDP, employment, and any collateral impacts on supporting industries.

10 Stakeholders' analysis – South Africa

The Stakeholder Assessment for South Africa focuses on exports of iron ore, citrus fruits and grapes. Iron ore represents the economically critical mining industry and is exported by bulk carrier to Asia. Citrus fruits and grapes are perishable food products and are exported to Asia in containers.

10.1 Geography, population, and economy

Geography

South Africa occupies the most southern tip of Africa with its long coastline stretching more than 3,000 km from the desert border with Namibia on the Atlantic coast southwards around the tip of Africa and then north to the border of subtropical Mozambique on the Indian Ocean.[127] The warm Mozambique-Agulhas Current skirts the east and south coasts as far as Cape Agulhas, while the cold Benguela Current flows northwards along the west coast as far as southern Angola. The contrast in temperature between these two currents partly accounts for significant differences in climate and vegetation, as well as differences in marine life.

Like much of the African continent south of the Sahara, South Africa's landscape is dominated by a high Central Plateau surrounded by coastal lowlands. This plateau is rimmed by the Great Escarpment which extends northwards to about 10° south of the Equator.[128]

South Africa is located in the global south, which is characterized by long trading distances and shipping times to market and resulting higher trading costs. Representative distances to markets for the selected commodities and ports are presented in Section 10.2.

Population

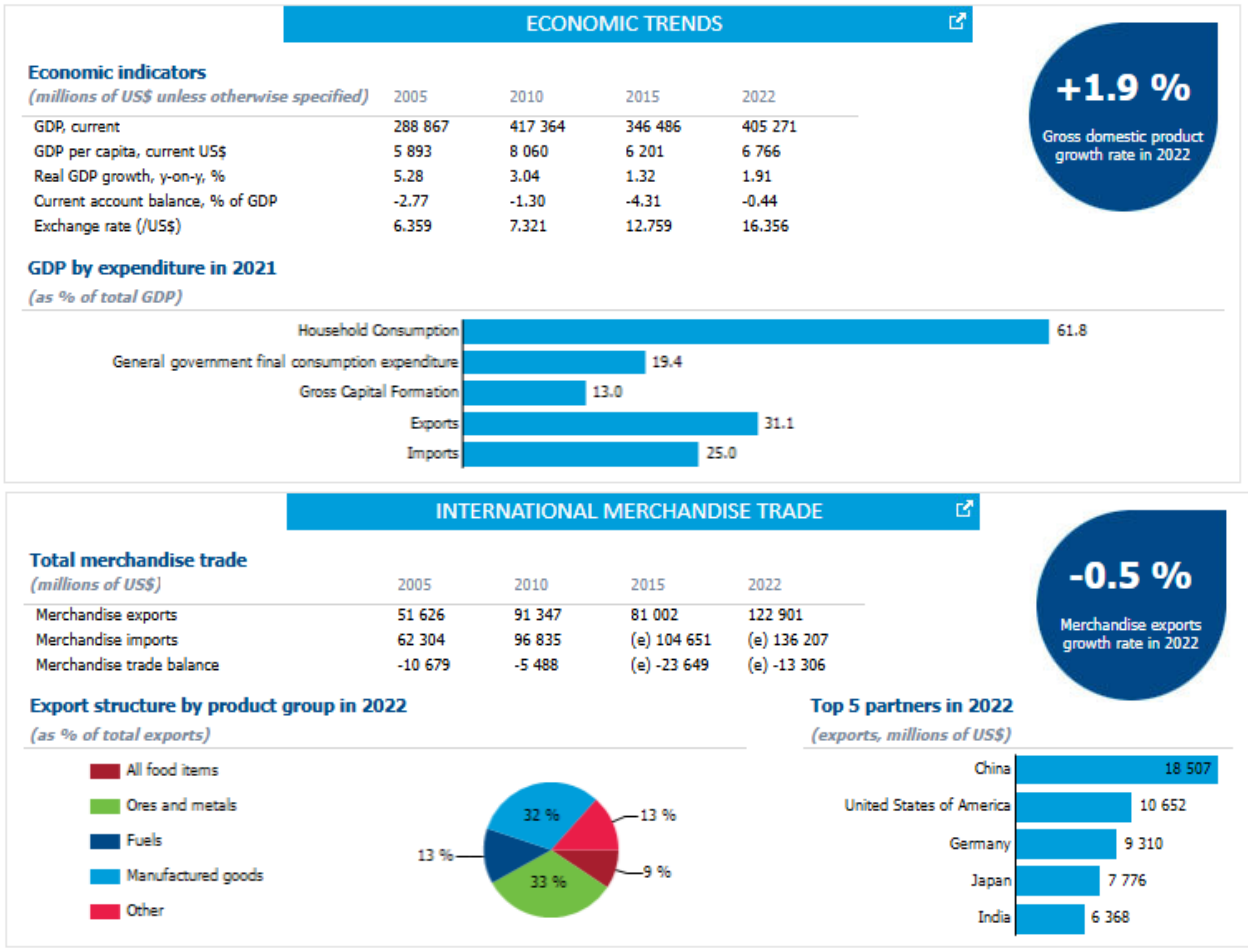
According to the 2022 census, the population of South Africa is about 62 million people of diverse origins, cultures, languages, and religions.[129] The population of South Africa increased from 51.7 million in 2011 to more than 62 million in 2022; a growth rate of 1.8% in that period.[130] Of that population, 68% live in urban areas and 32% in rural areas.[131]

Economy

South Africa is Africa's largest economy with a GDP of $405,271 million. South Africa's GDP per capita has fluctuated in recent years and in 2022, was $6,766.[132] The South African economy demonstrates both emerging market and upper-middle-income components. It is the most industrialized, technologically advanced, and diversified economy in Africa. The major manufacturing sectors are food processing and the production of textiles, metals, and chemicals. South Africa's economy is sensitive to global economic conditions due to its dependence on foreign trade. The country has a sizeable economy by Sub-Saharan African standards and upper-middle-income status but is burdened by high unemployment and inequality.[133] Key economic indicators are on the next page in Figure 10.1.[134]

[127] Republic of South Africa, *Geography and climate*, South African Government.
[128] Times Books Group, *The Times comprehensive atlas of the world* (1999), pp. 88–89, various authors.
[129] Republic of South Africa, *Census Dissemination*, SSA.
[130] Republic of South Africa, *People of South Africa*, South African Government.
[131] UNCTAD, General and Maritime Profiles: South Africa, *UNCTAD Statistics - General Profile*.
[132] UNCTAD, General and Maritime Profiles: South Africa, *UNCTADstat - General Profile*.
[133] World Bank Group, *The World Bank in South Africa*, accessed July 2024.
[134] UNCTAD, General and Maritime Profiles: *South Africa, UNCTAD Statistics - General Profile.*

Figure 10.1: Key economic indicators for South Africa



Source: UNCTAD, General and Maritime Profiles: *South Africa, UNCTAD Statistics - General Profile*

South Africa is rich in a variety of minerals. In addition to diamonds and gold, the country also contains reserves of iron ore, platinum, manganese, chromium, copper, uranium, silver, beryllium, and titanium. No commercially exploitable deposits of petroleum have been found, but moderate quantities of natural gas are located off the southern coast, and synthetic fuel is made from coal at two large plants in the provinces of Free State and Mpumalanga.

For decades, manufacturing has employed more people and produced a greater proportion of gross domestic product (GDP) than mining. However, the mining sector continues to form the core of the South African economy as mining-centered holding companies invest in other economic activity. Gold remains the most important mineral—South Africa is the world's largest producer—and reserves are large; however, production is slowly declining.[135] This strong global position in mining does create economic sensitivity to variation in international commodity prices.

Agriculture is of major importance to South Africa. It produces a significant portion of exports and contributes greatly to the domestic economy, especially as an employer, though land and water resources are generally poor. Arable land constitutes scant more than one-tenth of the country's surface area.[136]

[135] Encyclopedia Britannica, *South Africa – Economy, Mining, Manufacturing*, Randolph Vigne, Christopher C. Lowe.
[136] Encyclopedia Britannica, *Economy of South Africa*, Colin J. Bundy, Andries Nel.

10.2 Identified commodities and routes studied

The Stakeholder Assessment for South Africa focuses on exports of iron ore, citrus fruits and grapes. Iron ore represents the economically critical mining industry and is exported by bulk carrier to Asia. Grapes and citrus fruits are perishable food products that are exported to Asia in containers.

The commodities selected by the Member State for focus and illustrative trade routes are shown in Table 10.1. All commodities selected for this study are exports.

Table 10.1: Shipping distances from South Africa to market for selected commodities

Case Study	Commodity	Illustrative identified routes, by country	Ship Type(s)	Route Distance Range, nm min	avg	max	Stops
7a	Iron ore	South Africa --> China	Bulk carrier	5,818	7,747	8,931	1
7b	Citrus foods	South Africa --> Germany --> The Netherlands	Container	6,885	7,284	8,697	1-5
		South Africa --> Morroco --> Spain --> The Netherlands					
		South Africa --> Morroco --> The Netherlands					
		South Africa --> Nambia --> Morroco --> The Netherlands					
		South Africa --> Nambia --> The Netherlands					
		South Africa --> Spain --> Belgium --> The Netherlands					
		South Africa --> Spain --> Portugal --> The Netherlands					
		South Africa --> Spain --> The Netherlands					
		South Africa --> Spain --> United Kingdom --> The Netherlands					
		South Africa --> The Netherlands					
		South Africa --> United Kingdom --> Germany --> The Netherlands					
		South Africa --> United Kingdom --> The Netherlands					
7c	Grapes	South Africa --> Germany --> The Netherlands --> United Kingdom	Container	6,153	6,458	8,157	1-4
		South Africa --> Morroco --> Spain --> The Netherlands --> United Kingdom					
		South Africa --> Morroco --> The Netherlands --> United Kingdom					
		South Africa --> Portugal --> The Netherlands --> United Kingdom					
		South Africa --> Spain --> Portugal --> The Netherlands --> Belgium --> United Kingdom					
		South Africa --> Spain --> Portugal --> United Kingdom					
		South Africa --> Spain --> The Netherlands --> Belgium --> United Kingdom					
		South Africa --> Spain --> The Netherlands --> United Kingdom					
		South Africa --> Spain --> United Kingdom					

10.3 Quantitative analysis

This section presents the quantitative analysis summary results and is organized by fleet analysis summary, total commodity cost intensity changes from speed reduction, Task 2 cost intensity changes due to MTM, total commodity cost intensity impacts, and GDP contexts. The quantitative analysis incorporates the findings of Task 2 related to the selected bracketing MTM scenarios as presented below:[137]

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination: Policy code	GFI scope	GFI flexibility: RU % of price	SU % of price	Levy: Levy USD/tCO_2eq	Levy: Reward % of cost gap	Feebate Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

The detailed approach for the below analyses is provided in Appendix A.

[137] DNV 2024

Fleet analysis summary

As part of the fleet analysis, routes and ship characteristics were identified for each commodity case study. For the specific ship types identified with the commodity case study and transiting on the identified route the following were averaged to represent the fleet:

- Ship type and size
- Number of transits identified
- Route distances obtained from Marine Benchmark's 2022 AIS database were transit-weighted averaged and reported as minimum, average, and maximum distance sailed
- Transit-weighted average year of build, which was used to determine the average age in years

These characteristics for the case studies are presented in Table 5.2.

Table 10.2: South Africa – Fleet characteristics, by commodity case study

Case Study	Commodity	2022 Transits	Ship Types	Distance Range, nm min	avg	max	Avg Build
7a	Iron ore						
		66	Bulk carrier 35,000 - 59,999 dwt	6,971	**7,709**	8,931	2010
		34	Bulk carrier 60,000 - 99,999 dwt	6,782	**7,645**	8,626	2017
		136	Bulk carrier 100,000 - 199,999 dwt	5,818	**7,784**	8,820	2011
		29	Bulk carrier 200,000 + dwt	6,984	**7,778**	8,778	2011
7b	Citrus foods						
		51	Container 5,000-7,999 teu	6,885	**7,252**	8,084	2009
		35	Container 8,000-11,999 teu	6,993	**7,330**	8,697	2015
7c	Grapes						
		46	Container 5,000-7,999 teu	6,153	**6,522**	8,157	2009
		32	Container 8,000-11,999 teu	6,187	**6,365**	6,801	2016

In addition, transit weighted average speeds and average route times were estimated and the APEC Module 1 was used to estimate the longer transit times associated with the speed reduction groups of 10%, 20%, and 30%, as presented in Table 5.3.

Table 10.3: Average route distance, speed, & longer transit ,times, by speed reduction group

Country	Case Study	Commodity	Transits	Ship type & size	Avg Route Distance (nm)	Avg Route Speed (knots)	Avg Route Time (hours)	SR 10% Delay Delta (days)	SR 20% Delay Delta (days)	SR 30% Delay Delta (days)
South Africa	7a	Iron ore	66	Bulk carrier 35,000 - 59,999 dwt	7,709	10.6	726	3.4	7.6	13.0
			34	Bulk carrier 60,000 - 99,999 dwt	7,645	10.9	704	3.3	7.3	12.6
			136	Bulk carrier 100,000 - 199,999 dwt	7,784	10.2	766	3.5	8.0	13.7
			29	Bulk carrier 200,000 + dwt	7,778	10.1	773	3.6	8.1	13.8
	7b	Citrus foods	51	Container 5,000-7,999 teu	7,252	16.6	437	2.0	4.6	7.8
			35	Container 8,000-11,999 teu	7,330	17.2	425	2.0	4.4	7.6
	7c	Grapes	46	Container 5,000-7,999 teu	6,522	17.3	377	1.7	3.9	6.7
			32	Container 8,000-11,999 teu	6,365	17.8	357	1.7	3.7	6.4

Total commodity cost intensity changes due to speed reduction

APEC Module 2 was used to estimate the commodity cost intensity increases due to potentially longer transit times resulting from the three speed reduction groups. The module estimates the daily cost increases, in percentage, associated with the following

- Finance/interest costs – the financial cost of capital invested in inventory over time. This measures the impact of each hour or day of delay on the cost of the product due to cost of money or interest rate. A Member State rate was used when provided. Otherwise, it was assumed to be 5%.[138]
- Depreciation costs – the cost allocation of a commodity, or reduction of the commodity value, over its useful life. For this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry bulk cargo.[139]
- Insurance costs – a cost paid by the cargo owner to protect their goods while in transit. The percentage used in the economic analysis is the one provided by the Member State. If the Member State did not provide data, we assumed it to be 2%.[140]

The total commodity cost intensity change related to the three speed reduction groups for the case studies is presented in Table 5.4. Note that these values remain constant across scenarios and forecasted year.

Table 10.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Commodity-side Task 4 TCIsr Change, % SR 10%	SR 20%	SR 30%
South Africa	7a	Iron ore	66	Bulk carrier 35,000 - 59,999 dwt	13	0.37%	1.88%	5.52%
			34	Bulk carrier 60,000 - 99,999 dwt	6	0.35%	1.77%	5.20%
			136	Bulk carrier 100,000 - 199,999 dwt	12	0.41%	2.09%	6.14%
			29	Bulk carrier 200,000 + dwt	12	0.42%	2.13%	6.26%
	7b	Citrus foods	51	Container 5,000-7,999 teu	14	0.13%	0.68%	2.01%
			35	Container 8,000-11,999 teu	8	0.13%	0.65%	1.90%
	7c	Grapes	46	Container 5,000-7,999 teu	14	0.10%	0.51%	1.49%
			32	Container 8,000-11,999 teu	7	0.09%	0.45%	1.34%

The commodity cost intensity changes due to speed reduction, ranges as follows:

- 7a – SR 10% → 0.35%-0.42% SR 20% → 1.77%-2.13% SR 30% → 5.20%-6.26%
- 7b – SR 10% → negligible SR 20% → 0.65%-0.68% SR 30% → 1.90%-2.01%
- 7c – SR 10% → negligible SR 20% → 0.45%-0.51% SR 30% → 1.34%-1.49%

Task 2 cost intensity changes due to MTM

Based on the ship type, size, and age combination for each commodity case study, the applicable Task 2 ship-side commodity cost intensities due to the MTM were identified for the selected scenarios. In addition, in order to be able to add these to the commodity cost intensity changes due to speed reduction, the a*d valorem* freight rate percentage was identified using the UNCTAD Trade-and-Transport Dataset.[141] The *ad valorem* freight rate percentage represents the transportation cost percentage of a commodity's total cost. These two were multiplied to get the freight rate adjusted

[138] Lending Tree, *Assuming a line of credit 5%.*
[139] APEC 2019
[140] APEC 2019
[141] UNCTAD, *Trade-and-Transport Dataset*.

commodity cost intensity or FRACCI change for 2030, 2040, and 2050. Task 2 cost intensity change and FRACCI for each scenario are presented in Table 10.5, shown on the next page.

Table 10.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
South Africa	7a	Iron ore	66 Bulk carrier 35,000 - 59,999 dwt	13	7.8%	5.68%	51.22%	51.32%	0.44%	4.00%	4.00%
			34 Bulk carrier 60,000 - 99,999 dwt	6	7.8%	19.24%	42.69%	53.70%	1.50%	3.33%	4.19%
			136 Bulk carrier 100,000 - 199,999 dwt	12	7.8%	3.97%	59.68%	61.90%	0.31%	4.65%	4.83%
			29 Bulk carrier 200,000 + dwt	12	7.8%	6.62%	51.04%	61.59%	0.52%	3.98%	4.80%
	7b	Citrus foods	51 Container 5,000-7,999 teu	14	13.5%	8.57%	70.19%	77.81%	1.16%	9.48%	10.50%
			35 Container 8,000-11,999 teu	8	13.5%	23.52%	44.39%	62.78%	3.18%	5.99%	8.48%
	7c	Grapes	46 Container 5,000-7,999 teu	14	7.1%	8.57%	70.19%	77.81%	0.61%	4.98%	5.52%
			32 Container 8,000-11,999 teu	7	7.1%	23.52%	44.39%	62.78%	1.67%	3.15%	4.46%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
South Africa	7a	Iron ore	66 Bulk carrier 35,000 - 59,999 dwt	13	7.8%	5.57%	43.06%	51.16%	0.43%	3.36%	3.99%
			34 Bulk carrier 60,000 - 99,999 dwt	6	7.8%	17.31%	40.02%	54.13%	1.35%	3.12%	4.22%
			136 Bulk carrier 100,000 - 199,999 dwt	12	7.8%	3.37%	50.83%	64.96%	0.26%	3.96%	5.07%
			29 Bulk carrier 200,000 + dwt	12	7.8%	7.88%	48.45%	64.39%	0.61%	3.78%	5.02%
	7b	Citrus foods	51 Container 5,000-7,999 teu	14	13.5%	9.30%	53.92%	71.26%	1.26%	7.28%	9.62%
			35 Container 8,000-11,999 teu	8	13.5%	29.40%	41.82%	62.98%	3.97%	5.65%	8.50%
	7c	Grapes	46 Container 5,000-7,999 teu	14	7.1%	9.30%	53.92%	71.26%	0.66%	3.83%	5.06%
			32 Container 8,000-11,999 teu	7	7.1%	29.40%	41.82%	62.98%	2.09%	2.97%	4.47%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
South Africa	7a	Iron ore	66 Bulk carrier 35,000 - 59,999 dwt	13	7.8%	13.96%	45.74%	56.95%	1.09%	3.57%	4.44%
			34 Bulk carrier 60,000 - 99,999 dwt	6	7.8%	16.74%	44.14%	59.49%	1.31%	3.44%	4.64%
			136 Bulk carrier 100,000 - 199,999 dwt	12	7.8%	15.13%	56.18%	63.40%	1.18%	4.38%	4.95%
			29 Bulk carrier 200,000 + dwt	12	7.8%	25.01%	51.52%	63.27%	1.95%	4.02%	4.93%
	7b	Citrus foods	51 Container 5,000-7,999 teu	14	13.5%	18.52%	52.42%	71.47%	2.50%	7.08%	9.65%
			35 Container 8,000-11,999 teu	8	13.5%	21.74%	44.33%	70.15%	2.93%	5.98%	9.47%
	7c	Grapes	46 Container 5,000-7,999 teu	14	7.1%	18.52%	52.42%	71.47%	1.31%	3.72%	5.07%
			32 Container 8,000-11,999 teu	7	7.1%	21.74%	44.33%	70.15%	1.54%	3.15%	4.98%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
South Africa	7a	Iron ore	66 Bulk carrier 35,000 - 59,999 dwt	13	7.8%	13.52%	47.86%	54.71%	1.05%	3.73%	4.27%
			34 Bulk carrier 60,000 - 99,999 dwt	6	7.8%	16.75%	44.47%	58.06%	1.31%	3.47%	4.53%
			136 Bulk carrier 100,000 - 199,999 dwt	12	7.8%	16.39%	58.04%	66.53%	1.28%	4.53%	5.19%
			29 Bulk carrier 200,000 + dwt	12	7.8%	21.03%	52.06%	64.29%	1.64%	4.06%	5.01%
	7b	Citrus foods	51 Container 5,000-7,999 teu	14	13.5%	20.15%	55.80%	67.84%	2.72%	7.53%	9.16%
			35 Container 8,000-11,999 teu	8	13.5%	24.44%	44.87%	68.45%	3.30%	6.06%	9.24%
	7c	Grapes	46 Container 5,000-7,999 teu	14	7.1%	20.15%	55.80%	67.84%	1.43%	3.96%	4.82%
			32 Container 8,000-11,999 teu	7	7.1%	24.44%	44.87%	68.45%	1.74%	3.19%	4.86%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
South Africa	7a	Iron ore	66 Bulk carrier 35,000 - 59,999 dwt	13	7.8%	33.36%	49.90%	55.02%	2.60%	3.89%	4.29%
			34 Bulk carrier 60,000 - 99,999 dwt	6	7.8%	35.27%	49.89%	56.87%	2.75%	3.89%	4.44%
			136 Bulk carrier 100,000 - 199,999 dwt	12	7.8%	45.20%	59.37%	67.01%	3.53%	4.63%	5.23%
			29 Bulk carrier 200,000 + dwt	12	7.8%	54.34%	63.86%	69.35%	4.24%	4.98%	5.41%
	7b	Citrus foods	51 Container 5,000-7,999 teu	14	13.5%	51.53%	65.50%	73.94%	6.96%	8.84%	9.98%
			35 Container 8,000-11,999 teu	8	13.5%	44.36%	64.06%	66.70%	5.99%	8.65%	9.00%
	7c	Grapes	46 Container 5,000-7,999 teu	14	7.1%	51.53%	65.50%	73.94%	3.66%	4.65%	5.25%
			32 Container 8,000-11,999 teu	7	7.1%	44.36%	64.06%	66.70%	3.15%	4.55%	4.74%

The *ad valorem* rates for exported iron ore and grapes are 7.1% and 7.8% respectively, which means that they are relatively less sensitive to ship-side costs compared to exported citrus fruits which have an *ad valorem* rate of 13.5%.

Note that there are significant differences between ship type, size, and age groups between scenarios. As learned from our consultation with DNV, "It should be noted that scenarios 23 and 24, and to a lesser degree scenarios 31 and 32, show large differences in cost impacts in 2030 depending on the generation of ships deployed. Ships of 10 years or less of age – i.e. built in the period between 2020 and 2029 – have a significantly higher increase in costs compared to older vessels. In the scenarios with a GFI flexibility mechanism the newer ships built in 2020-2029 take the brunt of the GHG intensity reductions, resulting in a higher cost increase compared to older ships when looking at all abatement costs. This is as expected, as the cost of reduction is relatively lower for new ships compared to existing ships.

"However, it should also be expected that there should be some compensation from the older ships to the newer ships when joining in a compliance pool under the GFI flexibility mechanism. DNV indicates in their report that the emission unit exchange price is set to the marginal cost of the last ship in the pool that was selected to implement an additional measure.

"However, when applying this price the results showed that the newer ships are overcompensated (i.e. the compensation led to a cost decrease), meaning that the marginal cost of the last ship is likely not a very good indicator for the exchange price in a pool as the many ships will have lower abatement costs. For this reason the costs and incomes of joining a pool are not included in this analysis."[142]

Total commodity cost intensity due to speed reduction and MTM

For each commodity case study, combining Task 2 and Task 4 results estimates the total commodity cost intensity[143] associated with potential speed reduction and the MTM ($TCCI_{mtm}$), for the forecasted years of 2030, 2040, and 2050, as presented in Table 10.6, on the following page. For each commodity case study, the results were compiled into a transit-weighted average for each scenario and forecasted year. These results are presented as Table 10.7 shown on the next pages.

[142] Email exchange with Tore Longa, Project Manager Task 2, 1 June 2024.
[143] The term 'total commodity cost intensity' as used in this report is defined as the total 'landed cost' of the commodity.

Table 10.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
South Africa	7a	Iron ore	66 Bulk carrier 35,000 - 59,999 dwt	13	0.44%	0.81%	2.32%	5.97%	4.00%	4.37%	5.87%	9.52%	4.00%	4.37%	5.88%	9.53%
			34 Bulk carrier 60,000 - 99,999 dwt	6	1.50%	1.85%	3.27%	6.70%	3.33%	3.68%	5.10%	8.53%	4.19%	4.54%	5.96%	9.39%
			136 Bulk carrier 100,000 - 199,999 dwt	12	0.31%	0.72%	2.40%	6.45%	4.65%	5.07%	6.74%	10.80%	4.83%	5.24%	6.92%	10.97%
			29 Bulk carrier 200,000 + dwt	12	0.52%	0.94%	2.65%	6.77%	3.98%	4.40%	6.11%	10.24%	4.80%	5.22%	6.93%	11.06%
	7b	Citrus foods	51 Container 5,000-7,999 teu	14	1.16%	1.29%	1.84%	3.16%	9.48%	9.61%	10.16%	11.48%	10.50%	10.64%	11.19%	12.51%
			35 Container 8,000-11,999 teu	8	3.18%	3.30%	3.82%	5.07%	5.99%	6.12%	6.64%	7.89%	8.48%	8.60%	9.12%	10.37%
	7c	Grapes	46 Container 5,000-7,999 teu	14	0.61%	0.71%	1.12%	2.10%	4.98%	5.08%	5.49%	6.47%	5.52%	5.62%	6.03%	7.01%
			32 Container 8,000-11,999 teu	7	1.67%	1.76%	2.13%	3.01%	3.15%	3.24%	3.61%	4.49%	4.46%	4.55%	4.91%	5.79%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
South Africa	7a	Iron ore	66 Bulk carrier 35,000 - 59,999 dwt	13	0.43%	0.81%	2.31%	5.96%	3.36%	3.73%	5.24%	8.88%	3.99%	4.36%	5.87%	9.51%
			34 Bulk carrier 60,000 - 99,999 dwt	6	1.35%	1.70%	3.12%	6.55%	3.12%	3.47%	4.89%	8.32%	4.22%	4.57%	5.99%	9.42%
			136 Bulk carrier 100,000 - 199,999 dwt	12	0.26%	0.68%	2.35%	6.40%	3.96%	4.38%	6.05%	10.11%	5.07%	5.48%	7.16%	11.21%
			29 Bulk carrier 200,000 + dwt	12	0.61%	1.04%	2.74%	6.87%	3.78%	4.20%	5.91%	10.04%	5.02%	5.44%	7.15%	11.28%
	7b	Citrus foods	51 Container 5,000-7,999 teu	14	1.26%	1.39%	1.94%	3.26%	7.28%	7.41%	7.96%	9.28%	9.62%	9.76%	10.30%	11.63%
			35 Container 8,000-11,999 teu	8	3.97%	4.10%	4.61%	5.87%	5.65%	5.77%	6.29%	7.54%	8.50%	8.63%	9.15%	10.40%
	7c	Grapes	46 Container 5,000-7,999 teu	14	0.66%	0.76%	1.17%	2.15%	3.83%	3.93%	4.33%	5.32%	5.06%	5.16%	5.57%	6.55%
			32 Container 8,000-11,999 teu	7	2.09%	2.18%	2.54%	3.42%	2.97%	3.06%	3.42%	4.31%	4.47%	4.56%	4.93%	5.81%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
South Africa	7a	Iron ore	66 Bulk carrier 35,000 - 59,999 dwt	13	1.09%	1.46%	2.97%	6.61%	3.57%	3.94%	5.45%	9.09%	4.44%	4.81%	6.32%	9.96%
			34 Bulk carrier 60,000 - 99,999 dwt	6	1.31%	1.66%	3.08%	6.50%	3.44%	3.79%	5.21%	8.64%	4.64%	4.99%	6.41%	9.84%
			136 Bulk carrier 100,000 - 199,999 dwt	12	1.18%	1.59%	3.27%	7.32%	4.38%	4.79%	6.47%	10.52%	4.95%	5.36%	7.04%	11.09%
			29 Bulk carrier 200,000 + dwt	12	1.95%	2.37%	4.08%	8.21%	4.02%	4.44%	6.15%	10.28%	4.93%	5.36%	7.06%	11.19%
	7b	Citrus foods	51 Container 5,000-7,999 teu	14	2.50%	2.63%	3.18%	4.50%	7.08%	7.21%	7.76%	9.08%	9.65%	9.78%	10.33%	11.65%
			35 Container 8,000-11,999 teu	8	2.93%	3.06%	3.58%	4.83%	5.98%	6.11%	6.63%	7.88%	9.47%	9.60%	10.11%	11.37%
	7c	Grapes	46 Container 5,000-7,999 teu	14	1.31%	1.41%	1.82%	2.80%	3.72%	3.82%	4.23%	5.21%	5.07%	5.17%	5.58%	6.56%
			32 Container 8,000-11,999 teu	7	1.54%	1.63%	2.00%	2.88%	3.15%	3.24%	3.60%	4.48%	4.98%	5.07%	5.44%	6.32%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
South Africa	7a	Iron ore	66 Bulk carrier 35,000 - 59,999 dwt	13	1.05%	1.43%	2.93%	6.58%	3.73%	4.10%	5.61%	9.26%	4.27%	4.64%	6.15%	9.79%
			34 Bulk carrier 60,000 - 99,999 dwt	6	1.31%	1.66%	3.08%	6.51%	3.47%	3.82%	5.24%	8.67%	4.53%	4.88%	6.30%	9.73%
			136 Bulk carrier 100,000 - 199,999 dwt	12	1.28%	1.69%	3.37%	7.42%	4.53%	4.94%	6.62%	10.67%	5.19%	5.60%	7.28%	11.33%
			29 Bulk carrier 200,000 + dwt	12	1.64%	2.06%	3.77%	7.90%	4.06%	4.48%	6.19%	10.32%	5.01%	5.44%	7.14%	11.27%
	7b	Citrus foods	51 Container 5,000-7,999 teu	14	2.72%	2.85%	3.40%	4.73%	7.53%	7.67%	8.21%	9.54%	9.16%	9.29%	9.84%	11.16%
			35 Container 8,000-11,999 teu	8	3.30%	3.43%	3.94%	5.19%	6.06%	6.18%	6.70%	7.95%	9.24%	9.37%	9.89%	11.14%
	7c	Grapes	46 Container 5,000-7,999 teu	14	1.43%	1.53%	1.94%	2.92%	3.96%	4.06%	4.47%	5.45%	4.82%	4.92%	5.32%	6.31%
			32 Container 8,000-11,999 teu	7	1.74%	1.82%	2.19%	3.07%	3.19%	3.28%	3.64%	4.52%	4.86%	4.95%	5.31%	6.20%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
South Africa	7a	Iron ore	66	Bulk carrier 35,000 - 59,999 dwt	13	2.60%	2.97%	4.48%	8.12%	3.89%	4.26%	5.77%	9.41%	4.29%	4.66%	6.17%	9.81%
			34	Bulk carrier 60,000 - 99,999 dwt	6	2.75%	3.10%	4.52%	7.95%	3.89%	4.24%	5.66%	9.09%	4.44%	4.79%	6.20%	9.63%
			136	Bulk carrier 100,000 - 199,999 dwt	12	3.53%	3.94%	5.62%	9.67%	4.63%	5.04%	6.72%	10.77%	5.23%	5.64%	7.32%	11.37%
			29	Bulk carrier 200,000 + dwt	12	4.24%	4.66%	6.37%	10.50%	4.98%	5.40%	7.11%	11.24%	5.41%	5.83%	7.54%	11.67%
	7b	Citrus foods	51	Container 5,000-7,999 teu	14	6.96%	7.09%	7.64%	8.96%	8.84%	8.98%	9.53%	10.85%	9.98%	10.12%	10.66%	11.99%
			35	Container 8,000-11,999 teu	8	5.99%	6.12%	6.63%	7.89%	8.65%	8.77%	9.29%	10.54%	9.00%	9.13%	9.65%	10.90%
	7c	Grapes	46	Container 5,000-7,999 teu	14	3.66%	3.76%	4.17%	5.15%	4.65%	4.75%	5.16%	6.14%	5.25%	5.35%	5.76%	6.74%
			32	Container 8,000-11,999 teu	7	3.15%	3.24%	3.60%	4.49%	4.55%	4.64%	5.00%	5.88%	4.74%	4.83%	5.19%	6.07%

Table 10.7: 2030, 2040, & 2050 commodity case study transit-weighted average total commodity cost intensity, by scenario and forecasted year

2030

Country	Case Study	Case Study Commodity	Ship Type(s)	2030 Scenario 23 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2030 Scenario 24 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2030 Scenario 31 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2030 Scenario 32 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2030 Scenario 46 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%
South Africa	7a	Iron ore	Bulk carrier	0.52%	0.91%	2.52%	6.40%	0.48%	0.88%	2.48%	6.36%	1.26%	1.65%	3.26%	7.14%	1.27%	1.66%	3.27%	7.15%	3.27%	3.67%	5.27%	9.15%
	7b	Citrus foods	Container	1.98%	2.11%	2.65%	3.94%	2.36%	2.49%	3.03%	4.32%	2.68%	2.81%	3.34%	4.64%	2.96%	3.09%	3.62%	4.92%	6.56%	6.69%	7.23%	8.52%
	7c	Grapes	Container	1.04%	1.14%	1.53%	2.47%	1.25%	1.34%	1.73%	2.67%	1.41%	1.50%	1.89%	2.83%	1.56%	1.65%	2.04%	2.98%	3.45%	3.55%	3.94%	4.88%

2040

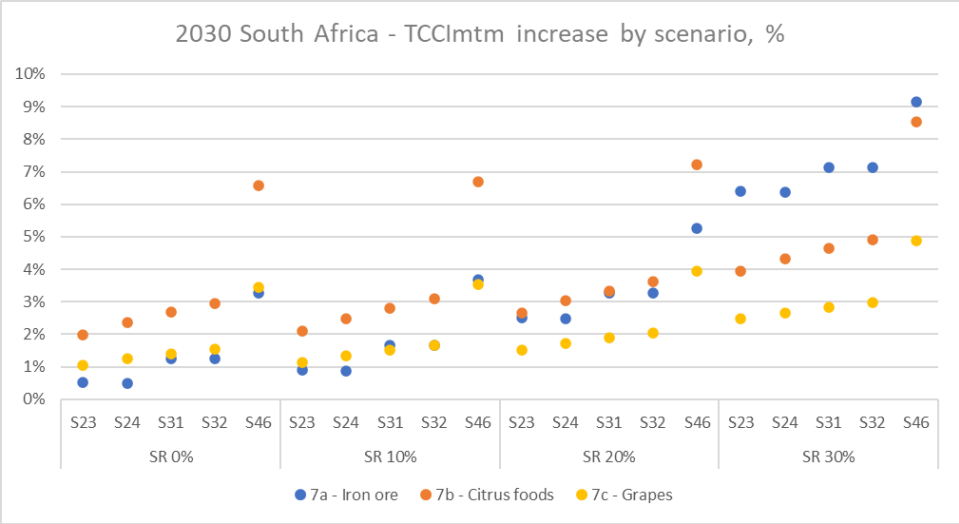
Country	Case Study	Case Study Commodity	Ship Type(s)	2040 Scenario 23 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2040 Scenario 24 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2040 Scenario 31 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2040 Scenario 32 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2040 Scenario 46 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%
South Africa	7a	Iron ore	Bulk carrier	4.25%	4.64%	6.25%	10.13%	3.69%	4.08%	5.69%	9.56%	4.02%	4.41%	6.02%	9.90%	4.14%	4.54%	6.14%	10.02%	4.39%	4.79%	6.39%	10.27%
	7b	Citrus foods	Container	8.06%	8.19%	8.73%	10.02%	6.61%	6.75%	7.28%	8.57%	6.63%	6.76%	7.30%	8.59%	6.93%	7.06%	7.60%	8.89%	8.76%	8.90%	9.43%	10.72%
	7c	Grapes	Container	4.23%	4.33%	4.72%	5.66%	3.48%	3.57%	3.96%	4.90%	3.49%	3.58%	3.97%	4.91%	3.64%	3.74%	4.13%	5.07%	4.61%	4.70%	5.09%	6.03%

2050

Country	Case Study	Case Study Commodity	Ship Type(s)	2050 Scenario 23 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2050 Scenario 24 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2050 Scenario 31 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2050 Scenario 32 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2050 Scenario 46 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%
South Africa	7a	Iron ore	Bulk carrier	4.54%	4.93%	6.54%	10.42%	4.69%	5.08%	6.69%	10.56%	4.78%	5.18%	6.78%	10.66%	4.86%	5.25%	6.86%	10.74%	4.91%	5.31%	6.91%	10.79%
	7b	Citrus foods	Container	9.68%	9.81%	10.35%	11.64%	9.17%	9.30%	9.83%	11.13%	9.58%	9.71%	10.24%	11.54%	9.19%	9.32%	9.86%	11.15%	9.58%	9.72%	10.25%	11.54%
	7c	Grapes	Container	5.09%	5.18%	5.57%	6.51%	4.82%	4.91%	5.30%	6.24%	5.04%	5.13%	5.52%	6.46%	4.83%	4.93%	5.32%	6.26%	5.04%	5.13%	5.52%	6.47%

The 2030, 2040, and 2050 transit-weighted averaged, total commodity cost intensity ranges across all scenarios, by speed reduction group is presented in Figures 10.2, 10.3, and 10.4, respectively.

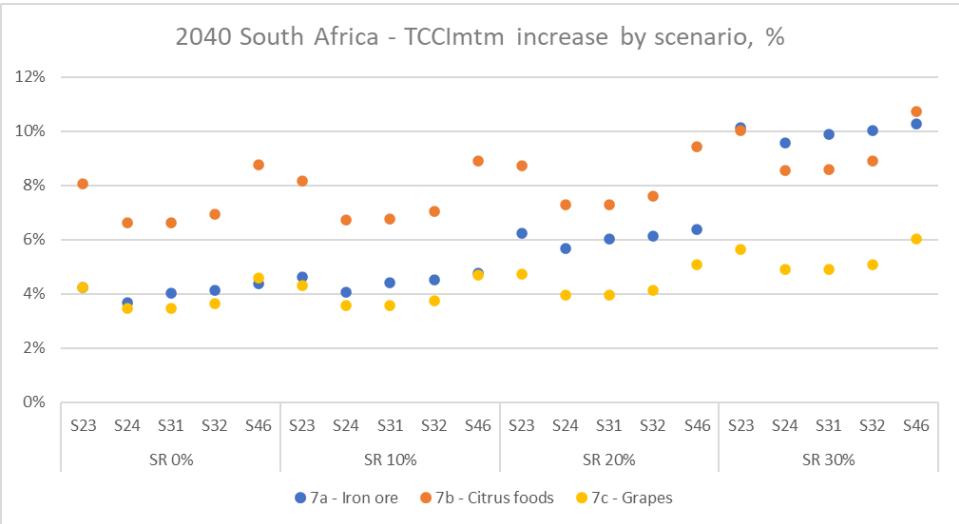
Figure 10.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2030, the citrus foods and grapes transported by container ships generally have increasing total commodity cost intensities, with a dominant increase in the strive scenario. They are less affected by speed reduction groups until SR 30%, where there is a more pronounced shift upwards. The separation between the two groups is associated with the difference in the *ad valorem* rates, as the rate of citrus fruits is twice that of grapes. Iron ore is more impacted by increasing speed reduction categories compared to citrus foods and grapes, because its longer transit times are 2.5 to 3 times higher. This is due to the slower speed that the bulk ship transits compared to the container ship, so potential slow down impacts are more pronounced. Note that the *ad valorem* rate for iron ore is similar to grapes. The costs are sensitive to the ship-side costs, with the spread between the commodity cost intensity at is narrowest compared to 2040 and 2050. The key parameters range from:

- **TCCImtm** **0.48% to 9.15%, with an average of 3.19%**

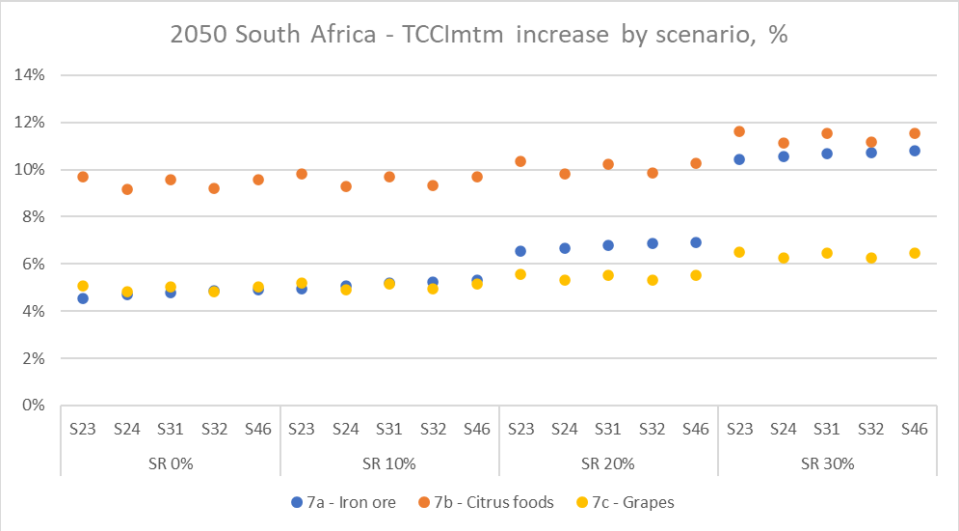
Figure 10.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2040, there are similar stratifications between the commodities as noted in 2030. The ship-side cost intensities for citrus and grapes become significantly more noticeable across all scenarios and speed reduction groups. Iron ore has a similar pattern, with the exception of SR 30% where speed still dominates the total cost intensity increase. The key parameters range from:

- **TCCImtm** **3.48% to 10.72%, with an average of 6.22%**

Figure 10.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2050, the total commodity cost intensity differences across all scenarios and speed reduction groups for citrus and grapes span a tight range (2% to 3%). Iron ore is still sensitive to the SR 30% group, due to the longer transit times, nearly two times that experienced by the container ships traveling nearly the same distances. The key parameters range from:

- **TCCImtm** **4.54% to 11.64%, with an average of 7.47%**

10.4 Qualitative analysis

South Africa's stakeholders who participated in the qualitative analysis provided detailed qualitative information on their perishable fruit commodities (citrus foods and grapes) using input from the South African Perishable Products Export Control Board (PPECB). The PPECB is South Africa's official perishable produce export certification agency. All South African exporters of perishable produce are required to be registered with the PPECB. The PPECB's range of services includes product inspections, supervision during the loading of cargo and enroute temperature management in order to provide exporters assurance that exported produce meets the minimum export standards and requirements of the importing country. PPECB also approves all equipment used within the supply chain for export.

Since PPECB's expertise is in product quality, sanitation, equipment and requirements of the receiving countries, their responses focused on those factors and general trends. PPECB could not provide detailed information on prices or vessel operational considerations.

No separate qualitative response was available for iron ore. However, qualitative responses were provided by ore exporters in other global south Member States. Therefore, South Africa's iron ore commodity will be considered together with these other Member States' inputs in Chapter 14, Trends and Conclusions.

Analyses of the South African responses on perishable fruits are displayed on the following SWOT grids (Tables 10.8 and 10.9) showing sensitivities to freight costs and sensitivities to transit times. Key takeaways for each grid are reflected below the SWOT grids.

Table 10.8: SWOT analysis of South Africa's commodities and their sensitivity to cost changes

Sensitivity to freight shipment cost changes as reported by the stakeholders	
Country: South Africa Commodities: 10a Citrus, 10b Grapes, (commodity 10c Iron Ore is not treated in this analysis)	
Strengths ➢ Growing season in the Southern Hemisphere is 6 months offset from the northern hemisphere, enabling a market for "out of season" fruits. ➢ Development of reefer shipping services has enabled growth in this market. ➢ South Africa's PPECB agency ensures product sanitation and approves all equipment used within the supply chain for export. This is an asset for ensuring quality and minimizing wastes and cost.	**Weaknesses** ➢ Market for some fruits is seasonal or holiday specific. These commodities may not be readily available throughout the year. ➢ Fresh fruits are perishable and must meet PPECB standards before shipping. ➢ Additional transport time impacts the condition of the product and may increase waste (so costs). ➢ Refrigerated containers and bulkers use significantly more fuel and energy. ➢ Longer shipping distances from many countries to markets in Asia & Europe vs some potential competitors.
Opportunities to adapt/mitigate ➢ Bigger vessels can be used however the SA growth in perishable volumes will determine the number and size of vessels. ➢ Electronic pre-trip inspections have reduced the usage of energy and allow quicker turnaround times for containers.	**Threats** ➢ Longer shipping times mean prolonged time under cooling which may impact shelf life and texture and may result in additional waste. ➢ If future low carbon fuels are not available in the region it will result in potentially higher cost and lower prices for producers.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis

- South Africa's PPECB agency ensures product sanitation and approves all equipment used within the supply chain for export. This is an asset for ensuring quality and minimizing waste and cost.
- Refrigerated containers and bulkers use significantly more fuel and energy.
- Electronic pre-trip inspections have reduced the usage of energy and allow quicker turnaround times for containers.
- If future low carbon fuels are not available in the region it will result in potentially higher cost and lower prices for producers.
- Another opportunity to mitigate impacts is to provide larger ships (if feasible) or additional ships to offset challenges and delays (however the SA growth in perishable volumes will determine the number and size of vessels).

Table 10.9: SWOT analysis of South Africa's commodities and their sensitivity to transport time changes.

Sensitivity to increased transport times as reported by the stakeholders	
Country: South Africa Commodities: 10a Citrus, 10b Grapes, (commodity 10c Iron ore is not treated in this analysis)	
Strengths ➢ South Africa's PPECB approves all equipment used within the supply chain for export and has time temperature tolerances (TTT) for various products.	**Weaknesses** ➢ Both citrus foods and grapes are perishable food products which demand timely arrivals. ➢ The main customers for these fruits are in China and northern Europe, located far from South Africa. This increases vulnerability to longer shipping times. ➢ Longer shipping times mean prolonged time under cooling which may impact shelf life and texture and may result in additional waste.
Opportunities to adapt/mitigate ➢ The electronic pre-trip inspections reduced the usage of energy and allowed quicker turnaround times for containers. ➢ There may be a need for more vessels to meet the demand.	**Threats** ➢ IMO GHG MTM may increase transport times. ➢ The speed will be imperative to meet the market demand during those festive holidays. These commodities are seasonal and may not be readily available throughout the year.

Key findings on transport time derived from stakeholder input to the SWOT analysis

- Longer shipping times mean prolonged time under cooling which may impact shelf life and texture and may result in additional waste.
- The main customers for these fruits are in China and northern Europe, located far from South Africa. This increases vulnerability to longer shipping times.
- South Africa is distant from the commodity destinations. Speed reduction would aggravate geographic disadvantage and worsen competitiveness due to longer lead times and potentially more expensive freight costs.
- There may be a need for more vessels to meet the demand as perishable volumes grow.
- The electronic pre-trip inspections allowed quicker turnaround times for containers.

10.5 Findings

Quantitative findings

The key findings from the quantitative analysis include:

- Longer transit times from potential speed reduction range across the case studies, including:
  - Iron ore
    - SR 10% - 3.5 days
    - SR 20% - 7-8 days
    - SR 30% - 12-13 days
  - Citrus foods
    - SR 10% - 2 days
    - SR 20% - 4.5 days
    - SR 30% - nearly 8 days
  - Grapes
    - SR 10% - <2 days
    - SR 20% - nearly 4 days
    - SR 30% - 6.5 to nearly 7 days
- The three export goods commodity case studies are generally driven by ship-side cost increases, however, depending on the scenario and forecasted year these can be balanced or speed reduction driven at the highest speed reduction group.
- The *ad valorem* rates for exported iron ore and grapes are 7.1% and 7.8% respectively, which means that they are relatively less sensitive to ship-side costs compared to exported citrus fruits which have an *ad valorem* rate of 13.5%.
- In 2030, the citrus foods and grapes, transported by container ships both generally have increasing total commodity cost intensities, with a dominant increase in strive scenario. They both generally not impacted by speed reduction groups until SR 30% where this is a more pronounced shift upwards. The separation between the two groups is associated with the difference in the *ad valorem* rates, which citrus fruits have twice that of grapes. Iron ore is more impacted by increasing speed reduction categories compared to the other two commodities, because its days of delay are 2.5 to 3 time higher. This is due to the slower speed that the bulk ship transits compared to the container ship, so potential slow down impacts are more pronounced. Note that its *ad valorem* rate for iron ore is similar to grapes. The costs are sensitive to the ship-side costs, with the spread between the commodity cost intensity at is narrowest compared to 2040 and 2050.
- In 2040, there are similar stratifications between the commodities as noted in2030. The ship-side cost intensities for citrus and grapes become significantly more dominant across all scenarios and speed reduction groups. For iron ore, a similar pattern with the exception of SR 30% where speed still dominates the total cost intensity increase.
- In 2050, the total commodity cost intensity differences across all scenarios and speed reduction groups for citrus and grapes span a tight range (2% to 3%). Iron ore is still sensitive to the SR 30% group, where it steps up do the longer transit times, nearly two times that experienced by the container ships traveling nearly the same distances.
- Total commodity cost intensity ranges across all scenarios and speed reduction groups, include:
  - Iron ore
    - 2030 – 0.48% to 9.15%, with an average of 3.43%
    - 2040 – 3.69% to 10.27%, with an average of 6.17%
    - 2050 – 4.54% to 10.79%, with an average of 6.82%

  - Citrus Foods
    - 2030 – 1.98% to 8.52%, with an average of 4.00%
    - 2040 – 6.61% to 10.72%, with an average of 8.09%
    - 2050 – 9.17% to 11.64%, with an average of 10.13%
  - Grapes
    - 2030 – 1.04% to 4.88%, with an average of 2.24%
    - 2040 – 3.48% to 6.03%, with an average of 4.39%
    - 2050 – 4.82% to 6.51%, with an average of 5.46%
- TCCImtm findings for the three commodity case studies across all scenarios and speed reduction groups, by forecasted year:
  - 2030 0.48% to 9.15%, with an average of 3.19%
  - 2040 3.48% to 10.72%, with an average of 6.22%
  - 2050 4.54% to 11.64%, with an average of 7.47%

Qualitative findings

For all three commodities selected by South Africa, the main markets are located far from South Africa, in China, the Netherlands and the UK. Challenges identified by the South African stakeholders who participated include:

- Two commodities from South Africa are perishable fruits: citrus and grapes. Refrigerated containers for such shipments use significantly more fuel and energy, impacting costs. The main customers for these fruits are in China and northern Europe, located far from South Africa. This increases vulnerability to longer shipping times. Longer shipping times mean prolonged time under cooling which may impact shelf life and texture and may result in additional waste.
- Vessel speed reduction would aggravate geographic disadvantage and worsen competitivity because of longer lead times and potentially more expensive freight costs.
- Iron ore is not time sensitive in terms of product degradation but may have specific delivery time criteria. This commodity will be discussed with other similar commodities in Section 14.

According to South Africa's stakeholders, opportunities to mitigate impacts include:

- Costs:
  - Bigger vessels can be used however the SA growth in perishable volumes will determine the number and size of vessels.
  - Electronic pre-trip inspections have reduced the usage of energy and allow quicker turnaround times for containers.
  - Stakeholders want to see low carbon fuels available in their region. They stated that if future low carbon fuels are not available in the region it will result in potentially higher cost and lower prices for producers.

- Longer transport times:
  - The electronic pre-trip inspections reduced the usage of energy and allowed quicker turnaround times for containers. To elaborate, South Africa has an agency in place responsible for ensuring quality and sanitation of exported perishable products. This is an asset for ensuring quality and minimizing wastes and cost. This agency (PPCEB) approves all equipment used within the supply chain for export and has time temperature tolerances (TTT) for various products. PPCEB cites the use of electronic pretrip inspections that have reduced electricity usage and led to faster turnaround times for containers. Sharing this and other best practices could benefit the Member States in adapting to the MTM.
  - Alternatives to vessel speed reduction are needed to meet decarbonization goals. South Africa is distant from the commodity export destinations. Speed reduction would aggravate geographic disadvantage and worsen competitiveness due to longer lead times and potentially more expensive freight costs.
  - There may be a need for more vessels to meet the demand.

Summary of key points related to potential impacts

The following points are key to understanding the potential impacts of the MTM:

- South Africa is Africa's largest economy with a GDP of $405,271 million. South Africa's GDP per capita has fluctuated in recent years and in 2022, was $6,766.
- The three commodities selected by South Africa for case studies are trade commodity exports of iron ore destined for China, citrus fruits destined for Europe, and grapes destined the UK. All three case studies are exported trade commodities, which means costs increases impact the sector/subsector of the economy associated with each commodity. In addition, the associated employment, supporting industries, and taxes and revenues associated with the commodity will be impacted.
- For these three case studies, the estimates indicate a range of total commodity cost intensity increases related to maritime transport. Across Scenarios 23/24 and 31/32, for all forecasted years, the estimates indicate a range of total commodity cost intensity increases. These increases are estimated to be lower in 2030, but are estimated to significantly increase in 2040 and 2050. Scenario 46 brings forward the significant increase in costs to 2030. Iron ore is the most sensitive commodity to speed reduction.
- Since these case studies represent export trade commodities only on particular routes, the entire economic sector/subsector is not captured. The full impact on the entire sector/subsector would need to be considered by the Member State and their national stakeholders to determine impacts to GDP, employment, and any collateral impacts on supporting industries.

11 Stakeholders' analysis – Togo

The Stakeholder Assessment for Togo focuses on imports of essential goods including essence (LPG), iron and steel and palm oil.

11.1 Geography, population, and economy

Geography

Togo is a coastal country in West Africa, sharing borders with Ghana, Benin, and Burkina Faso. Lomé, the capital, is situated in the southwest of the country and is the largest city and port. The Port of Lomé (under the Lomé Port Authority-PAL) is the oldest deep seaport in West Africa. From its 31-mile (50 km) coastline on the Gulf of Guinea, Togo extends northward for about 320 miles (515 km) between Ghana to the west and Benin to the east to its boundary with Burkina Faso in the north. The total land area is 56,600 km2. Representative shipping distances to markets are shown in Table 11.1.

Population

Togo, a country with diverse linguistic and cultural landscape has a population of approximately nine million people as of 2024.[144] It ranks 99th in the world by population density, with 166 people per square kilometer (431 people per square mile).[145] Around 44% of the population live in urban areas.[146] Significant efforts have been made to tackle poverty however Togo faces an overall poverty level of 42.4% (2023) while in the rural areas, poverty levels are twice as high (59%) compared to urban areas (27%).[147] Vulnerable populations face challenges to access to water and electricity.[147] Half of the population, 57% have access to electricity while only 25% in rural areas have access to electricity.[148]

Economy

Togo's economy relies heavily on agriculture, particularly coffee, cocoa, and cotton, which are major export commodities (cash crops). It also exports phosphate, which is a significant natural resource. The economy relies largely on agriculture, where more than half the labor force works in the agricultural sector.

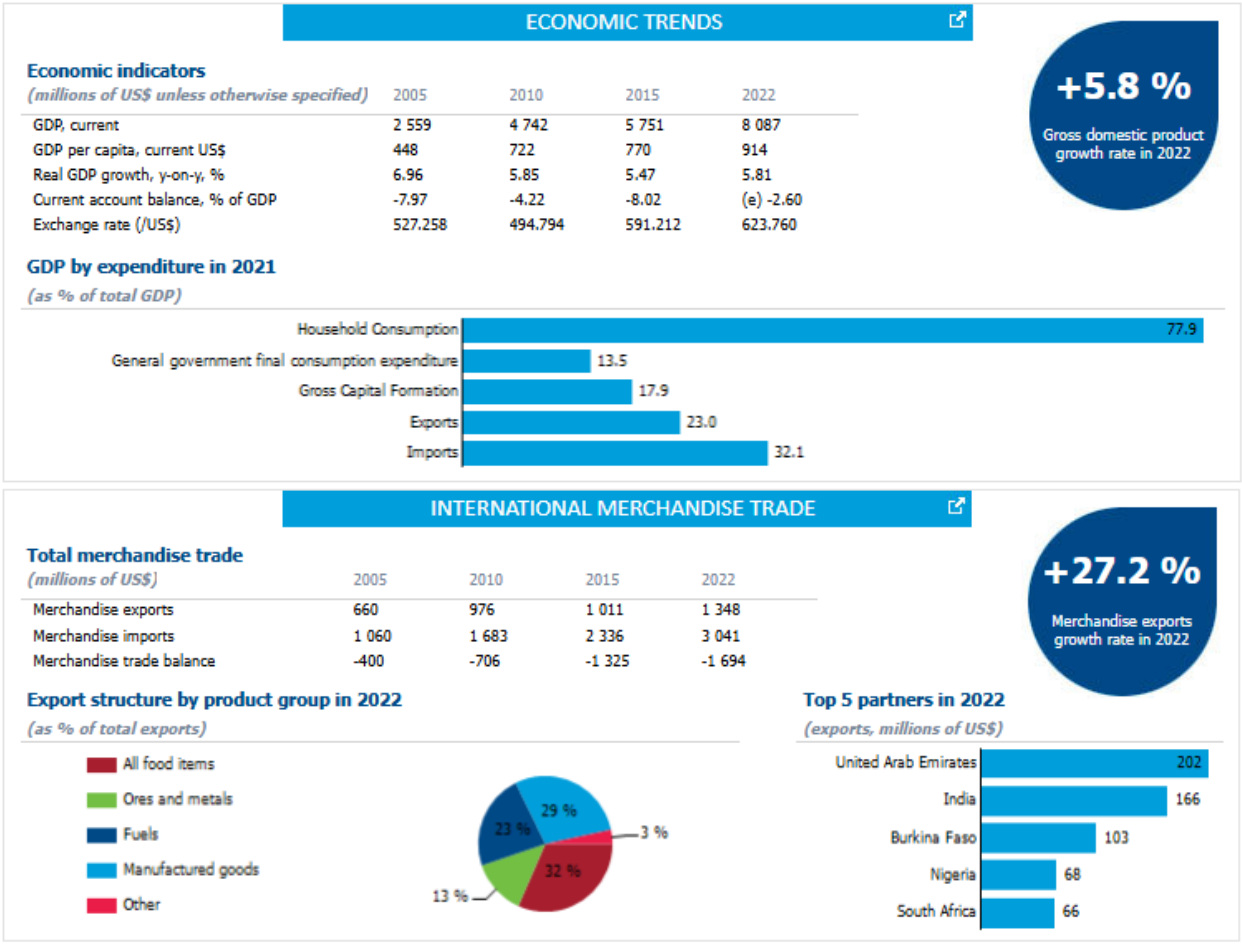
In 2022, Togo's GDP was $8,087 million, with a GDP per capita of $914.[149] As of 2024, the GDP of Togo is $9,830 million and currently the country is experiencing a growth rate of 5.3% which is a positive indication.[144] GDP per capita is $1,060 in 2024.[147] Despite increase in public spending, Togo faces a high debt to GDP ratio (68% of total GDP) which restricts spending in health, education and other public services.[147]

Togo is a logistics hub in West Africa providing vital transshipment services to landlocked neighbors, Burkina Faso, Mali and Niger. Challenges in infrastructure and logistics can affect Togo's trade efficiency, particularly in transporting goods to countries in the Sahal region, a region which faces food insecurity and challenges in border security. Within the ECOWAS region, Nigeria, Ghana and Côte d'Ivoire are major trading partner for Togo in terms of exports and imports. China is another significant partner, particularly in terms of infrastructure development and trade.

[144] International Monetary Fund, IMF DataMapper, *Togo*..
[145] Worldometer, *Countries in the world by population*. Projections based on *2022 Revision of World Population Prospects, UN DESA Population Division.*
[146] World Bank Group, *The World Bank in Togo*.
[147] Ibid.
[148] World Bank Group, DataBank, *Togo* (World Bank Group, 2024).
[149] UNCTAD, General and Maritime Profiles: Togo, *UNCTAD Statistics - General Profile*.

Key economic indicators are in Figure 11.1.[150]

Figure 11.1: Key economic indicators for Togo



Source: UNCTAD, General and Maritime Profiles: Togo, UNCTAD Statistics - General Profile.

The following was provided by the Member State:

Iron and steel

Overall, iron and steel play a pivotal role in Togo's economic development, infrastructure expansion, industrial growth, and improvement of living standards for its population. Iron and steel provides fundamental materials for building infrastructure such as roads, bridges, buildings, and transportation networks while also serving as essential raw materials for industrial processes. Iron and steel are used extensively in the automotive industry for manufacturing vehicles, including cars, trucks, and buses. Iron and steel are integral to the construction of housing and shelter, providing durable and reliable structures for residential, commercial, and institutional buildings. This is critical for improving living standards and accommodating urbanization. The iron and steel industry itself provides direct employment opportunities in mining, processing, manufacturing, and distribution. Indirectly, it supports related sectors such as logistics, engineering, and construction, contributing to economic diversification and development. Iron and steel are essential for the production of military equipment, and defense systems, ensuring national security and defense capabilities.

[150] UNCTAD, General and Maritime Profiles: Togo, *UNCTAD Statistics - General Profile*.

Essence (LPG)

Petroleum products are integral to the daily lives, economic activities, and development efforts in Togo. They are the primary source of energy for transportation and electricity generation in Togo. Essence, or petroleum products, such as gasoline, diesel, and kerosene, are essential for powering vehicles, generators, and machinery. Most vehicles in Togo, including cars, trucks, buses, and motorcycles, run on petroleum products. Reliable access to gasoline and diesel is critical for maintaining mobility, supporting trade, and facilitating economic activities including manufacturing, construction, mining and agriculture across the country. Kerosene provides an affordable and accessible energy source for cooking meals and lighting homes, particularly in rural areas where households access to electricity or natural gas. The availability and affordability of petroleum products directly impact the cost of living and business operations in Togo. Fluctuations in fuel prices can influence inflation rates, transportation costs, and overall economic stability. Petroleum products contribute significantly to government revenue through taxes and tariffs. This revenue supports public infrastructure projects, social services, and economic development initiatives across the country.

Palm oil

Palm oil, a staple cooking oil in Togo (and other parts of West Africa) is a vital source of nutrition and plays a significant role in the country's economy, culture, and sustainable development efforts. Palm oil is widely used in household cooking for frying, baking, and seasoning food. Palm oil sustains rural economies as it provides livelihoods for families and serves a major source of income for farmers in rural communities in Togo. Beyond household consumption, palm oil used in the industrial production of soaps, detergents, cosmetics, and various food products, contributing to the country's manufacturing sector and economic diversification. Palm oil is deeply rooted in the cultural and culinary traditions of Togo and plays central role in local cuisine, traditional ceremonies, and cultural practices, reflecting its cultural importance and heritage. Palm oil exports contribute to Togo's foreign exchange earnings. The country exports palm oil and palm kernel oil to regional and international markets, generating revenue that supports the national economy and trade balance. Sustainable palm oil production practices can promote environmental conservation and biodiversity in Togo. Efforts to adopt responsible cultivation methods, such as those aligned with Roundtable on Sustainable Palm Oil (RSPO) principles, can help mitigate deforestation and environmental degradation.

11.2 Identified commodities and routes studied

This Stakeholder Assessment for Togo focuses on imports of essence (LPG), iron and steel and palm oil. Essence (LPG) is imported from Estonia by container ships and tankers. Iron and Steel works are imported from China to Togo by container ship. Palm oil is shipped from Malaysia to Togo in container ships or tankers.

The commodities selected by the Member State for focus and illustrative trade routes selected are shown in Table 11.1. All commodities selected for this study are imports.

Table 11.1: Shipping distances from Togo to market for selected commodities

Case Study	Commodity	Illustrative identified routes, by country	Ship Type(s)	Route Distance Range, nm min	avg	max	Stops
8a	Essence (LPG)	Estonia --> Latvia --> Germany --> Belgium --> France --> Morroco --> Spain --> Senegal --> Guinea --> Cote d'Ivoire --> Togo Estonia --> Russia --> Senegal --> Cameroon --> Togo Estonia --> The Netherlands --> Russia --> France --> Spain --> Senegal --> Togo Estonia --> Togo	Container & Tanker	5,862	7,321	9,954	1-10
8b	Iron and steel	China --> South Korea --> China China --> South Korea --> China --> Singapore --> Nigeria --> Togo China --> South Korea --> China --> Singapore --> Sri Lanka --> Togo China --> South Korea --> China --> Singapore --> Togo	Container	10,373	12,217	13,387	1-3
8c	Palm oil	Malayasia --> China --> Singapore --> Nigeria --> Togo Malayasia --> Iraq --> India --> Togo Malayasia --> Kenya --> Mozambique --> South Africa --> Togo Malayasia --> Nigeria --> Togo Malayasia --> South Africa --> Togo	Container & Tanker	8,200	8,574	14,430	3-5

11.3 Quantitative analysis

This section presents the quantitative analysis summary results and is organized by fleet analysis summary, total commodity cost intensity changes from speed reduction, Task 2 cost intensity changes due to MTM, total commodity cost intensity impacts, and GDP contexts. The quantitative analysis incorporates the findings of Task 2 related to the selected bracketing MTM scenarios as presented below:[151]

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination: Policy code	GFI scope	GFI flexibility: RU % of price	SU % of price	Levy: Levy USD/tCO_2eq	Levy: Reward % of cost gap	Feebate Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

The detailed approach for the below analyses is provided in Appendix A.

Fleet analysis summary

As part of the fleet analysis, routes and ship characteristics were identified for each commodity case study. For the specific ship types identified with the commodity case study and transiting on the identified route the following were averaged to represent the fleet:

- Ship type and size
- Number of transits identified
- Route distances obtained from Marine Benchmark's 2022 AIS database were transit-weighted averaged and reported as minimum, average, and maximum distance sailed
- Transit-weighted average year of build, which was used to determine the average age in years

[151] DNV 2024

These characteristics for the case studies are presented in Table 11.2.

Table 11.2: Togo – Fleet characteristics, by commodity case study

Case Study	Commodity	2022 Transits	Ship Type(s)	Route Distance Range, nm min	avg	max	Avg Build
8a	Essence (LPG)						
		2	Chemical tanker 40,000 + dwt	5,862	**6,531**	7,201	2005
		1	Container 2,000-2,999 teu	6,267	**6,267**	6,267	2007
		1	Oil & Product tanker 20,000-59,999 dwt	9,954	**9,954**	9,954	2009
8b	Iron and steel						
		47	Container 3,000-4,999 teu	10,373	**12,107**	13,387	2014
		14	Container 8,000-11,999 teu	11,637	**12,209**	13,068	2010
		27	Container 12,000-14,499 teu	11,805	**12,412**	13,206	2012
8c	Palm oil						
		33	Container 3,000-4,999 teu	8,200	**8,574**	14,430	2009

In addition, transit weighted average speeds and average route times were estimated and the APEC Module 1 was used to estimate the longer transit times associated with the speed reduction groups of 10%, 20%, and 30%, as presented in Table 11.3.

Table 11.3: Average route distance, speed, & longer transit ,times, by speed reduction group

Country	Case Study	Commodity	Transits	Ship type & size	Avg Route Distance (nm)	Avg Route Speed (knots)	Avg Route Time (hours)	SR 10% Delay Delta (days)	SR 20% Delay Delta (days)	SR 30% Delay Delta (days)
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	6,267	13.6	462	2.1	4.8	8.2
			1	Oil & Product tanker 20,000-59,999 dwt	9,954	12.3	811	3.8	8.4	14.5
			2	Chemical tanker 40,000 + dwt	6,531	12.0	543	2.5	5.7	9.7
	8b	Iron and steel	47	Container 3,000-4,999 teu	12,107	15.1	802	3.7	8.4	14.3
			14	Container 8,000-11,999 teu	12,209	16.4	742	3.4	7.7	13.3
			27	Container 12,000-14,499 teu	12,412	15.4	804	3.7	8.4	14.4
	8c	Palm oil	33	Container 3,000-4,999 teu	8,574	14.4	594	2.7	6.2	10.6

Total commodity cost intensity changes due to speed reduction

APEC Module 2 was used to estimate the commodity cost intensity increases due to potentially longer transit times resulting from the three speed reduction groups. The module estimates the daily cost increases, in percentage, associated with the following:

- Finance/interest costs – the financial cost of capital invested in inventory over time. This measures the impact of each hour or day of delay on the cost of the product due to cost of money or interest rate. A Member State rate was used when provided. Otherwise, it was assumed to be 5%.[152]
- Depreciation costs – the cost allocation of a commodity, or reduction of the commodity value, over its useful life. For this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry bulk cargo.[153] Togo provided the following depreciation costs: essence 0.5%, iron and steel works 0.3%, fraction of non-food palms 0.4%.
- Insurance costs – a cost paid by the cargo owner to protect their goods while in transit. The percentage used in the economic analysis is the one provided by the Member State. Togo provided insurance costs for all commodities evaluated at a rate of 10%.

[152] Lending Tree, *Assuming a line of credit 5%*.
[153] APEC 2019

The total commodity cost intensity change related to the three speed reduction groups for the case studies is presented in Table 11.4. Note that these values remain constant across scenarios and forecasted year.

Table 11.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Commodity-side Task 4 TCCIsr Change, % SR 10%	SR 20%	SR 30%
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	16	0.15%	0.76%	2.24%
			1	Oil & Product tanker 20,000-59,999 dwt	14	0.46%	2.34%	6.88%
			2	Chemical tanker 40,000 + dwt	18	0.21%	1.05%	3.09%
	8b	Iron and steel	47	Container 3,000-4,999 teu	9	0.45%	2.29%	6.74%
			14	Container 8,000-11,999 teu	13	0.39%	1.96%	5.77%
			27	Container 12,000-14,499 teu	11	0.46%	2.30%	6.77%
	8c	Palm oil	33	Container 3,000-4,999 teu	14	0.25%	1.26%	3.69%

The commodity cost intensity changes due to speed reduction, ranges as follows:

- 8a – SR 10% → 0.15%-0.46% SR 20% → 0.76%-2.34% SR 30% → 2.24%-6.88%
- 8b – SR 10% → 0.39%-0.46% SR 20% → 1.96%-2.30% SR 30% → 5.77%-6.77%
- 8c – SR 10% → 0.25% SR 20% → 1.26% SR 30% → 3.69%

Task 2 cost intensity changes due to MTM

Based on the ship type, size, and age combination for each commodity case study, the applicable Task 2 ship-side commodity cost intensities due to the MTM were identified for the selected scenarios. In addition, in order to be able to add these to the commodity cost intensity changes due to speed reduction, the a*d valorem* freight rate percentage was identified using the UNCTAD Trade-and-Transport Dataset.[154] The *ad valorem* freight rate percentage represents the transportation cost percentage of a commodity's total cost. These two were multiplied to get the freight rate adjusted commodity cost intensity or FRACCI change for 2030, 2040, and 2050. Task 2 cost intensity change and FRACCI for each scenario are presented in Table 11.5 on the next page.

[154] UNCTAD, *Trade-and-Transport Dataset*.

Table 11.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	16	14.2%	5.22%	60.95%	76.84%	0.74%	8.66%	10.91%
			1	Oil & Product tanker 20,000-59,999 dwt	14	14.2%	10.44%	39.95%	58.59%	1.48%	5.67%	8.32%
			2	Chemical tanker 40,000 + dwt	18	14.2%	16.89%	52.94%	58.59%	2.40%	7.52%	8.32%
	8b	Iron and steel	47	Container 3,000-4,999 teu	9	12.8%	26.43%	61.09%	68.46%	3.38%	7.82%	8.76%
			14	Container 8,000-11,999 teu	13	12.8%	16.71%	64.48%	65.89%	2.14%	8.25%	8.43%
			27	Container 12,000-14,499 teu	11	12.8%	4.23%	76.22%	78.92%	0.54%	9.76%	10.10%
	8c	Palm oil	33	Container 3,000-4,999 teu	14	12.9%	9.16%	73.77%	67.78%	1.18%	9.52%	8.74%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	16	14.2%	6.03%	50.07%	74.73%	0.86%	7.11%	10.61%
			1	Oil & Product tanker 20,000-59,999 dwt	14	14.2%	6.97%	38.07%	54.88%	0.99%	5.41%	7.79%
			2	Chemical tanker 40,000 + dwt	18	14.2%	10.36%	40.69%	54.88%	1.47%	5.78%	7.79%
	8b	Iron and steel	47	Container 3,000-4,999 teu	9	12.8%	35.26%	52.52%	68.93%	4.51%	6.72%	8.82%
			14	Container 8,000-11,999 teu	13	12.8%	14.18%	44.40%	61.66%	1.82%	5.68%	7.89%
			27	Container 12,000-14,499 teu	11	12.8%	7.96%	61.14%	74.62%	1.02%	7.83%	9.55%
	8c	Palm oil	33	Container 3,000-4,999 teu	14	12.9%	10.59%	52.66%	67.58%	1.37%	6.79%	8.72%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	16	14.2%	20.15%	54.45%	75.39%	2.86%	7.73%	10.71%
			1	Oil & Product tanker 20,000-59,999 dwt	14	14.2%	13.26%	30.29%	57.49%	1.88%	4.30%	8.16%
			2	Chemical tanker 40,000 + dwt	18	14.2%	16.28%	41.08%	57.49%	2.31%	5.83%	8.16%
	8b	Iron and steel	47	Container 3,000-4,999 teu	9	12.8%	19.15%	47.60%	73.48%	2.45%	6.09%	9.41%
			14	Container 8,000-11,999 teu	13	12.8%	22.77%	47.01%	61.89%	2.92%	6.02%	7.92%
			27	Container 12,000-14,499 teu	11	12.8%	16.02%	61.94%	68.50%	2.05%	7.93%	8.77%
	8c	Palm oil	33	Container 3,000-4,999 teu	14	12.9%	18.51%	55.11%	64.54%	2.39%	7.11%	8.33%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	16	14.2%	17.87%	58.30%	75.58%	2.54%	8.28%	10.73%
			1	Oil & Product tanker 20,000-59,999 dwt	14	14.2%	14.80%	30.04%	54.14%	2.10%	4.27%	7.69%
			2	Chemical tanker 40,000 + dwt	18	14.2%	14.20%	42.16%	54.14%	2.02%	5.99%	7.69%
	8b	Iron and steel	47	Container 3,000-4,999 teu	9	12.8%	26.33%	48.89%	72.27%	3.37%	6.26%	9.25%
			14	Container 8,000-11,999 teu	13	12.8%	24.49%	51.22%	59.89%	3.13%	6.56%	7.67%
			27	Container 12,000-14,499 teu	11	12.8%	18.32%	63.71%	68.88%	2.34%	8.15%	8.82%
	8c	Palm oil	33	Container 3,000-4,999 teu	14	12.9%	21.78%	60.14%	65.30%	2.81%	7.76%	8.42%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	16	14.2%	52.93%	71.39%	77.10%	7.52%	10.14%	10.95%
			1	Oil & Product tanker 20,000-59,999 dwt	14	14.2%	33.82%	37.62%	58.41%	4.80%	5.34%	8.29%
			2	Chemical tanker 40,000 + dwt	18	14.2%	35.38%	52.30%	58.41%	5.02%	7.43%	8.29%
	8b	Iron and steel	47	Container 3,000-4,999 teu	9	12.8%	44.01%	67.15%	72.70%	5.63%	8.59%	9.31%
			14	Container 8,000-11,999 teu	13	12.8%	58.81%	67.01%	63.19%	7.53%	8.58%	8.09%
			27	Container 12,000-14,499 teu	11	12.8%	57.16%	85.14%	71.38%	7.32%	10.90%	9.14%
	8c	Palm oil	33	Container 3,000-4,999 teu	14	12.9%	59.80%	71.49%	68.04%	7.71%	9.22%	8.78%

The *ad valorem* rates of the imported essential goods ranged in a tight span from 12.8% to 14.2%, with an average of 13.4%.

Note that there are significant differences between ship type, size, and age groups between scenarios. As was learned from our consultation with DNV, "It should be noted that scenarios 23 and 24, and to a lesser degree scenarios 31 and 32, show large differences in cost impacts in 2030 depending on the generation of ships deployed. Ships with 10 years or less of age – i.e. built in the period between 2020 and 2029 – have a significantly higher increase in costs compared to older vessels. In the scenarios with a GFI flexibility mechanism the newer ships built in 2020-2029 take the brunt of the GHG intensity reductions, resulting in a higher cost increase compared to older ships when looking at all abatement costs. This is as expected, as the cost of reduction is relatively lower for new ships compared to existing ships.

However, it should also be expected that there should be some compensation from the older ships to the newer ships when joining in a compliance pool under the GFI flexibility mechanism. DNV indicates in their report that the emission unit exchange price is set to the marginal cost of the last ship in the pool that was selected to implement an additional measure.

However, when applying this price, the results showed that the newer ships are overcompensated (i.e. the compensation led to a cost decrease), meaning that the marginal cost of the last ship is likely not a very good indicator for the exchange price in a pool as the many ships will have lower abatement costs. For this reason, the costs and incomes of joining a pool are not included in this analysis."[155]

Total commodity cost intensity due to speed reduction and MTM

For each commodity case study, combining Task 2 and Task 4 results estimates the total commodity cost intensity[156] associated with potential speed reduction and the MTM ($TCCI_{mtm}$), for the forecasted years of 2030, 2040, and 2050, as presented in Table 11.6, on the following page. For each commodity case study, the results were compiled into a transit-weighted average for each scenario and forecasted year. These results are presented in Table 11.7.

[155] Email exchange with Tore Longa, Project Manager Task 2, 1 June 2024.
[156] The term 'total commodity cost intensity' as used in this report is defined as the total 'landed cost' of the commodity.

Table 11.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	16	0.74%	0.89%	1.50%	2.98%	8.66%	8.81%	9.42%	10.89%	10.91%	11.06%	11.67%	13.15%
			1	Oil & Product tanker 20,000-59,999 dwt	14	1.48%	1.95%	3.82%	8.37%	5.67%	6.14%	8.01%	12.56%	8.32%	8.78%	10.66%	15.20%
			2	Chemical tanker 40,000 + dwt	18	2.40%	2.61%	3.45%	5.49%	7.52%	7.72%	8.57%	10.61%	8.32%	8.53%	9.37%	11.41%
	8b	Iron and steel	47	Container 3,000-4,999 teu	9	3.38%	3.84%	5.68%	10.12%	7.82%	8.27%	10.11%	14.56%	8.76%	9.22%	11.06%	15.50%
			14	Container 8,000-11,999 teu	13	2.14%	2.53%	4.10%	7.91%	8.25%	8.64%	10.22%	14.03%	8.43%	8.82%	10.40%	14.21%
			27	Container 12,000-14,499 teu	11	0.54%	1.00%	2.84%	7.31%	9.76%	10.21%	12.06%	16.53%	10.10%	10.56%	12.41%	16.87%
	8c	Palm oil	33	Container 3,000-4,999 teu	14	1.18%	1.43%	2.44%	4.88%	9.52%	9.76%	10.77%	13.21%	8.74%	8.99%	10.00%	12.44%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	16	0.86%	1.01%	1.62%	3.09%	7.11%	7.26%	7.87%	9.35%	10.61%	10.76%	11.37%	12.85%
			1	Oil & Product tanker 20,000-59,999 dwt	14	0.99%	1.45%	3.33%	7.87%	5.41%	5.87%	7.75%	12.29%	7.79%	8.26%	10.13%	14.68%
			2	Chemical tanker 40,000 + dwt	18	1.47%	1.68%	2.52%	4.56%	5.78%	5.99%	6.83%	8.87%	7.79%	8.00%	8.85%	10.89%
	8b	Iron and steel	47	Container 3,000-4,999 teu	9	4.51%	4.97%	6.81%	11.25%	6.72%	7.18%	9.01%	13.46%	8.82%	9.28%	11.11%	15.56%
			14	Container 8,000-11,999 teu	13	1.82%	2.20%	3.78%	7.59%	5.68%	6.07%	7.65%	11.46%	7.89%	8.28%	9.86%	13.66%
			27	Container 12,000-14,499 teu	11	1.02%	1.47%	3.32%	7.79%	7.83%	8.28%	10.13%	14.60%	9.55%	10.01%	11.85%	16.32%
	8c	Palm oil	33	Container 3,000-4,999 teu	14	1.37%	1.61%	2.62%	5.06%	6.79%	7.04%	8.05%	10.49%	8.72%	8.97%	9.97%	12.41%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	16	2.86%	3.01%	3.62%	5.10%	7.73%	7.88%	8.49%	9.97%	10.71%	10.86%	11.47%	12.94%
			1	Oil & Product tanker 20,000-59,999 dwt	14	1.88%	2.35%	4.23%	8.77%	4.30%	4.76%	6.64%	11.18%	8.16%	8.63%	10.51%	15.05%
			2	Chemical tanker 40,000 + dwt	18	2.31%	2.52%	3.36%	5.40%	5.83%	6.04%	6.89%	8.93%	8.16%	8.37%	9.22%	11.26%
	8b	Iron and steel	47	Container 3,000-4,999 teu	9	2.45%	2.90%	4.74%	9.19%	6.09%	6.55%	8.39%	12.83%	9.41%	9.86%	11.70%	16.14%
			14	Container 8,000-11,999 teu	13	2.92%	3.30%	4.88%	8.69%	6.02%	6.40%	7.98%	11.79%	7.92%	8.31%	9.89%	13.69%
			27	Container 12,000-14,499 teu	11	2.05%	2.51%	4.35%	8.82%	7.93%	8.38%	10.23%	14.70%	8.77%	9.22%	11.07%	15.54%
	8c	Palm oil	33	Container 3,000-4,999 teu	14	2.39%	2.64%	3.64%	6.08%	7.11%	7.36%	8.37%	10.80%	8.33%	8.57%	9.58%	12.02%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	16	2.54%	2.69%	3.30%	4.77%	8.28%	8.43%	9.04%	10.51%	10.73%	10.88%	11.49%	12.97%
			1	Oil & Product tanker 20,000-59,999 dwt	14	2.10%	2.56%	4.44%	8.98%	4.27%	4.73%	6.61%	11.15%	7.69%	8.15%	10.03%	14.57%
			2	Chemical tanker 40,000 + dwt	18	2.02%	2.22%	3.07%	5.11%	5.99%	6.20%	7.04%	9.08%	7.69%	7.90%	8.74%	10.78%
	8b	Iron and steel	47	Container 3,000-4,999 teu	9	3.37%	3.82%	5.66%	10.11%	6.26%	6.71%	8.55%	12.99%	9.25%	9.70%	11.54%	15.99%
			14	Container 8,000-11,999 teu	13	3.13%	3.52%	5.10%	8.91%	6.56%	6.94%	8.52%	12.33%	7.67%	8.05%	9.63%	13.44%
			27	Container 12,000-14,499 teu	11	2.34%	2.80%	4.65%	9.12%	8.15%	8.61%	10.46%	14.93%	8.82%	9.27%	11.12%	15.59%
	8c	Palm oil	33	Container 3,000-4,999 teu	14	2.81%	3.06%	4.07%	6.50%	7.76%	8.01%	9.01%	11.45%	8.42%	8.67%	9.68%	12.12%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	2030 SR 10%	2030 SR 20%	2030 SR 30%	2040 TCCImtm Change, % SR 0%	2040 SR 10%	2040 SR 20%	2040 SR 30%	2050 TCCImtm Change, % SR 0%	2050 SR 10%	2050 SR 20%	2050 SR 30%
Togo	8a	Essence (LPG)	1	Container 2,000-2,999 teu	16	7.52%	7.67%	8.28%	9.75%	10.14%	10.29%	10.90%	12.37%	10.95%	11.10%	11.71%	13.18%
			1	Oil & Product tanker 20,000-59,999 dwt	14	4.80%	5.27%	7.15%	11.69%	5.34%	5.80%	7.68%	12.22%	8.29%	8.76%	10.64%	15.18%
			2	Chemical tanker 40,000 + dwt	18	5.02%	5.23%	6.08%	8.12%	7.43%	7.64%	8.48%	10.52%	8.29%	8.50%	9.35%	11.39%
	8b	Iron and steel	47	Container 3,000-4,999 teu	9	5.63%	6.09%	7.93%	12.37%	8.59%	9.05%	10.89%	15.33%	9.31%	9.76%	11.60%	16.04%
			14	Container 8,000-11,999 teu	13	7.53%	7.92%	9.49%	13.30%	8.58%	8.97%	10.54%	14.35%	8.09%	8.48%	10.05%	13.86%
			27	Container 12,000-14,499 teu	11	7.32%	7.77%	9.62%	14.09%	10.90%	11.35%	13.20%	17.67%	9.14%	9.59%	11.44%	15.91%
	8c	Palm oil	33	Container 3,000-4,999 teu	14	7.71%	7.96%	8.97%	11.41%	9.22%	9.47%	10.48%	12.92%	8.78%	9.03%	10.03%	12.47%

Table 11.7: 2030, 2040, & 2050 case study transit-weighted average total commodity cost intensity, by scenario & forecasted year

2030

Country	Case Study	Case Study Commodity	Ship Type(s)	2030 Scenario 23 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2030 Scenario 24 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2030 Scenario 31 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2030 Scenario 32 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2030 Scenario 46 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%
Togo	8a	Essence (LPG)	Container, Chemicaltanker, Product tanker	1.76%	2.01%	3.06%	5.58%	1.20%	1.45%	2.50%	5.02%	2.34%	2.60%	3.64%	6.17%	2.17%	2.42%	3.47%	5.99%	5.59%	5.85%	6.89%	9.42%
	8b	Iron and steel	Container	2.31%	2.76%	4.56%	8.91%	3.01%	3.46%	5.26%	9.60%	2.40%	2.84%	4.65%	8.99%	3.02%	3.46%	5.26%	9.61%	6.45%	6.89%	8.69%	13.04%
	8c	Palm oil	Chemical tanker	1.18%	1.43%	2.44%	4.88%	1.37%	1.61%	2.62%	5.06%	2.39%	2.64%	3.64%	6.08%	2.81%	3.06%	4.07%	6.50%	7.71%	7.96%	8.97%	11.41%

2040

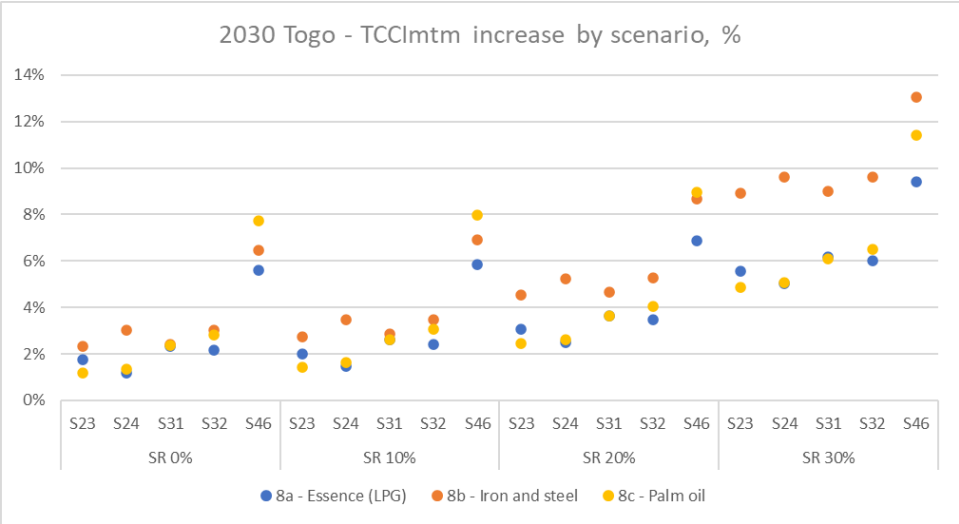
Country	Case Study	Case Study Commodity	Ship Type(s)	2040 Scenario 23 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2040 Scenario 24 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2040 Scenario 31 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2040 Scenario 32 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2040 Scenario 46 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%
Togo	8a	Essence (LPG)	Container, Chemicaltanker, Product tanker	7.34%	7.60%	8.64%	11.17%	6.02%	6.28%	7.32%	9.84%	5.92%	6.18%	7.23%	9.75%	6.13%	6.39%	7.43%	9.96%	7.58%	7.84%	8.89%	11.41%
	8b	Iron and steel	Container	8.48%	8.93%	10.73%	15.08%	6.90%	7.34%	9.14%	13.49%	6.64%	7.09%	8.89%	13.24%	6.89%	7.33%	9.13%	13.48%	9.30%	9.74%	11.54%	15.89%
	8c	Palm oil	Chemical tanker	9.52%	9.76%	10.77%	13.21%	6.79%	7.04%	8.05%	10.49%	7.11%	7.36%	8.37%	10.80%	7.76%	8.01%	9.01%	11.45%	9.22%	9.47%	10.48%	12.92%

2050

Country	Case Study	Case Study Commodity	Ship Type(s)	2050 Scenario 23 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2050 Scenario 24 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2050 Scenario 31 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2050 Scenario 32 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%	2050 Scenario 46 TCCImtm, % increase SR 0%	SR 10%	SR 20%	SR 30%
Togo	8a	Essence (LPG)	Container, Chemicaltanker, Product tanker	8.97%	9.22%	10.27%	12.79%	8.50%	8.75%	9.80%	12.32%	8.80%	9.06%	10.10%	12.63%	8.45%	8.71%	9.75%	12.27%	8.96%	9.22%	10.26%	12.78%
	8b	Iron and steel	Container	9.12%	9.56%	11.37%	15.71%	8.90%	9.34%	11.14%	15.49%	8.97%	9.42%	11.22%	15.57%	8.86%	9.31%	11.11%	15.46%	9.06%	9.50%	11.30%	15.65%
	8c	Palm oil	Chemical tanker	8.74%	8.99%	10.00%	12.44%	8.72%	8.97%	9.97%	12.41%	8.33%	8.57%	9.58%	12.02%	8.42%	8.67%	9.68%	12.12%	8.78%	9.03%	10.03%	12.47%

The 2030, 2040, and 2050 transit-weighted averaged, total commodity cost intensity ranges across all scenarios, by speed reduction group is presented in Figures 11.2, 11.3, and 11.4, respectively.

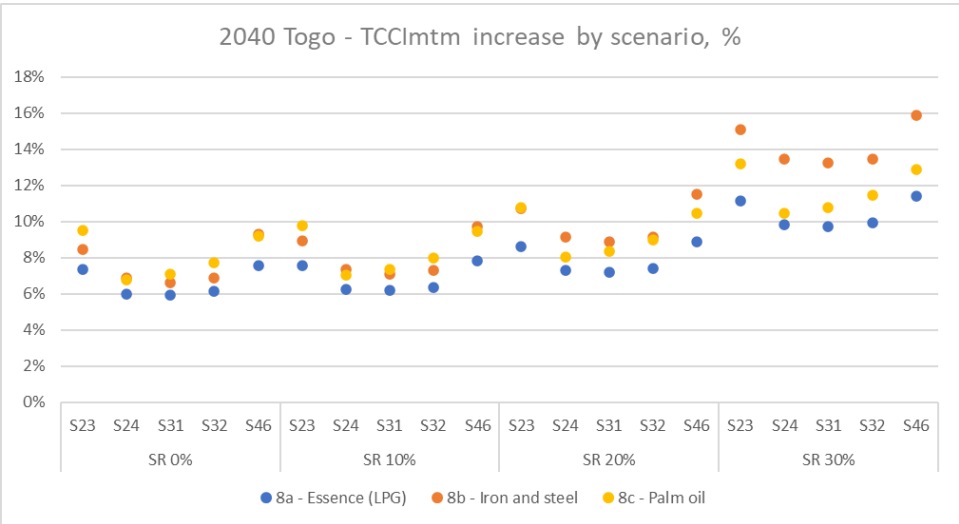
Figure 11.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2030, across all commodities, Scenarios 23 and 24 have generally the lowest ship-side cost intensity increase, while Scenario 46 shows the most total cost intensity increases. Iron and steel have by far the longest transits, nearly double that of essence and two-thirds longer than that of palm oil, hence the pronounced increase in the SR 30% group. As noted above, the *ad valorem* rates across all three case studies are close, so the driver for change across scenarios and speed reduction groups is the ship-side changes. The key parameters range from:

- **TCCImtm** **1.18% to 13.04%, with an average of 4.64%**

Figure 11.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group

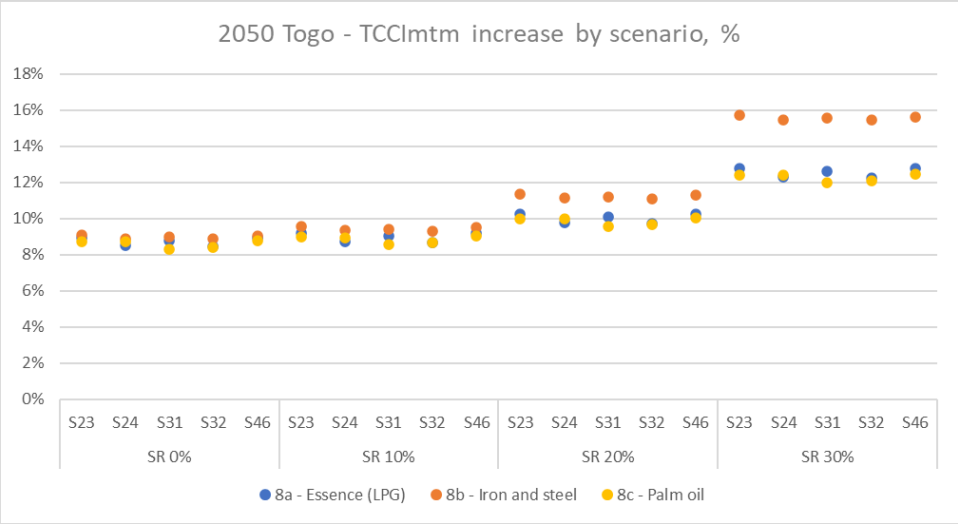


Note that in 2040, the spread across total commodity cost intensities significantly narrows across all scenarios and speed reduction groups, with the key parameters ranging from:

- **TCCImtm** **5.92% to 15.89%, with an average of 9.10%**

Scenario 46 is no longer predominant when compared to the increase in Scenario 23.

Figure 11.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2050, the total commodity cost intensities tightly align across all scenario and speed groups, with iron and steel more sensitive to speed reduction at the SR 30% due to the distance of the route compared to the others. The key parameters range from:

- **TCCImtm** **8.33% to 15.71%, with an average of 10.43%**

11.4 Qualitative analysis

Togo provided detailed Qualitative information on all three of their commodities using input from experts for each commodity. These are:

- Essence (LPG) responses were provided by Togo's team of Ministry of Maritime Economy, Fisheries and Coastal Protection
- Iron & steel responses were provided by Togo's team of Ministry of Maritime Economy, Fisheries and Coastal Protection
- Palm oil responses were provided by Togo's team of Ministry of Maritime Economy, Fisheries and Coastal Protection

In these Qualitative responses, emails and virtual meetings the stakeholders all showed strong awareness of the potential impacts of the IMO measures to decarbonize shipping, as well as related factors such as future fuels production and impacts on markets and competitiveness.

Analyses of these responses are displayed on the following SWOT grids (Tables 11.8 and 11.9) showing sensitivities to freight costs and sensitivities to transit times. Key takeaways for each grid are reflected in the SWOT grids on the next page.

Table 11.8: SWOT analysis of Togo's commodities and their sensitivity to cost changes

Sensitivity to freight shipment cost changes as reported by the stakeholders	
Country: Togo Commodities: 8a Essence (LPG), 8b iron & steel, 8c palm oil	
Strengths ➢ Togo is becoming a regional shipping center for the surrounding area. ➢ Togo is in equatorial west coast Africa, so not at the extreme south or north for shipping.	**Weaknesses** ➢ The main sources for all three commodities are located far from Togo. ➢ Delays in delivery during peak periods or holidays could lead to missed sales opportunities and disruptions in market dynamics. ➢ Palm oil suppliers may face pricing pressures and storage challenges.
Opportunities to adapt/mitigate ➢ Trade agreements can mitigate the impact of transportation costs by reducing trade barriers and facilitating market access. ➢ Lower speed reduces bunker costs. (However, other operational expenses may increase, offsetting fuel savings.) ➢ Provide additional storage, larger ships (if feasible) or additional ships to offset challenges and delays. ➢ Growth as a regional port could attract more cargo or larger vessels, potentially reducing costs.	**Threats** ➢ IMO GHG MTM may increase shipping costs for all commodities. ➢ The implementation of GHG emissions pricing in palm oil transportation could impact the cost of freight throughout the value chain. ➢ Higher transportation costs tied to distance can impact market accessibility, competitiveness, product pricing, and market expansion strategies. ➢ Exporters may prioritize closer markets to minimize costs and face challenges in competing with suppliers from regions with lower transportation costs. ➢ Reduced capacity ships due to lower energy density fuels could lead to increased transportation costs and logistical challenges. ➢ Ultimately, changes in freight costs may affect palm oil prices for consumers.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- Higher transportation costs tied to distance can impact market accessibility, competitiveness, product pricing, and market expansion strategies. Exporters may prioritize closer markets to minimize costs and face challenges in competing with suppliers from regions with lower transportation costs. Adjustments in product pricing may be necessary to maintain profitability, and market expansion efforts may be affected.
- Ultimately, changes in freight costs may affect prices for consumers.
- Trade agreements can mitigate the impact of transportation costs by reducing trade barriers and facilitating market access. However, issues of bargaining power are a real consideration.
- Another opportunity to mitigate impacts is to provide additional storage, larger ships (if feasible) or additional ships to offset challenges and delays.

Table 11.9: SWOT analysis of Togo's commodities and their sensitivity to transport time changes.

Sensitivity to increased transport times as reported by the stakeholders	
Country: Togo Commodities: 8a Essence (LPG), 8b iron & steel, 8c palm oil	
Strengths ➢ LPG and iron & steel are unlikely to degrade with longer transport time. ➢ Togo is becoming a shipping center for the surrounding area, making it more attractive to carriers as a consolidated destination. ➢ Togo is in equatorial west coast Africa, so not at the extreme south or north for shipping.	**Weaknesses** ➢ All 3 commodities demand timely arrivals for KPI and productivity reasons. ➢ The main suppliers for all three commodities are located far from Togo. This increases vulnerability to longer shipping times.
Opportunities to adapt/mitigate ➢ Lower vessel speed should reduce fuel consumption. ➢ Bigger ships may offer a potential solution to mitigate reduced cargo capacity, if feasible. ➢ There may be a need for more vessels or more storage facilities to meet the demand. ➢ Growth as a regional port could attract more or larger vessels. ➢ Temperature controlled shipping or storage could extend the shelf life of palm oil.	**Threats** ➢ IMO GHG MTM may increase transport times. ➢ Togo is distant from suppliers. ➢ Speed reduction would aggravate geographic disadvantage and worsen competitivity because of longer lead times and potentially more expensive freight costs. ➢ Reduced capacity ships due to lower energy density fuels could lead to increased transportation costs and logistical challenges for palm oil exporters.

Key findings on shipment transport times derived from stakeholder input to the SWOT analysis:

- Commodities may be time-sensitive for a variety of reasons – product degradation, customer demands (KPIs, production efficiency, seasonal demand), market forces and costs.
- Togo is distant from the commodity sources. Speed reduction would aggravate geographic disadvantage and worsen competitiveness due to longer lead times and potentially more expensive freight costs.
- Growth as a regional port could attract more or larger vessels, and support development of storage facilities.

Another insight to these stakeholders' awareness of and engagement in the decarbonization of shipping is the breadth of their responses to the final open-ended question "What questions should we have asked to more fully understand the impacts of potential vessel greenhouse gas reduction requirements on shipping, your population and your economy?" The additional question topics stakeholders from Togo suggested ranged from supply chain resilience and technology solutions to impacts on human needs and affordability.

11.5 Findings

Quantitative findings

The key findings from the quantitative analysis include:

- Longer transit times from potential speed reduction range across the case studies, including:
  - Essence (LPG)
    - SR 10% - 2 to nearly 4 days
    - SR 20% - nearly 5 to over 8 days
    - SR 30% - 8 to nearly 15 days
  - Iron and steel
    - SR 10% - nearly 4 days
    - SR 20% - 7 to 8 days
    - SR 30% - 13 to over 14 days
  - Palm oil
    - SR 10% - nearly 3 days
    - SR 20% - over 6 days
    - SR 30% - over 10 days
- Total commodity cost intensity increases across all scenarios are led by commodity costs associated with the MTM compared to the associated costs with speed reduction.
- The *ad valorem* rates of the imported essential goods ranged in a tight span from 12.8% to 14.2%, with an average of 13.4%.
- Note that in 2030, across all commodities, Scenarios 23 and 24 have generally the lowest ship-side cost intensity increase. Scenario 46 shows the most total cost intensity increases. Iron and steel have by far the longest transits, nearly double of essence and two-thirds longer than palm oil, hence the pronounced increase in the SR 30% group. As noted above the *ad valorem* rates across all three case studies are close, so the driver for change across scenarios and speed reduction groups is the ship-side changes.
- Note that in 2040, the spread across total commodity cost intensities significantly narrows across all scenarios and speed reduction groups. Scenario 46 is no longer predominant when compared to the increase in Scenario 23. Note that in 2050, the total commodity cost intensities tightly align across all scenario and speed groups, with iron and steel more sensitive to speed reduction at the SR 30% due to the distance of the route compared to the others.
- Total commodity cost intensity ranges across all scenarios and speed reduction groups, include:
  - Essence (LPG)
    - 2030 – 1.20% to 9.42%, with an average of 3.96%
    - 2040 – 5.92% to 11.41%, with an average of 7.95%
    - 2050 – 8.45% to 12.79%, with an average of 10.08%
  - Iron and steel
    - 2030 – 2.31% to 13.04%, with an average of 5.76%
    - 2040 – 6.64% to 15.89%, with an average of 9.96%
    - 2050 – 8.86% to 15.71%, with an average of 11.30%
  - Palm oil
    - 2030 – 1.18% to 11.41%, with an average of 4.39%
    - 2040 – 6.79% to 13.21%, with an average of 9.38%
    - 2050 – 8.33% to 12.47%, with an average of 9.90%

- TCCImtm findings for the three commodity case studies across all scenarios and speed reduction groups, by forecasted year:
  - 2030 1.18% to 13.04%, with an average of 4.64%
  - 2040 5.92% to 15.89%, with an average of 9.10%
  - 2050 8.33% to 15.71%, with an average of 10.43% %

Qualitative findings

Commodities may be time-sensitive for a variety of reasons – product degradation, customer demands (KPIs, production efficiency, seasonal demand), market forces and costs. For all three commodities selected by Togo, the main suppliers are located far from Togo, and timely delivery is important.

Togo's stakeholders who took part in the qualitative analysis reported that the effectiveness and efficiency of transport is of paramount importance.

Togo's stakeholders were of the opinion that vessel speed reduction would aggravate geographic disadvantage and worsen competitivity because of longer lead times and potentially more expensive freight costs.

Stakeholders stated that iron & steel and LPG are not time sensitive in terms of product degradation, but palm oil quality can be altered due to time or temperature.

They also stated that slower transit times for all commodities would mean increased costs to consumers.

Opportunities to mitigate impacts include a range of approaches identified by the stakeholders from Togo:

- Costs:
  - Trade agreements can mitigate the impact of transportation costs by reducing trade barriers and facilitating market access.
  - Lower speed reduces bunker costs. (However, other operational expenses may increase, offsetting fuel savings.)
  - Provide additional storage, larger ships (if feasible) or additional ships to offset challenges and delays.
- Transport time:
  - Stakeholders believe lower vessel speed should reduce fuel consumption, but this may be offset by other cost increases.
  - They also believe that bigger ships may offer a potential solution to mitigate reduced cargo capacity, if feasible.
  - There may be a need for more vessels or more storage facilities to meet the demand.
  - Growth as a regional port could attract more or larger vessels.
  - Temperature controlled shipping or storage could extend the shelf life of palm oil.

Summary of key points related to potential impacts

The following points are key to understanding the potential impacts of the MTM:

- Togo is an LDC.
- Togo's GDP in 2022 was $8,087 million, with a GDP per capita of $914.
- The three commodities selected by Togo for case studies are essential goods imports of LPG from Estonia, iron and steel works from China, and palm oil from Malaysia. All three commodity case studies are imported essential goods, which means cost increases impact the entire population. These impacts are significantly amplified when the essential goods are moved to the outer islands.
- For these three case studies, the estimates indicate a range of total commodity cost intensity increases related to maritime transport. Across Scenarios 23/24 and 31/32, for all forecasted years, the estimates indicate a range of total commodity cost intensity increases. These increases are estimated to be lower in 2030, but are estimated to significantly increase on average across the four scenarios by 3 times in 2040 and by nearly 4 times in 2050 compared to 2030. For strive Scenario 46, as expected, the significant increases in total commodity cost intensity increases are shifted forward to 2030 follow by on average increase of 1.2 times for 2040 and 1.5 in 2050 compared to 2030.
- Since these are essential goods, the impacts of delays weigh more heavily due to extremely limited national GDP, limited population and infrastructure to provide economies of scale, extremely limited disposal incomes to absorb cost increases, limited alternative transportation options to import essential goods, and country's remoteness to key trading partners.

12 Stakeholders' analysis – Tonga

The Stakeholder Assessment for Tonga focuses on the import of petroleum oil, and the exports of fish (fresh or chilled) and kava.

12.1 Geography, population, and economy

Geography

The Kingdom of Tonga is a Polynesian island nation and Small Island Developing State (SIDS) located south of Samoa and east of Fiji. It consists of 170 islands with a total land area of about 750 km^2 scattered over 700,000 km^2 of the Pacific Ocean. Around 35 islands are uninhabited. Tonga is divided into three main island groups. These are: Tongatapu in the south, Ha'apai in the center and Vava'u in the north. The capital, Nuku'alofa, is on Tongatapu. Ferries travel between each of these three island groups with trips ranging from 2 hours to over 10 hours. These ferries are an affordable means of transport for the Tongan people and also carry cargo, providing vital links between the islands.[157] Tonga is a self-governing country with a hereditary constitutional monarchy.

Tonga's geography places the islands significantly far from where essential goods are sourced. Tonga is thus heavily reliant on sea transport as air transport is expensive and used sparingly. Representative distances to markets for the selected commodities and ports are presented in Section 12.2. There are three main ports in Tonga: Neiafu, Nuku'alofa and Pangai. Nuku'alofa is the central hub for transport in Tonga and international import and export cargo shipping.[158] Although current ports have enough capacity for expected needs, infrastructure reportedly has declined in recent years. Tonga's government is tackling such issues with port upgrade projects currently in progress.

Nuku'alofa harbor, which serves as the main deep-water harbor for the islands, is crucial for connections to outer islands. The harbor basin is surrounded by reefs and access includes two main channels: one from the north for all vessels and another from the east for vessels up to 110 meters in length. Facilities at Nuku'alofa include two alongside berths and a mooring dolphin for discharge of oil and LPG cargoes. As Tonga's primary port, Nuku'alofa handles container, ro-ro (roll-on/roll-off), general cargo, and tanker traffic. Annually, about 200 vessels use the port.[159] Some ships also service numerous other SIDS along the way and any delays there have a direct negative impact on the schedule, delaying Tonga arrivals.

Population

The 2021 Population Census indicated that the resident population was 100,179, of which 97% have Polynesian ancestry. Nearly 74% of the population lives on Tongatapu, 14% on Vava'u and 6% on Ha'apai.[160] A majority of the population lives in rural villages, although the urban population has been growing in recent years. The total population has been declining since the 1970s and with the Covid-19 pandemic, the tourist trade stopped in March 2020 and associated jobs disappeared. There has been strong migration out of the islands through 2021 primarily to New Zealand, the United States and Australia.

[157] Kingdom of Tonga, *Getting Around Tonga*, 2011, Tonga Visitors Bureau.
[158] Pacific Community, *Improving the Availability of Maritime Transport Cost Data in the Pacific: Tonga Country Report*, 2022, MTCC Pacific.
[159] Pacific Community, *Improving the Availability of Maritime Transport Cost Data in the Pacific: Tonga Country Report*, 2022, MTCC Pacific.
[160] TSD, *Population and Housing Factsheet* 2021.

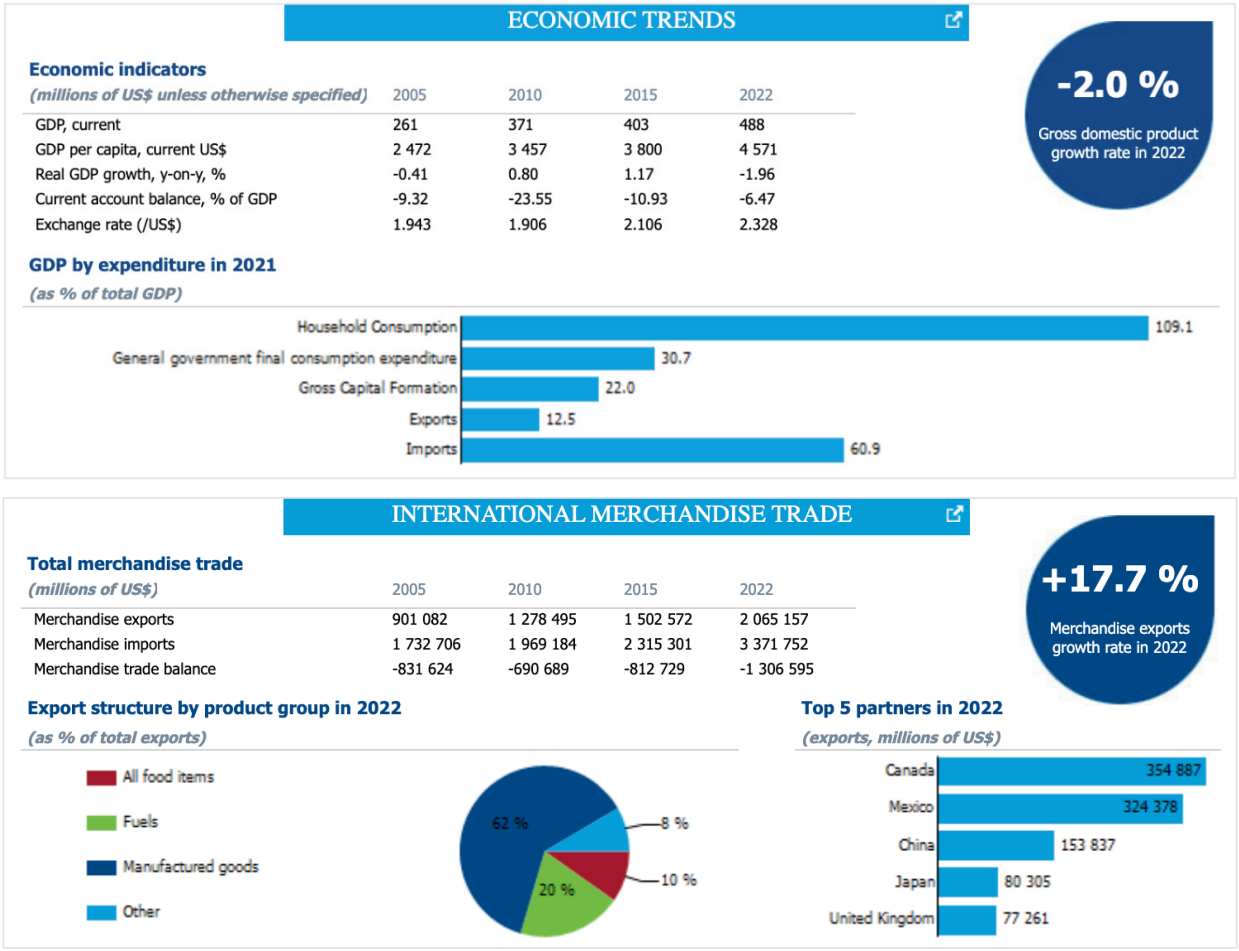
Economy

The 2022 GDP for Tonga was reported by UNCTADSTATS as $488 million, with a GDP per capita of $4,571.[144] The Covid-19 pandemic set the country's economy back, though donor support has helped to minimize some of the more negative impacts on Tonga's vulnerable population. [161]

Agriculture accounts for around 40% of the GDP and is the cornerstone of Tonga's economy. Approximately 70% of the population depends on farming for personal and domestic use.
Tourism represents the largest source of foreign currency earnings, following remittances.[162] The Covid-19 pandemic set the country's economy back, though donor support has helped to minimize some of the more negative impacts on Tonga's vulnerable population. [163]

Many of Tonga's agricultural products are consumed domestically, and food and beverages from New Zealand, Australia, and the United States make up the largest category of imports. Key economic indicators are shown in Figure 12.1.[164]

Figure 12.1: Key economic indicators for Tonga



UNCTAD, General and Maritime Profiles: Tonga, *UNCTAD Statistics - General Profile*.

[161] TSD, *National Accounts Division*.
[162] Pacific Community, *Improving the Availability of Maritime Transport Cost Data in the Pacific: Tonga Country Report*, 2022, MTCC Pacific.
[163] TSD, *National Accounts Division*.
[164] UNCTAD, General and Maritime Profiles: Tonga, *UNCTAD Statistics - General Profile*.

12.2 Identified commodities and routes studied

The case studies for Tonga focuses on the import of petroleum oil (diesel and petrol), and the exports of fish, fresh or chilled (tuna) and plants (root crops and kava).

The commodities selected by the Member State for focus and illustrative trade routes selected are shown in Table 12.1. One essential good commodity selected for this study is an import, and two trade commodities are exports.

Table 12.1: Shipping distances to and from Tonga for selected commodities

Case Study	Commodity	Illustrative identified routes, by country	Ship Type(s)	Route Distance Range, nm min	avg	max	Stops
9a	Petroleum oils	Singapore --> Fiji --> Tonga	Tanker	5,134	5,495	6,969	2-4
		Leg 1 - Singapore --> Fiji	Tanker	4,765	4,895	5,096	1
		Singapore --> Fiji					
		Singapore --> Malayasia --> Fiji					
		Singapore --> Malayasia --> Solomon Islands --> Fiji					
		Singapore --> Solomon Islands --> Fiji					
		Leg 2 - Fiji --> Tonga	Chemical tanker	369	600	1,873	1-3
		Fiji --> Tonga					
		Fiji --> Norfolk Island --> Tonga					
		Fiji --> Wallis and Futuna --> Tonga					
9b	Fish	Tonga --> Cook Islands --> Niue --> New Zealand	General cargo	1,066	1,604	3,824	2-5
9c	Kava	Tonga --> Cook Islands --> Samoa --> New Zealand					
		Tonga --> Fiji --> Samoa --> Niue --> Cook Islands --> New Zealand					
		Tonga --> New Zealand					
		Tonga --> Vava'u --> New Zealand					

12.3 Quantitative analysis

This section presents the quantitative analysis summary results and is organized by fleet analysis summary, total commodity cost intensity changes from speed reduction, Task 2 cost intensity changes due to MTM, total commodity cost intensity impacts, and GDP contexts. The quantitative analysis incorporates the findings of Task 2 related to the selected bracketing MTM scenarios as presented below:[165]

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination: Policy code	GFI scope	GFI flexibility: RU % of price	SU % of price	Levy: Levy USD/tCO_2eq	Levy: Reward % of cost gap	Feebate Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

The detailed approach for the below analyses is provided in Appendix A.

[165] DNV 2024

Fleet analysis summary

As part of the fleet analysis, routes and ship characteristics were identified for each commodity case study. For the specific ship types identified with the commodity case study and transiting on the identified route the following were averaged to represent the fleet:

- Ship type and size
- Number of transits identified
- Route distances obtained from Marine Benchmark's 2022 AIS database were transit-weighted averaged and reported as minimum, average, and maximum distance sailed
- Transit-weighted average year of build, which was used to determine the average age in years

These characteristics for the case studies are presented in Table 12.2.

Table 12.2: Tonga – Fleet characteristics, by commodity case study

Case Study	Commodity	2022 Transits	Ship Type	Distance Range, nm min	avg	max	Avg Build
9a	Petroleum oils	**Long haul route**					
		31	Chemical tanker 40,000+ dwt	4,765	**4,898**	5,096	2014
		2	Oil & Product tanker 20,000-59,999 dwt	4,831	**4,850**	4,869	2007
		Regional route					
		18	Chemical tanker 0-4,999 dwt	369	**568**	1,873	2009
		16	Chemical tanker 5,000-9,999 dwt	545	**637**	841	2008
9b	Fish						
9c	Kava	18	General cargo 5,000-9,999 dwt	1,066	**1,604**	3,824	2003

In addition, transit weighted average speeds and average route times were estimated and the APEC Module 1 was used to estimate the longer transit times associated with the speed reduction groups of 10%, 20%, and 30%, as presented in Table 12.3.

Table 12.3: Average route distance, speed, & longer transit ,times, by speed reduction group

Country	Case Study	Commodity	Transits	Ship type & size	Avg Route Distance (nm)	Avg Route Speed (knots)	Avg Route Time (hours)	SR 10% Delay Delta (days)	SR 20% Delay Delta (days)	SR 30% Delay Delta (days)
Tonga	9a	Petroleum oils	31	Chemical tanker 40,000+ dwt	4,898	12.2	403	1.9	4.2	7.2
			2	Oil & Product tanker 20,000-59,999 dwt	4,850	12.4	390	1.8	4.1	7.0
			18	Chemical tanker 0-4,999 dwt	568	8.6	66	0.3	0.7	1.2
			16	Chemical tanker 5,000-9,999 dwt	637	8.9	72	0.3	0.7	1.3
	9b	Fish	18	General cargo 5,000-9,999 dwt	1,604	12.6	128	0.6	1.3	2.3
	9c	Kava	18	General cargo 5,000-9,999 dwt	1,604	12.6	128	0.6	1.3	2.3

In 2022, most of the imported essential goods come via two general cargo ships that bring goods via container. These ships are connected with the fish and kava commodity case. Based on the Marine Benchmark data, presented in Table 8.3, these ships travel at average voyage speed of 12.6 knots from Tonga to New Zealand. Based on that information, the average voyage SR 10% speed would be 11.3 knots, the average voyage SR 20% speed would be 10.1 knots, and the average voyage SR 30% would be 8.8 knots. With an average rated speed of 15 knots, the potential benefit from additional speed reduction beyond SR 20% is limited. Similarly, the various tankers in 9a had an average voyage speed of 12.2/12.5 knots from Singapore to Fiji and the regional tanker had an average route speed of 8.6/8.9 knots. Additional voyage speed reduction for the regional ships would offer little benefit and may not be practicable.

The fleet characteristics are assumed to be consistent across the forecasted years of 2030, 2040, and 2050.

Total commodity cost intensity changes due to speed reduction

APEC Module 2 was used to estimate the commodity cost intensity increases due to potentially longer transit times resulting from the three speed reduction groups. The module estimates the daily cost increases, in percentage, associated with the following:

- Finance/interest costs - the financial cost of capital invested in inventory over time. This measures the impact of each hour or day of delay on the cost of the product due to cost of money or interest rate. A Member State rate was used when provided, otherwise, it was assumed to be 5%.[166]
- Depreciation costs - the cost allocation of a commodity, or reduction of the commodity value, over its useful life. For this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry bulk cargo.[167] Tonga provided depreciation costs for all three commodities as follows: Petroleum oil 0.5%, Fish (Tuna) 33%, and plants 0.25%. These rates were used to run the model for Tonga's economic impact analysis.
- Insurance costs - a cost paid by the cargo owner to protect their goods while in transit. The percentage used in the economic analysis is the one provided by the Member State. If the Member State did not provide data, we assumed it to be 2%.[168]

The total commodity cost intensity change related to the three speed reduction groups for the case studies is presented in Table 12.4. Note that these values remain constant across scenarios and forecasted year.

Table 12.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Commodity-side Task 4 TCIsr Change, % SR 10%	SR 20%	SR 30%
Tonga	9a	Petroleum oils	31	Chemical tanker 40,000+ dwt	10	0.11%	0.58%	1.70%
			2	Oil & Product tanker 20,000-59,999 dwt	16	0.11%	0.54%	1.59%
			18	Chemical tanker 0-4,999 dwt	14	0.00%	0.02%	0.05%
			16	Chemical tanker 5,000-9,999 dwt	15	0.00%	0.02%	0.05%
	9b	Fish	18	General cargo 5,000-9,999 dwt	20	0.01%	0.06%	0.17%
	9c	Kava	18	General cargo 5,000-9,999 dwt	20	0.01%	0.06%	0.17%

The commodity cost intensity changes due to speed reduction, ranges as follows:

- 9a – SR 10% negligible, SR 20% → negligible-0.58%, SR 30% → negligible-1.70%
- 9b – less than 1% across all speed reduction groups
- 9c – less than 1% across all speed reduction groups

As noted above, there is limited benefits from speed reduction beyond SR 20% for case studies 9b and 9c.

[166] Lending Tree, *Assuming a line of credit 5%*.
[167] APEC 2019
[168] APEC 2019

Task 2 cost intensity changes due to MTM

Based on the ship type, size, and age combination for each commodity case study, the applicable Task 2 ship-side commodity cost intensities due to the MTM were identified for the selected scenarios. In addition, in order to be able to add these to the commodity cost intensity changes due to speed reduction, the a*d valorem* freight rate percentage was identified using the UNCTAD Trade-and-Transport Dataset.[169] The *ad valorem* freight rate percentage represents the transportation cost percentage of a commodity's total cost. These two were multiplied to get the freight rate adjusted commodity cost intensity or FRACCI change for 2030, 2040, and 2050. Task 2 cost intensity change and FRACCI for each scenario are presented in Table 12.5.

[169] UNCTAD, *Trade-and-Transport Dataset*.

Table 12.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Tonga	9a	Petroleum oils	31 Chemical tanker 40,000+ dwt	10	10.4%	25.65%	54.63%	58.54%	2.67%	5.68%	6.09%
			2 Oil & Product tanker 20,000-59,999 dwt	16	10.4%	9.13%	40.88%	59.53%	0.95%	4.25%	6.19%
			18 Chemical tanker 0-4,999 dwt	14	10.4%	0.42%	31.98%	49.75%	0.04%	3.33%	5.17%
			16 Chemical tanker 5,000-9,999 dwt	15	10.4%	5.19%	42.61%	45.87%	0.54%	4.43%	4.77%
	9b	Fish	18 General cargo 5,000-9,999 dwt	20	6.4%	1.40%	60.20%	65.77%	0.09%	3.85%	4.21%
	9c	Kava	18 General cargo 5,000-9,999 dwt	20	30.2%	1.40%	60.20%	65.77%	0.42%	18.18%	19.86%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Tonga	9a	Petroleum oils	31 Chemical tanker 40,000+ dwt	10	10.4%	24.56%	46.80%	58.69%	2.55%	4.87%	6.10%
			2 Oil & Product tanker 20,000-59,999 dwt	16	10.4%	5.92%	38.35%	55.68%	0.62%	3.99%	5.79%
			18 Chemical tanker 0-4,999 dwt	14	10.4%	5.34%	28.88%	48.84%	0.56%	3.00%	5.08%
			16 Chemical tanker 5,000-9,999 dwt	15	10.4%	5.02%	38.85%	44.88%	0.52%	4.04%	4.67%
	9b	Fish	18 General cargo 5,000-9,999 dwt	20	6.4%	2.47%	47.92%	64.77%	0.16%	3.07%	4.15%
	9c	Kava	18 General cargo 5,000-9,999 dwt	20	30.2%	2.47%	47.92%	64.77%	0.75%	14.47%	19.56%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Tonga	9a	Petroleum oils	31 Chemical tanker 40,000+ dwt	10	10.4%	18.76%	45.48%	64.33%	1.95%	4.73%	6.69%
			2 Oil & Product tanker 20,000-59,999 dwt	16	10.4%	12.78%	30.71%	58.38%	1.33%	3.19%	6.07%
			18 Chemical tanker 0-4,999 dwt	14	10.4%	11.49%	33.17%	51.15%	1.20%	3.45%	5.32%
			16 Chemical tanker 5,000-9,999 dwt	15	10.4%	11.35%	35.50%	48.66%	1.18%	3.69%	5.06%
	9b	Fish	18 General cargo 5,000-9,999 dwt	20	6.4%	18.54%	44.76%	67.26%	1.19%	2.86%	4.30%
	9c	Kava	18 General cargo 5,000-9,999 dwt	20	30.2%	18.54%	44.76%	67.26%	5.60%	13.52%	20.31%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Tonga	9a	Petroleum oils	31 Chemical tanker 40,000+ dwt	10	10.4%	18.81%	44.94%	62.05%	1.96%	4.67%	6.45%
			2 Oil & Product tanker 20,000-59,999 dwt	16	10.4%	14.23%	30.33%	55.00%	1.48%	3.15%	5.72%
			18 Chemical tanker 0-4,999 dwt	14	10.4%	11.15%	32.98%	50.48%	1.16%	3.43%	5.25%
			16 Chemical tanker 5,000-9,999 dwt	15	10.4%	11.26%	34.75%	44.44%	1.17%	3.61%	4.62%
	9b	Fish	18 General cargo 5,000-9,999 dwt	20	6.4%	28.29%	47.30%	62.27%	1.81%	3.03%	3.99%
	9c	Kava	18 General cargo 5,000-9,999 dwt	20	30.2%	28.29%	47.30%	62.27%	8.54%	14.28%	18.81%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
Tonga	9a	Petroleum oils	31 Chemical tanker 40,000+ dwt	10	10.4%	40.88%	59.27%	60.57%	4.25%	6.16%	6.30%
			2 Oil & Product tanker 20,000-59,999 dwt	16	10.4%	33.82%	37.62%	59.33%	3.52%	3.91%	6.17%
			18 Chemical tanker 0-4,999 dwt	14	10.4%	38.35%	44.43%	52.40%	3.99%	4.62%	5.45%
			16 Chemical tanker 5,000-9,999 dwt	15	10.4%	30.06%	43.15%	49.95%	3.13%	4.49%	5.19%
	9b	Fish	18 General cargo 5,000-9,999 dwt	20	6.4%	42.25%	50.00%	67.75%	2.70%	3.20%	4.34%
	9c	Kava	18 General cargo 5,000-9,999 dwt	20	30.2%	42.25%	50.00%	67.75%	12.76%	15.10%	20.46%

The *ad valorem* rates of the imported essential goods, energy from petroleum oils, is 10.4%. For the export of trade commodities, fish have an *ad valorem* rate of 6.4%, and kava has a rate of 30.2%. This implies that kava and petroleum oils are highly sensitive to ship-side cost intensity increases, while fish exports are not as impacted by ship-side cost increases. Note that UNCTAD does not have Cook Island specific *ad valorem* rates.

Note that there are differences in the business-as-usual (BAU) within the DNV model that was used for Task 2. As learned from our consultation with DNV, "…ships in the DNV model that called the EU, will have a higher BAU because of the EU's regulatory requirements. Ships not calling the EU will have a lower BAU, which implies that their changes in ship-side cost intensity should be higher for the forecasted years compared to those calling the EU and the average of the entire ship size, type, and age category."[170] The non-EU BAU was used for all ship types servicing Tonga

Similar to the Cook Islands in terms of the relatively low Task 2 cost intensities based on the general cargo ship, size, and age range, Tore noted, "Looking into the profiles of the GC 5-10kdwt segment, it looks like the ships operate closer to design speed compared to other segments. This means that there is a higher potential for energy efficiency and cost improvements (but not GHG intensity). But this is a very diverse segments of many different sub-types – from heavy load carriers, small bulk carriers and container vessels with some GC carrying capability. Matson's GC vessels are in many aspects more similar to container ships (0-999 teu). The GC 5-10k dwt segment's average design speed is about 12 knots. The average design speed of container ships (0-999 teu) is 16 knots. Matsons vessels operating on these routes are 15-16 knots [less than 999 teus]. It also looks like Matson's vessel already operate at closer to 12-13 knots and the additional speed reduction potential is not that great."[171]

A further review was made of the cost intensity increases from the suggested very small container ships (0-999 teu) group, noted above. These showed a higher impact, which for two ships operating in the Pacific, seemed more anticipated.[172] The results presented in this report are based on the impacts on the applicable very small container ship grouping.

Note that Tonga is also served by two additional ships of the same ship size and type and they were grouped with the Matson ships and assigned the 0-999 teu impact as well.

Because these two ships also serviced both Member States, the change was made there as well to keep the two stakeholder analyses consistent.

Total commodity cost intensity due to speed reduction and MTM

For each commodity case study, combining Task 2 and Task 4 results estimates the total commodity cost intensity[173] associated with potential speed reduction and the MTM ($TCCI_{mtm}$), for the forecasted years of 2030, 2040, and 2050, as presented in Table 12.6, on the following page. For each commodity case study, the results were compiled into a transit-weighted average for each scenario and forecasted year. These results are presented as Table 12.7.

[170] Email exchange with Tore Longa, Project Manager Task 2, 17 June 2024.
[171] Email exchange with Tore Longa, Project Manager Task 2, 13 July 2024
[172] Email exchange with Tore Longa, Project Manager Task 2, 14 July 2024
[173] The term 'total commodity cost intensity' as used in this report is defined as the total 'landed cost' of the commodity.

Table 12.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Tonga	9a	Petroleum oils	31 Chemical tanker 40,000+ dwt	10	2.67%	2.78%	3.25%	4.37%	5.68%	5.80%	6.26%	7.38%	6.09%	6.20%	6.67%	7.79%
			2 Oil & Product tanker 20,000-59,999 dwt	16	0.95%	1.06%	1.49%	2.54%	4.25%	4.36%	4.79%	5.84%	6.19%	6.30%	6.73%	7.78%
			18 Chemical tanker 0-4,999 dwt	14	0.04%	0.05%	0.06%	0.09%	3.33%	3.33%	3.34%	3.37%	5.17%	5.18%	5.19%	5.22%
			16 Chemical tanker 5,000-9,999 dwt	15	0.54%	0.54%	0.56%	0.59%	4.43%	4.43%	4.45%	4.48%	4.77%	4.77%	4.79%	4.82%
	9b	Fish	18 General cargo 5,000-9,999 dwt	20	0.09%	0.10%	0.15%	0.26%	3.85%	3.86%	3.91%	4.02%	4.21%	4.22%	4.27%	4.38%
	9c	Kava	18 General cargo 5,000-9,999 dwt	20	0.42%	0.43%	0.48%	0.59%	18.18%	18.19%	18.24%	18.35%	19.86%	19.88%	19.92%	20.03%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Tonga	9a	Petroleum oils	31 Chemical tanker 40,000+ dwt	10	2.55%	2.67%	3.13%	4.25%	4.87%	4.98%	5.44%	6.56%	6.10%	6.22%	6.68%	7.80%
			2 Oil & Product tanker 20,000-59,999 dwt	16	0.62%	0.72%	1.16%	2.21%	3.99%	4.10%	4.53%	5.58%	5.79%	5.90%	6.33%	7.38%
			18 Chemical tanker 0-4,999 dwt	14	0.56%	0.56%	0.57%	0.60%	3.00%	3.01%	3.02%	3.05%	5.08%	5.08%	5.10%	5.13%
			16 Chemical tanker 5,000-9,999 dwt	15	0.52%	0.53%	0.54%	0.58%	4.04%	4.04%	4.06%	4.09%	4.67%	4.67%	4.69%	4.72%
	9b	Fish	18 General cargo 5,000-9,999 dwt	20	0.16%	0.17%	0.22%	0.33%	3.07%	3.08%	3.12%	3.24%	4.15%	4.16%	4.20%	4.32%
	9c	Kava	18 General cargo 5,000-9,999 dwt	20	0.75%	0.76%	0.80%	0.92%	14.47%	14.48%	14.53%	14.64%	19.56%	19.57%	19.62%	19.73%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Tonga	9a	Petroleum oils	31 Chemical tanker 40,000+ dwt	10	1.95%	2.07%	2.53%	3.65%	4.73%	4.84%	5.31%	6.43%	6.69%	6.80%	7.27%	8.39%
			2 Oil & Product tanker 20,000-59,999 dwt	16	1.33%	1.44%	1.87%	2.92%	3.19%	3.30%	3.73%	4.78%	6.07%	6.18%	6.61%	7.66%
			18 Chemical tanker 0-4,999 dwt	14	1.20%	1.20%	1.21%	1.24%	3.45%	3.45%	3.47%	3.50%	5.32%	5.32%	5.33%	5.36%
			16 Chemical tanker 5,000-9,999 dwt	15	1.18%	1.18%	1.20%	1.23%	3.69%	3.70%	3.71%	3.75%	5.06%	5.06%	5.08%	5.11%
	9b	Fish	18 General cargo 5,000-9,999 dwt	20	1.19%	1.20%	1.24%	1.36%	2.86%	2.88%	2.92%	3.04%	4.30%	4.32%	4.36%	4.48%
	9c	Kava	18 General cargo 5,000-9,999 dwt	20	5.60%	5.61%	5.66%	5.77%	13.52%	13.53%	13.57%	13.69%	20.31%	20.32%	20.37%	20.48%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Tonga	9a	Petroleum oils	31 Chemical tanker 40,000+ dwt	10	1.96%	2.07%	2.53%	3.65%	4.67%	4.79%	5.25%	6.37%	6.45%	6.57%	7.03%	8.15%
			2 Oil & Product tanker 20,000-59,999 dwt	16	1.48%	1.59%	2.02%	3.07%	3.15%	3.26%	3.70%	4.75%	5.72%	5.83%	6.26%	7.31%
			18 Chemical tanker 0-4,999 dwt	14	1.16%	1.16%	1.17%	1.20%	3.43%	3.43%	3.45%	3.48%	5.25%	5.25%	5.27%	5.30%
			16 Chemical tanker 5,000-9,999 dwt	15	1.17%	1.17%	1.19%	1.22%	3.61%	3.62%	3.63%	3.67%	4.62%	4.63%	4.64%	4.68%
	9b	Fish	18 General cargo 5,000-9,999 dwt	20	1.81%	1.82%	1.87%	1.98%	3.03%	3.04%	3.09%	3.20%	3.99%	4.00%	4.04%	4.16%
	9c	Kava	18 General cargo 5,000-9,999 dwt	20	8.54%	8.56%	8.60%	8.71%	14.28%	14.30%	14.34%	14.45%	18.81%	18.82%	18.86%	18.98%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits Ship type & size	Avg Age (years)	2030 TCCImtm Change, %				2040 TCCImtm Change, %				2050 TCCImtm Change, %			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Tonga	9a	Petroleum oils	31 Chemical tanker 40,000+ dwt	10	4.25%	4.37%	4.83%	5.95%	6.16%	6.28%	6.74%	7.86%	6.30%	6.41%	6.88%	8.00%
			2 Oil & Product tanker 20,000-59,999 dwt	16	3.52%	3.62%	4.06%	5.11%	3.91%	4.02%	4.45%	5.50%	6.17%	6.28%	6.71%	7.76%
			18 Chemical tanker 0-4,999 dwt	14	3.99%	3.99%	4.00%	4.03%	4.62%	4.62%	4.64%	4.67%	5.45%	5.45%	5.46%	5.49%
			16 Chemical tanker 5,000-9,999 dwt	15	3.13%	3.13%	3.14%	3.18%	4.49%	4.49%	4.51%	4.54%	5.19%	5.20%	5.21%	5.25%
	9b	Fish	18 General cargo 5,000-9,999 dwt	20	2.70%	2.72%	2.76%	2.88%	3.20%	3.21%	3.26%	3.37%	4.34%	4.35%	4.39%	4.51%
	9c	Kava	18 General cargo 5,000-9,999 dwt	20	12.76%	12.77%	12.82%	12.93%	15.10%	15.11%	15.16%	15.27%	20.46%	20.47%	20.52%	20.63%

Table 12.7: 2030, 2040, & 2050 commodity case study transit-weighted average total commodity cost intensity, by scenario and forecasted year

2030

Country	Case Study	Case Study Commodity	Ship Type(s)	2030 Scenario 23 TCCImtm, % increase				2030 Scenario 24 TCCImtm, % increase				2030 Scenario 31 TCCImtm, % increase				2030 Scenario 32 TCCImtm, % increase				2030 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Tonga	9a	Petroleum oils	Chemical tanker, Oil & product tanker	2.31%	2.42%	2.83%	3.83%	2.23%	2.33%	2.74%	3.74%	1.83%	1.94%	2.35%	3.35%	1.84%	1.95%	2.36%	3.36%	4.14%	4.24%	4.65%	5.65%
	9b	Fish	General cargo	0.09%	0.10%	0.15%	0.26%	0.16%	0.17%	0.22%	0.33%	1.19%	1.20%	1.24%	1.36%	1.81%	1.82%	1.87%	1.98%	2.70%	2.72%	2.76%	2.88%
	9c	Kava	General cargo	0.42%	0.43%	0.48%	0.59%	0.75%	0.76%	0.80%	0.92%	5.60%	5.61%	5.66%	5.77%	8.54%	8.56%	8.60%	8.71%	12.76%	12.77%	12.82%	12.93%

2040

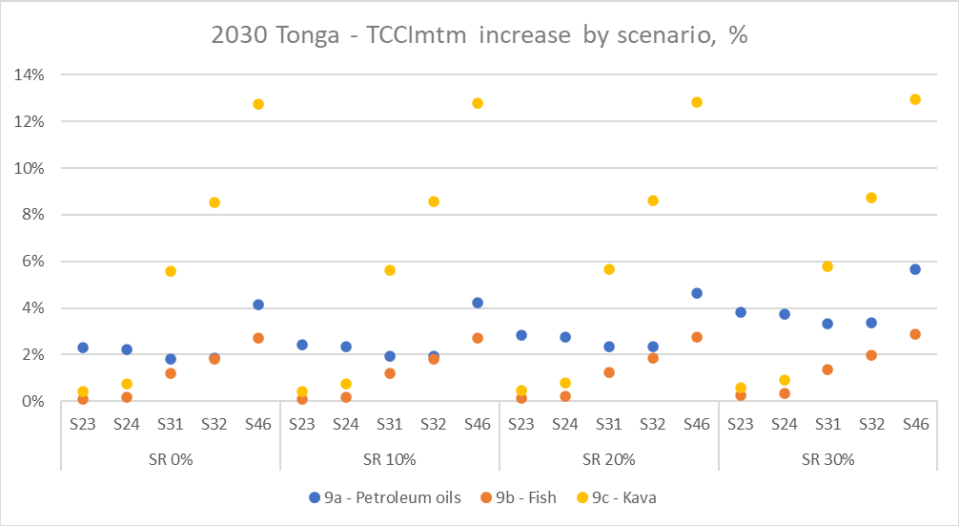
Country	Case Study	Case Study Commodity	Ship Type(s)	2040 Scenario 23 TCCImtm, % increase				2040 Scenario 24 TCCImtm, % increase				2040 Scenario 31 TCCImtm, % increase				2040 Scenario 32 TCCImtm, % increase				2040 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Tonga	9a	Petroleum oils	Chemical tanker, Oil & product tanker	5.41%	5.51%	5.92%	6.92%	4.67%	4.77%	5.19%	6.18%	4.52%	4.62%	5.03%	6.03%	4.47%	4.57%	4.98%	5.98%	5.87%	5.97%	6.38%	7.38%
	9b	Fish	General cargo	3.85%	3.86%	3.91%	4.02%	3.07%	3.08%	3.12%	3.24%	2.86%	2.88%	2.92%	3.04%	3.03%	3.04%	3.09%	3.20%	3.20%	3.21%	3.26%	3.37%
	9c	Kava	General cargo	18.18%	18.19%	18.24%	18.35%	14.47%	14.48%	14.53%	14.64%	13.52%	13.53%	13.57%	13.69%	14.28%	14.30%	14.34%	14.45%	15.10%	15.11%	15.16%	15.27%

2050

Country	Case Study	Case Study Commodity	Ship Type(s)	2050 Scenario 23 TCCImtm, % increase				2050 Scenario 24 TCCImtm, % increase				2050 Scenario 31 TCCImtm, % increase				2050 Scenario 32 TCCImtm, % increase				2050 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
Tonga	9a	Petroleum oils	Chemical tanker, Oil & product tanker	5.97%	6.07%	6.49%	7.48%	5.95%	6.05%	6.47%	7.46%	6.49%	6.59%	7.01%	8.00%	6.25%	6.35%	6.76%	7.76%	6.19%	6.29%	6.70%	7.70%
	9b	Fish	General cargo	4.21%	4.22%	4.27%	4.38%	4.15%	4.16%	4.20%	4.32%	4.30%	4.32%	4.36%	4.48%	3.99%	4.00%	4.04%	4.16%	4.34%	4.35%	4.39%	4.51%
	9c	Kava	General cargo	19.86%	19.88%	19.92%	20.03%	19.56%	19.57%	19.62%	19.73%	20.31%	20.32%	20.37%	20.48%	18.81%	18.82%	18.86%	18.98%	20.46%	20.47%	20.52%	20.63%

The 2030, 2040, and 2050 transit-weighted averaged, total commodity cost intensity ranges across all scenarios, by speed reduction group is presented in Figures 12.2, 12.3, and 12.4, respectively.

Figure 12.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group

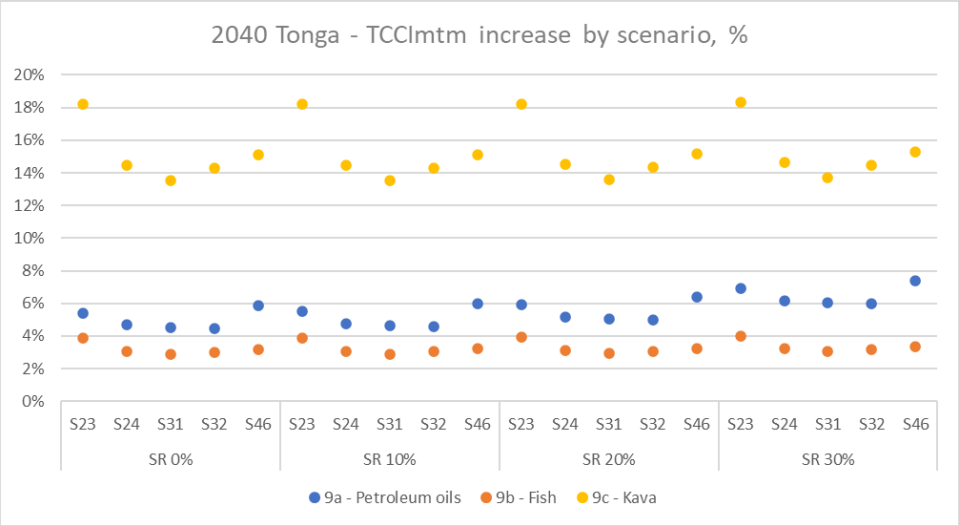


Note that in 2030, ship-side cost intensity increases are the primary driver across all scenarios and speed reduction groups, with the key parameters, ranging from:

- **TCCImtm** **0.09% to 12.93%, with an average of 3.31%**

Exports of fish moved by general cargo vessels. For fish, the commodity cost intensity increases are very low and have a consistent spread across all speed reduction groups. Kava's commodity cost intensity is double to triple that of fish, although moved on the same ships, it shows more sensitivity in the SR 30% group. The strive Scenario 46 is nearly 5 times higher for kava than fish. This is due to the *ad valorem* rate differences between fish at 6.4% compared to kava at 30.2%. For petroleum, there is little spread between the scenarios, with the exception of the strive Scenario 46 which is almost double the other scenarios. However, that spread is tighter in the SR 30% group.

Figure 12.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group

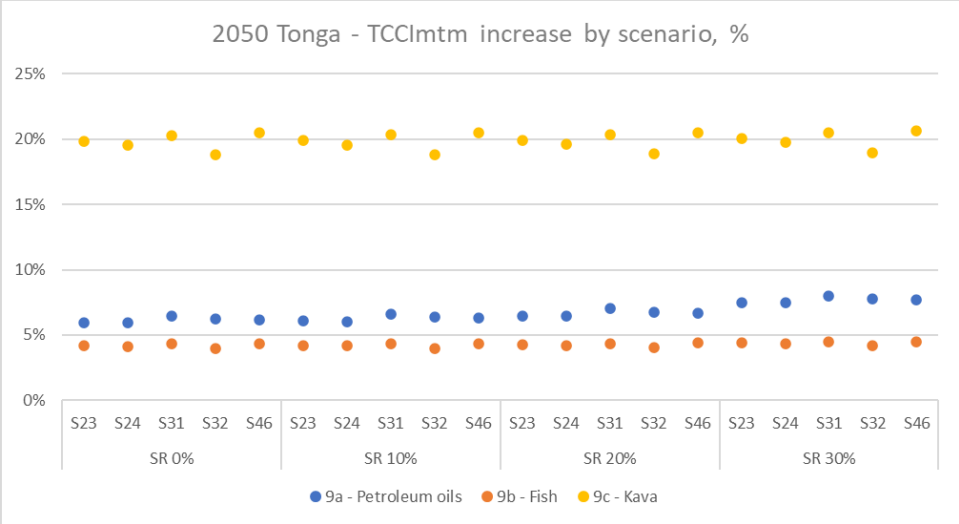


Note that in 2040, ship-side cost intensity increases are the primary driver across all scenarios and speed reduction groups, with the key parameters, ranging from:

- **TCCImtm** **2.86% to 18.35%, with an average of 7.98%**

The commodity cost intensity increase stratifies into increasing intensities. For fish, the intensities oscillate around 2% across all scenarios and speed reduction groups, again, this is due to its low *ad valorem* rate, as noted above. For petroleum, the intensities of Scenarios 23 and 46 are quite aligned with the other scenarios showing lower intensities, with a step up in intensity across all scenarios in the SR 30% group. Similar to fish, kava's intensities oscillate, ranging between just below 8% to just above 10% across all scenarios and speed reduction groups, with a narrow spread between Scenarios 23 and 46.

Figure 12.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2050, ship-side cost intensity increases are the primary driver across all scenarios and speed reduction groups, with the key parameters, ranging from:

- **TCCImtm** **3.99% to 20.63%, with an average of 10.27%**

The commodity cost intensities for fish remains similar to 2040 with a slight shift upward, oscillating between 2% and 4%. For petroleum, the intensity spreads across all scenarios and speed reduction groups narrow and Scenarios 23 and 46 lose their dominance over the other scenarios. For kava, the oscillations increase to between 10% and 16% with Scenario 23 significantly reducing compared to the other scenarios, while Scenario 31 closes the spread to Scenario 46.

GDP context

According to the information provided by Tonga, the sector of the country's economy that includes Petroleum oil accounts for a 57.25% share of the total country's GDP. The sector including fish, fresh or chilled (Tuna) has a 5.03% share, and the sector that includes plants makes up 37.48% of the country's GDP.

Fish, fresh or chilled, (Tuna) exports represent 2.71% of total Tonga exports (in value terms), while plants are 13.36%. Petroleum oils are 22.06% of total Tonga imports.

12.4 Qualitative analysis

Tonga provided detailed qualitative information on all three of their commodities using input from global industry experts for each commodity. These are:

- Petroleum oils: Responses were provided by Tonga Statistics Department, Department of Energy (under MEIDECC), Ports Authority Tonga and Marine and Ports Division (under MOI)
- Fish: Responses were provided by Tonga Statistics Department, Matson Shipping Company, Swire Shipping Company and Marine and Ports Division
- Kava: Responses were provided by Tonga Statistics Department, Matson Shipping Company, Swire Shipping Company and Marine and Ports Division

These stakeholders all showed strong awareness of the potential impacts of the IMO measures to decarbonize shipping, as well as related factors such as impacts on food and fuel prices.

Analyses of these responses are displayed on the following SWOT grids (Tables 12.8 and 12.9), showing sensitivities to freight costs and sensitivities to transit times. Key takeaways for each grid are reflected below the SWOT grids.

Table 12.8: SWOT analysis of Tonga's commodities and their sensitivity to cost changes

Sensitivity to freight shipment cost changes as reported by the stakeholders	
Country: Tonga Commodities: 9a Petroleum oil, 9b Fish, 9c Kava	
Strengths ➢ Many of Tonga's agricultural products are consumed domestically, allowing for less reliance on agricultural imports. ➢ Donors have provided budgetary support to offset the impacts of the Covid-19 pandemic. ➢ Most high-value fish is exported via air freight and is thus less sensitive to maritime transport costs. ➢ Increases in freight costs are partly absorbed by the government.	**Weaknesses** ➢ Covid-19 increased the costs of freight, and it has not come down to pre-Covid levels. ➢ Cost increases are ultimately passed to the end-consumer, many of which rely on remittances from abroad. ➢ Tonga is entirely reliant on imported fuel. ➢ Tonga is an isolated SIDS in the Pacific Ocean, and freight shipment costs are directly related to the distance sailed and the amount of fuel used.
Opportunities to adapt/mitigate ➢ Trade agreements could help to solve cost gaps vs. other countries. ➢ Lower speed reduces bunker costs. ➢ Costs for low-value fish exported via air transport could impact competitiveness. ➢ Because of a lack of competition following implementation of speed reduction requirements, prices of exported goods from Tonga could go up.	**Threats** ➢ IMO GHG MTM may increase shipping costs for all commodities. ➢ Exporters may need to consider the GHG emission cost on their logistic cost to avoid deviation from market price. ➢ More ships will be needed to ship the same volume of goods. In the short term, the capacity reduction of the spot fleet will push up freight rates for a number of years before the fleet adjusts via newbuilds. ➢ Paying for GHG emissions could increase the cost of freight for importers of fish. ➢ Higher transport costs could result in higher logistics costs and higher overall prices paid by importers. ➢ Higher costs could lead to substitution to other exporting economies. ➢ Natural disasters increase fuel consumption and combined with cost changes; this could be detrimental.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- Many of Tonga's agricultural products are consumed domestically, allowing for less reliance on agricultural imports and thus reducing Tonga's sensitivity to cost changes.
- Covid-19 increased costs of freight and they have not decreased to pre-Covid levels. Although donors have provided budgetary support to offset these impacts, cost increases are ultimately passed to the end-consumer. This is made worse by Tonga's reliance on remittances from abroad.
- Exporters may need to consider the GHG emissions cost on their logistic cost to avoid deviation from market price. Trade agreements could help to solve any cost gaps.
- Most high-value fish is exported via air freight and is thus less sensitive to maritime transport costs. However, Tonga is an isolated Small Island Developing State and freight shipment costs are directly related to the distance traveled and the amount of fuel used.
- Tonga is entirely reliant on imported fuel. The country is attempting to understand its future fuel options. However, there is little research into what they may be, thus there are currently no future plans for these fuels.
- IMO GHG MTM may increase shipping costs. However, lower speeds also reduce bunker costs.
- Costs for low-value fish exported via air transport could impact competitiveness. Because of a lack of competition following the implementation of speed reduction requirements, Tonga could raise the price of their exported goods.
- Higher costs could lead to substitution to other exporting countries, some of which may be closer to market.
- Natural disasters in Tonga increase fuel consumption due to electricity use. Combined with cost changes, this could be detrimental to Tonga's economy.
- Identified threats/risks of freight rate increases due to the MTM include increasing food costs worldwide. Exporters may need to consider the GHG emission cost on their logistic cost to avoid deviation from market price.

Table 12.9: SWOT analysis of Tonga's commodities and their sensitivity to transport time changes

Sensitivity to increased transport times as reported by the stakeholders	
Country: Tonga Commodities: 9a Petroleum oil, 9b Fish, 9c Kava	
Strengths ➢ Tonga holds fuel reserves for around 21 days. ➢ High value fish is exported via airfreight. ➢ Frozen fish and kava are relatively stable and non-perishable and therefore not sensitive to extreme delays. ➢ Fish and kava are not seasonal and export volumes are mostly continuous, so the threat of delays impacting demand is not as present. ➢ Impacts of speed reduction on prices of kava are small because it is a high-value product. ➢ Lack of competition because kava is a niche commodity with very few major exporters. ➢ Shipping maintained consistency of vessel arrivals as best they could during the Covid-19 pandemic.	**Weaknesses** ➢ Transit delays of over two weeks could be critical in relation to fuel reserves. ➢ Since Tonga is reliant on imported fuel, increased transit times will increase costs of petroleum imports. ➢ Tonga is a spoke in the system, so preceding delays stack up. ➢ Bigger ships may not be able to reach Nuku'Alofa. ➢ The freshness of fish when eaten is critical, so delays would impact taste, texture, value and revenue. ➢ Tonga's kava exports are high-value and dependent on container shipping. ➢ Change of shipping speeds caused freight rates to rise. ➢ There are seasonal peaks of petroleum oil usage in Tonga, mostly during cyclone season.
Opportunities to adapt/mitigate ➢ A small percentage of Tonga's kava exports could possibly be transported via air transport to avoid increased transport times. ➢ Utilization of future fuels is a low possibility, causing little difference in ship capacity and thus transport times. ➢ If transit time will be affected, it will be necessary to adjust logistics to provide increased stock at destination. ➢ More frequent shipments or increased storage capacity at destination. However, this may lead to higher emissions due to more frequent shipments or longer storage. ➢ Lower vessel speed should reduce fuel consumption.	**Threats** ➢ IMO GHG MTM may increase transport times. ➢ Increased costs of petroleum imports due to speed reductions would raise prices of many domestic goods (e.g. electricity, food, services, healthcare, transportation). ➢ Kava exports are high-value, so loss of sales from vessel delays could yield significant economic consequences. ➢ Speed reduction would aggravate geographic disadvantages because of longer lead times and potentially more expensive freight costs. ➢ Speed reduction would result in loss of market share due to the competitiveness of international fish markets.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- Tonga relies on imported fuel and holds fuel reserves for around 21 days, though increased transit times and delays of over two weeks could be critical.
- High-value fish is exported via airfreight and unlikely to be impacted by increased transport times. A small percentage of high-value kava has the potential to be transported via airfreight as well.
- Kava is a niche commodity with few major exporters, so there are lower levels of competition. Kava exports are primarily dependent on container shipping.
- Commodities may be time-sensitive for a variety of reasons—product degradation, customer demands (KPIs, production efficiency), market forces and costs. Tonga's frozen fish and kava are relatively stable and not sensitive to extreme delays.
- An opportunity to mitigate risks is to provide more frequent shipments or increased storage capacity at destination, this could lead to higher emissions and longer storage with more costs.
- Potential to develop shipment and storage conditions to prolong the acceptable lifetime of agricultural products.
- Tonga is a spoke in the system, so preceding delays stack up. Changes in shipping speeds previously caused freight rates to rise.
- Delays could impact the freshness of Tonga's fish exports, thus impacting values and revenue.
- Increased costs of petroleum imports due to speed reductions would raise prices of many domestic goods. Since there are also seasonal peaks of petroleum oil usage, this could have a domino effect.
- Kava exports are high-value, so loss of sale from vessel delays could yield significant economic consequences. Similarly, speed reduction for fish exports would result in loss of market share due to the competitiveness of fish markets.
- Tonga's remote location could lead to disadvantages if transport times are increased.

Another insight to these stakeholders' awareness of and engagement in the decarbonization of shipping is their answer to the final open-ended question "What questions should we have asked to more fully understand the impacts of potential vessel greenhouse gas reduction requirements on shipping, your population and your economy?" Tonga's response related to specialized research.

12.5 Findings

Quantitative findings

The key findings from the quantitative analysis include:

- Longer transit times from potential speed reduction range across the case studies, including:
  - Petroleum oils
    - SR 10% - just over 2 days
    - SR 20% - nearly 5 days
    - SR 30% - 7 to 8 days
  - Fish
    - SR 10% - less than 1 day
    - SR 20% - just over 1 days
    - SR 30% - just over 2 days
  - Kava
    - SR 10% - less than 1 day
    - SR 20% - just over 1 days
    - SR 30% - just over 2 days

- Total commodity cost intensity increases across all scenarios are sensitive to commodity costs associated with the MTM compared to the associated costs with speed reduction.
- The *ad valorem* rates of the imported essential good is 10.4% while the two trade commodities rates are significantly different with fish being 6.4% and kava at 30.2%. This means that kava is extremely sensitive to ship-side cost intensity changes as they make up nearly one-third the landed value. Fish exports are relatively the least sensitive to ship-side cost intensity increases.
- In 2030, for exports of fish moved by general cargo the commodity cost intensity increases are very low and have a consistent spread across all speed reduction groups. Kava's commodity cost intensity is double to triple that of fish, on the same ships with more sensitivity in the SR 30% group. The strive Scenario 46 is nearly 5 times higher for kava than fish. This is due to the *ad valorem* rate differences between fish at 6.4% compared to kava at 30.2%. For petroleum, there is little difference in spread between the scenarios with the exception of the strive Scenario 46 which is double the other scenarios. However, that spread closes in the SR 30% group.
- In 2040, the commodity cost intensity increase stratifies into increasing intensities. For fish, the intensities oscillate around 2% across all scenarios and speed reduction groups, again, this due to its low *ad valorem* rate, as noted above. For petroleum, the intensities of Scenarios 23 and 46 are quite aligned with the other scenarios showing lower intensities, with a step up in intensity across all scenarios in the SR 30% group. Similar to fish, kava's intensities oscillate between just below 8% to just above 10% across all scenarios and speed reduction groups, with a narrow spread between Scenarios 23 and 46.
- In 2050, the commodity cost intensities for fish remains similar to 2040 with a slight shift upward, oscillating between 2% and 4%. For petroleum, the intensity spreads across all scenarios and speed reduction groups narrows and Scenarios 23 and 46 lose their dominance over the other scenarios. For kava, the oscillations increase to between 10% and 16% with Scenario 23 significantly reducing, while Scenario 31 closes the spread to Scenario 46.
- Total commodity cost intensity ranges across all scenarios and speed reduction groups, include:
  - Petroleum oils (essential good)
    - 2030 – 1.83% to 5.65%, with an average of 3.00%
    - 2040 – 4.47% to 7.38%, with an average of 5.52%
    - 2050 – 5.95% to 8.00%, with an average of 6.70%
  - Fish (trade export)
    - 2030 – 0.09% to 2.88%, with an average of 1.25%
    - 2040 – 2.86% to 4.02%, with an average of 3.26%
    - 2050 – 3.99% to 4.51%, with an average of 4.26%
  - Kava (trade export)
    - 2030 – 0.42% to 12.93%, with an average of 5.67%
    - 2040 – 13.52% to 18.35%, with an average of 15.17%
    - 2050 – 18.81% to 20.63%, with an average of 19.86%
- TCCImtm findings for the one essential good import and two trade commodity export commodity case studies across all scenarios and speed reduction groups, by forecasted year:
  - 2030 0.09% to 12.93%, with an average of 3.31%
  - 2040 2.86% to 18.35%, with an average of 7.98%
  - 2050 3.99% to 20.63%, with an average of 10.27%

Qualitative findings

Tonga's stakeholders who participated in the qualitative analysis highlighted several critical points on freight shipment cost changes. Firstly, Tonga's farming industry reduces agricultural import costs. Covid-19 significantly raised expenses, which have not returned to pre-pandemic levels. Donor support has alleviated some costs, but costs ultimately impact the consumers; this is compounded by Tonga's reliance on remittances. Tonga's geographical isolation raises maritime shipping expenses which are tied to distance and fuel consumption. IMO GHG MTM increasing shipping costs may redirect trade to closer markets, while natural disasters in Tonga amplify fuel use, worsening economic vulnerabilities tied to cost fluctuations. The country's dependence on imported fuel also underscores a need for future energy alternatives. However, research into this area remains limited.

In relation to increased transport times, Tonga's stakeholders shared that the country imports all of its fuel. Longer transport times could prove detrimental, as reserves last approximately 21 days. Although fish (frozen) and kava are relatively stable and are less affected by delays, their perishable nature makes them time sensitive commodities. Fresh fish is especially important as delays would impact its taste and texture and thus its value. Significant economic repercussions could arise from delayed kava exports and reduced market share for fish due to competitive pressures. Mitigating risks could involve more frequent shipments or increased storage. Developing optimal shipment and storage conditions could enhance the longevity of certain products. Cumulative delays can impact supply chains and raise freight rates for Tonga. Any increased costs from import delays due to speed reductions would ripple through Tonga's economy. Tonga's remote location further magnifies disadvantages if transport times increase, stressing the need for efficient logistical strategies to sustain economic stability.

Opportunities to mitigate impacts include a range of approaches identified by the stakeholders from Tonga:

- Costs:
  - Trade agreements could help to solve cost gaps vs. other countries.
  - Lower speed reduces bunker costs.
  - Costs for low-value fish exported via air transport could impact competitiveness.
  - Because of a lack of competition following implementation of speed reduction requirements, prices of exported goods from Tonga could go up.
- Longer transport times:
  - A small percentage of Tonga's kava exports could possibly be transported via air transport to avoid increased transport times.
  - Utilization of future fuels is a low possibility, causing little difference in ship capacity and thus transport times.
  - If transit time will be affected, it will be necessary to adjust logistics to provide increased stock at destination.
  - More frequent shipments or increased storage capacity at destination. However, this may lead to higher emissions due to more frequent shipments or longer storage.
  - Lower vessel speed should reduce fuel consumption.

Summary of key points related to potential impacts

The following key points are key to understanding the potential impacts of the MTM:

- Tonga is a SIDS.
- The 2022 GDP for Tonga was $488 million, with a GDP per capita of $4,571.
- The three commodities selected by Tonga for case studies included the imported essential goods of diesel and petrol from Singapore and two trade commodity exports of tuna and kava to New Zealand. The imported fuels/energy are essential goods, which means cost increases impact the entire population, while the two trade commodities impact the sector/subsector of the economy associated with each commodity. In addition, the associated employment, supporting industries, and taxes and revenues associated with the commodity will be impacted.
- According to the information provided by Tonga, the sector of the country's economy that includes Petroleum oil accounts for a 57.25% share of the total country's GDP. The sector including fish, fresh or chilled (Tuna) has a 5.03% share, and the sector that includes plants makes up 37.48% of the country's GDP. Fish, fresh or chilled, (Tuna) exports represent 2.71% of total Tonga exports (in value terms), while plants are 13.36%. Petroleum oils are 22.06% of total Tonga imports.
- For these three case studies, the estimates indicate a range of total commodity cost intensity increases related to maritime transport. For imported energy, across Scenarios 23/24 and 31/32, for all forecasted years, the estimates indicate a range of negative financial impacts in the form total commodity cost intensity increases related to maritime transport. These increases are estimated to be lower in 2030, but are estimated to significantly increase in 2040 and 2050. For the two export trade commodities, Scenarios 23/24 cost impacts are significantly lower than Scenarios 31/32 in 2030. Kava exports are extremely sensitive to increases in ship-side costs as 30% of its value is maritime transport, the second highest of the 39 commodity case studies. Kava is significantly affected by Scenarios 31/32/46 in 2030 and remains significantly impacted in the forecasted years. Fish export cost increases are also more impacted by Scenarios 31/32/46 in 2030, and then generally all the scenarios normalize in 2040 and 2050.
- Since energy is an essential goods, the impacts of delays weigh more heavily due to extremely limited national GDP, limited population and infrastructure to provide economies of scale, extremely limited disposal incomes to absorb cost increases, limited alternative transportation options to import essential goods, and country's remoteness to key trading partners.
- The case studies for fish and kava represent export trade commodities only on particular routes, the entire economic sector/subsector is not captured. The full impact on the entire sector/subsector would need to be considered by the Member State and their national stakeholders to determine impacts to GDP, employment, and any collateral impacts on supporting industries.

13 Stakeholders' analysis – United States

The Stakeholder Assessment for the United States (US) focuses on exports of soybeans, wood/wood products, and Automobiles. Soybeans and wood/wood products are shipped by bulk carrier to Asia. Automobiles are exported to Asia via vehicle carriers.

13.1 Geography, population, and economy

Geography

The United States (US), a country in North America, is a federal republic comprised of 50 states. Besides the 48 contiguous states that occupy the middle latitudes of the continent, the United States includes the state of Alaska, at the northwestern extreme of North America, and the island state of Hawaii, in the mid-Pacific Ocean. The contiguous states are bounded on the north by Canada, on the east by the Atlantic Ocean, on the south by the Gulf of Mexico and Mexico, and on the west by the Pacific Ocean. The United States is the fourth largest country in the world in area (after Russia, Canada, and China). The national capital is Washington, which is in the District of Columbia, the federal capital region in the mid-Atlantic area.[174]

The US has great variety in its physical environment and natural resources. Its location between the major oceans and growth by immigration has greatly facilitated port and trade development. Representative distances to markets for the selected commodities and ports are presented in Section 13.2.

Population

Although the total population of the US is large by world standards, its overall population density is relatively low. The country includes some of the world's largest urban concentrations as well as extensive areas that are almost devoid of habitation. The United States population is approximately 342 million people[175] spread across an area roughly the size of the European continent. Of that population, 83% live in urban areas and 17% in rural areas.[176] The US population has a diversity that to a great degree comes from an immense and sustained global immigration.

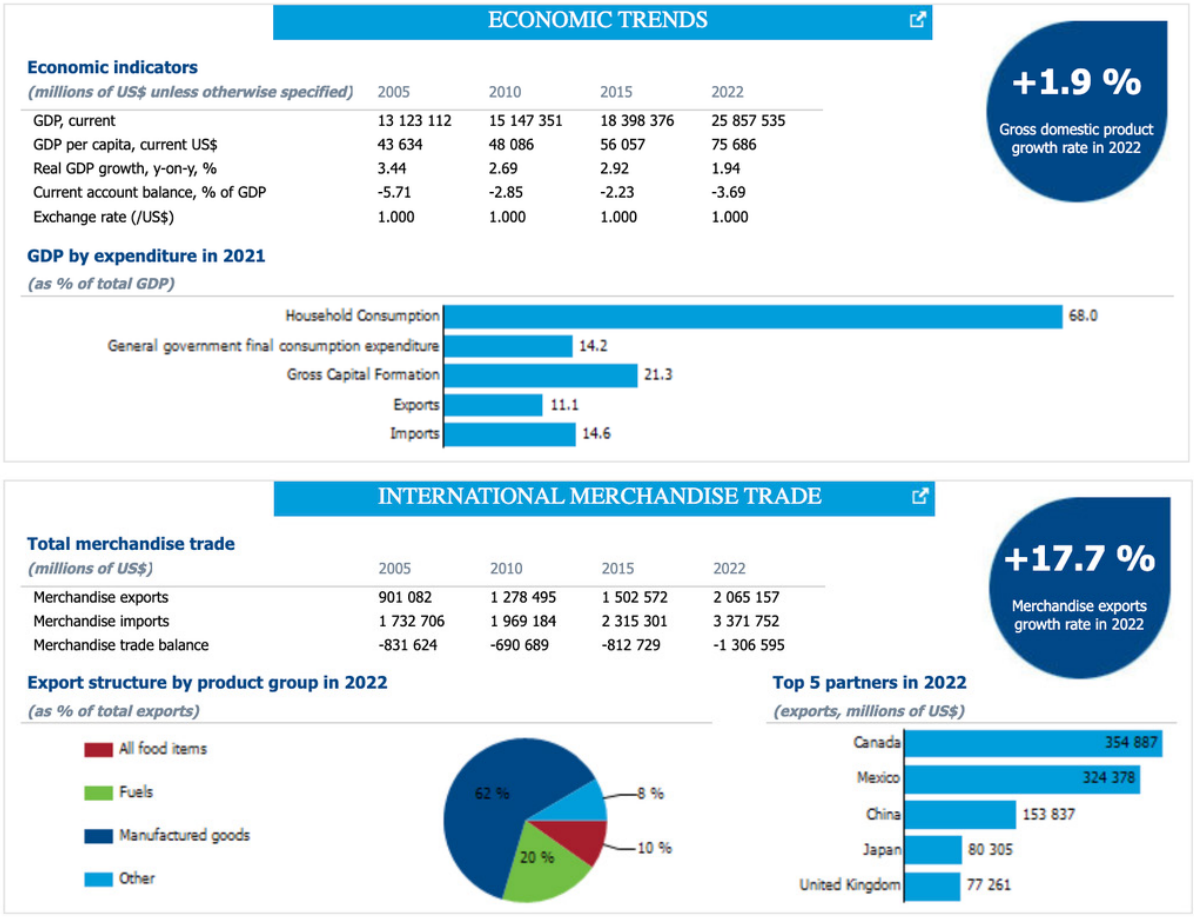
The United States population is equivalent to 4.23% of the total world population, ranking third in the list of countries by population. The population density in the United States is 37 per km^2 (96 people per mi^2). The median age in the United States is 38.1 years.

[174] Encyclopedia Britannica at *US, History, Map, Flag, & Population*, Adam Gopnik, Harold Whitman Bradley.
[175] Michigan Journal of Economics, *The Economic Geography of the United States*, Nicolas Costa.
[176] UNCTAD, General and Maritime Profiles: United States, *UNCTAD Statistics - General Profile.*

Economy

The US had largest economy in the world with a GDP at $25,857,535 million in 2022. It also ranks high in terms of GDP per capita of $75,686 per UNCTAD stats, reflecting its economic strength and productivity.[177] The United States economy is rather diversified. Several industries dominate the American economy, but these industries are not uniformly distributed across the country, and many industries are anchored to specific city(ies) or regions. Key economic indicators are below in Figure 13.1.[165]

Figure 13.1: Key economic indicators for the United States



Source: UNCTAD, General and Maritime Profiles: US, UNCTAD Statistics - General Profile.

The US's location between the major oceans has positioned it well for global trade, and the ports and inland infrastructure are well-developed.[178] The US has consistently run trade deficits since 1976, primarily due to high imports of oil and consumer products.[179]

[177] UNCTAD, General and Maritime Profiles: US, *UNCTAD Statistics - General Profile*.
[178] MARAD, *Office of Ports and Waterways*.
[179] MARAD, *Trading Economics, United States Balance of Trade.*

13.2 Identified commodities and routes studied

The commodities selected by the US for this Stakeholder Assessment are exports of soybeans, wood/wood products and Automobiles. Soybeans and wood/wood products are shipped by bulk carrier to Asia. Automobiles are exported to Asia via vehicle carriers.

The commodities selected by the Member State for focus and illustrative trade routes selected are shown in Table 13.1 on the following page. All commodities selected for this study are exports.

Table 13.1: Shipping distances from the United States to market for selected commodities

Case Study	Commodity	Identified Unique Routes, by Country	Ship Type(s)	Route Distance Range, nm min	avg	max	Stops
10a	Soybeans	United States --> China United States --> Dominican Republic --> Mexico -> China United States --> Honduras --> China	Bulk carrier	10,227	11,110	12,473	1-4
10b	Wood and wood products	United States --> Japan	Bulk carrier &	4,073	4,265	5,114	1
10c	Automobiles	United States --> Brazil --> South Africa --> Singapore --> South Korea United States --> China --> South Korea United States --> Columbia --> Mexico --> United States --> South Korea United States --> Dominican Republic --> China --> South Korea United States --> Dominican Republic --> South Korea United States --> Dominican Republic --> United States --> South Korea United States --> Mexico --> United States --> China--> South Korea United States --> Nambia --> South Africa --> Singapore --> China --> South Korea United States --> Panama --> South Korea United States --> Panama --> United States --> South Korea United States --> Saudi Arabia --> UAE --> Saudia Arabia --> UAE --> Sri Lanka --> South Korea United States --> South Korea	RoRo	10,402	12,268	17,003	1-7

13.3 Quantitative analysis

This section presents the quantitative analysis summary results and is organized by fleet analysis summary, total commodity cost intensity changes from speed reduction, Task 2 cost intensity changes due to MTM, total commodity cost intensity impacts, and GDP contexts. The quantitative analysis incorporates the findings of Task 2 related to the selected bracketing MTM scenarios as presented below:[180]

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination						
			Policy code	GFI scope	GFI flexibility RU % of price	GFI flexibility SU % of price	Levy USD/tCO_2eq	Levy Reward % of cost gap	Feebate Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

The detailed approach for the below analyses is provided in Appendix A.

[180] DNV 2024

Fleet analysis summary

As part of the fleet analysis, routes and ship characteristics were identified for each commodity case study. For the specific ship types identified with the commodity case study and transiting on the identified route the following were averaged to represent the fleet:

- Ship type and size
- Number of transits identified
- Route distances obtained from Marine Benchmark's 2022 AIS database were transit-weighted averaged and reported as minimum, average, and maximum distance sailed
- Transit-weighted average year of build, which was used to determine the average age in years

These characteristics for the case studies are presented in Table 13.2 on the following page.

Table 13.2: US – Fleet characteristics, by commodity case study

Case Study	Commodity	2022 Transits	Ship Type(s)	Route Distance Range, nm min	avg	max	Avg Build
10a	Soybeans						
		1	Bulk carrier 35,000-59,999 dwt	12,473	**12,473**	12,473	2016
		5	Bulk carrier 60,000-99,999 dwt	10,227	**10,837**	11,813	2015
10b	Wood and wood products						
		4	Bulk carrier 10,000-34,999 dwt	4,169	**4,209**	4,243	2012
		12	Bulk carrier 35,000-59,999 dwt	4,073	**4,227**	4,525	2011
		4	Bulk carrier 60,000-99,999 dwt	4,171	**4,437**	5,114	2013
10c	Automobiles						
		46	Vehicle 50,000+ gt	10,402	**12,268**	17,003	2008

In addition, transit weighted average speeds and average route times were estimated and the APEC Module 1 was used to estimate the longer transit times associated with the speed reduction groups of 10%, 20%, and 30%, as presented in Table 13.3.

Table 13.3: Average route distance, speed, & longer transit ,times, by speed reduction group

Country	Case Study	Commodity	Transits	Ship type & size	Avg Route Distance (nm)	Avg Route Speed (knots)	Avg Route Time (hours)	SR 10% Delay Delta (days)	SR 20% Delay Delta (days)	SR 30% Delay Delta (days)
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	12,473	12.8	974	4.5	10.2	17.4
			5	Bulk carrier 60,000-99,999 dwt	10,837	10.9	998	4.6	10.4	17.8
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	4,209	11.1	378	1.7	3.9	6.7
			12	Bulk carrier 35,000-59,999 dwt	4,227	10.9	387	1.8	4.0	6.9
			4	Bulk carrier 60,000-99,999 dwt	4,437	10.8	413	1.9	4.3	7.4
	10c	Automobiles	46	Vehicle 50,000+ gt	12,268	16.7	737	3.4	7.7	13.2

Total commodity cost intensity changes due to speed reduction

APEC Module 2 was used to estimate the commodity cost intensity increases due to potentially longer transit times resulting from the three speed reduction groups. The module estimates the daily cost increases, in percentage, associated with the following:

- Finance/interest costs – the financial cost of capital invested in inventory over time. This measures the impact of each hour or day of delay on the cost of the product due to cost of money or interest rate. A Member State rate was used when provided, otherwise, it was assumed to be 5%.[181] The financial cost provided by the US was 8%.
- Depreciation costs – the cost allocation of a commodity, or reduction of the commodity value, over its useful life. For this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry bulk cargo.[182] For automobiles, the US provided a depreciation rate of USD$11/day.
- Insurance costs – a cost paid by the cargo owner to protect their goods while in transit. The percentage used in the economic analysis is the one provided by the Member State. If the Member State did not provide data, we assume it as 2%.[183]

The total commodity cost intensity change related to the three speed reduction groups for the case studies is presented in Table 13.4. Note that these values remain constant across scenarios and forecasted year.

Table 13.4: Total commodity cost intensity changes due to speed reduction, by speed reduction group

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	Commodity-side Task 4 TCCIsr Change, % SR 10%	SR 20%	SR 30%
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	7	0.67%	3.39%	9.95%
			5	Bulk carrier 60,000-99,999 dwt	8	0.70%	3.55%	10.44%
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	11	0.10%	0.51%	1.50%
			12	Bulk carrier 35,000-59,999 dwt	12	0.11%	0.53%	1.57%
			4	Bulk carrier 60,000-99,999 dwt	10	0.12%	0.61%	1.78%
	10c	Automobiles	46	Vehicle 50,000+ gt	15	0.38%	1.94%	5.69%

The commodity cost intensity changes due to speed reduction, ranges as follows:

- 10a – SR 10% → 0.67%-0.70% SR 20% → 3.39%-3.55% SR 30% → 9.95%-10.44%
- 10b – SR 10% → 0.10%-0.12% SR 20% → 0.51%-0.61% SR 30% → 1.50% to 1.78%
- 10c – SR 10% → 0.38% SR 20% → 1.94% SR 30% → 5.69%

Task 2 cost intensity changes due to MTM

Based on the ship type, size, and age combination for each commodity case study, the applicable Task 2 ship-side commodity cost intensities due to the MTM were identified for the selected scenarios. In addition, in order to be able to add these to the commodity cost intensity changes due to speed reduction, the a*d valorem* freight rate percentage was identified using the UNCTAD Trade-and-Transport Dataset.[184] The *ad valorem* freight rate percentage represents the transportation cost percentage of a commodity's total cost. These two were multiplied to get the freight rate adjusted commodity cost intensity or FRACCI change for 2030, 2040, and 2050. Task 2 cost intensity change and FRACCI for each scenario are presented in Table 13.5.

[181] Assuming a line of credit 5%, source: https://www.lendingtree.com/business/rates/
[182] APEC 2019
[183] APEC 2019
[184] UNCTAD, *Trade-and-Transport Dataset*.

Table 13.5: Task 2 cost intensity & FRACCI changes, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	7	6.2%	14.83%	48.40%	57.89%	0.92%	3.00%	3.59%
			5	Bulk carrier 60,000-99,999 dwt	8	6.2%	19.24%	42.69%	53.70%	1.19%	2.65%	3.33%
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	11	32.1%	9.93%	49.37%	46.01%	3.19%	15.85%	14.77%
			12	Bulk carrier 35,000-59,999 dwt	12	32.1%	5.68%	51.22%	51.32%	1.82%	16.44%	16.47%
			4	Bulk carrier 60,000-99,999 dwt	10	32.1%	19.24%	42.69%	53.70%	6.18%	13.70%	17.24%
	10c	Automobiles	46	Vehicle 50,000+ gt	15	6.5%	2.06%	31.43%	29.37%	0.13%	2.04%	1.91%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	7	6.2%	16.97%	42.72%	58.36%	1.05%	2.65%	3.62%
			5	Bulk carrier 60,000-99,999 dwt	8	6.2%	17.31%	40.02%	54.13%	1.07%	2.48%	3.36%
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	11	32.1%	8.34%	38.80%	44.53%	2.68%	12.45%	14.29%
			12	Bulk carrier 35,000-59,999 dwt	12	32.1%	5.57%	43.06%	51.16%	1.79%	13.82%	16.42%
			4	Bulk carrier 60,000-99,999 dwt	10	32.1%	17.31%	40.02%	54.13%	5.55%	12.85%	17.38%
	10c	Automobiles	46	Vehicle 50,000+ gt	15	6.5%	2.27%	21.90%	29.01%	0.15%	1.42%	1.89%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	7	6.2%	16.51%	47.79%	63.97%	1.02%	2.96%	3.97%
			5	Bulk carrier 60,000-99,999 dwt	8	6.2%	16.74%	44.14%	59.49%	1.04%	2.74%	3.69%
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	11	32.1%	13.45%	38.66%	49.40%	4.32%	12.41%	15.86%
			12	Bulk carrier 35,000-59,999 dwt	12	32.1%	13.96%	45.74%	56.95%	4.48%	14.68%	18.28%
			4	Bulk carrier 60,000-99,999 dwt	10	32.1%	16.74%	44.14%	59.49%	5.38%	14.17%	19.10%
	10c	Automobiles	46	Vehicle 50,000+ gt	15	6.5%	11.33%	21.38%	31.40%	0.74%	1.39%	2.04%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	7	6.2%	16.35%	48.12%	62.08%	1.01%	2.98%	3.85%
			5	Bulk carrier 60,000-99,999 dwt	8	6.2%	16.75%	44.47%	58.06%	1.04%	2.76%	3.60%
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	11	32.1%	13.74%	40.22%	47.33%	4.41%	12.91%	15.19%
			12	Bulk carrier 35,000-59,999 dwt	12	32.1%	13.52%	47.86%	54.71%	4.34%	15.36%	17.56%
			4	Bulk carrier 60,000-99,999 dwt	10	32.1%	16.75%	44.47%	58.06%	5.38%	14.27%	18.64%
	10c	Automobiles	46	Vehicle 50,000+ gt	15	6.5%	6.96%	23.48%	30.67%	0.45%	1.53%	1.99%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	*Ad valorem* FR	Ship-side Task 2 CI Change, % 2030	2040	2050	Ship-side Task 2 FRACCI, % 2030	2040	2050
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	7	6.2%	37.32%	55.72%	59.96%	2.31%	3.45%	3.72%
			5	Bulk carrier 60,000-99,999 dwt	8	6.2%	35.27%	49.89%	56.87%	2.19%	3.09%	3.53%
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	11	32.1%	28.23%	44.96%	47.30%	9.06%	14.43%	15.18%
			12	Bulk carrier 35,000-59,999 dwt	12	32.1%	33.36%	49.90%	55.02%	10.71%	16.02%	17.66%
			4	Bulk carrier 60,000-99,999 dwt	10	32.1%	35.27%	49.89%	56.87%	11.32%	16.01%	18.25%
	10c	Automobiles	46	Vehicle 50,000+ gt	15	6.5%	19.78%	28.94%	31.06%	1.29%	1.88%	2.02%

Note that the *ad valorem* rate for wood and wood products is 5 times the magnitude of automobiles and soybeans. Wood chips are low-value cargos which the transportation costs are a substantial portion of the landed costs of the commodity. Further note that the vehicle carriers are significantly less impacted from the Task 2 cost intensity changes compared to the bulk carriers.

Note that there are significant differences between ship type, size, and age groups between scenarios. As learned from our consultation with DNV, "It should be noted that scenarios 23 and 24, and to a lesser degree scenarios 31 and 32, show large differences in cost impacts in 2030 depending on the generation of ships deployed. Ships with 10 years or less of age – i.e. built in the period between 2020 and 2029 – have a significantly higher increase in costs compared to older vessels. In the scenarios with a GFI flexibility mechanism the newer ships built in 2020-2029 take the brunt of the GHG intensity reductions, resulting in a higher cost increase compared to older ships when looking at all abatement costs. This is as expected, as the cost of reduction is relatively lower for new ships compared to existing ships.

"However, it should also be expected that there should be some compensation from the older ships to the newer ships when joining in a compliance pool under the GFI flexibility mechanism. DNV indicates in their report that the emission unit exchange price is set to the marginal cost of the last ship in the pool that was selected to implement an additional measure.

"However, when applying this price the results showed that the newer ships are overcompensated (i.e. the compensation led to a cost decrease), meaning that the marginal cost of the last ship is likely not a very good indicator for the exchange price in a pool as the many ships will have lower abatement costs. For this reason, the costs and incomes of joining a pool are not included in this analysis."[185]

Total commodity cost intensity due to speed reduction and MTM

For each commodity case study, combining Task 2 and Task 4 results estimates the total commodity cost intensity[186] associated with potential speed reduction and the MTM ($TCCI_{mtm}$), for the forecasted years of 2030, 2040, and 2050, as presented in Table 13.6, on the following page. For each commodity case study, the results were compiled into a transit-weighted average for each scenario and forecasted year. These results are presented in Table 13.7.

[185] Email exchange with Tore Longa, Project Manager Task 2, 1 June 2024.
[186] The term 'total commodity cost intensity' as used in this report is defined as the total 'landed cost' of the commodity.

Table 13.6: 2030, 2040, & 2050 Total commodity cost intensity, by scenario & forecasted year

Scenario 23

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	7	0.92%	1.59%	4.30%	10.87%	3.00%	3.67%	6.39%	12.95%	3.59%	4.26%	6.97%	13.54%
			5	Bulk carrier 60,000-99,999 dwt	8	1.19%	1.89%	4.75%	11.64%	2.65%	3.35%	6.20%	13.09%	3.33%	4.03%	6.88%	13.77%
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	11	3.19%	3.29%	3.70%	4.68%	15.85%	15.95%	16.36%	17.35%	14.77%	14.87%	15.28%	16.27%
			12	Bulk carrier 35,000-59,999 dwt	12	1.82%	1.93%	2.36%	3.39%	16.44%	16.55%	16.97%	18.01%	16.47%	16.58%	17.01%	18.04%
			4	Bulk carrier 60,000-99,999 dwt	10	6.18%	6.30%	6.78%	7.96%	13.70%	13.82%	14.31%	15.49%	17.24%	17.36%	17.84%	19.02%
	10c	Automobiles	46	Vehicle 50,000+ gt	15	0.13%	0.52%	2.07%	5.82%	2.04%	2.42%	3.98%	7.73%	1.91%	2.29%	3.84%	7.60%

Scenario 24

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	7	1.05%	1.72%	4.44%	11.00%	2.65%	3.32%	6.03%	12.60%	3.62%	4.29%	7.00%	13.57%
			5	Bulk carrier 60,000-99,999 dwt	8	1.07%	1.77%	4.63%	11.52%	2.48%	3.18%	6.03%	12.92%	3.36%	4.06%	6.91%	13.80%
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	11	2.68%	2.78%	3.19%	4.17%	12.45%	12.56%	12.96%	13.95%	14.29%	14.39%	14.80%	15.79%
			12	Bulk carrier 35,000-59,999 dwt	12	1.79%	1.89%	2.32%	3.35%	13.82%	13.93%	14.35%	15.39%	16.42%	16.53%	16.95%	17.99%
			4	Bulk carrier 60,000-99,999 dwt	10	5.55%	5.67%	6.16%	7.34%	12.85%	12.97%	13.45%	14.63%	17.38%	17.50%	17.98%	19.16%
	10c	Automobiles	46	Vehicle 50,000+ gt	15	0.15%	0.53%	2.08%	5.83%	1.42%	1.81%	3.36%	7.11%	1.89%	2.27%	3.82%	7.57%

Scenario 31

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	7	1.02%	1.69%	4.41%	10.97%	2.96%	3.63%	6.35%	12.91%	3.97%	4.64%	7.35%	13.91%
			5	Bulk carrier 60,000-99,999 dwt	8	1.04%	1.74%	4.59%	11.48%	2.74%	3.44%	6.29%	13.18%	3.69%	4.39%	7.24%	14.13%
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	11	4.32%	4.42%	4.83%	5.82%	12.41%	12.51%	12.92%	13.91%	15.86%	15.96%	16.37%	17.35%
			12	Bulk carrier 35,000-59,999 dwt	12	4.48%	4.59%	5.01%	6.05%	14.68%	14.79%	15.21%	16.25%	18.28%	18.39%	18.81%	19.85%
			4	Bulk carrier 60,000-99,999 dwt	10	5.38%	5.49%	5.98%	7.16%	14.17%	14.29%	14.78%	15.95%	19.10%	19.22%	19.70%	20.88%
	10c	Automobiles	46	Vehicle 50,000+ gt	15	0.74%	1.12%	2.67%	6.42%	1.39%	1.77%	3.32%	7.08%	2.04%	2.42%	3.98%	7.73%

Scenario 32

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	7	1.01%	1.68%	4.40%	10.96%	2.98%	3.65%	6.37%	12.93%	3.85%	4.52%	7.23%	13.80%
			5	Bulk carrier 60,000-99,999 dwt	8	1.04%	1.74%	4.59%	11.48%	2.76%	3.46%	6.31%	13.20%	3.60%	4.30%	7.15%	14.04%
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	11	4.41%	4.51%	4.92%	5.91%	12.91%	13.01%	13.42%	14.41%	15.19%	15.29%	15.70%	16.69%
			12	Bulk carrier 35,000-59,999 dwt	12	4.34%	4.45%	4.87%	5.90%	15.36%	15.47%	15.89%	16.93%	17.56%	17.67%	18.09%	19.13%
			4	Bulk carrier 60,000-99,999 dwt	10	5.38%	5.50%	5.98%	7.16%	14.27%	14.39%	14.88%	16.06%	18.64%	18.76%	19.24%	20.42%
	10c	Automobiles	46	Vehicle 50,000+ gt	15	0.45%	0.83%	2.39%	6.14%	1.53%	1.91%	3.46%	7.21%	1.99%	2.38%	3.93%	7.68%

Scenario 46

Country	Case Study	Case Study Commodity	2022 Transits	Ship type & size	Avg Age (years)	2030 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2040 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%	2050 TCCImtm Change, % SR 0%	SR 10%	SR 20%	SR 30%
United States	10a	Soybeans	1	Bulk carrier 35,000-59,999 dwt	7	2.31%	2.98%	5.70%	12.26%	3.45%	4.12%	6.84%	13.40%	3.72%	4.39%	7.10%	13.67%
			5	Bulk carrier 60,000-99,999 dwt	8	2.19%	2.89%	5.74%	12.63%	3.09%	3.80%	6.65%	13.54%	3.53%	4.23%	7.08%	13.97%
	10b	Wood and wood products	4	Bulk carrier 10,000-34,999 dwt	11	9.06%	9.16%	9.57%	10.56%	14.43%	14.53%	14.94%	15.93%	15.18%	15.28%	15.69%	16.68%
			12	Bulk carrier 35,000-59,999 dwt	12	10.71%	10.81%	11.24%	12.27%	16.02%	16.12%	16.55%	17.58%	17.66%	17.77%	18.19%	19.23%
			4	Bulk carrier 60,000-99,999 dwt	10	11.32%	11.44%	11.93%	13.10%	16.01%	16.13%	16.62%	17.80%	18.25%	18.37%	18.86%	20.04%
	10c	Automobiles	46	Vehicle 50,000+ gt	15	1.29%	1.67%	3.22%	6.97%	1.88%	2.26%	3.82%	7.57%	2.02%	2.40%	3.95%	7.71%

Table 13.7: 2030, 2040, & 2050 commodity case study transit-weighted average total commodity cost intensity, by scenario and forecasted year

2030

Country	Case Study	Case Study Commodity	Ship Type(s)	2030 Scenario 23 TCCImtm, % increase				2030 Scenario 24 TCCImtm, % increase				2030 Scenario 31 TCCImtm, % increase				2030 Scenario 32 TCCImtm, % increase				2030 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
United States	10a	Soybeans	Bulk carrier	1.15%	1.84%	4.67%	11.51%	1.07%	1.77%	4.59%	11.43%	1.04%	1.73%	4.56%	11.40%	1.03%	1.73%	4.56%	11.40%	2.21%	2.90%	5.73%	12.57%
	10b	Wood and wood products	Bulk carrier	2.97%	3.07%	3.51%	4.56%	2.72%	2.83%	3.26%	4.31%	4.63%	4.73%	5.17%	6.22%	4.56%	4.67%	5.10%	6.16%	10.50%	10.61%	11.04%	12.10%
	10c	Automobiles	Vehicle carrier	0.13%	0.52%	2.07%	5.82%	0.15%	0.53%	2.08%	5.83%	0.74%	1.12%	2.67%	6.42%	0.45%	0.83%	2.39%	6.14%	1.29%	1.67%	3.22%	6.97%

2040

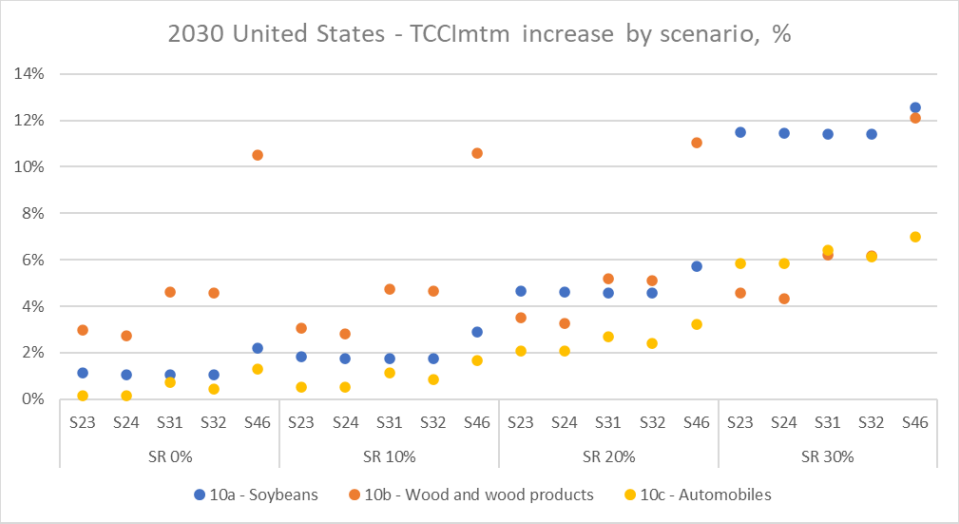
Country	Case Study	Case Study Commodity	Ship Type(s)	2040 Scenario 23 TCCImtm, % increase				2040 Scenario 24 TCCImtm, % increase				2040 Scenario 31 TCCImtm, % increase				2040 Scenario 32 TCCImtm, % increase				2040 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
United States	10a	Soybeans	Bulk carrier	2.71%	3.40%	6.23%	13.07%	2.51%	3.21%	6.03%	12.87%	2.77%	3.47%	6.30%	13.14%	2.79%	3.49%	6.32%	13.16%	3.15%	3.85%	6.68%	13.51%
	10b	Wood and wood products	Bulk carrier	15.78%	15.88%	16.32%	17.37%	13.35%	13.46%	13.90%	14.95%	14.12%	14.23%	14.67%	15.72%	14.65%	14.76%	15.20%	16.25%	15.70%	15.81%	16.24%	17.29%
	10c	Automobiles	Vehicle carrier	2.04%	2.42%	3.98%	7.73%	1.42%	1.81%	3.36%	7.11%	1.39%	1.77%	3.32%	7.08%	1.53%	1.91%	3.46%	7.21%	1.88%	2.26%	3.82%	7.57%

2050

Country	Case Study	Case Study Commodity	Ship Type(s)	2050 Scenario 23 TCCImtm, % increase				2050 Scenario 24 TCCImtm, % increase				2050 Scenario 31 TCCImtm, % increase				2050 Scenario 32 TCCImtm, % increase				2050 Scenario 46 TCCImtm, % increase			
				SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
United States	10a	Soybeans	Bulk carrier	3.37%	4.07%	6.90%	13.73%	3.40%	4.10%	6.93%	13.76%	3.73%	4.43%	7.26%	14.10%	3.64%	4.34%	7.17%	14.00%	3.56%	4.25%	7.08%	13.92%
	10b	Wood and wood products	Bulk carrier	16.29%	16.39%	16.83%	17.88%	16.19%	16.29%	16.73%	17.78%	17.96%	18.07%	18.50%	19.55%	17.30%	17.41%	17.85%	18.90%	17.28%	17.39%	17.83%	18.88%
	10c	Automobiles	Vehicle carrier	1.91%	2.29%	3.84%	7.60%	1.89%	2.27%	3.82%	7.57%	2.04%	2.42%	3.98%	7.73%	1.99%	2.38%	3.93%	7.68%	2.02%	2.40%	3.95%	7.71%

The 2030, 2040, and 2050 transit-weighted averaged, total commodity cost intensity ranges across all scenarios, by speed reduction group, are presented in Figures 13.2, 13.3, and 13.4, respectively.

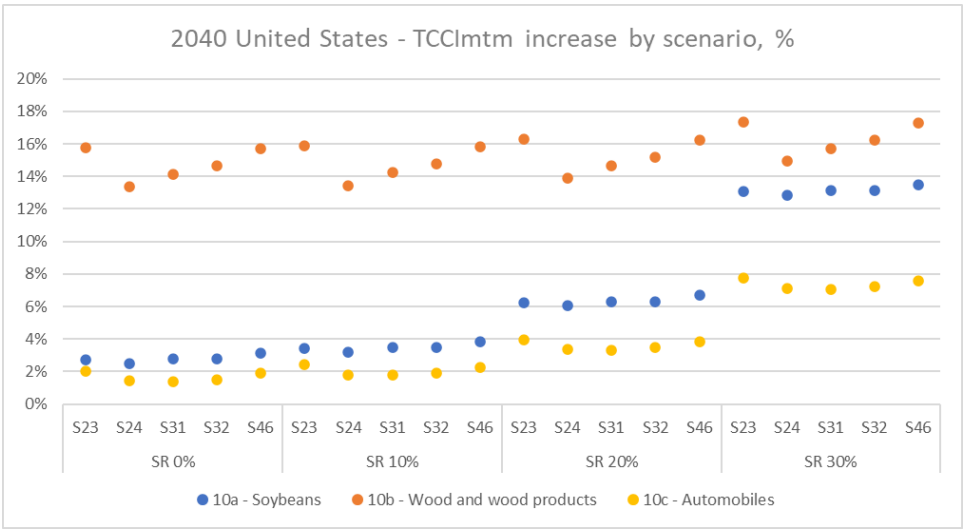
Figure 13.2: 2030 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2030, the bulk carriers carrying soybeans and the vehicle carriers carrying automobiles for this case study travel nearly three times the distance than the bulk carriers transporting wood chips. The auto carriers transit roughly 30% faster than the bulk carriers. As noted above, wood chips have five times the *ad valorem* rate as the other two commodities and automobiles which makes the other two commodities significantly less impacted by the Task 2 ship-side cost intensity changes in comparison. The Task 2 cost intensity increases dominate the changes across all commodities, all scenarios, and all speed reduction groups. Wood chips are most sensitive to Scenario 46 across SR 0% through SR 20%, then joined by soybeans, which are sensitive to the SR 30% associated longer transit times. For soybeans and automobiles, Scenarios 23 and 24 generally have less impact than Scenarios 31 and 32, across all speed reduction groups with the exception of SR 30%. Note that soybeans are the most sensitive to long delays as they have the longest transits at slower speeds compared to the auto carriers. The key parameters range from:

- **TCCImtm** **0.13% to 12.57%, with an average of 4.40%**

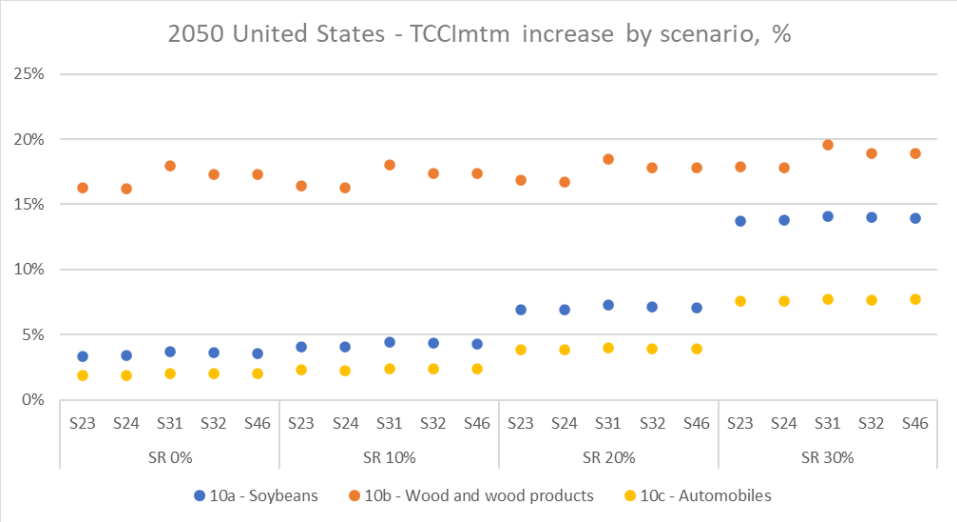
Figure 13.3: 2040 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2040, wood chips have a prominent increase in their ship-side cost intensity increases compared to 2030 and the other two commodities – on the order of magnitude of 5 times as high. Due to this jump the commodity is significantly less sensitive to speed reduction across all groups. Soybeans and automobiles have generally closer increase spans with a near double occurring at the SR 20% and again at the SR 30% speed group. The key parameters range from:

- **TCCImtm** **1.39% to 17.37%, with an average of 8.46%**

Figure 13.4: 2050 Total commodity cost intensity range across all scenarios, by speed reduction group



Note that in 2050, all three case studies have stratified, with automobiles being the least impacted, follow by soybeans and then wood chips. There is not the prominent increase between 2030 and 2040 in 2050 as the change in ship-side costs moved slightly above 2040 levels. Across all scenarios there is little difference within each speed reduction group. Soybeans remains the most sensitive to speed reduction at the SR 30% group, nearly tripling compared to the SR 0% and SR 10% groups. The key parameters range from:

- **TCCImtm** **1.89% to 19.55%, with an average of 9.57%**

GDP context

According to the information provided by the Member State, soybeans and wood & wood products sector provides a 0.65% share of national GDP, and the automobiles sector provides a 4.91% share. in terms of employment generation, soybeans generate 500,000 positions, wood and wood products 26,500 and automobile 6,300 employees.

13.4 Qualitative analysis

The US Department of Transportation Maritime Administration (MARAD) Office of Environment and Innovation aggregated information from a number of authoritative resources to provide the qualitative responses for the three US commodities. MARAD reported the process used and resources accessed were as follows:

- MARAD reached out to the individual port authorities on the origin side. These were the Port of Southern Louisiana for soybeans, the Port of Longview for wood, and the Georgia Ports Authority (GPA).
- MARAD then consulted a number of industry partners based on the above port connections. In the case of GPA and Longview, these conversations led to connections on the commodity

shippers side. These shippers preferred not to be named at the time of this report. For soybeans, MARAD connected with the Illinois Soybean Association who connected them to the Soy Transportation Coalition and also referred MARAD to resources from the US Department of Agriculture and the United Soybean Board.

- MARAD compiled internal data that MARAD's Office of Policy and Plans collects and maintains in internal databases or has access to from a range of external products, as well as resources from the Bureau of Transportation Statistics (BTS).
- MARAD reports that the more general trade and commodity data came from MARAD's policy group, often checked against the industry partners, and more specific information came from industry partners.
- The Member State also accessed internet resources and available literature.

In these qualitative responses, the stakeholders' responses, as reported, showed some awareness of the potential impacts on their businesses of the IMO measures to decarbonize shipping. The Member State noted that some industry has not looked that far out. Analyses of these responses are displayed on the following SWOT grids (Tables 13.8 and 13.9) showing sensitivities to freight costs and sensitivities to transit times. Key takeaways for each grid are reflected below the SWOT grids.

Table 13.8 – SWOT analysis of US's commodities and their sensitivity to cost changes

Sensitivity to freight shipment cost changes as reported by the stakeholders	
Country: US Commodities: 10a Soybeans, 10b Wood & wood products, 10c Automobiles	
Strengths ➢ Speed is unlikely to impact wood product export. ➢ Soy has a relatively low cost of shipping per ton.	**Weaknesses** ➢ Distance to Asian markets are long vs local producers. ➢ For soy, although the cost of shipping is relatively low, the market competition means that demand can change based on minor changes in cost. ➢ US made vehicles already have a 43-day transit time.
Opportunities to adapt/mitigate ➢ For green fuels production there are "plans" (but nothing solid related to the relevant ports or commodities). ➢ Soy producers are interested in expanding use of their products in green fuel production (but this may not be marine fuels) ➢ The vehicle carrier is more progressive, and the ports are likely willing to support any future fuel needs if possible. If fuels are not available, they will likely pay the penalty, but it is unlikely that they will lag the field.	**Threats** ➢ Higher transport cost will disadvantage wood products due to competing products in the Asia Pacific region and potentially from Russia, who can transport their softwood products overland if prices get high enough. ➢ Any higher transport costs will substantially affect market demand due to the high degree of competition in the market. For longer supply chains coming out of the US to Asia, US products will be put at a distinct disadvantage. ➢ For automobiles, much greater transit times could affect some aspects of the business model, but it's more likely that higher fuel costs would be absorbed/passed on before it causes major changes. ➢ Higher transport costs will bias the market against US manufactured vehicles. US made vehicles could be substantially disadvantaged in the market. Changes in freight costs are ultimately added on as a cost to the end user.

Key findings on shipment costs derived from stakeholder input to the SWOT analysis:

- Higher transport costs will bias the market against US manufactured vehicles. Changes in freight costs are ultimately added on as a cost to the end user. Already with a 43-day transit time, US made vehicles could be substantially disadvantaged in the market.
- Higher transport cost will disadvantage wood products due to competing products in the Asia Pacific region and potentially from Russia, who can transport their softwood products overland if prices get high enough.
- For wood, ship size is limited by the terminals. Since this industry is largely served by tramp vessels, if more volume is needed, more vessels are used.
- For soy, although the cost of shipping is relatively low, the market competition means that demand can change based on minor changes in cost.
- Reduced vessel capacity due to green fuels is not a given. It could be that vessels just have to bunker more often. This is more likely than reducing capacity.
- If green fuels are not readily available in the US, the vessel will have to buy credits in a flexible system. This will likely be the case for much longer for vessels like this that serve fewer major ports with a less consistent fleet.

Table 13.9 – SWOT analysis of US's commodities and their sensitivity to transport time changes.

Sensitivity to increased transport times as reported by the stakeholders	
Country: US Commodities: 10a Soybeans, 10b Wood & wood products, 10c Automobiles	
Strengths ➢ Speed is unlikely to impact wood product export. ➢ Soybeans would see limited effects of speed reduction. Dry bulk carriers for soy already move quite slowly. ➢ Even during Covid-19 soy didn't see major fluctuations in demand. Many soy products move in dedicated containers and transportation modes, so the effects were limited. ➢ Vehicles have certain targets related to model year roll outs but would more likely absorb higher costs than miss major targets. If speed reductions are known, it can be accounted for with minimal impact.	**Weaknesses** ➢ Distance to Asian markets are long vs local producers. ➢ All 3 commodities demand timely arrivals for KPI and productivity reasons.
Opportunities to adapt/mitigate ➢ Reduced vessel capacity due to green fuels is not a given. It could be that vessels just have to bunker more often. This is more likely than reducing capacity. ➢ For wood, ship size is limited by the terminals. Since this industry is largely served by tramp vessels, if more volume is needed, more vessels are used. For automobiles, delays are acceptable when they are built into the expected transit time. It is unlikely that slower steaming would substantially affect this calculation unless it is unexpected. ➢ More frequent bunkering could reduce the potential capacity loss due to green fuels.	**Threats** ➢ IMO GHG criteria may increase shipping costs more for shippers with longer distance to market than some potential competitors. ➢ Major delays could lead to a request for a discount, but not necessarily. Most extended shipping times can be factored into the logistics planning. ➢ Higher transport costs will bias the market against US manufactured vehicles. Already with a 43-day transit time, US made vehicles could be substantially disadvantaged in the market

Key findings on shipment transport times derived from stakeholder input to the SWOT analysis:

- Commodities may be time-sensitive for a variety of reasons – product degradation, customer demands (KPIs, production efficiency, seasonal demand), market forces, and costs. This was well demonstrated by US's chosen commodities.
- The wood industry is largely served by tramp vessels, so if more volume is needed, more vessels are used.
- Vehicles have certain targets related to model year roll outs but would more likely absorb higher costs than miss major targets. If speed reductions are known, it can be accounted for with minimal impact.

Another insight into these stakeholders' awareness of and engagement in the decarbonization of shipping is the breadth of their responses to the final open-ended question "What questions should we have asked to more fully understand the impacts of potential vessel greenhouse gas reduction requirements on shipping, your population and your economy?" While stakeholders from the US did not suggest additional questions, their answers to other questions showed a strong understanding of the potential impacts, threats and mitigations that may occur as a result of the analyzed measure.

13.5 Findings

Quantitative findings

The key findings from the quantitative analysis include:

- Longer transit times from potential speed reduction range across the case studies, including:
  - Soybeans
    - SR 10% - 4 to 5 days
    - SR 20% - just over 10 days
    - SR 30% - just under 18 days
  - Wood and wood products
    - SR 10% - less than 2 days
    - SR 20% - just over 4 days
    - SR 30% - approximately 7 days
  - Automobiles
    - SR 10% - 3 to 4 days
    - SR 20% - 7 to 8 days
    - SR 30% - just over 13 days
- Total commodity cost intensity increases across all scenarios are more sensitive to commodity costs associated with the MTM than to the associated costs with speed reduction. This is especially the case in 2040 and 2050.
- Note that the *ad valorem* rate for wood and wood products is five times the magnitude of automobiles and soybeans. Wood chips are low-value cargos for which the transportation costs are a substantial portion of the landed costs of the commodity. Further noted, the vehicle carriers are significantly less impacted by the Task 2 cost intensity changes compared to the bulk carriers.
- In 2030 the bulk carriers carrying soybeans and the vehicle carriers carrying automobiles for this commodity case study travel nearly three time the distance compared to the bulk carriers transporting wood chips. The auto carriers transit roughly 30% faster than the bulk carriers. As noted above, wood chips have five times the *ad valorem* rate as the other two commodities and automobiles which makes the other two commodities significantly less impacted by the Task 2 ship-side cost intensity changes in comparison. The Task 2 cost intensity increases dominate the changes across all commodities, all scenarios, and all speed reduction groups. Wood chips are most sensitive to Scenario 46 across SR 0% through SR 20%, then joined by soybeans, which are sensitive to the SR 30% associated longer transit times. For soybeans and automobiles, Scenarios 23 and 24 generally have less impact than Scenarios 31 and 32, across all speed reduction groups with the exception of SR 30%. Note that soybeans are the most sensitive to long delays as they have the longest transits and slower speeds compared to the auto carriers.
- In 2040, wood chips have a prominent increase in their ship-side cost intensity increases compared to 2030 and the other two commodities – on the order of magnitude of five times as high. Due to this jump the commodity is significantly less sensitive to speed reduction across all groups. Soybeans and automobiles have generally closer increase spans with a near double occurring at the SR 20% and again at the SR 30% speed group.

- In 2050, all three case studies have stratified, with automobiles being the least impacted, followed by soybeans, and then wood chips. There is no prominent increase between 2040 and 2050 as the change in ship-side costs moved slightly above 2040 levels. Across all scenarios there is little difference within each speed reduction group. Soybeans remains the most sensitive to speed reduction at the SR 30% group, nearly tripling compared to the SR 0% and SR 10% groups.
- Total commodity cost intensity ranges across all scenarios and speed reduction groups, include:
  - Soybeans
    - 2030 – 1.03% to 12.57%, with an average of 4.94%
    - 2040 – 2.51% to 13.51%, with an average of 6.43%
    - 2050 – 3.37% to 14.10%, with an average of 7.19%
  - Wood and wood products
    - 2030 – 2.72% to 12.10%, with an average of 5.64%
    - 2040 – 13.35% to 17.37%, with an average of 15.28%
    - 2050 – 16.19% to 19.55%, with an average of 17.57%
  - Automobiles
    - 2030 – 0.13% to 6.97%, with an average of 2.55%
    - 2040 – 1.39% to 7.73%, with an average of 3.65%
    - 2050 – 1.89% to 7.73%, with an average of 3.79%
- TCCImtm findings for the three commodity case studies across all scenarios and speed reduction groups, by forecasted year:
  - 2030 0.13% to 12.57%, with an average of 4.40%
  - 2040 1.39% to 17.37%, with an average of 8.46%
  - 2050 1.89% to 19.55%, with an average of 9.57%

Qualitative findings

The United States (US) selected three different export commodities: Soybeans (only moderately sensitive to shipping time), wood and wood products (quality is relatively insensitive to time) and automobiles (do not deteriorate but have strict industry KPI timing requirements as little as two days). While time and cost sensitivities varied by commodity, they shared common concerns for vessel speed or capacity reductions, efficient and timely deliveries and increased costs.

For all three commodities selected by the US, the main customers are in Asia and timely delivery is important.

Higher transport costs will bias the market against US manufactured vehicles. Already with a 43-day transit time, US made vehicles could be substantially disadvantaged in the market.

Opportunities to mitigate impacts include a range of approaches recommended by the stakeholders from the US:

- Costs:
  - For green fuels production there are "plans" (but nothing solid related to the relevant ports or commodities).
  - Soy producers are interested in expanding use of their products in green fuel production (but this may not be marine fuels)
  - The vehicle carrier is more progressive and the ports are likely willing to support any future fuel needs if possible. If fuels are not available, they will likely pay the penalty, but it is unlikely that they will lag the field.

- Longer transport times:
  - Reduced vessel capacity due to green fuels is not a given. It could be that vessels just have to bunker more often. This is more likely than reducing capacity.
  - For wood, ship size is limited by the terminals. Since this industry is largely served by tramp vessels, if more volume is needed, more vessels are used. For automobiles, delays are acceptable when they are built into the expected transit time. It is unlikely that slower steaming would substantially affect this calculation unless it is unexpected.

Summary of key points related to potential impacts

The following key points are key to understanding the potential impacts of the MTM:

- The United States boasts the largest economy in the world by GDP at $25,857,535 million in 2022. It also ranks high in terms of GDP per capita at $75,686.
- The three commodities selected by the US for case studies are trade commodity exports of soybeans, wood chips and automobiles, all destined for Asia. All three commodity case studies are exported trade commodities, which means costs increases impact the sector/subsector of the economy associated with each commodity. In addition, the associated employment, supporting industries, and taxes and revenues associated with the commodity will be impacted.
- According to the information provided by the Member State, soybeans and wood & wood products sector provides a 0.65% share of national GDP, and the automobiles sector provides a 4.91% share. in terms of employment generation, soybeans generate 500,000 positions, wood and wood products 26,500 and automobile 6,300 employees.
- For these three case studies, the estimates indicate a range of total commodity cost intensity increases related to maritime transport. Wood chips to Japan are the most ship-side cost sensitive commodity because its *ad valorem* rate is 32%, the highest of all the commodity case studies. In 2030, Scenarios 31/32 generally run double the cost intensity increases compared to Scenarios 23/24, with Scenario 46 bringing forward significant increase estimated for 2040 and 2050. There are significant increases in 2030/2040 across all scenarios.
- In 2030, for both soybeans and automobiles, generally all scenarios track closely. There are significant increases in 2040 and 2050, but significantly lower than wood chips.
- Since these case studies represent export trade commodities only on particular routes the entire sector/subsector is not captured. The full impact on the entire sector/subsector is not known. However, since the United States has both the largest economy and a significantly large population, the impacts will be limited to those directly involved in the specific trades.

14 Stakeholders' analysis – Quantitative results, trends, and conclusions

Impacts on costs

Impacts on costs vary widely by scenario, case study, speed reduction group, and forecasted year.

2030

The Task 4 2030 total commodity cost intensity results for all case studies, by scenario, and by speed reduction group are presented in Table 14.1 on the next page.

- The expected total commodity cost intensity increases across all scenarios are:
  - 0.09% to 17.78%, with an average of 3.83%

- The expected total commodity cost intensity increases for **SR 0%** across all case studies and scenarios are:
  - Scenario 23 0.09% to 4.62%, with an average of 1.21%
  - Scenario 24 0.15% to 4.44%, with an average of 1.25%
  - Scenario 31 0.22% to 5.60%, with an average of 2.00%
  - Scenario 32 0.22% to 8.54%, with an average of 2.38%
  - Scenario 46 0.47% to 12.76%, with an average of 4.82%

- The expected total commodity cost intensity increases for **SR 10%** across all case studies and scenarios are:
  - Scenario 23 0.10% to 5.17%, with an average of 1.50%
  - Scenario 24 0.17% to 5.00%, with an average of 1.53%
  - Scenario 31 0.75% to 5.61%, with an average of 2.29%
  - Scenario 32 0.79% to 8.56%, with an average of 2.66%
  - Scenario 46 1.04% to 12.77%, with an average of 5.10%

- The expected total commodity cost intensity increases for **SR 20%** across all case studies and scenarios are:
  - Scenario 23 0.15% to 7.42%, with an average of 2.66%
  - Scenario 24 0.22% to 7.25%, with an average of 2.70%
  - Scenario 31 1.24% to 6.87%, with an average of 3.45%
  - Scenario 32 1.52% to 8.60%, with an average of 3.83%
  - Scenario 46 2.08% to 12.82%, with an average of 6.27%

- The expected total commodity cost intensity increases for **SR 30%** across all case studies and scenarios are:
  - Scenario 23 0.26% to 15.85%, with an average of 5.48%
  - Scenario 24 0.33% to 15.28%, with an average of 5.51%
  - Scenario 31 1.36% to 15.84%, with an average of 6.26%
  - Scenario 32 1.98% to 15.90%, with an average of 6.64%
  - Scenario 46 2.88% to 17.78%, with an average of 9.08%

Table 14.1: 2030 Task 4 total commodity cost intensity results for all case studies by scenario & speed reduction group

	Country	Case Study	Case Study Commodity	Ship Type(s)	2030 Scenario 23 TCCImtm, % increase				2030 Scenario 24 TCCImtm, % increase				2030 Scenario 31 TCCImtm, % increase				2030 Scenario 32 TCCImtm, % increase				2030 Scenario 46 TCCImtm, % increase			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
T	Argentina	1a	Soybeans	Bulk carrier	0.90%	1.83%	5.62%	14.77%	0.83%	1.76%	5.55%	14.70%	0.95%	1.88%	5.67%	14.82%	0.95%	1.88%	5.67%	14.82%	2.08%	3.01%	6.80%	15.95%
T		1b	Soybean meal	Bulk carrier	1.75%	2.02%	3.10%	5.71%	1.58%	1.84%	2.92%	5.53%	1.70%	1.97%	3.05%	5.66%	1.70%	1.97%	3.05%	5.65%	3.64%	3.91%	4.99%	7.60%
T		1c	Chilled bovine meat	Container	0.61%	0.78%	1.48%	3.16%	0.76%	0.94%	1.63%	3.32%	0.58%	0.75%	1.45%	3.13%	0.65%	0.83%	1.52%	3.20%	1.21%	1.38%	2.08%	3.76%
T		1d	Apples and pears	Container	1.99%	2.06%	2.36%	3.09%	2.37%	2.45%	2.75%	3.47%	2.08%	2.16%	2.46%	3.18%	2.27%	2.34%	2.64%	3.37%	4.64%	4.71%	5.01%	5.74%
T		1e	Soy oil	Chemical tanker	4.62%	5.17%	7.42%	12.86%	4.44%	5.00%	7.25%	12.69%	3.54%	4.09%	6.34%	11.78%	3.58%	4.13%	6.38%	11.82%	7.74%	8.30%	10.55%	15.99%
T		1f	Corn	Bulk carrier	2.17%	2.81%	5.40%	11.67%	1.96%	2.60%	5.19%	11.45%	1.98%	2.62%	5.21%	11.47%	1.98%	2.62%	5.21%	11.47%	4.21%	4.85%	7.44%	13.71%
T	Belize	2a	Bananas	Container	0.54%	0.65%	1.09%	2.16%	0.63%	0.74%	1.18%	2.24%	2.10%	2.20%	2.65%	3.71%	1.86%	1.97%	2.41%	3.47%	5.50%	5.61%	6.05%	7.12%
T		2b	Sugar	Bulk carrier	1.01%	1.20%	1.94%	3.75%	0.85%	1.03%	1.78%	3.59%	1.37%	1.56%	2.30%	4.11%	1.40%	1.59%	2.33%	4.14%	2.88%	3.06%	3.81%	5.62%
EG		2c	Steel	Container	1.48%	1.74%	2.81%	5.40%	1.27%	1.54%	2.61%	5.20%	2.16%	2.43%	3.50%	6.09%	2.37%	2.64%	3.71%	6.30%	5.54%	5.81%	6.88%	9.47%
T	Brazil	3a	Iron ore	Bulk carrier	2.25%	3.16%	6.88%	15.85%	1.69%	2.60%	6.31%	15.28%	2.24%	3.16%	6.87%	15.84%	2.31%	3.22%	6.93%	15.90%	4.19%	5.10%	8.81%	17.78%
T		3b	Soybeans	Bulk carrier	0.95%	1.87%	5.62%	14.68%	0.86%	1.79%	5.53%	14.59%	0.96%	1.89%	5.63%	14.69%	0.96%	1.88%	5.63%	14.68%	2.09%	3.01%	6.76%	15.82%
T		3c	Woodpulp (paper and paper products)	General cargo	2.90%	3.62%	6.53%	13.57%	3.03%	3.75%	6.66%	13.71%	2.50%	3.22%	6.14%	13.18%	2.88%	3.59%	6.51%	13.55%	6.52%	7.23%	10.15%	17.19%
T	Chile	4a	Cherries	Container	0.90%	1.16%	2.20%	4.72%	0.81%	1.06%	2.11%	4.62%	1.32%	1.58%	2.62%	5.14%	1.45%	1.71%	2.75%	5.27%	3.60%	3.86%	4.90%	7.42%
EG		4b	Petroleum oils	Chemical tanker	1.38%	1.48%	1.84%	2.73%	1.33%	1.42%	1.79%	2.67%	1.06%	1.15%	1.52%	2.40%	1.07%	1.16%	1.53%	2.42%	2.32%	2.41%	2.78%	3.67%
T		4c	Lithium carbonate	Container	0.55%	0.90%	2.33%	5.77%	0.61%	0.96%	2.38%	5.82%	2.11%	2.46%	3.89%	7.33%	2.51%	2.86%	4.29%	7.73%	9.30%	9.65%	11.08%	14.52%
EG	Cook Islands	5a	Miscellaneous edible preparations	Container	1.58%	1.71%	2.24%	3.52%	1.94%	2.07%	2.60%	3.88%	1.94%	2.07%	2.60%	3.88%	2.26%	2.39%	2.92%	4.20%	4.32%	4.45%	4.98%	6.26%
EG		5b	Pharmaceutical goods	General cargo	0.20%	0.25%	0.44%	0.88%	0.36%	0.41%	0.59%	1.04%	2.71%	2.75%	2.94%	3.39%	4.13%	4.18%	4.36%	4.81%	6.17%	6.21%	6.40%	6.85%
EG		5c	Fuels (LPG)	LPG tanker	0.83%	1.00%	1.69%	3.35%	0.83%	1.00%	1.69%	3.35%	0.83%	1.00%	1.69%	3.35%	0.83%	1.00%	1.69%	3.35%	2.36%	2.53%	3.22%	4.89%
EG		5d	Articles of iron and steel	General cargo	0.25%	0.29%	0.48%	0.93%	0.44%	0.49%	0.67%	1.12%	3.30%	3.35%	3.53%	3.98%	5.04%	5.08%	5.27%	5.72%	7.52%	7.57%	7.75%	8.20%
EG		5e	Edible vegetables, certain roots, & tubers	General cargo	0.23%	0.28%	0.46%	0.91%	0.41%	0.46%	0.64%	1.09%	3.08%	3.12%	3.31%	3.76%	4.70%	4.74%	4.93%	5.38%	7.01%	7.06%	7.25%	7.69%
EG		5f	Electrical machinery & equip	General cargo	0.24%	0.28%	0.47%	0.92%	0.42%	0.47%	0.65%	1.10%	3.15%	3.20%	3.38%	3.83%	4.81%	4.86%	5.04%	5.49%	7.18%	7.23%	7.41%	7.86%
EG		5g	Meat & edible meat offal	Container, General cargo	1.71%	1.80%	2.13%	2.93%	2.00%	2.08%	2.42%	3.22%	1.99%	2.07%	2.40%	3.20%	1.85%	1.94%	2.27%	3.07%	4.13%	4.21%	4.54%	5.35%
EG		5h	Dairy produce, birds eggs, natural honey+	General cargo	0.10%	0.14%	0.33%	0.78%	0.17%	0.22%	0.40%	0.85%	1.28%	1.33%	1.51%	1.96%	1.95%	2.00%	2.18%	2.63%	2.92%	2.96%	3.15%	3.60%
EG		5i	Products of the milling industry, etc.	General cargo	0.18%	0.23%	0.41%	0.86%	0.32%	0.37%	0.56%	1.00%	2.43%	2.47%	2.66%	3.11%	3.71%	3.75%	3.94%	4.39%	5.54%	5.58%	5.77%	6.22%
T	Peru	6a	Copper	Bulk carrier	0.22%	0.79%	3.12%	8.73%	0.22%	0.79%	3.12%	8.73%	0.22%	0.79%	3.11%	8.73%	0.22%	0.79%	3.11%	8.72%	0.47%	1.04%	3.37%	8.98%
T		6b	Grapes	Container	1.16%	1.47%	2.71%	5.72%	1.03%	1.33%	2.58%	5.58%	1.63%	1.94%	3.18%	6.19%	1.75%	2.05%	3.30%	6.30%	4.24%	4.54%	5.79%	8.79%
T		6c	Pota (squid)	Container	0.79%	1.09%	2.35%	5.38%	0.79%	1.09%	2.35%	5.38%	1.35%	1.66%	2.91%	5.94%	1.48%	1.78%	3.04%	6.07%	3.86%	4.17%	5.42%	8.45%
T	South Africa	7a	Iron ore	Bulk carrier	0.52%	0.91%	2.52%	6.40%	0.48%	0.88%	2.48%	6.36%	1.26%	1.65%	3.26%	7.14%	1.27%	1.66%	3.27%	7.15%	3.27%	3.67%	5.27%	9.15%
T		7b	Citrus foods	Container	1.98%	2.11%	2.65%	3.94%	2.36%	2.49%	3.03%	4.32%	2.68%	2.81%	3.34%	4.64%	2.96%	3.09%	3.62%	4.92%	6.56%	6.69%	7.23%	8.52%
T		7c	Grapes	Container	1.04%	1.14%	1.53%	2.47%	1.25%	1.34%	1.73%	2.67%	1.41%	1.50%	1.89%	2.83%	1.56%	1.65%	2.04%	2.98%	3.45%	3.55%	3.94%	4.88%
EG	Togo	8a	Essence (LPG)	Container, Chemicaltanker, Product tanker	1.76%	2.01%	3.06%	5.58%	1.20%	1.45%	2.50%	5.02%	2.34%	2.60%	3.64%	6.17%	2.17%	2.42%	3.47%	5.99%	5.59%	5.85%	6.89%	9.42%
T		8b	Iron and steel	Container	2.31%	2.76%	4.56%	8.91%	3.01%	3.46%	5.26%	9.60%	2.40%	2.84%	4.65%	8.99%	3.02%	3.46%	5.26%	9.61%	6.45%	6.89%	8.69%	13.04%
EG		8c	Palm oil	Chemical tanker	1.18%	1.43%	2.44%	4.88%	1.37%	1.61%	2.62%	5.06%	2.39%	2.64%	3.64%	6.08%	2.81%	3.06%	4.07%	6.50%	7.71%	7.96%	8.97%	11.41%
EG	Tonga	9a	Petroleum oils	Chemical tanker, Oil & product tanker	2.31%	2.42%	2.83%	3.83%	2.23%	2.33%	2.74%	3.74%	1.83%	1.94%	2.35%	3.35%	1.84%	1.95%	2.36%	3.36%	4.14%	4.24%	4.65%	5.65%
T		9b	Fish	General cargo	0.09%	0.10%	0.15%	0.26%	0.16%	0.17%	0.22%	0.33%	1.19%	1.20%	1.24%	1.36%	1.81%	1.82%	1.87%	1.98%	2.70%	2.72%	2.76%	2.88%
T		9c	Kava	General cargo	0.42%	0.43%	0.48%	0.59%	0.75%	0.76%	0.80%	0.92%	5.60%	5.61%	5.66%	5.77%	8.54%	8.56%	8.60%	8.71%	12.76%	12.77%	12.82%	12.93%
T	United States	10a	Soybeans	Bulk carrier	1.15%	1.84%	4.67%	11.51%	1.07%	1.77%	4.59%	11.43%	1.04%	1.73%	4.56%	11.40%	1.03%	1.73%	4.56%	11.40%	2.21%	2.90%	5.73%	12.57%
T		10b	Wood and wood products	Bulk carrier	2.97%	3.07%	3.51%	4.56%	2.72%	2.83%	3.26%	4.31%	4.63%	4.73%	5.17%	6.22%	4.56%	4.67%	5.10%	6.16%	10.50%	10.61%	11.04%	12.10%
T		10c	Automobiles	Vehicle carrier	0.13%	0.52%	2.07%	5.82%	0.15%	0.53%	2.08%	5.83%	0.74%	1.12%	2.67%	6.42%	0.45%	0.83%	2.39%	6.14%	1.29%	1.67%	3.22%	6.97%

Note: *EG – imported essential good*
T – exported trade good

2040

The Task 4 2040 total commodity cost intensity results for all case studies, by scenario, and by speed reduction group are presented in Table 14.2 on the next page.

- The expected total commodity cost intensity increases across all scenarios are:
  - 0.54% to 21.13%, with an average of 7.20%

- The expected total commodity cost intensity increases for **SR 0%** across all case studies and scenarios are:
  - Scenario 23 0.59% to 18.18%, with an average of 6.34%
  - Scenario 24 0.54% to 14.47%, with an average of 5.26%
  - Scenario 31 0.60% to 14.12%, with an average of 5.17%
  - Scenario 32 0.60% to 14.65%, with an average of 5.37%
  - Scenario 46 0.69% to 15.70%, with an average of 6.37%

- The expected total commodity cost intensity increases for **SR 10%** across all case studies and scenarios are:
  - Scenario 23 1.16% to 18.19%, with an average of 6.63%
  - Scenario 24 1.11% to 14.48%, with an average of 5.55%
  - Scenario 31 1.17% to 14.23%, with an average of 5.46%
  - Scenario 32 1.17% to 14.76%, with an average of 5.65%
  - Scenario 46 1.26% to 15.81%, with an average of 6.66%

- The expected total commodity cost intensity increases for **SR 20%** across all case studies and scenarios are:
  - Scenario 23 2.10% to 18.24%, with an average of 7.79%
  - Scenario 24 2.01% to 14.53%, with an average of 6.71%
  - Scenario 31 2.08% to 14.67%, with an average of 6.62%
  - Scenario 32 2.10% to 15.20%, with an average of 6.82%
  - Scenario 46 2.60% to 16.24%, with an average of 7.82%

- The expected total commodity cost intensity increases for **SR 30%** across all case studies and scenarios are:
  - Scenario 23 3.79% to 21.13%, with an average of 10.60%
  - Scenario 24 3.24% to 18.98%, with an average of 9.52%
  - Scenario 31 3.04% to 17.68%, with an average of 9.43%
  - Scenario 32 3.20% to 17.80%, with an average of 9.63%
  - Scenario 46 3.37% to 20.44%, with an average of 10.63%

Table 14.2: 2040 Task 4 Task 4 total commodity cost intensity results for all case studies by scenario & speed reduction group

	Country	Case Study	Case Study Commodity	Ship Type(s)	2040 Scenario 23 TCCImtm, % increase				2040 Scenario 24 TCCImtm, % increase				2040 Scenario 31 TCCImtm, % increase				2040 Scenario 32 TCCImtm, % increase				2040 Scenario 46 TCCImtm, % increase			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
T	Argentina	1a	Soybeans	Bulk carrier	2.73%	3.66%	7.45%	16.60%	2.47%	3.40%	7.19%	16.34%	2.67%	3.60%	7.39%	16.54%	2.72%	3.65%	7.44%	16.59%	2.99%	3.93%	7.71%	16.87%
T		1b	Soybean meal	Bulk carrier	4.71%	4.98%	6.06%	8.67%	4.27%	4.54%	5.62%	8.23%	4.65%	4.91%	5.99%	8.60%	4.72%	4.99%	6.07%	8.68%	5.24%	5.51%	6.59%	9.20%
T		1c	Chilled bovine meat	Container	1.24%	1.41%	2.10%	3.79%	1.15%	1.32%	2.01%	3.70%	1.21%	1.38%	2.08%	3.76%	1.23%	1.40%	2.10%	3.78%	1.73%	1.90%	2.60%	4.28%
T		1d	Apples and pears	Container	5.27%	5.34%	5.64%	6.37%	4.69%	4.76%	5.06%	5.79%	4.82%	4.90%	5.20%	5.92%	5.01%	5.09%	5.39%	6.11%	6.72%	6.80%	7.10%	7.82%
T		1e	Soy oil	Chemical tanker	10.13%	10.68%	12.94%	18.38%	8.75%	9.30%	11.56%	17.00%	8.44%	9.00%	11.25%	16.69%	8.37%	8.92%	11.17%	16.61%	11.14%	11.69%	13.94%	19.39%
T		1f	Corn	Bulk carrier	5.21%	5.85%	8.44%	14.70%	4.83%	5.47%	8.06%	14.33%	5.31%	5.95%	8.54%	14.81%	5.37%	6.01%	8.60%	14.86%	5.99%	6.62%	9.22%	15.48%
T	Belize	2a	Bananas	Container	6.34%	6.45%	6.89%	7.96%	5.21%	5.32%	5.76%	6.82%	5.66%	5.77%	6.21%	7.28%	6.06%	6.17%	6.61%	7.68%	7.42%	7.53%	7.97%	9.04%
T		2b	Sugar	Bulk carrier	5.04%	5.22%	5.97%	7.77%	3.96%	4.14%	4.89%	6.70%	3.94%	4.13%	4.87%	6.68%	4.10%	4.29%	5.03%	6.84%	4.59%	4.77%	5.52%	7.32%
EG		2c	Steel	Container	6.49%	6.76%	7.83%	10.42%	4.73%	4.99%	6.06%	8.65%	4.81%	5.08%	6.15%	8.74%	5.24%	5.50%	6.58%	9.17%	6.64%	6.90%	7.98%	10.56%
T	Brazil	3a	Iron ore	Bulk carrier	3.70%	4.61%	8.33%	17.30%	3.81%	4.73%	8.44%	17.41%	3.95%	4.87%	8.58%	17.55%	4.16%	5.07%	8.78%	17.75%	4.63%	5.55%	9.26%	18.23%
T		3b	Soybeans	Bulk carrier	2.69%	3.61%	7.36%	16.42%	2.45%	3.37%	7.12%	16.17%	2.67%	3.60%	7.34%	16.40%	2.72%	3.64%	7.39%	16.45%	2.99%	3.92%	7.66%	16.72%
T		3c	Woodpulp (paper and paper products)	General cargo	10.46%	11.18%	14.09%	21.13%	8.31%	9.03%	11.94%	18.98%	7.01%	7.73%	10.64%	17.68%	7.13%	7.85%	10.76%	17.80%	9.76%	10.48%	13.40%	20.44%
T	Chile	4a	Cherries	Container	4.08%	4.34%	5.38%	7.90%	2.84%	3.09%	4.14%	6.65%	3.00%	3.25%	4.29%	6.81%	3.26%	3.52%	4.56%	7.08%	4.16%	4.41%	5.46%	7.97%
EG		4b	Petroleum oils	Chemical tanker	3.04%	3.13%	3.50%	4.38%	2.63%	2.72%	3.08%	3.97%	2.53%	2.62%	2.99%	3.88%	2.51%	2.60%	2.97%	3.85%	3.34%	3.43%	3.80%	4.68%
T		4c	Lithium carbonate	Container	12.01%	12.36%	13.78%	17.22%	11.55%	11.90%	13.33%	16.77%	10.42%	10.77%	12.19%	15.64%	9.91%	10.27%	11.69%	15.13%	14.01%	14.36%	15.79%	19.23%
EG	Cook Islands	5a	Miscellaneous edible preparations	Container	4.69%	4.82%	5.35%	6.63%	4.41%	4.54%	5.07%	6.34%	4.19%	4.32%	4.85%	6.13%	4.30%	4.43%	4.96%	6.24%	5.71%	5.84%	6.37%	7.65%
EG		5b	Pharmaceutical goods	General cargo	8.79%	8.83%	9.02%	9.47%	7.00%	7.04%	7.23%	7.68%	6.53%	6.58%	6.77%	7.21%	6.91%	6.95%	7.14%	7.59%	7.30%	7.35%	7.53%	7.98%
EG		5c	Fuels (LPG)	LPG tanker	2.43%	2.60%	3.29%	4.95%	2.43%	2.60%	3.29%	4.95%	2.43%	2.60%	3.29%	4.95%	2.43%	2.60%	3.29%	4.95%	2.82%	2.99%	3.68%	5.35%
EG		5d	Articles of iron and steel	General cargo	10.72%	10.76%	10.95%	11.40%	8.53%	8.58%	8.76%	9.21%	7.97%	8.01%	8.20%	8.65%	8.42%	8.46%	8.65%	9.10%	8.90%	8.95%	9.13%	9.58%
EG		5e	Edible vegetables, certain roots, & tubers	General cargo	9.99%	10.04%	10.22%	10.67%	7.95%	8.00%	8.19%	8.63%	7.43%	7.48%	7.66%	8.11%	7.85%	7.90%	8.08%	8.53%	8.30%	8.35%	8.53%	8.98%
EG		5f	Electrical machinery & equip	General cargo	10.23%	10.28%	10.47%	10.91%	8.15%	8.19%	8.38%	8.83%	7.61%	7.65%	7.84%	8.29%	8.04%	8.09%	8.27%	8.72%	8.50%	8.55%	8.73%	9.18%
EG		5g	Meat & edible meat offal	Container, General cargo	5.44%	5.52%	5.86%	6.66%	5.11%	5.20%	5.53%	6.33%	4.78%	4.86%	5.19%	5.99%	4.85%	4.93%	5.26%	6.06%	6.15%	6.24%	6.57%	7.37%
EG		5h	Dairy produce, birds eggs, natural honey+	General cargo	4.15%	4.20%	4.39%	4.83%	3.31%	3.35%	3.54%	3.99%	3.09%	3.13%	3.32%	3.77%	3.26%	3.31%	3.50%	3.94%	3.45%	3.50%	3.68%	4.13%
EG		5i	Products of the milling industry, etc.	General cargo	7.89%	7.93%	8.12%	8.57%	6.28%	6.32%	6.51%	6.96%	5.86%	5.91%	6.09%	6.54%	6.20%	6.24%	6.43%	6.88%	6.55%	6.60%	6.78%	7.23%
T	Peru	6a	Copper	Bulk carrier	0.59%	1.16%	3.49%	9.10%	0.54%	1.11%	3.43%	9.05%	0.60%	1.17%	3.49%	9.11%	0.60%	1.17%	3.50%	9.11%	0.69%	1.26%	3.58%	9.20%
T		6b	Grapes	Container	4.88%	5.18%	6.43%	9.43%	3.49%	3.80%	5.04%	8.05%	3.62%	3.93%	5.17%	8.18%	3.92%	4.22%	5.47%	8.47%	5.00%	5.31%	6.55%	9.56%
T		6c	Pota (squid)	Container	4.58%	4.89%	6.15%	9.18%	3.40%	3.71%	4.96%	7.99%	3.51%	3.82%	5.07%	8.10%	3.73%	4.03%	5.29%	8.32%	4.91%	5.22%	6.47%	9.50%
T	South Africa	7a	Iron ore	Bulk carrier	4.25%	4.64%	6.25%	10.13%	3.69%	4.08%	5.69%	9.56%	4.02%	4.41%	6.02%	9.90%	4.14%	4.54%	6.14%	10.02%	4.39%	4.79%	6.39%	10.27%
T		7b	Citrus foods	Container	8.06%	8.19%	8.73%	10.02%	6.61%	6.75%	7.28%	8.57%	6.63%	6.76%	7.30%	8.59%	6.93%	7.06%	7.60%	8.89%	8.76%	8.90%	9.43%	10.72%
T		7c	Grapes	Container	4.23%	4.33%	4.72%	5.66%	3.48%	3.57%	3.96%	4.90%	3.49%	3.58%	3.97%	4.91%	3.64%	3.74%	4.13%	5.07%	4.61%	4.70%	5.09%	6.03%
EG	Togo	8a	Essence (LPG)	Container, Chemicaltanker, Product tanker	7.34%	7.60%	8.64%	11.17%	6.02%	6.28%	7.32%	9.84%	5.92%	6.18%	7.23%	9.75%	6.13%	6.39%	7.43%	9.96%	7.58%	7.84%	8.89%	11.41%
T		8b	Iron and steel	Container	8.48%	8.93%	10.73%	15.08%	6.90%	7.34%	9.14%	13.49%	6.64%	7.09%	8.89%	13.24%	6.89%	7.33%	9.13%	13.48%	9.30%	9.74%	11.54%	15.89%
EG		8c	Palm oil	Chemical tanker	9.52%	9.76%	10.77%	13.21%	6.79%	7.04%	8.05%	10.49%	7.11%	7.36%	8.37%	10.80%	7.76%	8.01%	9.01%	11.45%	9.22%	9.47%	10.48%	12.92%
EG	Tonga	9a	Petroleum oils	Chemical tanker, Oil & product tanker	5.41%	5.51%	5.92%	6.92%	4.67%	4.77%	5.19%	6.18%	4.52%	4.62%	5.03%	6.03%	4.47%	4.57%	4.98%	5.98%	5.87%	5.97%	6.38%	7.38%
T		9b	Fish	General cargo	3.85%	3.86%	3.91%	4.02%	3.07%	3.08%	3.12%	3.24%	2.86%	2.88%	2.92%	3.04%	3.03%	3.04%	3.09%	3.20%	3.20%	3.21%	3.26%	3.37%
T		9c	Kava	General cargo	18.18%	18.19%	18.24%	18.35%	14.47%	14.48%	14.53%	14.64%	13.52%	13.53%	13.57%	13.69%	14.28%	14.30%	14.34%	14.45%	15.10%	15.11%	15.16%	15.27%
T	United States	10a	Soybeans	Bulk carrier	2.71%	3.40%	6.23%	13.07%	2.51%	3.21%	6.03%	12.87%	2.77%	3.47%	6.30%	13.14%	2.79%	3.49%	6.32%	13.16%	3.15%	3.85%	6.68%	13.51%
T		10b	Wood and wood products	Bulk carrier	15.78%	15.88%	16.32%	17.37%	13.35%	13.46%	13.90%	14.95%	14.12%	14.23%	14.67%	15.72%	14.65%	14.76%	15.20%	16.25%	15.70%	15.81%	16.24%	17.29%
T		10c	Automobiles	Vehicle carrier	2.04%	2.42%	3.98%	7.73%	1.42%	1.81%	3.36%	7.11%	1.39%	1.77%	3.32%	7.08%	1.53%	1.91%	3.46%	7.21%	1.88%	2.26%	3.82%	7.57%

Note: *EG – imported essential good*
T – exported trade good

2050

The Task 4 2050 total commodity cost intensity results for all case studies, by scenario, and by speed reduction group are presented in Table 14.3 on the next page.

- The expected total commodity cost intensity increases across all scenarios are:
  - 0.73% to 20.90%, with an average of 8.43%

- The expected total commodity cost intensity increases for **SR 0%** across all case studies and scenarios are:
  - Scenario 23 0.73% to 19.86%, with an average of 6.89%
  - Scenario 24 0.73% to 19.56%, with an average of 6.80%
  - Scenario 31 0.80% to 20.31%, with an average of 7.09%
  - Scenario 32 0.78% to 18.81%, with an average of 6.81%
  - Scenario 46 0.76% to 20.46%, with an average of 7.07%

- The expected total commodity cost intensity increases for **SR 10%** across all case studies and scenarios are:
  - Scenario 23 1.30% to 19.88%, with an average of 7.17%
  - Scenario 24 1.30% to 19.57%, with an average of 7.09%
  - Scenario 31 1.37% to 20.32%, with an average of 7.38%
  - Scenario 32 1.35% to 18.82%, with an average of 7.10%
  - Scenario 46 1.33% to 20.47%, with an average of 7.36%

- The expected total commodity cost intensity increases for **SR 20%** across all case studies and scenarios are:
  - Scenario 23 2.59% to 19.92%, with an average of 8.34%
  - Scenario 24 2.58% to 19.62%, with an average of 8.25%
  - Scenario 31 2.76% to 20.37%, with an average of 8.54%
  - Scenario 32 2.72% to 18.86%, with an average of 8.26%
  - Scenario 46 2.68% to 20.52%, with an average of 8.52%

- The expected total commodity cost intensity increases for **SR 30%** across all case studies and scenarios are:
  - Scenario 23 4.27% to 20.42%, with an average of 11.15%
  - Scenario 24 4.26% to 20.44%, with an average of 11.06%
  - Scenario 31 4.45% to 20.83%, with an average of 11.35%
  - Scenario 32 4.16% to 20.84%, with an average of 11.07%
  - Scenario 46 4.36% to 20.90%, with an average of 11.33%

Table 14.3: 2050 Task 4 Task 4 total commodity cost intensity results for all case studies by scenario & speed reduction group

	Country	Case Study	Case Study Commodity	Ship Type(s)	2050 Scenario 23 TCCImtm, % increase				2050 Scenario 24 TCCImtm, % increase				2050 Scenario 31 TCCImtm, % increase				2050 Scenario 32 TCCImtm, % increase				2050 Scenario 46 TCCImtm, % increase			
					SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%	SR 0%	SR 10%	SR 20%	SR 30%
T	Argentina	1a	Soybeans	Bulk carrier	3.17%	4.10%	7.89%	17.04%	3.18%	4.12%	7.90%	17.06%	3.51%	4.44%	8.23%	17.38%	3.41%	4.34%	8.13%	17.28%	3.37%	4.30%	8.09%	17.24%
T		1b	Soybean meal	Bulk carrier	5.58%	5.85%	6.93%	9.54%	5.60%	5.87%	6.95%	9.56%	6.17%	6.44%	7.52%	10.13%	6.00%	6.27%	7.35%	9.96%	5.91%	6.17%	7.25%	9.86%
T		1c	Chilled bovine meat	Container	1.72%	1.89%	2.59%	4.27%	1.71%	1.88%	2.58%	4.26%	1.90%	2.07%	2.76%	4.45%	1.85%	2.02%	2.72%	4.40%	1.81%	1.98%	2.68%	4.36%
T		1d	Apples and pears	Container	6.78%	6.86%	7.16%	7.88%	6.71%	6.79%	7.09%	7.82%	7.19%	7.27%	7.57%	8.30%	7.02%	7.09%	7.40%	8.12%	7.05%	7.12%	7.42%	8.15%
T		1e	Soy oil	Chemical tanker	10.88%	11.43%	13.68%	19.12%	10.89%	11.45%	13.70%	19.14%	11.96%	12.51%	14.77%	20.21%	11.50%	12.06%	14.31%	19.75%	11.28%	11.84%	14.09%	19.53%
T		1f	Corn	Bulk carrier	6.42%	7.06%	9.65%	15.91%	6.47%	7.10%	9.70%	15.96%	7.11%	7.75%	10.34%	16.61%	6.93%	7.57%	10.16%	16.43%	6.81%	7.44%	10.04%	16.30%
T	Belize	2a	Bananas	Container	7.99%	8.10%	8.54%	9.61%	7.77%	7.88%	8.32%	9.39%	7.84%	7.95%	8.39%	9.46%	7.86%	7.97%	8.41%	9.48%	8.02%	8.13%	8.57%	9.63%
T		2b	Sugar	Bulk carrier	4.69%	4.88%	5.62%	7.43%	4.54%	4.73%	5.47%	7.28%	5.04%	5.22%	5.97%	7.78%	4.83%	5.01%	5.76%	7.57%	4.82%	5.01%	5.76%	7.56%
EG		2c	Steel	Container	6.68%	6.94%	8.01%	10.60%	6.35%	6.61%	7.68%	10.27%	6.38%	6.64%	7.71%	10.30%	6.15%	6.41%	7.48%	10.07%	6.52%	6.78%	7.86%	10.44%
T	Brazil	3a	Iron ore	Bulk carrier	5.36%	6.28%	9.99%	18.96%	5.41%	6.33%	10.04%	19.01%	6.01%	6.92%	10.64%	19.61%	5.62%	6.54%	10.25%	19.22%	5.51%	6.42%	10.13%	19.10%
T		3b	Soybeans	Bulk carrier	3.19%	4.11%	7.86%	16.91%	3.20%	4.13%	7.87%	16.93%	3.53%	4.45%	8.20%	17.26%	3.43%	4.36%	8.10%	17.16%	3.38%	4.31%	8.06%	17.11%
T		3c	Woodpulp (paper and paper products)	General cargo	9.75%	10.47%	13.38%	20.42%	9.77%	10.49%	13.40%	20.44%	10.16%	10.88%	13.79%	20.83%	10.17%	10.89%	13.80%	20.84%	10.23%	10.94%	13.86%	20.90%
T	Chile	4a	Cherries	Container	4.05%	4.31%	5.35%	7.86%	3.85%	4.11%	5.15%	7.67%	3.82%	4.07%	5.12%	7.63%	3.74%	3.99%	5.04%	7.55%	3.93%	4.19%	5.23%	7.75%
EG		4b	Petroleum oils	Chemical tanker	3.26%	3.35%	3.72%	4.61%	3.27%	3.36%	3.72%	4.61%	3.59%	3.68%	4.04%	4.93%	3.45%	3.54%	3.91%	4.79%	3.39%	3.48%	3.84%	4.73%
T		4c	Lithium carbonate	Container	8.48%	8.83%	10.25%	13.70%	9.13%	9.48%	10.90%	14.35%	7.73%	8.08%	9.51%	12.95%	8.11%	8.46%	9.89%	13.33%	8.43%	8.78%	10.20%	13.65%
EG	Cook Islands	5a	Miscellaneous edible preparations	Container	5.78%	5.91%	6.44%	7.71%	5.70%	5.83%	6.36%	7.64%	6.13%	6.26%	6.79%	8.07%	5.83%	5.96%	6.49%	7.77%	5.80%	5.93%	6.46%	7.74%
EG		5b	Pharmaceutical goods	General cargo	9.60%	9.65%	9.83%	10.28%	9.46%	9.50%	9.69%	10.14%	9.82%	9.87%	10.05%	10.50%	9.09%	9.14%	9.32%	9.77%	9.89%	9.94%	10.12%	10.57%
EG		5c	Fuels (LPG)	LPG tanker	3.24%	3.41%	4.10%	5.76%	3.24%	3.41%	4.10%	5.76%	3.24%	3.41%	4.10%	5.76%	3.24%	3.41%	4.10%	5.76%	4.30%	4.47%	5.16%	6.83%
EG		5d	Articles of iron and steel	General cargo	11.71%	11.75%	11.94%	12.39%	11.53%	11.57%	11.76%	12.21%	11.97%	12.02%	12.20%	12.65%	11.08%	11.13%	11.32%	11.77%	12.06%	12.11%	12.29%	12.74%
EG		5e	Edible vegetables, certain roots, & tubers	General cargo	10.92%	10.96%	11.15%	11.60%	10.75%	10.80%	10.98%	11.43%	11.16%	11.21%	11.40%	11.85%	10.34%	10.38%	10.57%	11.02%	11.25%	11.29%	11.48%	11.93%
EG		5f	Electrical machinery & equip	General cargo	11.18%	11.23%	11.41%	11.86%	11.01%	11.06%	11.24%	11.69%	11.43%	11.48%	11.67%	12.11%	10.59%	10.63%	10.82%	11.27%	11.52%	11.56%	11.75%	12.20%
EG		5g	Meat & edible meat offal	Container, General cargo	6.65%	6.74%	7.07%	7.87%	6.72%	6.80%	7.13%	7.93%	7.07%	7.15%	7.48%	8.28%	6.68%	6.76%	7.09%	7.90%	6.49%	6.57%	6.91%	7.71%
EG		5h	Dairy produce, birds eggs, natural honey+	General cargo	4.54%	4.58%	4.77%	5.22%	4.47%	4.51%	4.70%	5.15%	4.64%	4.69%	4.87%	5.32%	4.30%	4.34%	4.53%	4.98%	4.67%	4.72%	4.91%	5.36%
EG		5i	Products of the milling industry, etc.	General cargo	8.62%	8.66%	8.85%	9.30%	8.48%	8.53%	8.72%	9.16%	8.81%	8.86%	9.04%	9.49%	8.16%	8.20%	8.39%	8.84%	8.88%	8.92%	9.11%	9.56%
T	Peru	6a	Copper	Bulk carrier	0.73%	1.30%	3.62%	9.23%	0.73%	1.30%	3.63%	9.24%	0.80%	1.37%	3.70%	9.31%	0.78%	1.35%	3.68%	9.29%	0.76%	1.33%	3.65%	9.27%
T		6b	Grapes	Container	5.19%	5.50%	6.74%	9.75%	4.86%	5.17%	6.41%	9.42%	4.90%	5.21%	6.45%	9.46%	4.75%	5.05%	6.30%	9.30%	5.01%	5.31%	6.56%	9.56%
T		6c	Pota (squid)	Container	4.74%	5.05%	6.30%	9.34%	4.46%	4.77%	6.02%	9.05%	4.33%	4.64%	5.89%	8.93%	4.25%	4.55%	5.81%	8.84%	4.45%	4.76%	6.01%	9.05%
T	South Africa	7a	Iron ore	Bulk carrier	4.54%	4.93%	6.54%	10.42%	4.69%	5.08%	6.69%	10.56%	4.78%	5.18%	6.78%	10.66%	4.86%	5.25%	6.86%	10.74%	4.91%	5.31%	6.91%	10.79%
T		7b	Citrus foods	Container	9.68%	9.81%	10.35%	11.64%	9.17%	9.30%	9.83%	11.13%	9.58%	9.71%	10.24%	11.54%	9.19%	9.32%	9.86%	11.15%	9.58%	9.72%	10.25%	11.54%
T		7c	Grapes	Container	5.09%	5.18%	5.57%	6.51%	4.82%	4.91%	5.30%	6.24%	5.04%	5.13%	5.52%	6.46%	4.83%	4.93%	5.32%	6.26%	5.04%	5.13%	5.52%	6.47%
EG	Togo	8a	Essence (LPG)	Container, Chemicaltanker, Product tanker	8.97%	9.22%	10.27%	12.79%	8.50%	8.75%	9.80%	12.32%	8.80%	9.06%	10.10%	12.63%	8.45%	8.71%	9.75%	12.27%	8.96%	9.22%	10.26%	12.78%
T		8b	Iron and steel	Container	9.12%	9.56%	11.37%	15.71%	8.90%	9.34%	11.14%	15.49%	8.97%	9.42%	11.22%	15.57%	8.86%	9.31%	11.11%	15.46%	9.06%	9.50%	11.30%	15.65%
EG		8c	Palm oil	Chemical tanker	8.74%	8.99%	10.00%	12.44%	8.72%	8.97%	9.97%	12.41%	8.33%	8.57%	9.58%	12.02%	8.42%	8.67%	9.68%	12.12%	8.78%	9.03%	10.03%	12.47%
EG	Tonga	9a	Petroleum oils	Chemical tanker, Oil & product tanker	5.97%	6.07%	6.49%	7.48%	5.95%	6.05%	6.47%	7.46%	6.49%	6.59%	7.01%	8.00%	6.25%	6.35%	6.76%	7.76%	6.19%	6.29%	6.70%	7.70%
T		9b	Fish	General cargo	4.21%	4.22%	4.27%	4.38%	4.15%	4.16%	4.20%	4.32%	4.30%	4.32%	4.36%	4.48%	3.99%	4.00%	4.04%	4.16%	4.34%	4.35%	4.39%	4.51%
T		9c	Kava	General cargo	19.86%	19.88%	19.92%	20.03%	19.56%	19.57%	19.62%	19.73%	20.31%	20.32%	20.37%	20.48%	18.81%	18.82%	18.86%	18.98%	20.46%	20.47%	20.52%	20.63%
T	United States	10a	Soybeans	Bulk carrier	3.37%	4.07%	6.90%	13.73%	3.40%	4.10%	6.93%	13.76%	3.73%	4.43%	7.26%	14.10%	3.64%	4.34%	7.17%	14.00%	3.56%	4.25%	7.08%	13.92%
T		10b	Wood and wood products	Bulk carrier	16.29%	16.39%	16.83%	17.88%	16.19%	16.29%	16.73%	17.78%	17.96%	18.07%	18.50%	19.55%	17.30%	17.41%	17.85%	18.90%	17.28%	17.39%	17.83%	18.88%
T		10c	Automobiles	Vehicle carrier	1.91%	2.29%	3.84%	7.60%	1.89%	2.27%	3.82%	7.57%	2.04%	2.42%	3.98%	7.73%	1.99%	2.38%	3.93%	7.68%	2.02%	2.40%	3.95%	7.71%

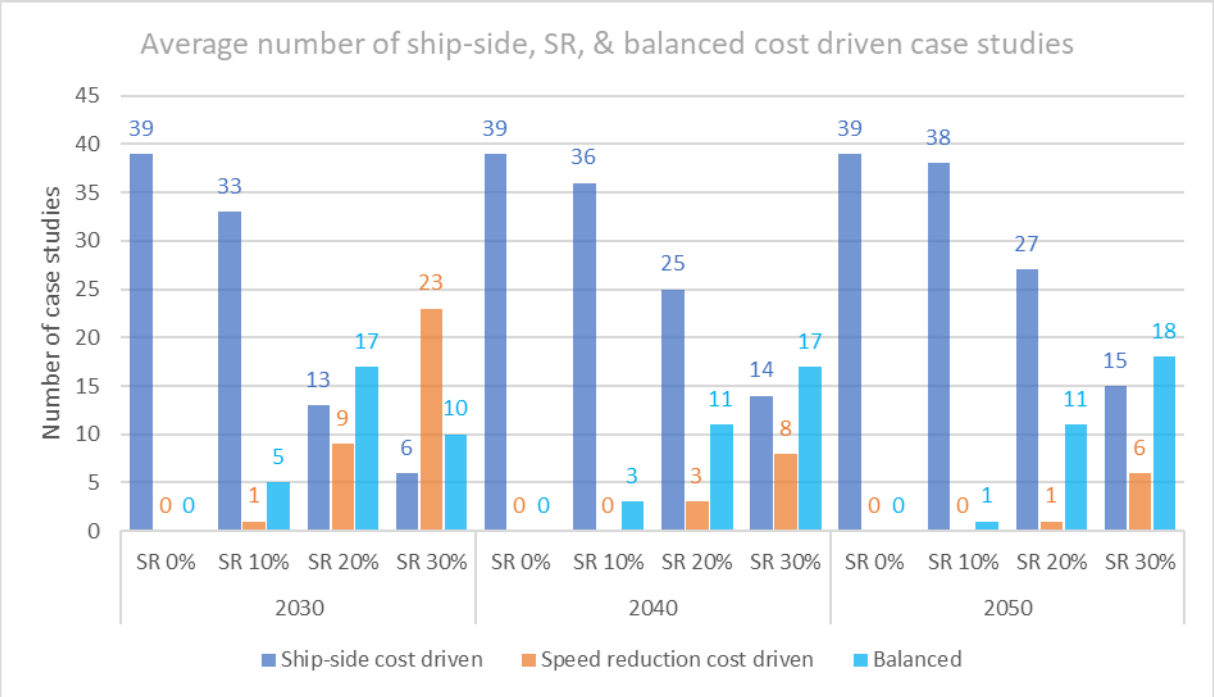
Note: *EG – imported essential good*
T – exported trade good

From the analysis of the 39 case studies, there are three types of case studies with respect to the cost intensity changes associated with the MTM:

- Ship side cost intensity driven case studies. These case studies typically include low-value commodities, traded on shorter to medium distance routes, and have relatively medium to high *ad valorem* freight rates.
- Speed reduction commodity cost intensity driven case studies. These cases studies typically include high-value commodities, traded on medium to long distance routes, and have relatively low *ad valorem* freight rates.
- Balance driven case studies. These case studies were generally equally driven by both costs and associated with commodities traded on medium distance routes, with relatively medium *ad valorem* freight rates. These were less common than the other two types.

The average number of each type of case studies, across all scenarios, by speed reduction group, and forecasted year is presented in Figure 14.1. As observed from the figure, the ship-side cost intensity is the predominant driver across the 39 commodity case studies.

Figure 14.1: Average number of ship-side, speed reduction, & balanced driven commodity case studies

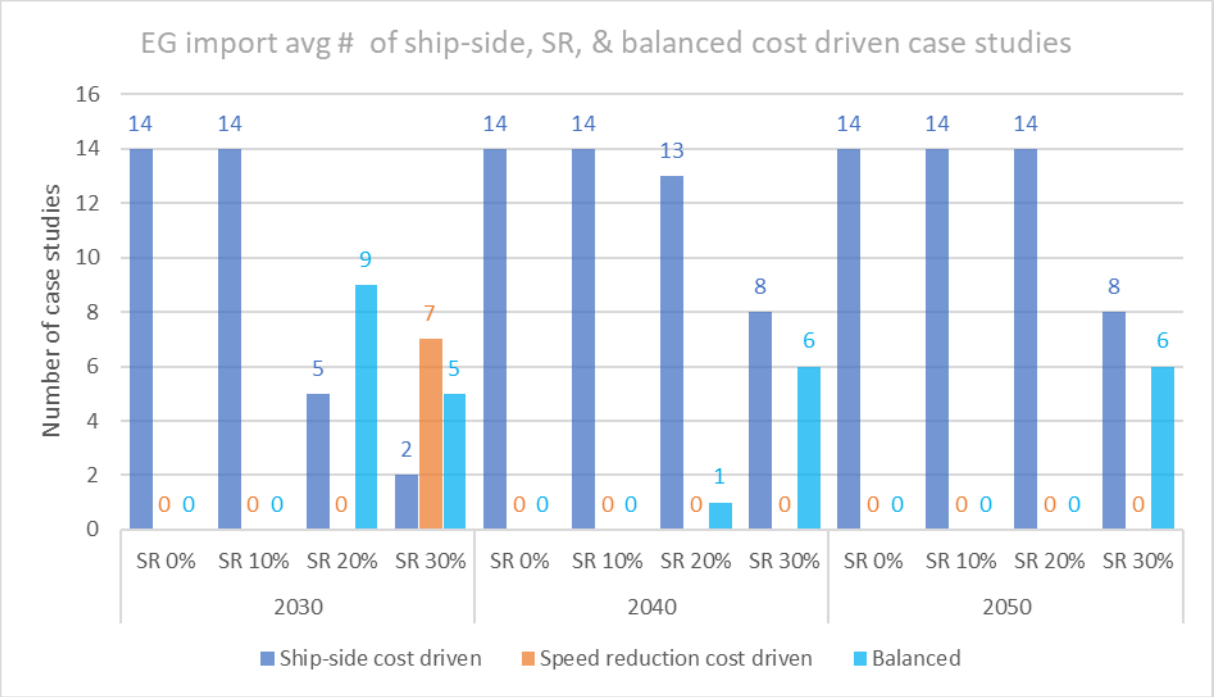


Observations from the figure:

- 2030 – ship-side cost intensity is the primary driver across SR 10% and SR 20%, with speed reduction the primary driver for SR 30%.
- 2040 – ship-side cost intensity is the primary drive across all speed reduction groups. Balanced and speed reduction have their most cases in the highest speed reduction group.
- 2050 – similar to 2050

The 14 exported trade good commodity case studies across all scenarios and forecasted years, the following distribution of primary commodity cost intensity changes are presented in Figure 14.2.

Figure 14.2: Import essential goods average number of ship-side, speed reduction, & balanced driven commodity case studies

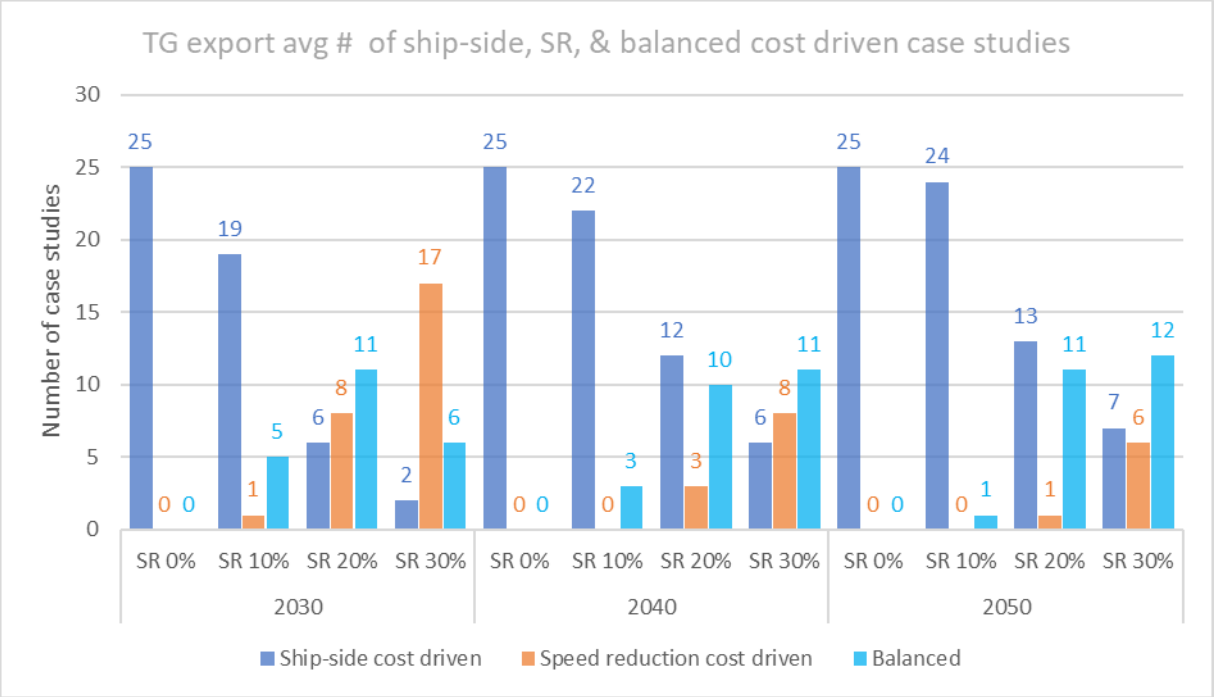


Observations from the figure:

- 2030 – import essential goods cost intensities changes are driven primarily by ship-side cost intensity changes for SR 0% to SR 120% groups, while the SR 20% highest speed reduction group is led by balance, and for SR 30% split between speed reduction and balanced drivers.
- 2040 – ship-side cost intensity is the primary drive across all scenarios and speed reduction zones.
- 2050 – is similar to 2040.

The 25 exported trade commodity case studies across all scenarios and forecasted years, the following distribution of primary commodity cost intensity changes are presented in Figure 14.3.

Figure 14.3: Export trade commodities average number of ship-side, speed reduction, & balanced driven commodity case studies



Observations from the figure:

- 2030 – export trade commodities are primarily driven by ship-side cost intensity changes at SR 0% and SR 10% groups, then fairly even across all three types, with ship-side slightly higher in the SR 20% group, and speed reduction is the primary driver to the SR 30% group.
- 2040 – ship-side it is the primary drivers for the SR 0% and SR 10% groups, while for SR 20% ship-side and balanced are close, with all three types are generally evenly distributed in the SR 30% group.
- 2050 – is similar to 2040, with more prevalence of ship-side and balanced driven commodity case studies, with speed reduction nearly half of the other two types.

Scenario 23

The Task 2 ship-side freight rates adjusted commodity cost intensity (FRACCI) changes, by year and the total commodity cost intensity change due to speed reduction (TCCIsr) are presented in the Table 14.4 and Illustrative figures for each year and speed reduction group are presented in Figures 14.4 through 14.6.

Table 14.4: 2030, 2040, & 2050 Scenario 23 FRACCI & TCCIsr results for all case studies, by year & speed reduction group

	Country	Case Study	Case Study Commodity	Ship Type(s)	Ship-side -> Commodity-side Task 2 FRACCI, %			Commodity-side Task 4 TCCIsr Change, %		
					2030	2040	2050	SR 10%	SR 20%	SR 30%
T	Argentina	1a	Soybeans	Bulk carrier	0.90%	2.73%	3.17%	0.93%	4.72%	13.87%
T		1b	Soybean meal	Bulk carrier	1.75%	4.71%	5.58%	0.27%	1.35%	3.96%
T		1c	Chilled bovine meat	Container	0.61%	1.24%	1.72%	0.17%	0.87%	2.55%
T		1d	Apples and pears	Container	1.99%	5.27%	6.78%	0.07%	0.37%	1.10%
T		1e	Soy oil	Chemical tanker	4.62%	10.13%	10.88%	0.55%	2.81%	8.25%
T		1f	Corn	Bulk carrier	2.17%	5.21%	6.42%	0.64%	3.23%	9.49%
T	Belize	2a	Bananas	Container	0.54%	6.34%	7.99%	0.11%	0.55%	1.62%
T		2b	Sugar	Bulk carrier	1.01%	5.04%	4.69%	0.18%	0.93%	2.74%
EG		2c	Steel	Container	1.48%	6.49%	6.68%	0.26%	1.34%	3.92%
T	Brazil	3a	Iron ore	Bulk carrier	2.25%	3.70%	5.36%	0.91%	4.63%	13.60%
T		3b	Soybeans	Bulk carrier	0.95%	2.69%	3.19%	0.92%	4.67%	13.73%
T		3c	Woodpulp (paper and paper products)	General cargo	2.90%	10.46%	9.75%	0.72%	3.63%	10.67%
T	Chile	4a	Cherries	Container	0.90%	4.08%	4.05%	0.26%	1.30%	3.82%
EG		4b	Petroleum oils	Chemical tanker	1.38%	3.04%	3.26%	0.09%	0.46%	1.34%
T		4c	Lithium carbonate	Container	0.55%	12.01%	8.48%	0.35%	1.78%	5.22%
EG	Cook Islands	5a	Miscellaneous edible preparations	Container	1.58%	4.69%	5.78%	0.13%	0.66%	1.94%
EG		5b	Pharmaceutical goods	General cargo	0.20%	8.79%	9.60%	0.05%	0.23%	0.68%
EG		5c	Fuels (LPG)	LPG tanker	0.83%	2.43%	3.24%	0.17%	0.86%	2.52%
EG		5d	Articles of iron and steel	General cargo	0.25%	10.72%	11.71%	0.05%	0.23%	0.68%
EG		5e	Edible vegetables, certain roots, & tubers	General cargo	0.23%	9.99%	10.92%	0.05%	0.23%	0.68%
EG		5f	Electrical machinery & equip	General cargo	0.24%	10.23%	11.18%	0.05%	0.23%	0.68%
EG		5g	Meat & edible meat offal	Container, General cargo	1.71%	5.44%	6.65%	0.08%	0.41%	1.21%
EG		5h	Dairy produce, birds eggs, natural honey+	General cargo	0.10%	4.15%	4.54%	0.05%	0.23%	0.68%
EG		5i	Products of the milling industry, etc.	General cargo	0.18%	7.89%	8.62%	0.05%	0.23%	0.68%
T	Peru	6a	Copper	Bulk carrier	0.22%	0.59%	0.73%	0.57%	2.90%	8.51%
T		6b	Grapes	Container	1.16%	4.88%	5.19%	0.31%	1.55%	4.56%
T		6c	Pota (squid)	Container	0.79%	4.58%	4.74%	0.31%	1.56%	4.60%
T	South Africa	7a	Iron ore	Bulk carrier	0.52%	4.25%	4.54%	0.40%	2.00%	5.88%
T		7b	Citrus foods	Container	1.98%	8.06%	9.68%	0.13%	0.67%	1.96%
T		7c	Grapes	Container	1.04%	4.23%	5.09%	0.10%	0.49%	1.43%
EG	Togo	8a	Essence (LPG)	Container, Chemicaltanker, Product tanker	1.76%	7.34%	8.97%	0.26%	1.30%	3.83%
T		8b	Iron and steel	Container	2.31%	8.48%	9.12%	0.44%	2.24%	6.59%
EG		8c	Palm oil	Chemical tanker	1.18%	9.52%	8.74%	0.25%	1.26%	3.69%
EG	Tonga	9a	Petroleum oils	Chemical tanker, Oil & product tanker	2.31%	5.41%	5.97%	0.10%	0.51%	1.51%
T		9b	Fish	General cargo	0.09%	3.85%	4.21%	0.01%	0.06%	0.17%
T		9c	Kava	General cargo	0.42%	18.18%	19.86%	0.01%	0.06%	0.17%
T	United States	10a	Soybeans	Bulk carrier	1.15%	2.71%	3.37%	0.70%	3.53%	10.36%
T		10b	Wood and wood products	Bulk carrier	2.97%	15.78%	16.29%	0.11%	0.54%	1.59%
T		10c	Automobiles	Vehicle carrier	0.13%	2.04%	1.91%	0.38%	1.94%	5.69%

Note: EG – imported essential good
T – exported trade good

The summary of ranges for Scenario 23

- The expected FRACCI changes across all case studies range from:
  - 2030 0.09% to 4.62%, with an average of 1.21%
  - 2040 0.59% to 18.18%, with an average of 6.34%
  - 2050 0.73% to 19.86%, with an average of 6.89%

Figure 14.4: 2030 Scenario 23 combined results for all case studies, by speed reduction group

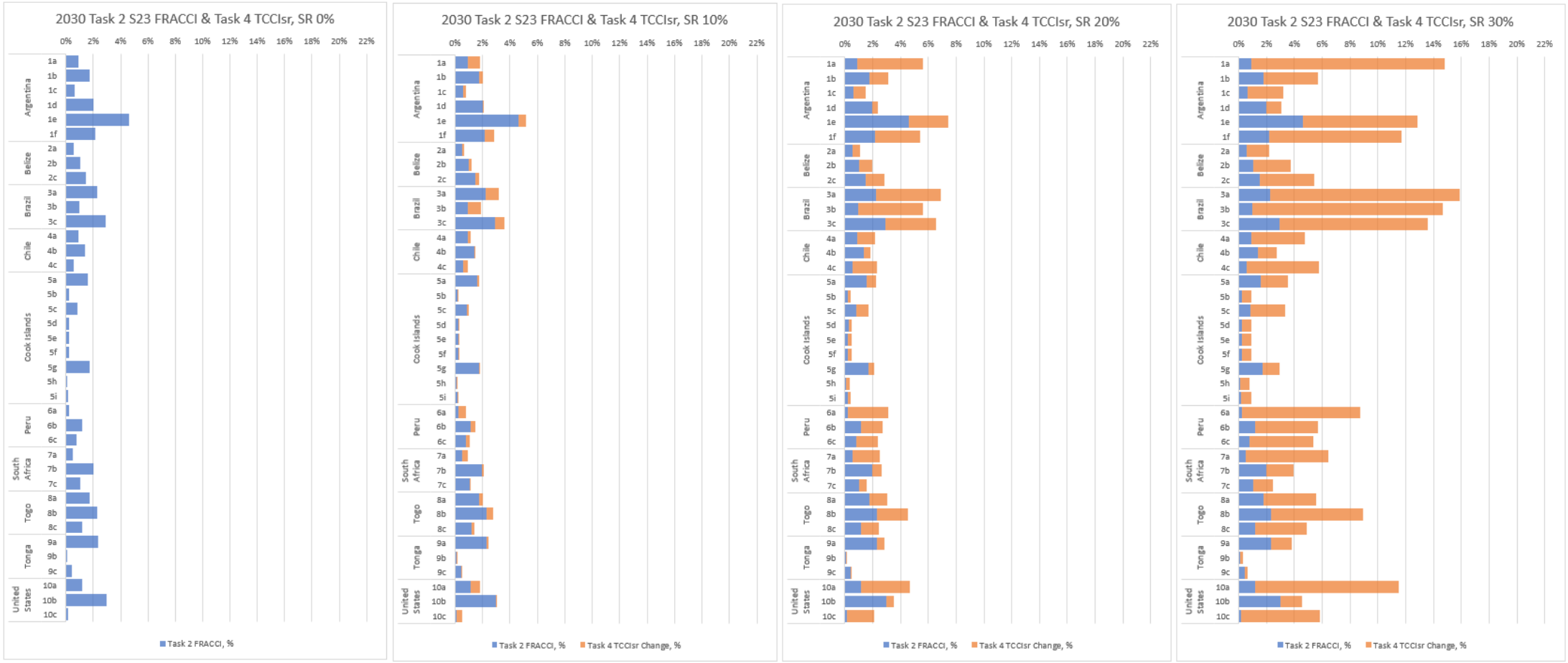


Figure 14.5: 2040 Scenario 23 combined results for all case studies, by speed reduction group

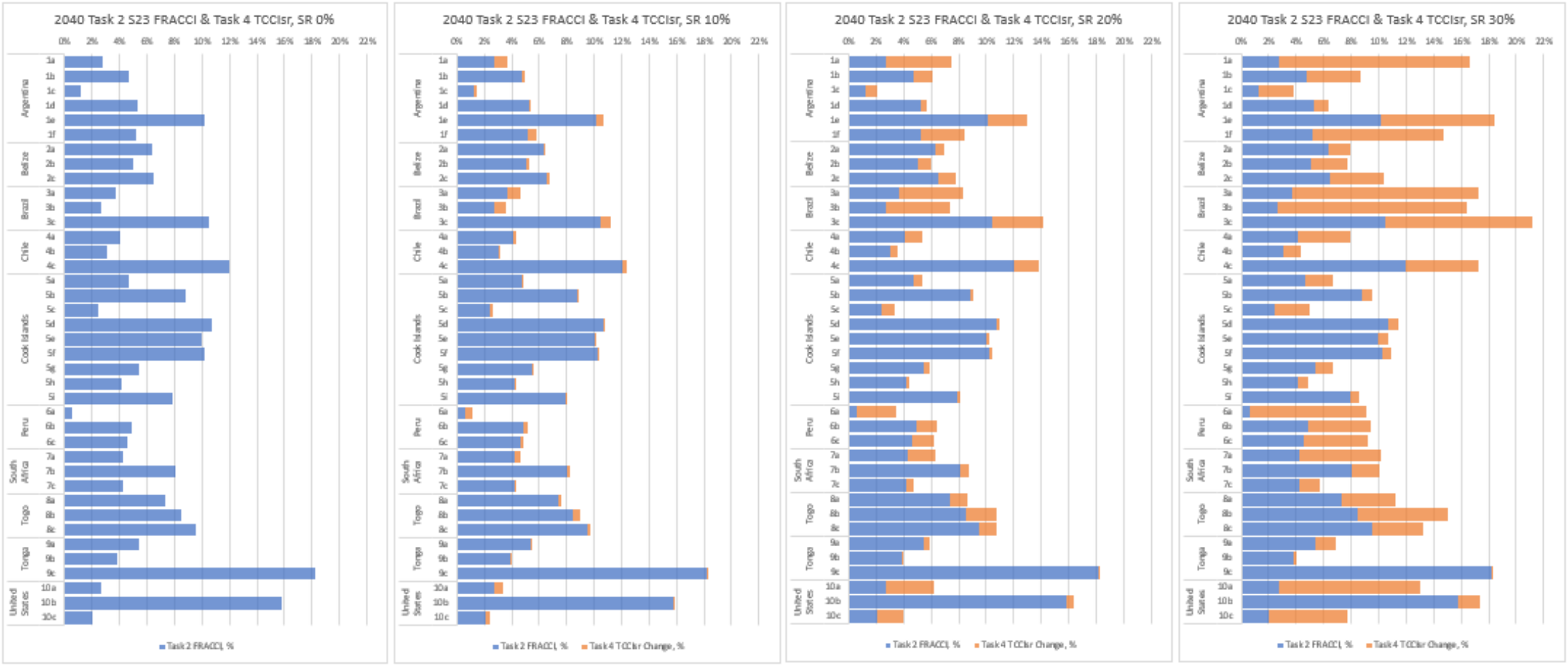
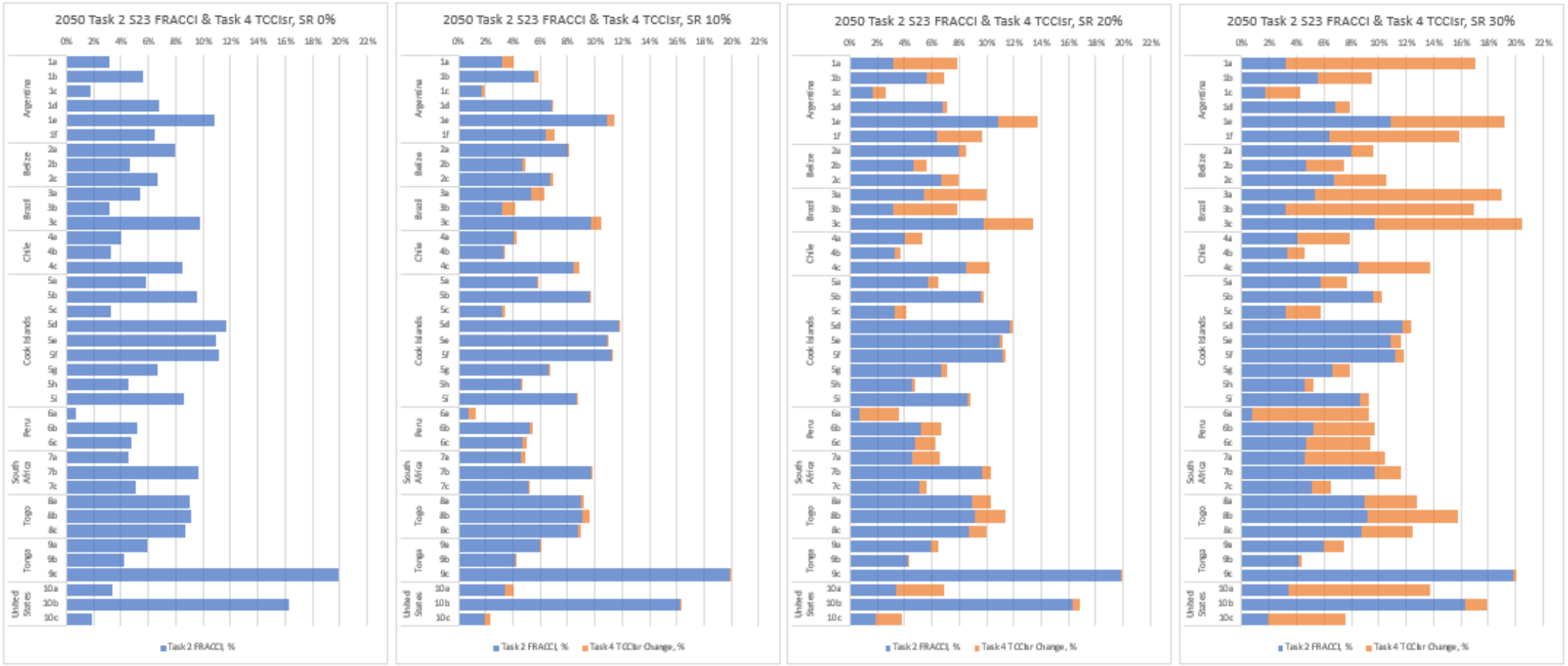


Figure 14.6: 2050 Scenario 23 combined results for all case studies, by speed reduction group



Scenario 24

The Task 2 ship-side freight rates adjusted commodity cost intensity (FRACCI) changes, by year and the total commodity cost intensity change due to speed reduction (TCCIsr) are presented in the Table 14.5 and Illustrative figures for each year and speed reduction group are presented in Figures 14.7 through 14.9.

Table 14.5: 2030, 2040, & 2050 Scenario 24 FRACCI & TCCIsr results for all case studies, by year & speed reduction group

	Country	Case Study	Case Study Commodity	Ship Type(s)	Ship-side -> Commodity-side Task 2 FRACCI, %			Commodity-side Task 4 TCCIsr Change, %		
					2030	2040	2050	SR 10%	SR 20%	SR 30%
T	Argentina	1a	Soybeans	Bulk carrier	0.83%	2.47%	3.18%	0.93%	4.72%	13.87%
T		1b	Soybean meal	Bulk carrier	1.58%	4.27%	5.60%	0.27%	1.35%	3.96%
T		1c	Chilled bovine meat	Container	0.76%	1.15%	1.71%	0.17%	0.87%	2.55%
T		1d	Apples and pears	Container	2.37%	4.69%	6.71%	0.07%	0.37%	1.10%
T		1e	Soy oil	Chemical tanker	4.44%	8.75%	10.89%	0.55%	2.81%	8.25%
T		1f	Corn	Bulk carrier	1.96%	4.83%	6.47%	0.64%	3.23%	9.49%
T	Belize	2a	Bananas	Container	0.63%	5.21%	7.77%	0.11%	0.55%	1.62%
T		2b	Sugar	Bulk carrier	0.85%	3.96%	4.54%	0.18%	0.93%	2.74%
EG		2c	Steel	Container	1.27%	4.73%	6.35%	0.26%	1.34%	3.92%
T	Brazil	3a	Iron ore	Bulk carrier	1.69%	3.81%	5.41%	0.91%	4.63%	13.60%
T		3b	Soybeans	Bulk carrier	0.86%	2.45%	3.20%	0.92%	4.67%	13.73%
T		3c	Woodpulp (paper and paper products)	General cargo	3.03%	8.31%	9.77%	0.72%	3.63%	10.67%
T	Chile	4a	Cherries	Container	0.81%	2.84%	3.85%	0.26%	1.30%	3.82%
EG		4b	Petroleum oils	Chemical tanker	1.33%	2.63%	3.27%	0.09%	0.46%	1.34%
T		4c	Lithium carbonate	Container	0.61%	11.55%	9.13%	0.35%	1.78%	5.22%
EG	Cook Islands	5a	Miscellaneous edible preparations	Container	1.94%	4.41%	5.70%	0.13%	0.66%	1.94%
EG		5b	Pharmaceutical goods	General cargo	0.36%	7.00%	9.46%	0.05%	0.23%	0.68%
EG		5c	Fuels (LPG)	LPG tanker	0.83%	2.43%	3.24%	0.17%	0.86%	2.52%
EG		5d	Articles of iron and steel	General cargo	0.44%	8.53%	11.53%	0.05%	0.23%	0.68%
EG		5e	Edible vegetables, certain roots, & tubers	General cargo	0.41%	7.95%	10.75%	0.05%	0.23%	0.68%
EG		5f	Electrical machinery & equip	General cargo	0.42%	8.15%	11.01%	0.05%	0.23%	0.68%
EG		5g	Meat & edible meat offal	Container, General cargo	2.00%	5.11%	6.72%	0.08%	0.41%	1.21%
EG		5h	Dairy produce, birds eggs, natural honey+	General cargo	0.17%	3.31%	4.47%	0.05%	0.23%	0.68%
EG		5i	Products of the milling industry, etc.	General cargo	0.32%	6.28%	8.48%	0.05%	0.23%	0.68%
T	Peru	6a	Copper	Bulk carrier	0.22%	0.54%	0.73%	0.57%	2.90%	8.51%
T		6b	Grapes	Container	1.03%	3.49%	4.86%	0.31%	1.55%	4.56%
T		6c	Pota (squid)	Container	0.79%	3.40%	4.46%	0.31%	1.56%	4.60%
T	South Africa	7a	Iron ore	Bulk carrier	0.48%	3.69%	4.69%	0.40%	2.00%	5.88%
T		7b	Citrus foods	Container	2.36%	6.61%	9.17%	0.13%	0.67%	1.96%
T		7c	Grapes	Container	1.25%	3.48%	4.82%	0.10%	0.49%	1.43%
EG	Togo	8a	Essence (LPG)	Container, Chemicaltanker, Product tanker	1.20%	6.02%	8.50%	0.26%	1.30%	3.83%
T		8b	Iron and steel	Container	3.01%	6.90%	8.90%	0.44%	2.24%	6.59%
EG		8c	Palm oil	Chemical tanker	1.37%	6.79%	8.72%	0.25%	1.26%	3.69%
EG	Tonga	9a	Petroleum oils	Chemical tanker, Oil & product tanker	2.23%	4.67%	5.95%	0.10%	0.51%	1.51%
T		9b	Fish	General cargo	0.16%	3.07%	4.15%	0.01%	0.06%	0.17%
T		9c	Kava	General cargo	0.75%	14.47%	19.56%	0.01%	0.06%	0.17%
T	United States	10a	Soybeans	Bulk carrier	1.07%	2.51%	3.40%	0.70%	3.53%	10.36%
T		10b	Wood and wood products	Bulk carrier	2.72%	13.35%	16.19%	0.11%	0.54%	1.59%
T		10c	Automobiles	Vehicle carrier	0.15%	1.42%	1.89%	0.38%	1.94%	5.69%

Note: EG – imported essential good
T – exported trade good

The summary of ranges for Scenario 24

- The expected FRACCI changes across all case studies range from:
  - 2030 0.15% to 4.44%, with an average of 1.25%
  - 2040 0.54% to 14.47%, with an average of 5.26%
  - 2050 0.73% to 19.56%, with an average of 6.80%

Figure 14.7: 2030 Scenario 24 combined results for all case studies, by speed reduction group

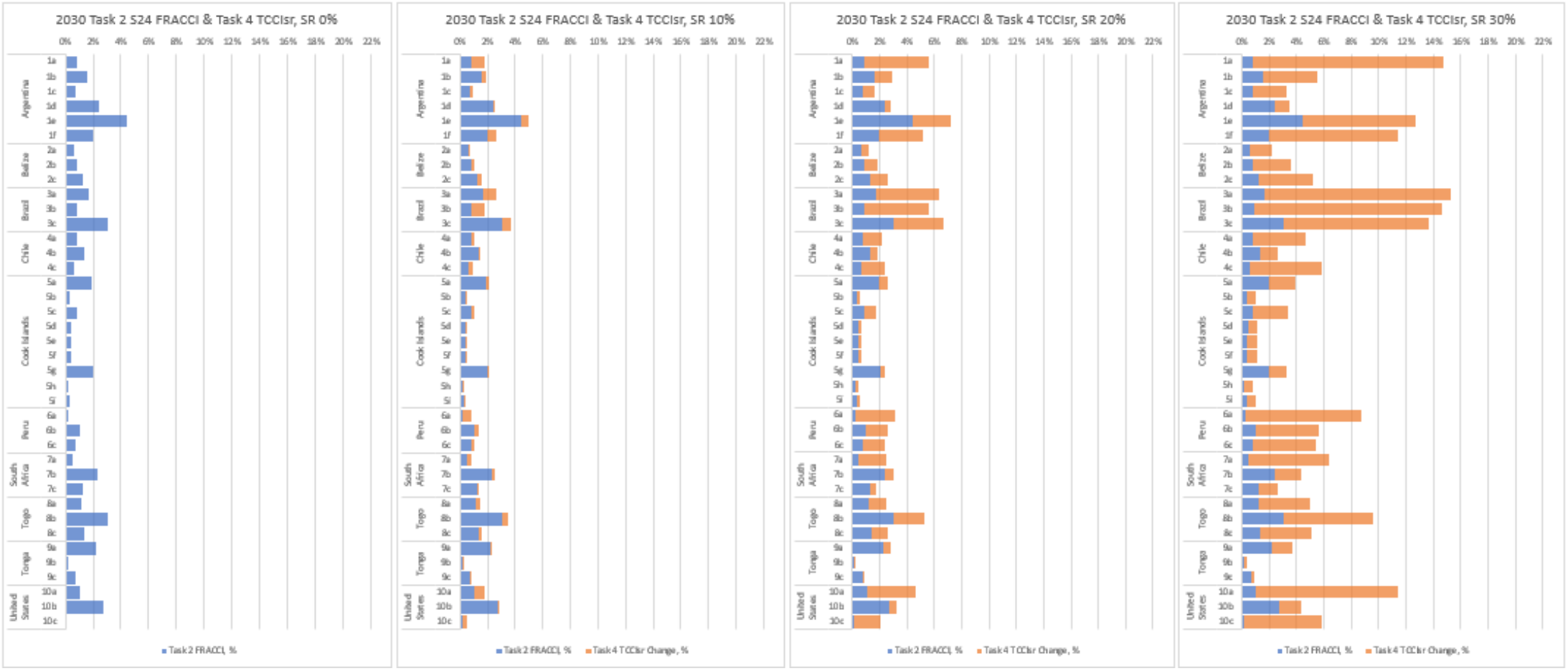


Figure 14.8: 2040 Scenario 24 combined results for all case studies, by speed reduction group

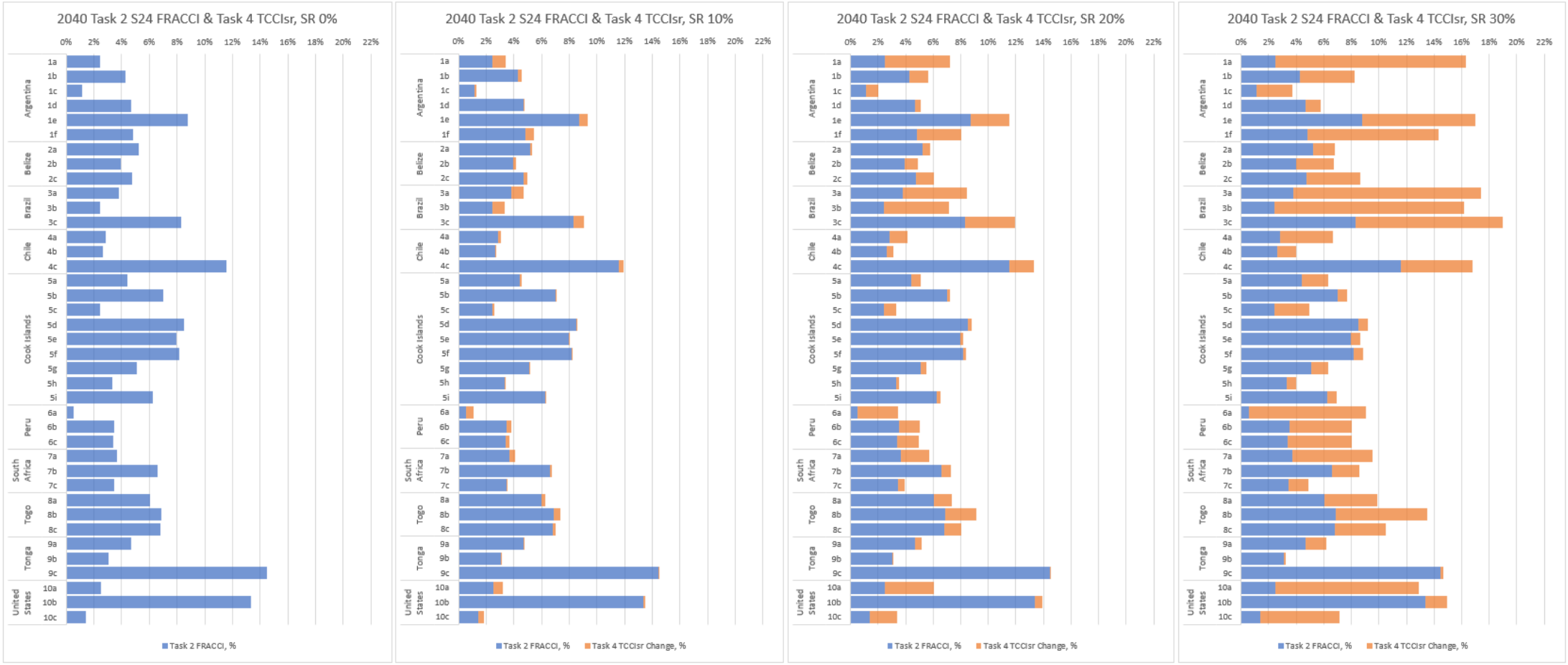
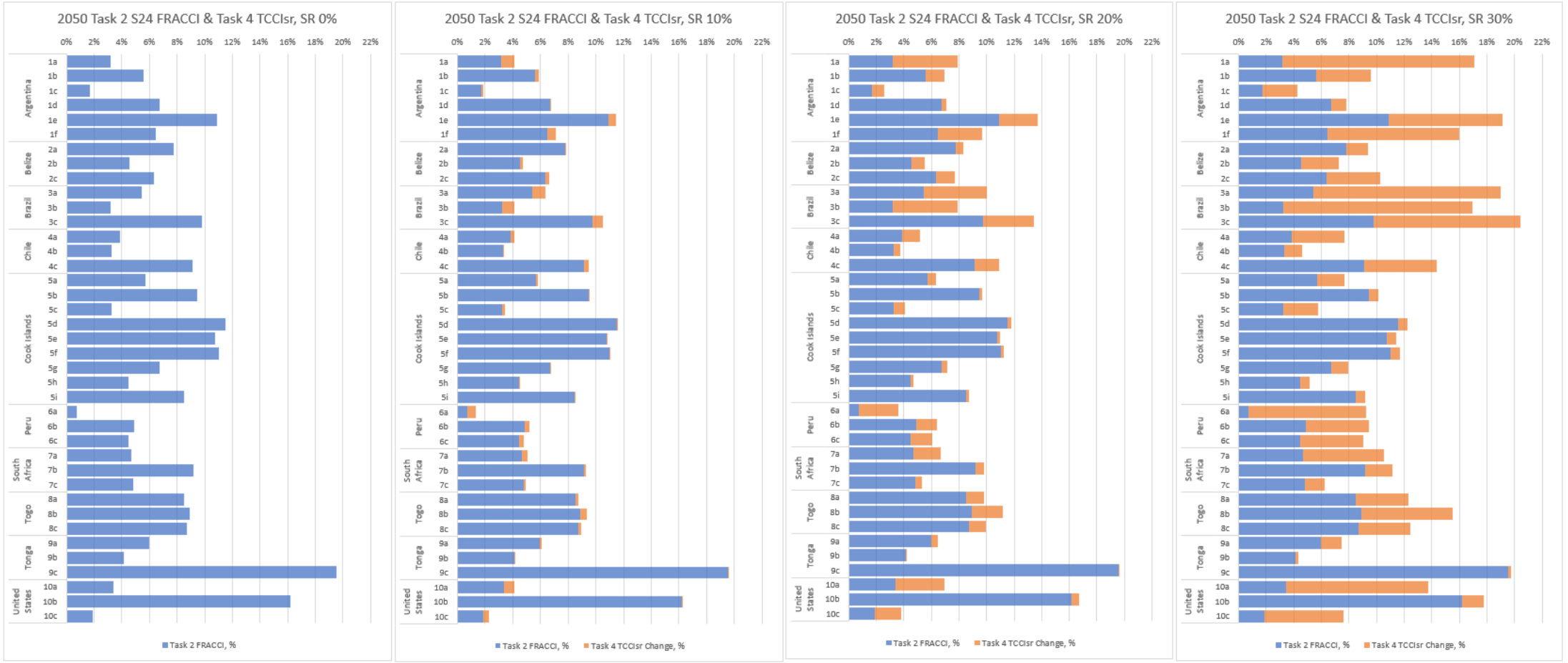


Figure 14.9: 2050 Scenario 24 combined results for all case studies, by speed reduction group



Scenario 31

The Task 2 ship-side freight rates adjusted commodity cost intensity (FRACCI) changes, by year and the total commodity cost intensity change due to speed reduction (TCCIsr) are presented in the Table 14.6 and Illustrative figures for each year and speed reduction group are presented in Figures 14.10 through 14.12.

Table 14.6: 2030, 2040, & 2050 Scenario 31 FRACCI & TCCIsr results for all case studies, by year & speed reduction group

	Country	Case Study	Case Study Commodity	Ship Type(s)	Ship-side -> Commodity-side Task 2 FRACCI, %			Commodity-side Task 4 TCCIsr Change, %		
					2030	2040	2050	SR 10%	SR 20%	SR 30%
T	Argentina	1a	Soybeans	Bulk carrier	0.95%	2.67%	3.51%	0.93%	4.72%	13.87%
T		1b	Soybean meal	Bulk carrier	1.70%	4.65%	6.17%	0.27%	1.35%	3.96%
T		1c	Chilled bovine meat	Container	0.58%	1.21%	1.90%	0.17%	0.87%	2.55%
T		1d	Apples and pears	Container	2.08%	4.82%	7.19%	0.07%	0.37%	1.10%
T		1e	Soy oil	Chemical tanker	3.54%	8.44%	11.96%	0.55%	2.81%	8.25%
T		1f	Corn	Bulk carrier	1.98%	5.31%	7.11%	0.64%	3.23%	9.49%
T	Belize	2a	Bananas	Container	2.10%	5.66%	7.84%	0.11%	0.55%	1.62%
T		2b	Sugar	Bulk carrier	1.37%	3.94%	5.04%	0.18%	0.93%	2.74%
EG		2c	Steel	Container	2.16%	4.81%	6.38%	0.26%	1.34%	3.92%
T	Brazil	3a	Iron ore	Bulk carrier	2.24%	3.95%	6.01%	0.91%	4.63%	13.60%
T		3b	Soybeans	Bulk carrier	0.96%	2.67%	3.53%	0.92%	4.67%	13.73%
T		3c	Woodpulp (paper and paper products)	General cargo	2.50%	7.01%	10.16%	0.72%	3.63%	10.67%
T	Chile	4a	Cherries	Container	1.32%	3.00%	3.82%	0.26%	1.30%	3.82%
EG		4b	Petroleum oils	Chemical tanker	1.06%	2.53%	3.59%	0.09%	0.46%	1.34%
T		4c	Lithium carbonate	Container	2.11%	10.42%	7.73%	0.35%	1.78%	5.22%
EG	Cook Islands	5a	Miscellaneous edible preparations	Container	1.94%	4.19%	6.13%	0.13%	0.66%	1.94%
EG		5b	Pharmaceutical goods	General cargo	2.71%	6.53%	9.82%	0.05%	0.23%	0.68%
EG		5c	Fuels (LPG)	LPG tanker	0.83%	2.43%	3.24%	0.17%	0.86%	2.52%
EG		5d	Articles of iron and steel	General cargo	3.30%	7.97%	11.97%	0.05%	0.23%	0.68%
EG		5e	Edible vegetables, certain roots, & tubers	General cargo	3.08%	7.43%	11.16%	0.05%	0.23%	0.68%
EG		5f	Electrical machinery & equip	General cargo	3.15%	7.61%	11.43%	0.05%	0.23%	0.68%
EG		5g	Meat & edible meat offal	Container, General cargo	1.99%	4.78%	7.07%	0.08%	0.41%	1.21%
EG		5h	Dairy produce, birds eggs, natural honey+	General cargo	1.28%	3.09%	4.64%	0.05%	0.23%	0.68%
EG		5i	Products of the milling industry, etc.	General cargo	2.43%	5.86%	8.81%	0.05%	0.23%	0.68%
T	Peru	6a	Copper	Bulk carrier	0.22%	0.60%	0.80%	0.57%	2.90%	8.51%
T		6b	Grapes	Container	1.63%	3.62%	4.90%	0.31%	1.55%	4.56%
T		6c	Pota (squid)	Container	1.35%	3.51%	4.33%	0.31%	1.56%	4.60%
T	South Africa	7a	Iron ore	Bulk carrier	1.26%	4.02%	4.78%	0.40%	2.00%	5.88%
T		7b	Citrus foods	Container	2.68%	6.63%	9.58%	0.13%	0.67%	1.96%
T		7c	Grapes	Container	1.41%	3.49%	5.04%	0.10%	0.49%	1.43%
EG	Togo	8a	Essence (LPG)	Container, Chemicaltanker, Product tanker	2.34%	5.92%	8.80%	0.26%	1.30%	3.83%
T		8b	Iron and steel	Container	2.40%	6.64%	8.97%	0.44%	2.24%	6.59%
EG		8c	Palm oil	Chemical tanker	2.39%	7.11%	8.33%	0.25%	1.26%	3.69%
EG	Tonga	9a	Petroleum oils	Chemical tanker, Oil & product tanker	1.83%	4.52%	6.49%	0.10%	0.51%	1.51%
T		9b	Fish	General cargo	1.19%	2.86%	4.30%	0.01%	0.06%	0.17%
T		9c	Kava	General cargo	5.60%	13.52%	20.31%	0.01%	0.06%	0.17%
T	United States	10a	Soybeans	Bulk carrier	1.04%	2.77%	3.73%	0.70%	3.53%	10.36%
T		10b	Wood and wood products	Bulk carrier	4.63%	14.12%	17.96%	0.11%	0.54%	1.59%
T		10c	Automobiles	Vehicle carrier	0.74%	1.39%	2.04%	0.38%	1.94%	5.69%

Note: EG – imported essential good
T – exported trade good

The summary of ranges for Scenario 31

- The expected FRACCI changes across all case studies range from:
  - 2030 0.22% to 5.60%, with an average of 2.00%
  - 2040 0.60% to 14.12%, with an average of 5.17%
  - 2050 0.80% to 20.31%, with an average of 7.09%

Figure 14.10: 2030 Scenario 31 combined results for all case studies, by speed reduction group

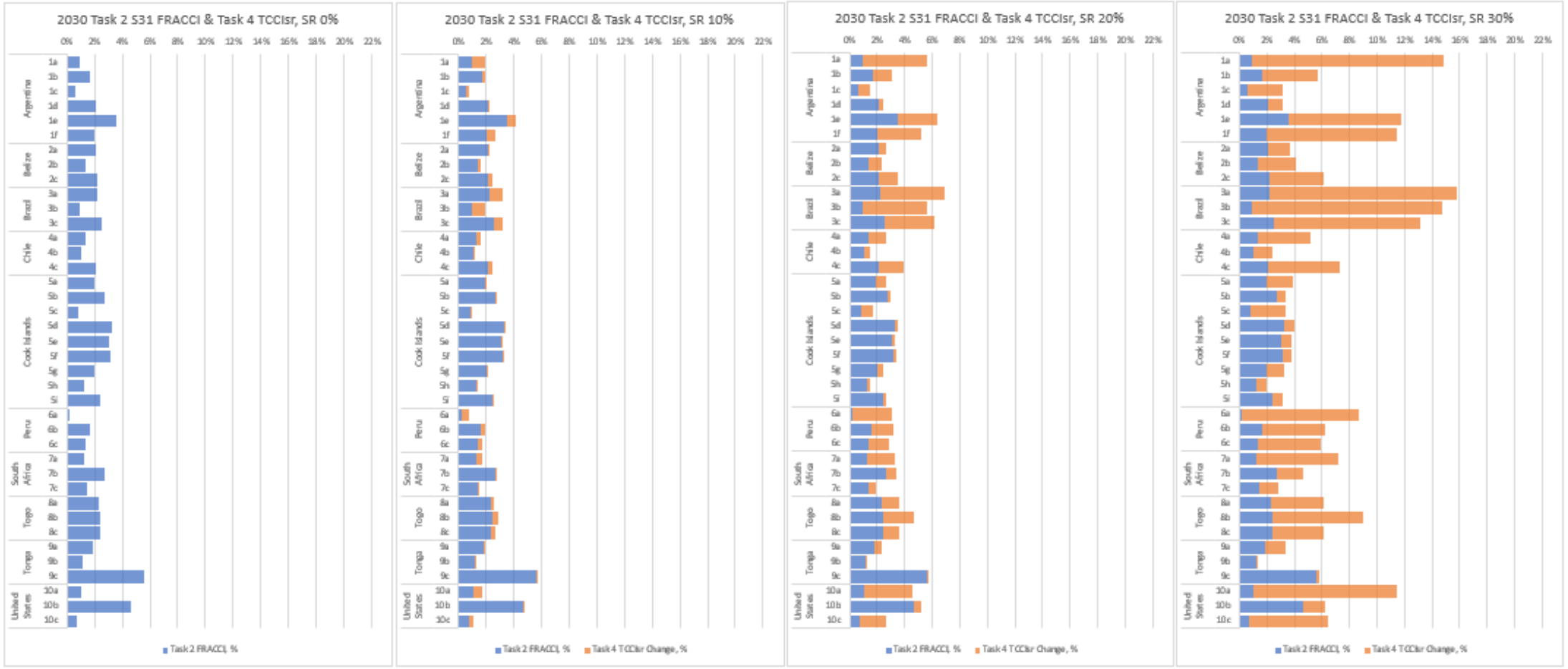


Figure 14.11: 2040 Scenario 31 combined results for all case studies, by speed reduction group

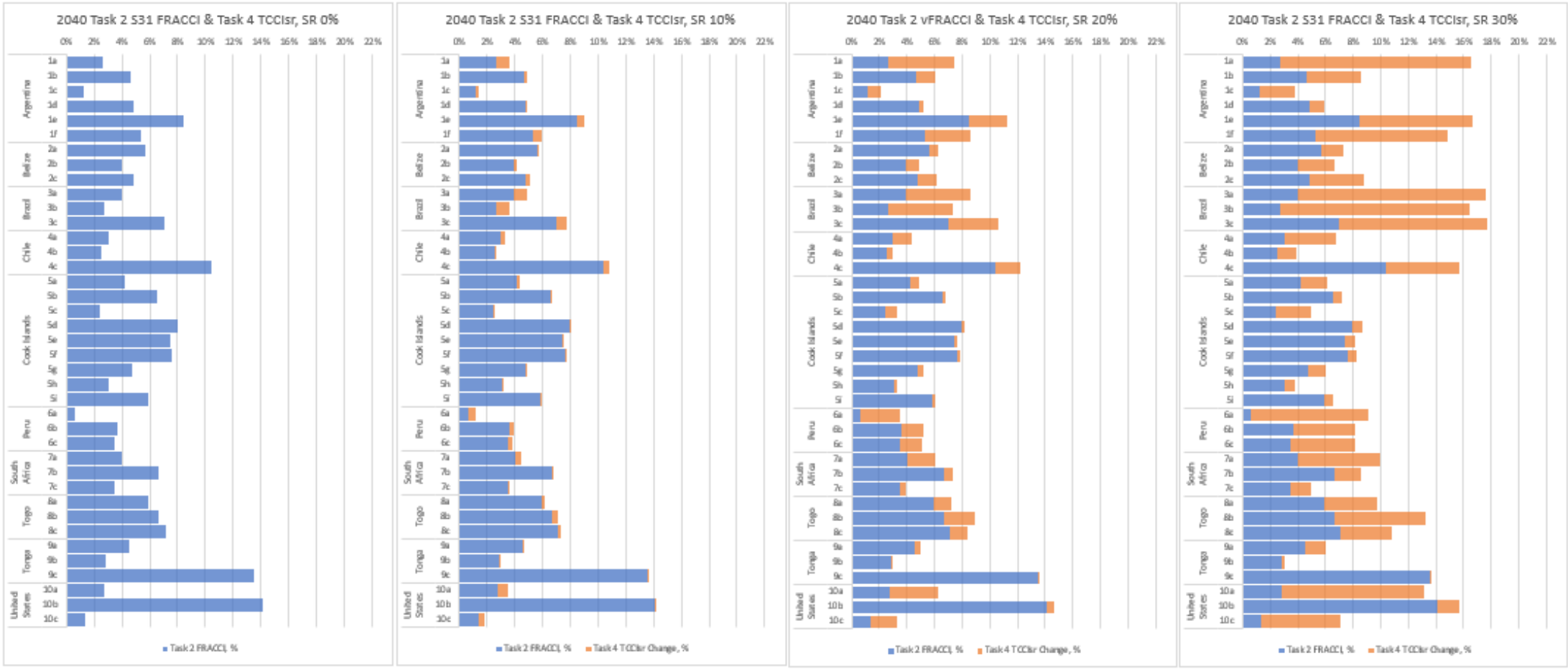
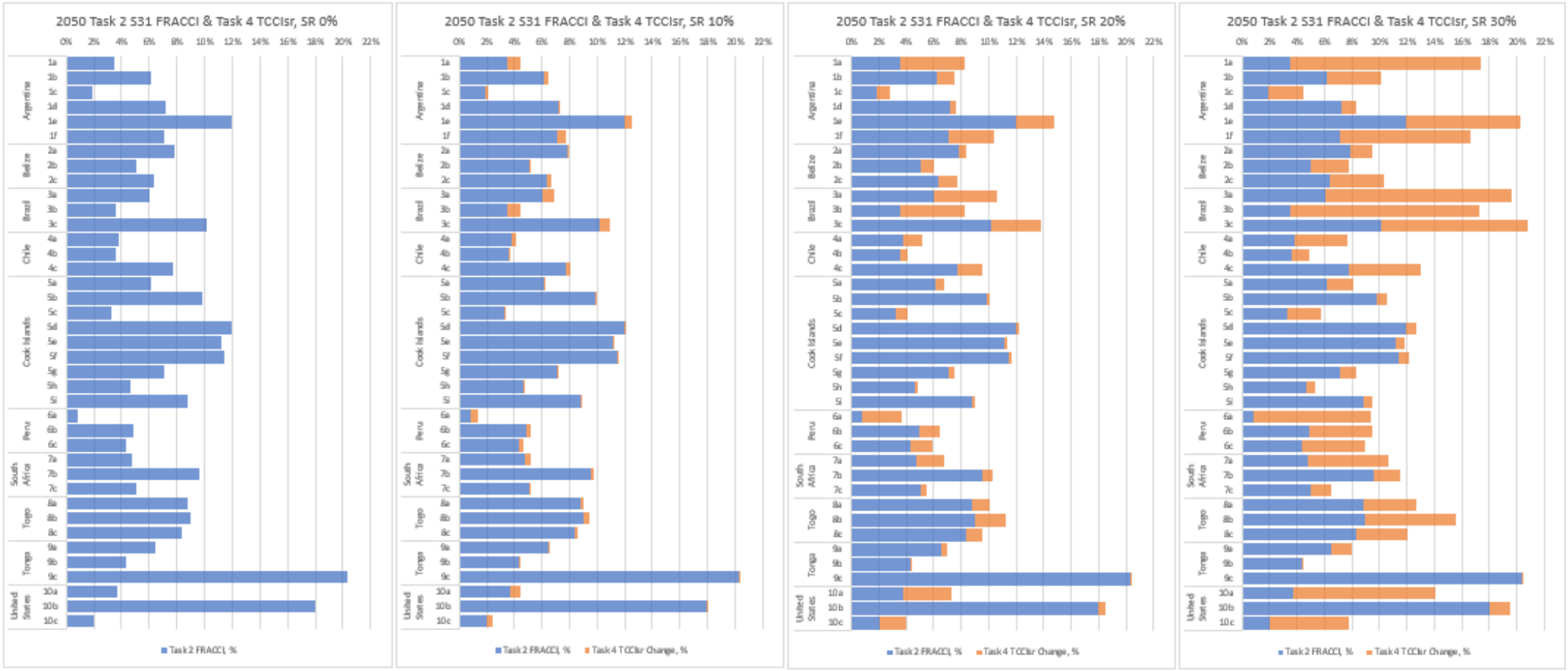


Figure 14.12: 2050 Scenario 31 combined results for all case studies, by speed reduction group



Scenario 32

The Task 2 ship-side freight rates adjusted commodity cost intensity (FRACCI) changes, by year and the total commodity cost intensity change due to speed reduction (TCCIsr) are presented in the Table 14.7 and Illustrative figures for each year and speed reduction group are presented in Figures 14.13 through 14.15.

Table 14.7: 2030, 2040, & 2050 Scenario 32 FRACCI & TCCIsr results for all case studies, by year & speed reduction group

	Country	Case Study	Case Study Commodity	Ship Type(s)	Ship-side -> Commodity-side Task 2 FRACCI, %			Commodity-side Task 4 TCCIsr Change, %		
					2030	2040	2050	SR 10%	SR 20%	SR 30%
T	Argentina	1a	Soybeans	Bulk carrier	0.95%	2.72%	3.41%	0.93%	4.72%	13.87%
T		1b	Soybean meal	Bulk carrier	1.70%	4.72%	6.00%	0.27%	1.35%	3.96%
T		1c	Chilled bovine meat	Container	0.65%	1.23%	1.85%	0.17%	0.87%	2.55%
T		1d	Apples and pears	Container	2.27%	5.01%	7.02%	0.07%	0.37%	1.10%
T		1e	Soy oil	Chemical tanker	3.58%	8.37%	11.50%	0.55%	2.81%	8.25%
T		1f	Corn	Bulk carrier	1.98%	5.37%	6.93%	0.64%	3.23%	9.49%
T	Belize	2a	Bananas	Container	1.86%	6.06%	7.86%	0.11%	0.55%	1.62%
T		2b	Sugar	Bulk carrier	1.40%	4.10%	4.83%	0.18%	0.93%	2.74%
EG		2c	Steel	Container	2.37%	5.24%	6.15%	0.26%	1.34%	3.92%
T	Brazil	3a	Iron ore	Bulk carrier	2.31%	4.16%	5.62%	0.91%	4.63%	13.60%
T		3b	Soybeans	Bulk carrier	0.96%	2.72%	3.43%	0.92%	4.67%	13.73%
T		3c	Woodpulp (paper and paper products)	General cargo	2.88%	7.13%	10.17%	0.72%	3.63%	10.67%
T	Chile	4a	Cherries	Container	1.45%	3.26%	3.74%	0.26%	1.30%	3.82%
EG		4b	Petroleum oils	Chemical tanker	1.07%	2.51%	3.45%	0.09%	0.46%	1.34%
T		4c	Lithium carbonate	Container	2.51%	9.91%	8.11%	0.35%	1.78%	5.22%
EG	Cook Islands	5a	Miscellaneous edible preparations	Container	2.26%	4.30%	5.83%	0.13%	0.66%	1.94%
EG		5b	Pharmaceutical goods	General cargo	4.13%	6.91%	9.09%	0.05%	0.23%	0.68%
EG		5c	Fuels (LPG)	LPG tanker	0.83%	2.43%	3.24%	0.17%	0.86%	2.52%
EG		5d	Articles of iron and steel	General cargo	5.04%	8.42%	11.08%	0.05%	0.23%	0.68%
EG		5e	Edible vegetables, certain roots, & tubers	General cargo	4.70%	7.85%	10.34%	0.05%	0.23%	0.68%
EG		5f	Electrical machinery & equip	General cargo	4.81%	8.04%	10.59%	0.05%	0.23%	0.68%
EG		5g	Meat & edible meat offal	Container, General cargo	1.85%	4.85%	6.68%	0.08%	0.41%	1.21%
EG		5h	Dairy produce, birds eggs, natural honey+	General cargo	1.95%	3.26%	4.30%	0.05%	0.23%	0.68%
EG		5i	Products of the milling industry, etc.	General cargo	3.71%	6.20%	8.16%	0.05%	0.23%	0.68%
T	Peru	6a	Copper	Bulk carrier	0.22%	0.60%	0.78%	0.57%	2.90%	8.51%
T		6b	Grapes	Container	1.75%	3.92%	4.75%	0.31%	1.55%	4.56%
T		6c	Pota (squid)	Container	1.48%	3.73%	4.25%	0.31%	1.56%	4.60%
T	South Africa	7a	Iron ore	Bulk carrier	1.27%	4.14%	4.86%	0.40%	2.00%	5.88%
T		7b	Citrus foods	Container	2.96%	6.93%	9.19%	0.13%	0.67%	1.96%
T		7c	Grapes	Container	1.56%	3.64%	4.83%	0.10%	0.49%	1.43%
EG	Togo	8a	Essence (LPG)	Container, Chemicaltanker, Product tanker	2.17%	6.13%	8.45%	0.26%	1.30%	3.83%
T		8b	Iron and steel	Container	3.02%	6.89%	8.86%	0.44%	2.24%	6.59%
EG		8c	Palm oil	Chemical tanker	2.81%	7.76%	8.42%	0.25%	1.26%	3.69%
EG	Tonga	9a	Petroleum oils	Chemical tanker, Oil & product tanker	1.84%	4.47%	6.25%	0.10%	0.51%	1.51%
T		9b	Fish	General cargo	1.81%	3.03%	3.99%	0.01%	0.06%	0.17%
T		9c	Kava	General cargo	8.54%	14.28%	18.81%	0.01%	0.06%	0.17%
T	United States	10a	Soybeans	Bulk carrier	1.03%	2.79%	3.64%	0.70%	3.53%	10.36%
T		10b	Wood and wood products	Bulk carrier	4.56%	14.65%	17.30%	0.11%	0.54%	1.59%
T		10c	Automobiles	Vehicle carrier	0.45%	1.53%	1.99%	0.38%	1.94%	5.69%

Note: EG – imported essential good
T – exported trade good

The summary of ranges for Scenario 32

- The expected FRACCI changes across all case studies range from:
  - 2030 0.22% to 8.54%, with an average of 2.38%
  - 2040 0.60% to 14.65%, with an average of 5.37%
  - 2050 0.78% to 18.81%, with an average of 6.81%

Figure 14.13: 2030 Scenario 32 combined results for all case studies, by speed reduction group

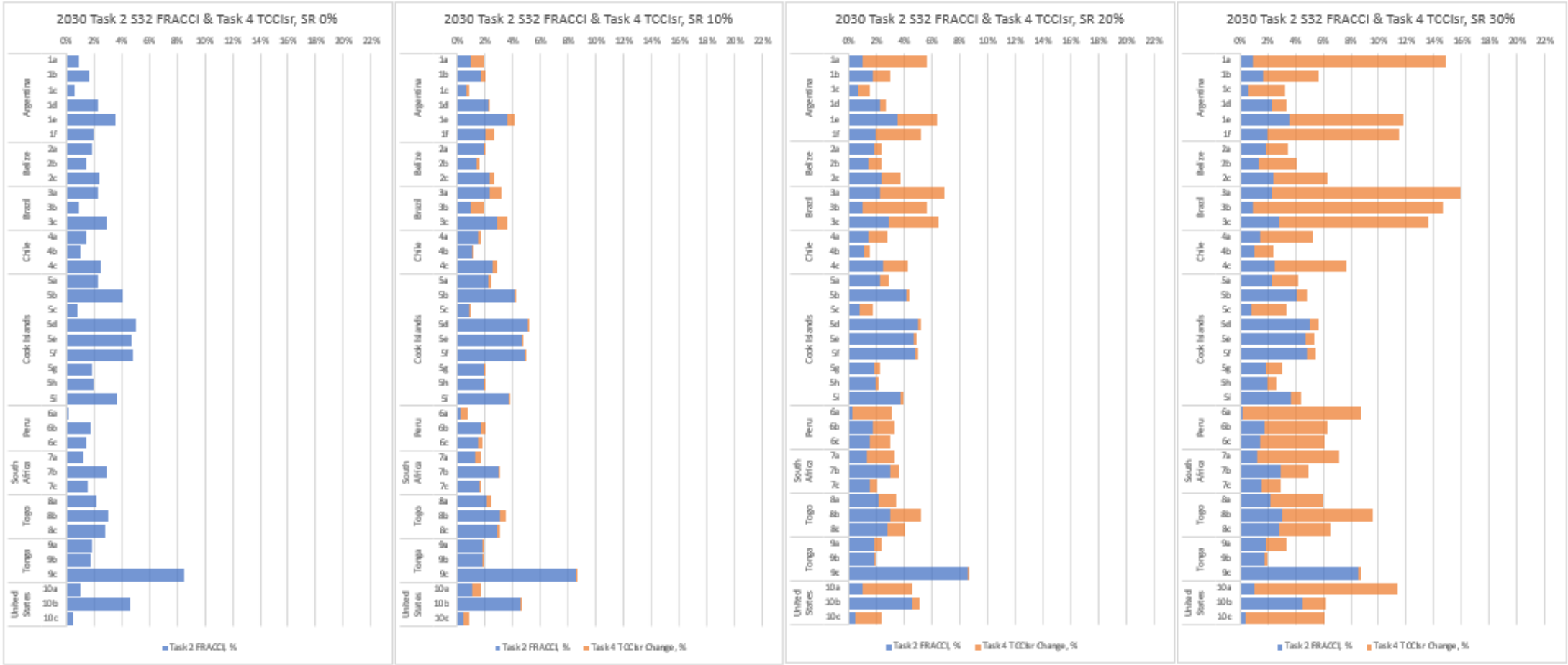


Figure 14.14: 2040 Scenario 32 combined results for all case studies, by speed reduction group

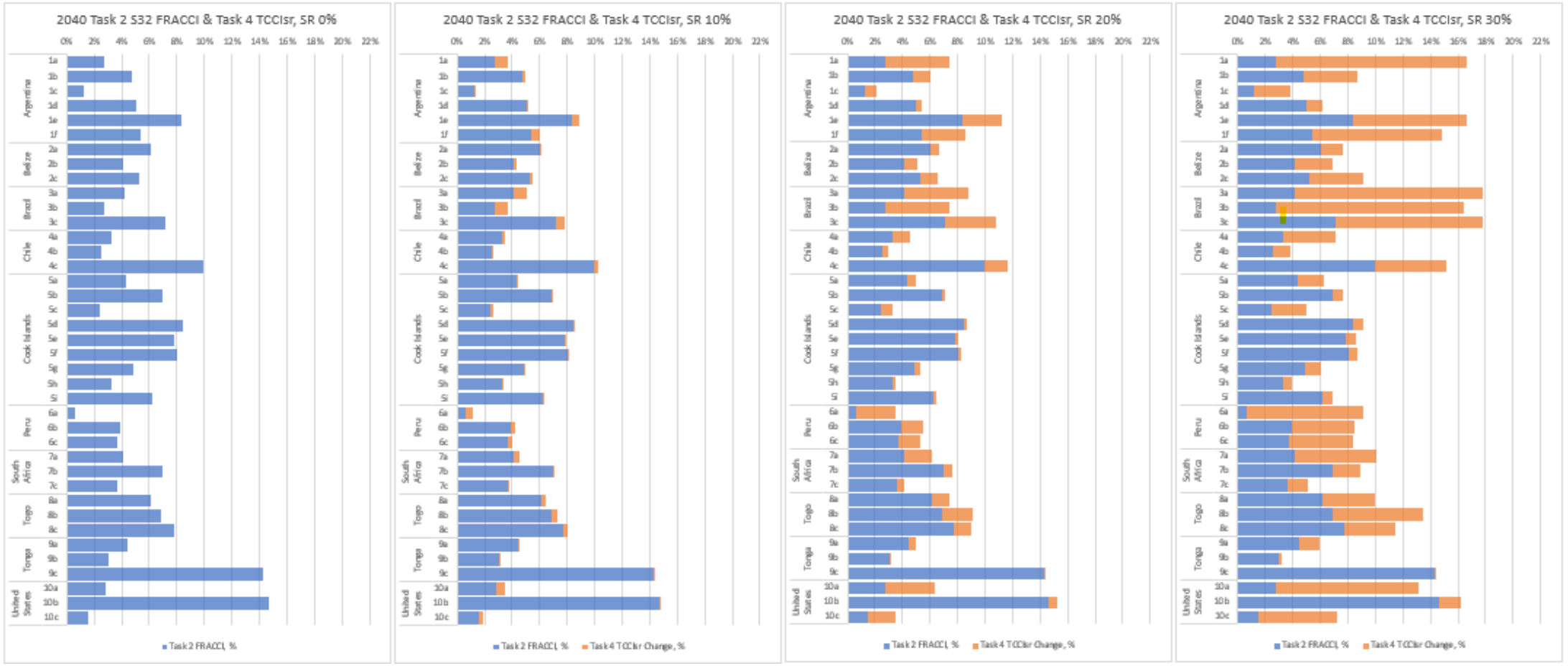
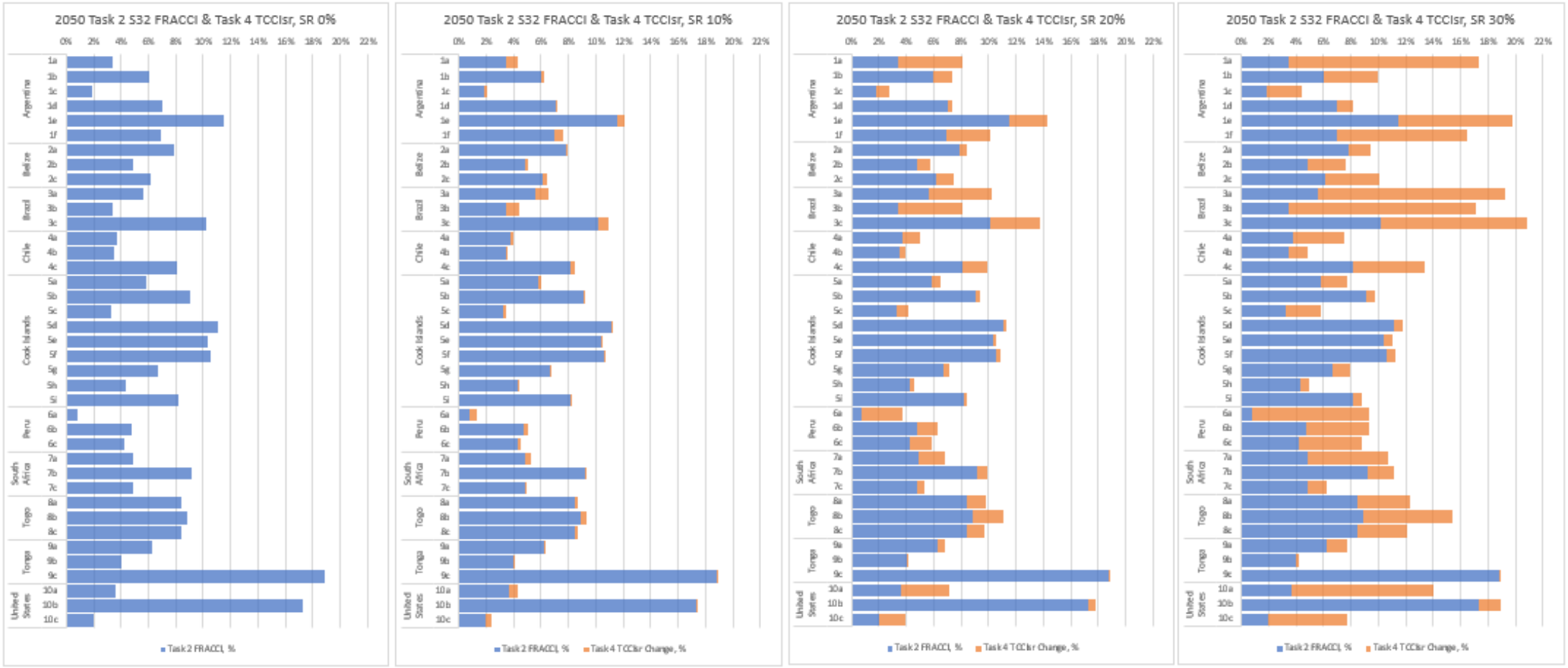


Figure 14.15: 2050 Scenario 32 combined results for all case studies, by speed reduction group



Scenario 46

The Task 2 ship-side freight rates adjusted commodity cost intensity (FRACCI) changes, by year and the total commodity cost intensity change due to speed reduction (TCCIsr) are presented in the Table 14.8 and Illustrative figures for each year and speed reduction group are presented in Figures 14.16 through 14.18.

Table 14.8: 2030, 2040, & 2050 Scenario 46 FRACCI & TCCIsr results for all case studies, by year & speed reduction group

	Country	Case Study	Case Study Commodity	Ship Type(s)	Ship-side -> Commodity-side Task 2 FRACCI, %			Commodity-side Task 4 TCCIsr Change, %		
					2030	2040	2050	SR 10%	SR 20%	SR 30%
T	Argentina	1a	Soybeans	Bulk carrier	2.08%	2.99%	3.37%	0.93%	4.72%	13.87%
T		1b	Soybean meal	Bulk carrier	3.64%	5.24%	5.91%	0.27%	1.35%	3.96%
T		1c	Chilled bovine meat	Container	1.21%	1.73%	1.81%	0.17%	0.87%	2.55%
T		1d	Apples and pears	Container	4.64%	6.72%	7.05%	0.07%	0.37%	1.10%
T		1e	Soy oil	Chemical tanker	7.74%	11.14%	11.28%	0.55%	2.81%	8.25%
T		1f	Corn	Bulk carrier	4.21%	5.99%	6.81%	0.64%	3.23%	9.49%
T	Belize	2a	Bananas	Container	5.50%	7.42%	8.02%	0.11%	0.55%	1.62%
T		2b	Sugar	Bulk carrier	2.88%	4.59%	4.82%	0.18%	0.93%	2.74%
EG		2c	Steel	Container	5.54%	6.64%	6.52%	0.26%	1.34%	3.92%
T	Brazil	3a	Iron ore	Bulk carrier	4.19%	4.63%	5.51%	0.91%	4.63%	13.60%
T		3b	Soybeans	Bulk carrier	2.09%	2.99%	3.38%	0.92%	4.67%	13.73%
T		3c	Woodpulp (paper and paper products)	General cargo	6.52%	9.76%	10.23%	0.72%	3.63%	10.67%
T	Chile	4a	Cherries	Container	3.60%	4.16%	3.93%	0.26%	1.30%	3.82%
EG		4b	Petroleum oils	Chemical tanker	2.32%	3.34%	3.39%	0.09%	0.46%	1.34%
T		4c	Lithium carbonate	Container	9.30%	14.01%	8.43%	0.35%	1.78%	5.22%
EG	Cook Islands	5a	Miscellaneous edible preparations	Container	4.32%	5.71%	5.80%	0.13%	0.66%	1.94%
EG		5b	Pharmaceutical goods	General cargo	6.17%	7.30%	9.89%	0.05%	0.23%	0.68%
EG		5c	Fuels (LPG)	LPG tanker	0.83%	2.43%	3.24%	0.17%	0.86%	2.52%
EG		5d	Articles of iron and steel	General cargo	7.52%	8.90%	12.06%	0.05%	0.23%	0.68%
EG		5e	Edible vegetables, certain roots, & tubers	General cargo	7.01%	8.30%	11.25%	0.05%	0.23%	0.68%
EG		5f	Electrical machinery & equip	General cargo	7.18%	8.50%	11.52%	0.05%	0.23%	0.68%
EG		5g	Meat & edible meat offal	Container, General cargo	4.13%	6.15%	6.49%	0.08%	0.41%	1.21%
EG		5h	Dairy produce, birds eggs, natural honey+	General cargo	2.92%	3.45%	4.67%	0.05%	0.23%	0.68%
EG		5i	Products of the milling industry, etc.	General cargo	5.54%	6.55%	8.88%	0.05%	0.23%	0.68%
T	Peru	6a	Copper	Bulk carrier	0.47%	0.69%	0.76%	0.57%	2.90%	8.51%
T		6b	Grapes	Container	4.24%	5.00%	5.01%	0.31%	1.55%	4.56%
T		6c	Pota (squid)	Container	3.86%	4.91%	4.45%	0.31%	1.56%	4.60%
T	South Africa	7a	Iron ore	Bulk carrier	3.27%	4.39%	4.91%	0.40%	2.00%	5.88%
T		7b	Citrus foods	Container	6.56%	8.76%	9.58%	0.13%	0.67%	1.96%
T		7c	Grapes	Container	3.45%	4.61%	5.04%	0.10%	0.49%	1.43%
EG	Togo	8a	Essence (LPG)	Container, Chemicaltanker, Product tanker	5.59%	7.58%	8.96%	0.26%	1.30%	3.83%
T		8b	Iron and steel	Container	6.45%	9.30%	9.06%	0.44%	2.24%	6.59%
EG		8c	Palm oil	Chemical tanker	7.71%	9.22%	8.78%	0.25%	1.26%	3.69%
EG	Tonga	9a	Petroleum oils	Chemical tanker, Oil & product tanker	4.14%	5.87%	6.19%	0.10%	0.51%	1.51%
T		9b	Fish	General cargo	2.70%	3.20%	4.34%	0.01%	0.06%	0.17%
T		9c	Kava	General cargo	12.76%	15.10%	20.46%	0.01%	0.06%	0.17%
T	United States	10a	Soybeans	Bulk carrier	2.21%	3.15%	3.56%	0.70%	3.53%	10.36%
T		10b	Wood and wood products	Bulk carrier	10.50%	15.70%	17.28%	0.11%	0.54%	1.59%
T		10c	Automobiles	Vehicle carrier	1.29%	1.88%	2.02%	0.38%	1.94%	5.69%

Note: EG – imported essential good
T – exported trade good

The summary of ranges for Scenario 46

- The expected FRACCI changes across all case studies range from:
  - 2030 0.47% to 12.76%, with an average of 4.78%
  - 2040 0.69% to 15.70%, with an average of 6.36%
  - 2050 0.76% to 20.46%, with an average of 7.04%

Figure 14.16: 2030 Scenario 46 combined results for all case studies, by speed reduction group



Figure 14.17: 2040 Scenario 46 combined results for all case studies, by speed reduction group

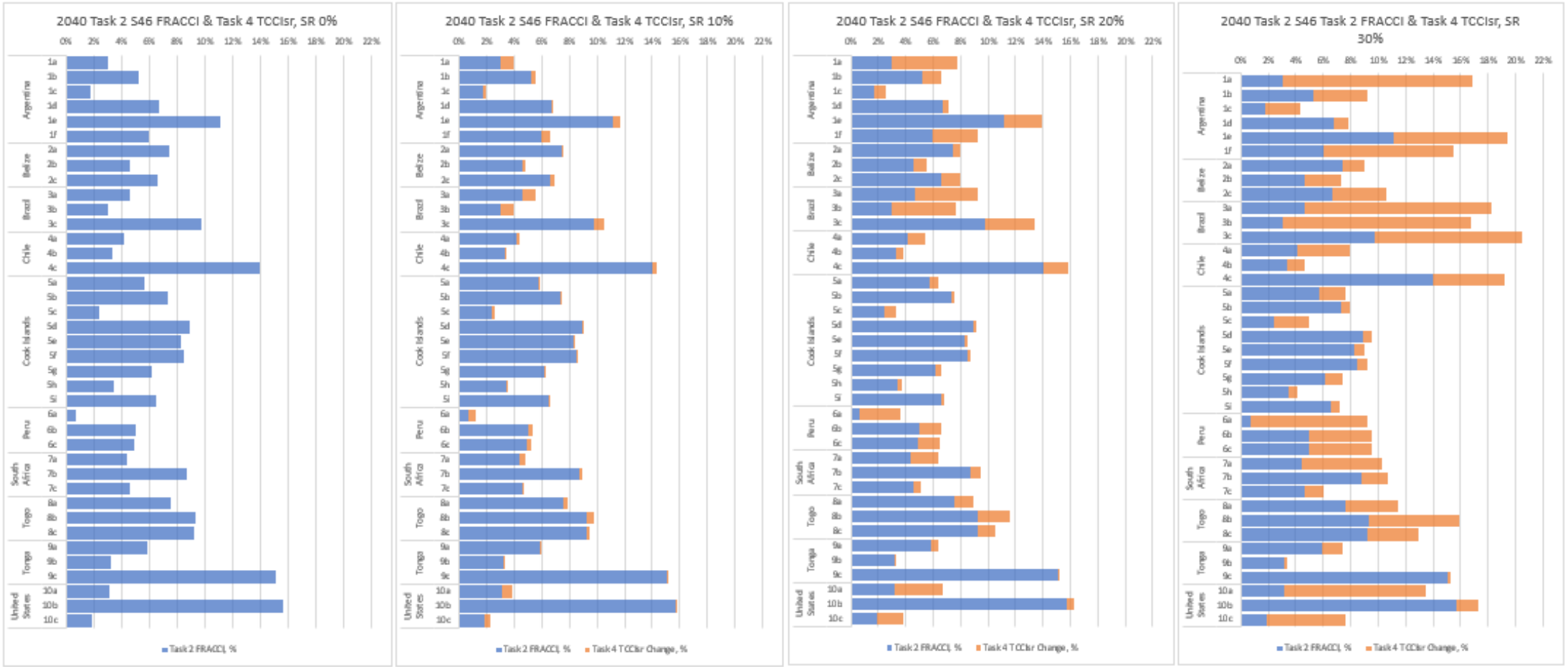
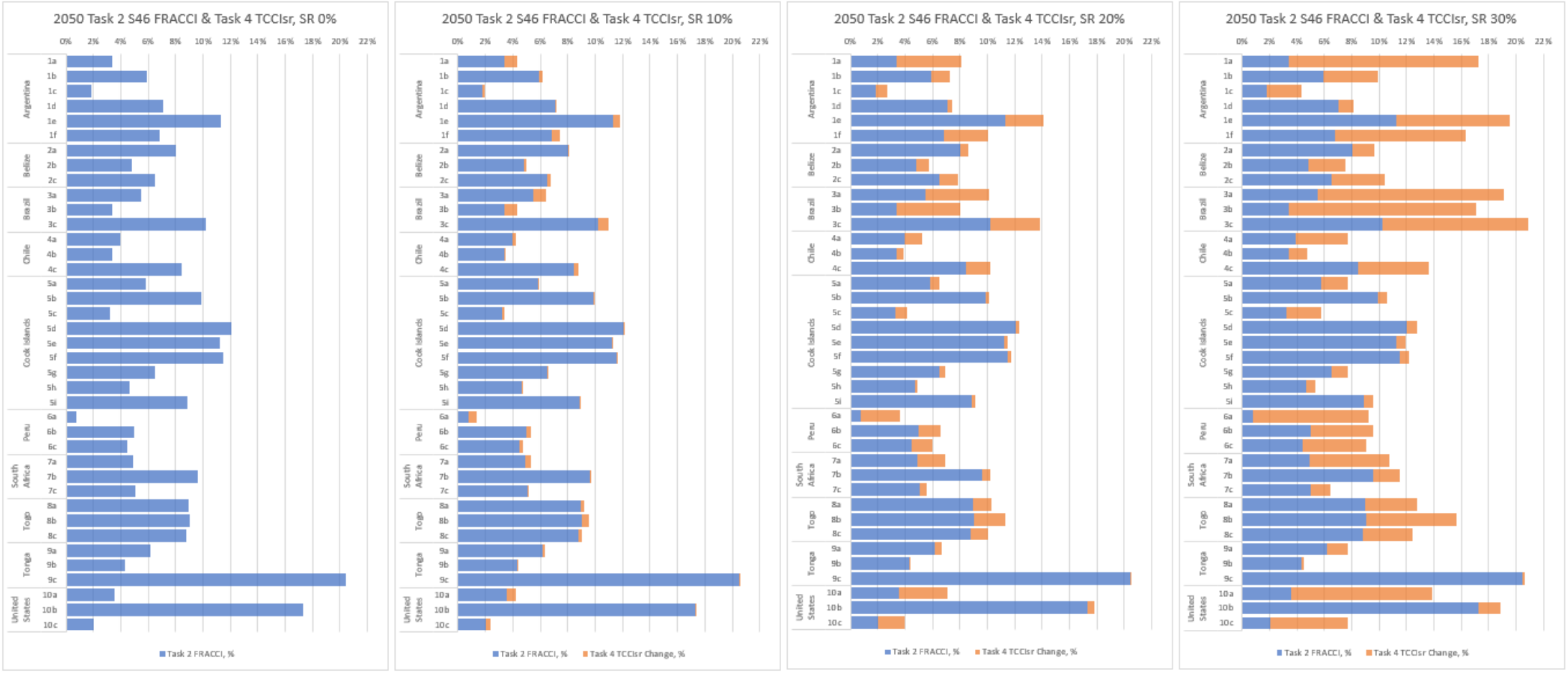


Figure 14.18: 2050 Scenario 46 combined results for all case studies, by speed reduction group



15 Summary of findings from the qualitative analysis & recommendations

The focus of this section is to highlight the key findings and identify convergences across the broad range of Member States' stakeholder's input through the qualitative analysis. The stakeholder qualitative responses identified a number of converging concerns, cross-cutting themes, and opportunities to mitigate the impacts of the MTM, which are presented in this section. All the information provided is from the qualitative responses and information, and in some cases, summarized by the Project Team. This section is organized into subsections as follows:

- Key takeaways and cross-cutting themes on cost and time sensitivities
- Special considerations for SIDS and LDCs
- Additional questions provided by Member State stakeholders
- Recommendations

The stakeholder input reveals that cargo owner and customer tolerance for longer transits or increased costs of trade goods is low for many perishable, consumer, and industrial goods. Considerations include:

- Cost of holding and insuring inventory on ships during longer transport times.
- Affordability: transport costs as a percentage of total cost; transport alternatives (air, sea-air, road-air).
- Products may be either essential goods or trade goods. Essential goods are more sensitive to longer transits, potential delays and increasing costs.
- Product degradation over time may be due to refrigeration, heat/humidity/water intrusion, using too many shelf-life days for transport, or other factors.
- Possible market loss as customers source faster delivery suppliers.

The Project Team notes and highlights the detailed and sophisticated input by some stakeholders on "questions to consider." This information demonstrates that a number of national stakeholders have a high level of knowledge and engagement – this is beneficial with regards to any future plans.

Key takeaways and cross-cutting themes on cost and time sensitivities

Key qualitative findings on shipment costs identified by the stakeholders who participated in the SWOT analysis:

- Higher transportation costs tied to distance can impact market accessibility, competitiveness, product pricing, and market expansion strategies. Exporters may prioritize closer markets to minimize costs and face challenges in competing with suppliers from regions with lower transportation costs. Adjustments in product pricing may be necessary to maintain profitability, and market expansion efforts may be affected.
- Ultimately, changes in freight costs will affect prices for consumers.
- Trade agreements can mitigate the impact of transportation costs by reducing trade barriers and facilitating market access.
- Transportation costs impact product affordability and accessibility. Certain goods may no longer be imported at all due to increased costs and time frames. This is a particular concern for SIDS.

Key qualitative findings on transport time identified by the stakeholders who participated in the SWOT analysis:

- Commodities may be time-sensitive for a variety of reasons – product degradation, customer demands (Key Performance Indicators (KPIs), production efficiency, seasonal demand), market forces, and costs.
- Stakeholders reported that the effectiveness and efficiency of transport is of paramount importance.
- Timely reliable delivery is important for most goods and very important for perishable goods, but also very important for non-perishable goods supplied to time-sensitive operations or markets. Speed reduction would affect the ripening conditions and shelf life of perishables like bananas. Longer transit times would also alter the taste and texture of these products.
- Many of the participating Member States are distant from the commodity sources or destinations. Speed reduction would aggravate geographic disadvantage and worsen competitiveness due to longer lead times and potentially more expensive freight costs.
- Slower transit times for all commodities would mean increased costs to consumers.
- The human impact of slower transit times could include shortages of perishable products or fuels, impacting food security, employment opportunities, livelihoods, and environmental justice.
- Longer ocean transit times can also prolong payment times from importers to exporters, impacting their financial viability.
- Clients would need to buy raw materials sooner, increasing working capital needs and impacting balance sheets negatively.

Key qualitative findings on opportunities to mitigate impacts identified by the stakeholders who participated in the SWOT analysis:

- Compliance alternatives that result in arrival delays are concerns for some but not all stakeholders.
- Some stakeholders felt that trade agreements can mitigate the impact of transportation costs by reducing trade barriers and facilitating market access. Others reported that expiring trade agreements can exacerbate transportation costs by forcing new markets to be secured for goods, which could be more distant to market.
- Other opportunities listed by the stakeholders to mitigate the impacts of longer shipping times include providing additional storage, larger ships (if feasible), or additional ships to offset challenges and delays.
- Temperature and atmosphere-controlled shipping and storage may extend the shelf life of even long-lived perishables.
- Growth of regional ports could attract more or larger vessels, and support development of storage facilities. This could lead to reduced costs per unit of cargo.
- Some stakeholders believe lower vessel speed should reduce fuel consumption, but this may be offset by other cost increases.
- Early availability and conversion to low-carbon fuels was seen as a positive by some stakeholders.

Special considerations for participating SIDS and LDC

Small Island Developing States (SIDS) and Least Developed Countries (LDCs) face unique challenges. In this study, the Cook Islands and Tonga are participating SIDS, and Togo is the participating LDC. SIDS are heavily disadvantaged due to their small size, geographical isolation, and often limited resources.[187] Though not necessarily isolated or small, LDCs experience similar obstacles. Both SIDS and LDCs often rely on foreign aid and their economies are not self-sustaining.[188]

Participating SIDS

The Cook Islands and Tonga are distant from major markets, with the closest being New Zealand. They are served by smaller ships due to demand and infrastructure limitations; small ships are less cost-effective than larger ships. This increases freight rates, making maritime transport expensive.[189] Their small market size also reduces the frequency of shipping services, which they depend on for imports of essential goods. These countries' low GDP means that there is little disposable income to absorb higher commodity prices. Due to limited domestic manufacturing and production capacities, delays due to weather conditions or global shipping trends have the potential to cause commodity shortages or food insecurity.[190] The Cook Islands and Tonga have limited port infrastructure and storage facilities. This can increase turnaround times and restrict certain vessel types. Their vulnerability to natural disasters and other environmental impacts has and will continue to disrupt trade flows and routes and damage port infrastructure.[191] Recovery is often slow, costly, and affects import and export logistics. The Cook Islands and Tonga import all of their fuels and the development of renewable energy sources will be difficult and costly.[192] SIDS require international support and cooperation to effectively manage maritime activities and address gaps in knowledge.

Participating LDC

Togo is the representative LDC in this report. LDCs share limitations with SIDS in that they often have underdeveloped port infrastructure, insufficient storage facilities, and are distant from major markets.[193] They also typically rely on foreign shipping services, leaving them vulnerable to external shocks and limiting their control. Like Tonga and the Cook Islands, Togo is impacted by climate change-related events including flooding, coastal erosion, and more.[194] These can disrupt maritime transport operations and increase risks. LDCs usually also have limited export diversification; for example, Togo relies on a narrow range of commodities for trade, causing imbalances.[195] These are agricultural commodities like cocoa, coffee and cotton fiber. Concerns have also been raised by Togo's stakeholders on LPG-dependent communities, where GHG reduction regulations could exacerbate the economic and social challenges LDCs already face. Perhaps the most glaring disadvantage is their limited access to the funds and investment opportunities needed to update port infrastructure or implement industry upgrades that would improve competitiveness, productivity, organization and capabilities.[196]

---

[187] World Bank Group, *Climate Resilience and Transport in Small Island Developing States*.
[188] UNCTAD, *Building resilience in small island developing States*.
[189] International Transport Forum, OECD, *The Impact of Mega Ships*.
[190] UNOPS, *Infrastructure for Small Island Developing States: The role of infrastructure in enabling sustainable, resilient and inclusive development in SIDS.*
[191] Ibid.
[192] *International Renewable Energy Agency, Small Island Developing States (SIDS): Navigating the Energy Transition Crossroads.*
[193] UNCTAD, *The Least Developed Countries Report.*
[194] World Bank Group, *Climate Risk Country Profile: Togo.*
[195] UNCDF, *Least Developed Countries*.
[196] UNCTAD, *The Least Developed Countries Report*.

The Cook Islands, Tonga, and Toga stakeholders share similar concerns. One major concern is the consideration of essential goods versus trade commodities, and the associated affordability compounded by the low GDPs of SIDS and LDCs. More shared concerns derived from stakeholders' responses are outlined below.

- The MTM will increase shipping costs and these higher costs could result in higher logistics costs and overall prices paid by importers. The Cook Islands, Tonga and Togo are mainly importing countries.
- Higher transport costs could increase the costs of goods for consumers, increasing inflation. Costs of goods in the Cook Islands especially are already expensive. Countries which rely on tourism, like the Cook Islands and Tonga, report that visitors often complain about the cost of groceries. Further increases could potentially harm tourism.
- Certain goods, like specialty products or seasonal goods, may no longer be imported at all due to increased costs from emissions taxes or increased transport times.
- Higher costs could lead to substitutions by receiving importers, to source from other exporting economies. Exporters to the Cook Islands, Tonga and Togo may also prioritize closer markets to minimize these costs.
- Natural disasters increase fuel consumption. Cook Islands, Tonga, and Togo all import much of their fuel and experience adverse weather. This combined with cost changes could be detrimental.
- Reduced capacity ships due to lower energy density fuels could lead to increased transportation costs and logistical challenges.
- The MTM may increase transport times; the Cook Islands, Togo, and Tonga are distant from suppliers. Speed reduction would aggravate geographical disadvantages and competition because of longer lead times and potentially more expensive freight costs.
- Speed reduction would require higher holding stock, putting pressure on warehousing. For the Cook Islands and Tonga, larger stock holdings are a major expense for frozen or chilled products.
- The timing of transshipping goods across various shipping lines is already difficult. Slowing shipping speeds would aggravate this.

Addressing these concerns involves the following special considerations:

- Upgrading and expanding port facilities and warehousing to increase storage and efficiency.
  - This could enable the handling of larger volumes of goods or allow the accommodation of more diverse types of cargo, while providing resilience for shipping delays, special occasions or natural disasters.
  - Upgraded port facilities could minimize delays, increase efficiencies, and support economic growth.
  - Note that upgrading is not a silver bullet. Not all ports can upgrade their way out of all challenges due to constraints like land and access to sea configurations, financial limitations, knowledge. For example, port facilities that are land or channel constrained can be complex undertakings
- Aligning domestic maritime regulations with international ones to ensure harmonization.
  - Consistency could simplify compliance for the various entities involved in maritime transport operations, reducing confusion or potential disputes.
  - Aligning standards and streamlining regulations could allow SIDS and LDCs to increase their participation in global maritime trade networks.

- Providing investment and financial opportunities, funding assistance, capacity-building and technical cooperation programs to SIDS and LDCs.
  - Not only could investment and financial opportunities generate capital for sustainable development and import and export logistics but could also stimulate economic growth through job creation.
  - Capacity-building could foster knowledge sharing in operational efficiency and management.
  - Technical cooperation could influence collaborative efforts between stakeholders, international organizations and more.
- Strengthening regional or international cooperation through addressing common challenges between like countries and social groups.
  - Strengthening cooperation could build resilience to market fluctuations and prioritize collective support and responsibility to the sustainable development of maritime transport.

Additional questions provided by Member State stakeholders

A number of stakeholders participating in the study showed strong awareness of and engagement in the decarbonization of shipping. Their responses to the final open-ended question "What questions should we have asked to more fully understand the impacts of potential vessel greenhouse gas reduction requirements on shipping, your population and your economy?" can provide a starting resource for Member States in developing planning processes to enable education and preparedness for the implementation of the MTM and other climate measures. These topics ranged from supply chain resilience and technology solutions to impacts on human needs and affordability.

The full qualitative question set is provided in Table A.3 of Appendix A.

Recommendations

Member States are now dealing with the implementation of the STM, and many of the recommendations from the 2021 IMO CIA STM Stakeholder Analysis remain relevant.[197] A summary of these is below.

- Member States are encouraged to use the sensitivity analysis findings of this assessment to further determine, plan for, prepare for, and track the potential impacts of higher maritime transport costs and potential longer transit times.
- It is recommended that the participating Member States stay actively engaged with exporters/importers, trade associations, shipping lines, and other stakeholders around these key export trade commodities to determine if direct or indirect impacts from the STM and MTM could lead to port arrival delays or modal shifts in transportation that would impact the costs/values and/or the markets for those imports/exports.
- Across all participating Member States, the corresponding governments should evaluate the report findings to determine the potential effects delays (vessel speed reductions, longer transit times) might have on their countries and economies. For other non-participating Member State governments, it is suggested to look for commodity case studies that are relevant to their country and use the findings to illustrate potential impacts from longer transit times and increased commodity costs from higher maritime transport costs or longer transit times.

[197] APEC 2019

- Periodic analysis and updates of ship speeds, routes used, and make-up of ship type/size/age would be important to keep the sensitivity analysis current and a useful tool to monitor what is happening related to these commodities and routes.
- There was generally a lack of sectoral GDP data across the 39 commodity case studies. It is recommended that Member State governments and national statistics offices make this data available to those government officials attending IMO MEPC for future analyses.
- It is also important for MS to include National Customs Offices to provide international trade data (volumes, values, freight rates) at least at 4-6 HS Code.
- Finally, it is important to track developments at IMO related to the measures and their implementation. The sensitivity analysis performed is valid for what is understood at this time for those measures. Adjustments or tightening of the measures or their implementation would warrant a review to ensure that the analysis is still valid or to identify what needs to be updated.

The follow additional recommendations are based on the results of this IMO CIA MTM Task 4 study:

- Take advantage of these conversations with stakeholders to build or strengthen an ongoing country or regional planning effort and raise awareness in the country/region, governmental and supply chain participants.
- Consider both the qualitative and quantitative aspects of this study to fully understand potential impacts of the MTM on economic, supply chain and business entities as well as people, cultures and livelihoods.
- Consider how domestic maritime, port and supply chain regulations and other requirements and practices could be better harmonized with international ones to enable adaptation.
- Special consideration for the participating SIDS/LDC:
    - Consider how best to upgrade and/or expand port facilities and warehousing to increase storage and efficiency and relieve port access restrictions.
    - Align domestic maritime and supply chain regulations with international ones to ensure harmonization and enable adaptation.
    - Provide investment and financial opportunities, funding assistance, capacity-building and technical cooperation programs to SIDS and LDCs.
    - Strengthen regional and international cooperation through addressing common challenges between like countries and social groups.

CIA procedural recommendations:

- Starting Task 4 after Tasks 1, 2, and 3 have started puts the Stakeholder Analysis in a difficult position in that:
    - The project team/leaders are not involved in the CIA Steering Committee meetings from the beginning so they lose essential and critical understanding of the progression of the methods, approaches, outputs, and direction from the Steering Committee to other tasks. This also does not afford the Task 4 perspective in those discussions.
- The timelines for the CIA in general should be extended and started sooner. Get contracting done well in advance so the teams can move forward together and further out from the due dates. For example, this would help limit/minimize the compressed review loops of the Steering Committee and the compressed weeks for the Project Teams when they receive hundreds of comments on Fridays and must produce revisions by Monday.
- Starting Task 4 with the other tasks is important as that gives more time to the participating Member States to organize national resources and facilitate the collection and transfer of data and contextual information. It also allows for more time to review data and case study drafts and circle back with questions or gather greater understanding through virtual meetings.

- Strongly suggest IMO provide capacity building for Member States to understand the need to collect and have robust reviewed data nationally to support future CIAs and to track impacts from the measures adopted. This also provides Member States information on the context around the data and analyses so that there is national understanding about what is being collected, why it's being collected, how to use what's being collected, how to do the analyses, and how to interpret results.

Appendix A – Detailed approach

Appendix A – Detailed approach

Two fundamental analyses are conducted under Task 4: quantitative and qualitative. This appendix describes the approach used for conducting each of these analyses.

Quantitative analysis

The quantitative analysis is made up of two components, a vessel fleet analysis and an economic analysis, as detailed below. The vessel fleet analysis identifies actual ships engaged in the trade identified by the Member States. This information is used to determine ship type, age, size, operational characteristics, and other parameters used in the analysis. Similar to the approach used in the CIA STM, the Asian Pacific Economic Cooperation (APEC) Module 1[198] is used to estimate potential longer transit times due to vessel speed reduction (as modelled in Task 2) on the ship type and size combination identified for each commodity case study. The economic analysis uses these transit delays in the APEC Module 2 to estimate the commodity cost intensity increase related to the commodity-side, for each commodity case study for each ship type and size combination. These outputs are then added to the Task 2 freight rate adjusted commodity cost intensity (FRACCI) to obtain the percent change in total commodity cost intensity due to the MTM and speed reduction, for each commodity case study.

Unlike the other CIA MTM Tasks, Task 4 is dependent on Member States collecting the needed data to inform each Stakeholders' Analysis. Seven key datasets are needed to complete Task 4 analyses for each stakeholder; these are highlighted in Figure 2.1. Four of these datasets come directly from the Member States. For each commodity selected, a quantitative and a qualitative analysis were completed, building from the datasets compiled by the Member States for the project. Task 4 is predicated on the modeling results from Task 2 and the ship activity data used in Task 3. Therefore, Task 4's timeline was linked to Member State data delivery, Task 2 results deliverable timelines, and Task 3 ship activity data availability.

[198] APEC, *Analysis of the Impacts of Slow Steaming for Distant Economies,* submitted by Chile, ISWG-GHG 7/2/17, 7/2/25, Starcrest, December 2021, [APEC 2019] *https://www.apec.org/Publications/2019/12/Analysis-of-the-Impacts-of-Slow-Steaming-for-Distant-Economies*

Table A.1: Task 4 Key datasets descriptions & data provider

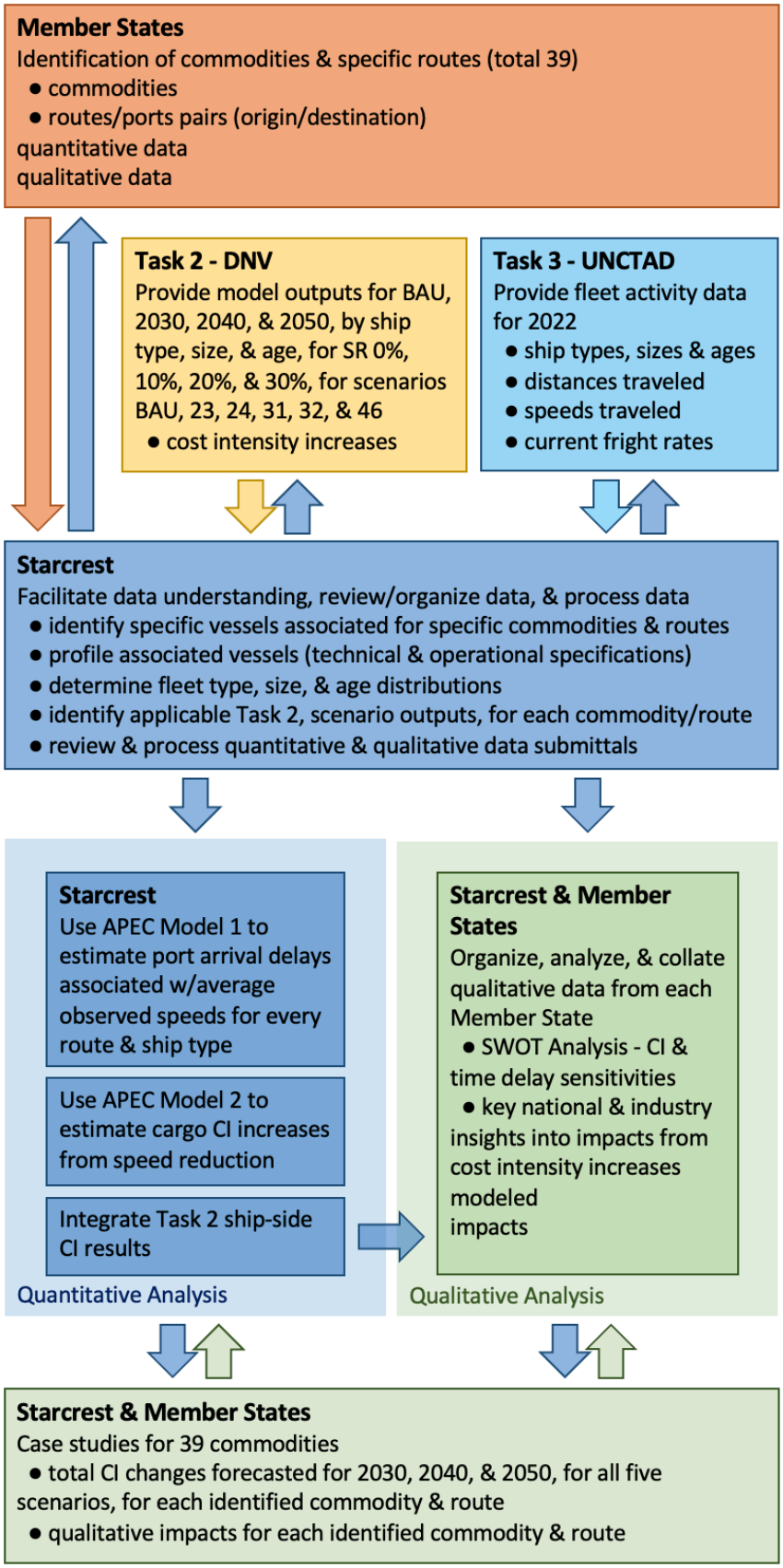
	Key Task 4 Datasets descriptions	Data provider
1	For each commodity of interest, HS code, including ports of origin and departure (specific route)	Member State
2	Commodity economic & contextual data	Member State
3	Qualitative survey input from in-country resources (government, trade association, shippers, institutions, etc.)	Member State
4	Port call data associated with commodity (ships, associated commodity cargo throughput, port contextual data, etc.)	Member State
5	Fleet parameter data (physical characteristics)	Starcrest
6	Fleet operational data (ship port calls/routes, average speeds, etc.)	Task 3 UNCTAD (data provider)
7	Cost intensity changes for mean & high impact scenarios; by ship size, age; for 2023, 2030, 2040, 2050	Task 2 DNV

Participating Member States collected both quantitative and qualitative data related to their selected commodities and trade routes. Two primary quantitative data questionnaire input files were provided to the Member States to facilitate the data collection. These were similar to the files used during the last CIA. A third questionnaire requested qualitative information from knowledgeable stakeholders related to potential impacts associated with increases in maritime transport costs and longer vessel transit times. These questionnaires provided the primary data inputs needed for the two APEC models used study. Data gaps were identified and noted.

An illustration of the overall approach for Task 4 is presented in the figure on the next page.

In this document the term "delay" is often used to refer to a scheduled longer transit time, and not a one-time arrival reliability failure. This is consistent with the STM report and APEC usage. This statement is provided in the interest of clarity.

Figure A.1: Illustrative flow chart of main efforts under Task 4



Fleet analysis

For the previous CIA, vessel speed reduction was a primary reduction option for meeting the various energy efficiency targets set out in the STM. For the CIA MTM, speed reduction plays a diminishing role out to 2050 as the new fuels are integrated into the fleet, additional efficiency improvements are incorporated through design of new ships, and improvements are made to existing ships. Further, Task 2 modeling no longer include a 50% speed reduction.

The Task 2 modeling results for each scenario are organized by the following:

- cost intensity (CI) estimates and associated data for baseline year 2023 (also referred to as business as usual, BAU) and 2030, 2040, and 2050, by
    - ship type, size, and age groups, and by
        - speed reduction groups: 0%, 10%, 20%, and 30%

UNCTAD made the ship activity data used in Task 3 available for use in Task 4, which allowed both analyses to be based on the same data. Starcrest coordinated with UNCTAD and its data provider, Marine Benchmark,[199] to provide ship activity data for the 39 case studies. The datasets provided were for calendar year 2022. This data was processed in a manner similar to that used in the previous CIA to generate inputs for the APEC Models.

The ship activity data along the identified routes for each commodity was provided by Marine Benchmark, the Task 3 data provider, and included the following key data:

- vessel current name
- vessel IMO number
- vessel IMO type size name
- vessel commercial type size
- vessel build date
- vessel deadweight,
- from country
- from port
- from departure date & time departing berth
- to country
- to port
- to arrival date & time arriving berth
- sailing distances, times, & average speeds
- number of calls on the identified route
- routing sequence from origin to destination port

The APEC Module 1 – Emission Impacts (APEC Module 1) was used to estimate time of delay. Due to time constraints, instead of binning vessels into ship type, size, and age bins, the average age across all the identified ships and trips identified was used for each type and size group. The data input into APEC Module 1 was based on the processed ship activity data that was organized for each ship type and size group combination identified, and the following were derived:

- average age
- average distance sailed
- average speed

[199] *Marine Benchmark.*

Based on the processed fleet data for each of the 39 commodity routes, the ship type and size group combinations were identified for the ships that operated on these routes in 2022. The average age distributions were kept constant in order to align with corresponding Task 2 cost intensity outputs that were provided in vessel age ranges (e.g., if the average age of the identified ship on a specific route is 20 years old, then this age was assumed for ships on this route in 2030, 2040, and 2050). This approach keeps the status quo and avoids numerous assumptions around specific route-focused fleet transitions, which would be highly speculative. This approach was confirmed in a meeting with DNV.

For each commodity case study, there were one to many ship type and size groups identified, with a total of 87 combinations across all 39 case studies. For each of these groups, the average longer transit times were estimated for 10%, 20%, and 30% speed reduction of the average marine transit speeds. This data was then input into APEC Module 2 – Economic Impacts (APEC Module 2) for the economic analysis. Due to project time constraints and to reduce the size and complexity of tables and figures to make them as concise as possible, trip-weighted averages were used to produce one set of results for each commodity case study, for each forecasted year.

Note that the emission elements of the model were not used in this analysis as they are not relevant to the greater analysis of the CIA MTM. Appendix B of APEC 2019 provides detailed documentation for both Module 1, used for the fleet analysis, and Module 2, used for the economic analysis.

The selection of scenarios to include in the quantitative analysis completed under Task 4

Due to time constraints, the scope of Task 4 does not include all the scenarios that DNV modeled for Task 2. Therefore, a bracketing approach was approved by the CIA Steering Committee. A key consideration for the scenarios selected for Task 4 is the need to select from the group of scenarios UNCTAD modeled in Task 3, thus ensuring alignment between the tasks. For Task 3, UNCTAD modeled the following Task 2 scenarios:

- 21, 22, 23, 24, 26, 31, 32, 36, 43, and 46

For scenarios 26, 31, 32, and 46, UNCTAD also modeled four revenue distribution scenarios. Again, due to time and scope constraints, it was not feasible to model all of UNCTAD's scenarios in Task 4. Task 4 is intended to evaluate very specific Member State identified case studies.

It is important to note that Task 4 was not able to discern how revenue is moved internally within a country to a specific segment or part of a segment within the overall economy. ***Therefore, the revenue disbursements associated with those scenarios that include it, were not considered in Task 4.*** Some of the scenarios are designed to generate excess funds that are intended to be used to help offset impacts, among other expenditures like research and development. Please see the Task 2 DNV 2024 and 3 UNCTAD 2024 reports for information related to revenue disbursements.

In consultation with DNV and UNCTAD, and approval by the CIA Steering Committee, and in consideration of the discussions related to tank-to-wake (TtW) and well-to-wake (WtW), five MTM scenarios were selected for inclusion in Task 4, as presented in Table ES.2.

Table A.2: Selected Task 2 Scenarios used for Task 4

Scenario number	Emissions trajectory	Seaborne trade growth	Policy combination						
					GFI flexibility		Levy		Feebate
			Policy code	GFI scope	RU % of price	SU % of price	Levy USD/tCO_2eq	Reward % of cost gap	Reward % of cost gap
BAULG	BAU	Low	None						
23	Base	Low	X.4	TtW	120%	80%	No Levy		No Feebate
24	Base	Low	Y.4	WtW	120%	80%	No Levy		No Feebate
31	Base	Low	X.5	TtW	120%	80%	30 to 120	105% to 2040	No Feebate
32	Base	Low	Y.5	WtW	120%	80%	30 to 120	105% to 2040	No Feebate
46	Strive	Low	Y.2	WtW	No flexibility		150 to 300	90 to 65% to 2040	No Feebate

Scenario pairs 23/24 and 31/32 differ only in TtW and WtW, and their differences are observed in the Task 2 modelling outputs. The business-as-usual low growth (BAULG) scenario was used as a benchmark to determine ship-side cost intensity changes for each of the forecasted scenarios.

While some Member States on the Steering Committee would have preferred to have additional scenarios considered, the above approach was ultimately approved. Note that from DNV's perspective, feebate-based scenarios were expected to fall between the selected scenarios for Task 4.

Economic analysis

In terms of potential impacts from the five selected MTM scenarios and the speed reduction groups, two key components were found to drive the total commodity cost intensity changes that were analyzed:

- **Ship-side cost intensity changes.** These cost changes include all cost elements associated with the ship (capital expenditures, operational costs, regulation costs, carbon capture costs, global fleet capacity associated with speed reduction, etc.) for the forecasted years 2030, 2040, and 2050. Ship-side cost intensity changes modeled by DNV were assumed to be fully reflected in freight rates over the low growth BAU cost intensity scenario.
- **Commodity cost intensity changes** due to speed reduction. These cost changes are associated with the cargo (commodities) and include the daily cost increases of finance/interest, depreciation, and insurance costs that increase with each additional day resulting from speed reduction.

These cost changes are independent and additive which make up portions of the landed costs of commodities upon arrival at the destination port compared to BAU transit times. It is assumed in Task 4 that both costs intensity changes will be ultimately passed on to the final consumer.
The Task 4 economic analysis builds upon the APEC study and models and the CIA STM stakeholder analysis, and adds in maritime transport cost data used in Task 3 and provided by UNCTAD. Additionally, literature review (listed in an annex to this report) as well as close coordination and communication with DNV and UNCTAD have also been conducted. The Task 4 economic impact analysis evaluates the impacts of longer vessel transit times due to reduced speed on maritime transport cost and commodity cost (imports or exports) for the specific ship types, sizes, and ages associated with each of the commodities and routes identified for 2030, 2040, and 2050.

Task 2 economic modeling forecasts increased total commodity cost intensities, related to the ship-side costs associated with each scenario, on combinations of ship type, size, age, and speed reduction. Task 4 modeling estimates the economic impact of IMO measures on Member States (commodity value side) at the sectorial GDP importance in the national GDP level and more specifically the commodity cost intensity increases due to ship arrival delays, primarily from speed reduction. Together, the combination of Task 2 and Task 4 results covers both the ship-side (assuming 100% of ship-side cost intensity will be reflected in the freight rates) and the commodity-side for the specific case studies identified.

The main sources of data for economic analysis included a range of data provided by Member States for each commodity in two quantitative spreadsheet templates developed for the CIA STM. The data provided ranges from commodity specific to macroeconomic data, including:

- World Customs Organization (WCO) Harmonized System Code (HS code)[200]
- Gross Domestic Product (GDP) data including sector and country level data for both import and exports (the same year of data for import, export and GDP)
- Share of sea transport
- Employment generation
- Typical parcel cargo
- Typical vessel/service
- Freight rate
- Trade routes including countries and ports of origin and destination
- Route trade data including total volume and national share of volume
- Transit times and acceptable port arrival delays
- Cargo average inventory cost per day
- Typical cargo depreciation cost per day
- Typical cargo insurance cost per day
- Typical cargo financial cost per day
- Applicable cargo shelf life, in days
- Potential cargo substitution providers
- Transport mode change potential

In terms of potential impacts from the five selected MTM scenarios and the speed reduction groups, two key components were found to drive the total commodity cost intensity changes that were analyzed:

- Ship-side cost intensity changes. These cost changes include all cost elements associated with the ship (capital expenditures, operational costs, regulation costs, carbon capture costs, global fleet capacity associated with speed reduction, etc.) for the forecasted years 2030, 2040, and 2050. Ship-side cost intensity changes modeled by DNV were assumed to be fully reflected in freight rates over the low growth BAU cost intensity scenario.
- Commodity cost intensity changes due to speed reduction. These cost changes are associated with the cargo (commodities) and include the daily cost increases of finance/interest, depreciation, and insurance costs that increase with each additional day resulting from speed reduction.

[200] ITA, *HS Codes*.

These costs are added and are part of the landed costs of commodities upon arrival at the destination port compared to BAU transit times. It is assumed in Task 4 that both costs intensity changes will be ultimately passed on to the final consumer.

DNV in Task 2 modelled three speed reduction (SR) groups: SR 10%, SR 20% and SR 30%. Recall that speed reduction was a critical part of the STM and was one of the primary options for meeting the Carbon Intensity Indicator (CII). For the MTM, speed reduction is still a relevant element but diminished in that the SR 50% included in the STM was not brought forward.

In order to combine ship-side and commodity-side cost impacts, in coordination with UNCTAD and aligned with the modeling of Task 3, *ad valorem* freight rates from UNCTAD were used. This resulted in freight rate adjusted commodity cost intensity (FRACCI). Due to the specific nature of the Task 4 case studies, it was agreed between UNCTAD and Starcrest to use UNCTAD's specific rates and not the aggregated rates used in the state level modeling in Task 3. The rates used in both tasks are 2021 basis rates.

From the analysis of the 39 case studies, there are three types of case studies with respect to the cost intensity changes associated with the MTM:

- Ship-side cost intensity driven case studies. These case studies typically include low-value commodities, traded on shorter to medium distance routes, and have relatively medium to high *ad valorem* freight rates.
- Speed reduction commodity cost intensity driven case studies. These cases studies typically include high-value commodities, traded on medium to long distance routes, and have relatively low *ad valorem* freight rates.
- Balance driven case studies. These case studies were generally equally driven by both costs and associated with commodities traded on medium distance routes, with relatively medium *ad valorem* freight rates. These were less common than the other two types.

Member States organized national resources around each of their selected commodities. They organized the data packages and submitted them to the analysis team for review. Due to the challenging project timeline, not all necessary data could be collected by all Member States. For a limited number of case studies, missing data was sourced from:

- Trade related data – UN Comtrade database[201]
- Macroeconomic data – Member States official sources (central banks or national statistics offices) and/or the World Bank[202]
- Freight Rates – UNCTAD Transport Cost Data webpage[203] for all commodities and trade routes

[201] UN, *Comtrade database*.
[202] World Bank, *World Bank open data*.
[203] UNCTAD, *Transport Cost Data webpage*.

Global logistics networks are dictated by the needs of the shippers (cargo owners) who primarily value three metrics in designing their supply chains: cost, time, and reliability. These metrics are further influenced by a number of factors including market demand, port and inland infrastructure, availability of skilled labor, vessel and network capacity, transit times, government and regulatory issues, and environment and energy efficiency. These case studies focus on maritime transport only (port of origin to port of destination analysis), and not the entire or total supply chain costs. There are some Member States which relays on transshipment, so in these particular instances the case studies evaluated the intermediate ports too.

Most of the existing literature focuses on the economic impact from the ship operator's point of view; that is, the reduction in shipping cost due to the reduction of speed, as well, the environmental impact of doing so. Several earlier papers (Hong Liang 2014,[204] Kalimeris 2015-2016)[205] considered slow steaming as strategy during periods of weak demand, low freight rates, and/or high fuel costs, and as a way generally to reduce vessel operating costs (Stopford 2009). Starcrest research focused on the impact on the shipper's total landed cost and the economic impact on economies.

Transport costs are one of the key elements of trade costs. As noted below, the transportation cost percentage of a commodities price were estimated using the UNCTAD Transport Cost Data webpage for each commodity case study. Based on this information, transport costs ranged just below 10% of a commodity's total cost.

Longer transit times due to vessel speed reduction can increase a shipper's logistics costs. One of the main components to be adjusted on a shipper's supply chain is inventory. Longer transit times require more inventory in the pipeline; that, in turn, creates additional capital expense, inventory carrying costs, storage fees, and the possible adjustment of a shipper's supply chain. Surveys referenced in the literature indicate that shippers value the reliability of ocean transport more than longer transit times resulting from slow steaming. Industry reports that many cargo owners continue to request faster transit times.[206]

Some of the higher costs included in longer transit times include depreciation in the value of products, inventory holding costs, insurance cost, and interest/financing. Other technical literature also considers shippers' cash flow, lost sales, and production breakdown as additional potential impacts of slow steaming, as well as the impact on product shelf-life (food, pharmaceuticals, chemicals, fashion, ephemeral products, electronics, etc.). To counter some of these higher costs, transport in refrigerated containers can extend product storage life, if best practice techniques are adopted.

Reviewed literature (Supply Chain Costs: A Definitive Guide for 2024)[207] on supply chain and logistics costs considers inventory costs to be determined by the value of the inventory, the interest rate, and the inventory and service levels. The inventory cost includes the inventory holding cost and pipeline costs.

[204] Hong Liang, Lee. (2014). The Economics of Slow Steaming. Seatrade Maritime News, and comments by Ma Shou, professor at World Maritime Univ., Sweden
[205] Kalimeris, George. (2015-2016). The viability of slow steaming from a supply chain perspective though a break-even bunker price analysis. Master Thesis Erasmus University Rotterdam
[206] Lee, Chung-Yee; Lee, Hau L.; Zhang, Jibeng. (2013). *The impact of slow steaming on delivery reliability and fuel consumption.* The Hong Kong University of Science and Technology
[207] Throughput Inc., *Supply Chain Costs: A Definitive Guide for 2024, Anita Raj.*

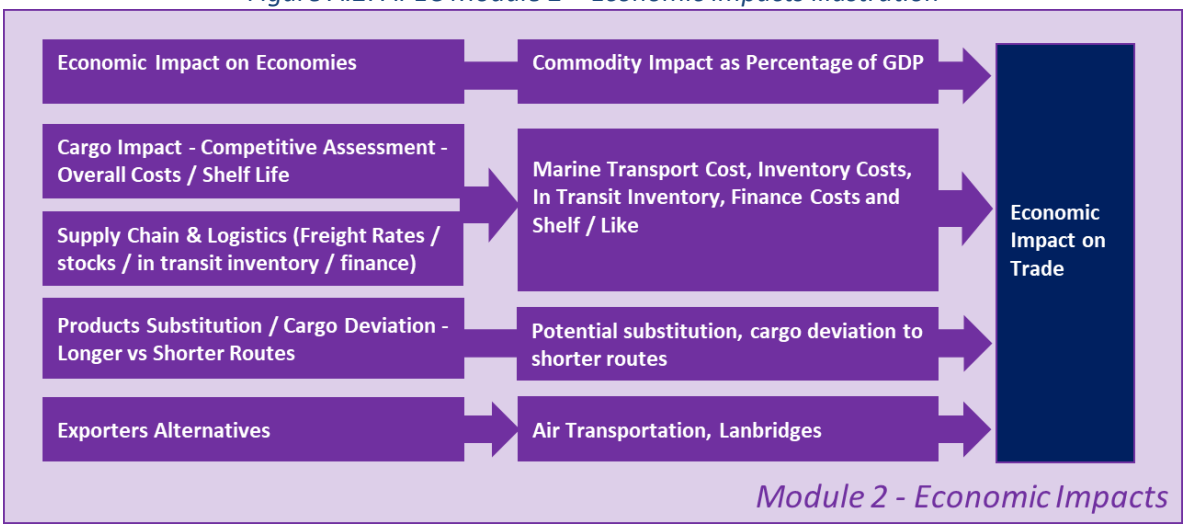
Note that the marginal value of time in a supply chain falls within a range of 0.4 – 0.8% of product unit cost per week.[208] This means that changes in lead-time have very small impacts on inventory costs.

Product characteristics are a determinant of selection of transport mode, and total transport costs also influence the modal choice. The selection of transport mode becomes a trade-off between in-transit time and freight charges. Even though it is not always possible, perishable, high-value products may select air transport over sea transport because the value of the product can absorb the cost of typically higher air freight. Time sensitive products are also more likely to select air transport over sea transport in order to meet their supply chain delivery deadlines. Other intermodal options as for example sea-air and air-sea transportation are also used and considered by cargo owners as a way to meet delivery timeframe.

For these case studies, the economic impact modeling related to longer transit times was accomplished by adapting and updating the APEC Module 2 – Economic Impacts to the CIA MTM. Module 2 inputs include data and results from Module 1, commodity data input and trade flows, and macroeconomic data inputs. The modelled outputs for each commodity case study provide economic impacts related to longer transit times due to vessel speed reduction, in days of delay.

The original objective of APEC Module 2 was to inform countries of the potential economic impacts on their economies due to vessel speed reduction. Speed reduction was an outcome of the IMO GHG Strategy, from a shipper's/trade view point, as illustrated in the figure below. Therefore, the APEC economic impact analysis focuses mainly on the cargo effects and the implications for a country (cargo owners – importers and exporters).

Figure A.2: APEC Module 2 – Economic impacts illustration



The economic impact analysis was based on total annual trade (full year volume) between the Member State selected pairs (export and import economies), in both total volume (kilos or tons) and value (US Dollars or local currency) for the year provided by the Member State. Three different speed reductions levels were modeled: 10%, 20%, and 30% slower. The assumption is that the total volume of yearly trade will not change simply because of long transit time from vessel speed reduction.[209] Our

[208] *Valuing Time in Supply Chains: Establishing Limits of Time-based Competition, 2019*
[209] Michael Maolni, Jomon Aliyas Paul and David M. Gigor, Slow steaming impacts on ocean carriers and shippers, 2013, Maritime Economics & Logistics

consulting team also assumes that there will be sufficient fleet availability to respond to ocean transport demand.

APEC Module 2 captures only ocean transit or time differentials from vessel speed reduction; no impact on the vessel or ship owner, or on inland transportation or warehousing is considered. The analysis is based on actual maritime distances for liners and bulk carriers, average vessel speed and a range of slow steaming speed options to calculate the impact of delay on annual commodity trade. Shippers' costs include interest or financial commodity cost, commodity depreciation cost, and insurance costs. The key elements analyzed to measure the economic impact of slow steaming include the following: time delay, GDP impact, financial/interest costs, depreciation costs, and insurance costs. These elements are further detailed and the equations have been adapted from Appendix B of APEC 2019, to use nomenclature that is more specific to the CIA MTM and to adapt the outputs of Task 2 such that they can be added to the outputs of Task 4 to estimate the total maritime transport cost intensity changes from speed reduction and MTM.

Time delay – number of hours or days that vessel speed reduction will add to the commodity arrival at the destination port compared with current observed speeds from the fleet analysis and speed reduction of 10%, 20%, and 30% using APEC Module 1.

GDP impact – for each commodity case study, the commodity is measured as their sectorial importance on total economy GDP. In order to measure the relative importance of the commodity category under analysis, the analysis also compares the impact in its sector category of GDP. Data provided by Member States, as well as data from the World Bank's website has been used as the source of information for total economy GDP and GDP sectors for the respective case studies. GDP impact was estimated using the equation below. ***Note this was not done for this study due to data gaps and the compressed project timeline.***

Equation 1

$$GDPI = SC\ GDP\ /\ GDP$$

GDPI – GDP impact from commodity case study
SC GDP – Sector category GDP, national currency or USD (currency)
GDP – national GDP, currency[210]

Financial/Interest cost – the financial cost of capital invested in inventory over time. This measures the impact of each hour or day of delay in the cost of the product due to cost of money or interest rate (for Member States was used when provided, else it was assumed to be 5% per year).[211] Financial cost increases due to longer transit times from speed reduction were estimated using the equation below. This approach is based on common business practices based on the value of money, the proportion of a loan or a line of credit charged as interest to the borrower, expressed as an annual percentage of the loan outstanding. Interest rates vary between countries because countries have different inflation rates, interest rates also vary between banks. For the purpose of this report, we have used the same rate for those MS which did not provide interest rates.

[210] The analysis was conducted in US dollar or national currency, as provided by MS.
[211] Lending Tree, *Assuming a line of credit 5%.*

Equation 2

$$FCI_{SR} = (CV \times ICR) \times (D_{SR} / 365.25)$$

FCI_{SR} – financial or interest cost increase change due to speed reduction, %
CV – yearly total export or import value, currency
ICR –interest cost rate, %/year
365.25 – number of days per year
D_{SR} – number of days added to marine transit due to speed reduction from fleet analysis, days

Depreciation cost – the cost allocation of a commodity, or reduction of the commodity value, over its useful life (for this economic analysis, it is assumed as 10% for containerized cargo that is non-perishable, 30% for perishable cargo, and 5% for dry and liquid bulk cargo per day).[212] Depreciation cost increases (DCR) due to longer transit times from speed reduction were estimated using the equation below.

Equation 3

$$DCI_{SR} = (CV \times DCR) \times (D_{SR} / 365.25)$$

DCI_{SR} – depreciation cost increase change due to speed reduction, %
CV – described previously
DCR – depreciation cost rate, %/year
365.25 – described previously
D_{SR} – described previously

Insurance cost – a cost paid by the cargo owner to protect their goods while in transit (the percentage used in the economic analysis is the one provided by MS, in case MS did not provide data, we assume it as 0.25% for container cargo (not reefer cargo), 0.50% for reefer container, 0.35% for dry bulk cargo, and 1% for fuel).[213] Insurance cost increases due to longer transit times from speed reduction were estimated using the equation below.

Equation 4

$$ICI_{SR} = (CV \times ICR) \times (D_{SR} / 365.25)$$

ICI_{SR} – insurance cost increase change due to speed reduction, %
CV – described previously
ICR – insurance cost rate, %/year
365.25 – described previously
D_{SR} – described previously

[212] APEC 2019
[213] Interview with Luis Alberto Alvarado, insurance cargo broker, Probroker

The total commodity cost intensity change due to longer transit times from speed reduction is estimated using the equation below.

Equation 5

$$TCCI_{SR} = (FCI_{SR} + DCI_{SR} + ICI_{SR}) \times D_{SR}$$

$TCCI_{SR}$ – total commodity cost intensity changes due to speed reduction, %
FCI_{SR} – described previously
DCI_{SR} – described previously
ICI_{SR} – described previously
D_{SR} – described previously

For each commodity case study, the $TCCI_{SR}$ was estimated by using a transit-weighted average of each ship type and size combinations identified.

As noted above, the Task 2 outputs are related to the ship-side cost intensity changes due to the various MTM scenarios. It is assumed that these cost intensity changes would be 100% covered in increases to the freight rates, consistent with Task 3. In order to relate freight rate cost intensity changes to the commodity cost intensity changes and add the outputs of Task 2 and 4, a freight rate adjusted commodity cost intensity (FRACCI) was estimated using the equations below.

Equation 6

$$FRACCI_{MTM} = SCI_{Task2} \times AVR_{CS}$$

$FRACCI_{MTM}$ – freight rate adjusted commodity cost intensity change from MTM, %
SCI_{Task2} – ship-side cost intensity increase change from Task 2 by average ship type, size, and age combination, %
AVR_{CS} – *ad valorem* rate which is the maritime transport cost percentage (freight rate percentage) of total commodity cost, by commodity and trade route case study, %

Equation 7

$$TCCI_{MTM} = TCCI_{SR} + FRACCI_{MTM}$$

$TCCI_{MTM}$ – total commodity cost intensity changes due to speed reduction and MTM, %
$TCCI_{SR}$ – described previously, %

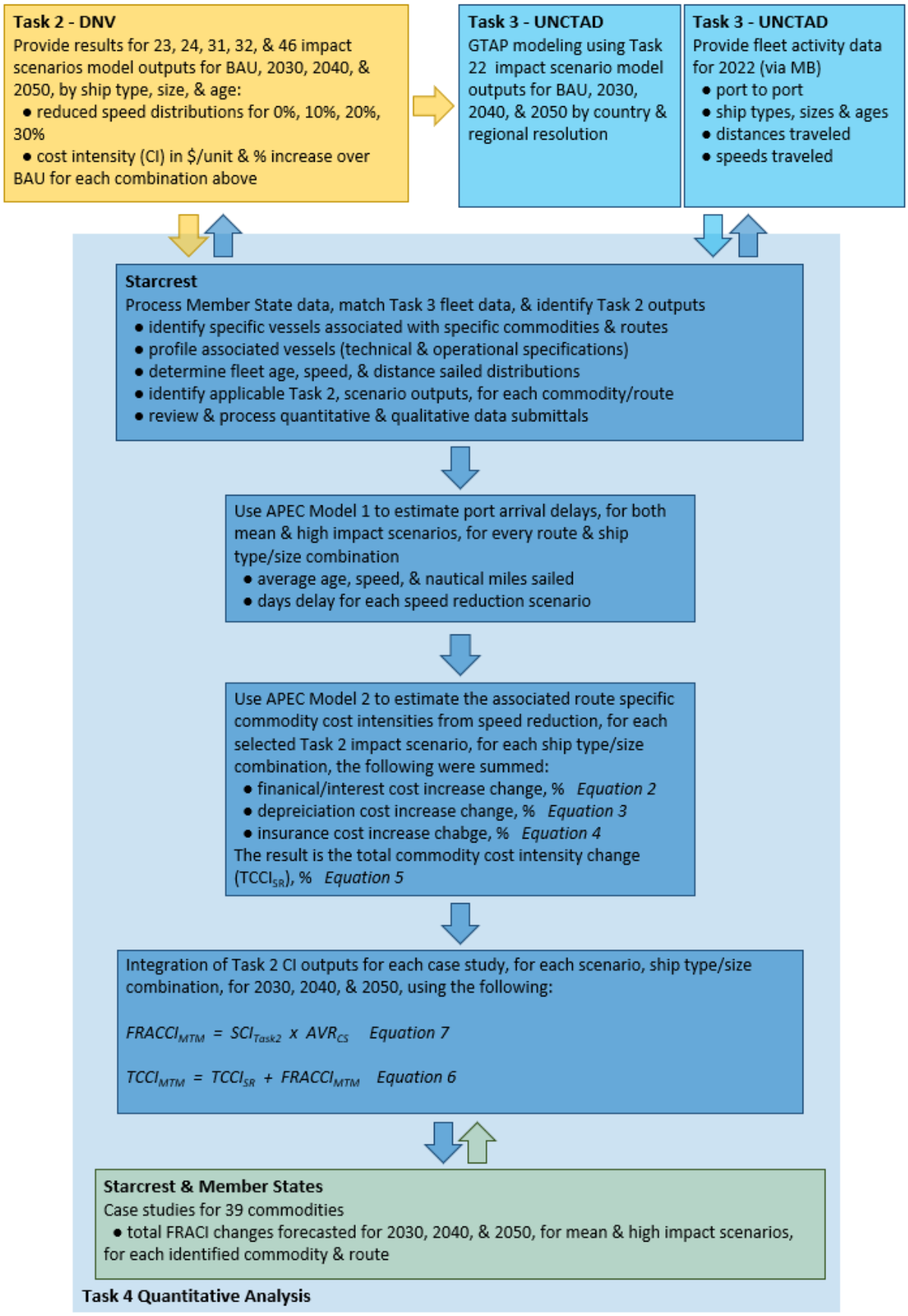
The approach was discussed and coordinated with UNCTAD and aligns with Task 3 modeling. The TCP_{CS} values used were the *ad valorem* rates obtained from the UNCTAD Trade-and-Transport Dataset[214] for each commodity case study. Note that they were found to range from 1.3% to 32.1%, with an average of 9.8% across all case studies.

These values are provided in each of the Member State section within the quantitative analysis. For more information see APEC 2019.

An illustration of the overall process for Task 4 is provided in Figure A.3 on the next page.

[214] UNCTAD, *Trade-and-Transport Dataset*

Figure A.3: Illustration of overall process of Task 4



Qualitative analysis

Building on the CIA STM and as noted above, one of the unique aspects of Task 4 is the gathering and inclusion of qualitative data and information provided by the Member States gathered from national resources. In many cases, the qualitative input has been prepared by industry stakeholders who are directly linked to the commodities for which they provided responses.

Qualitative information illuminates contextual elements and insights that are not identified in the quantitative analysis nor in the models used in other tasks. The qualitative information was collected based on commodity type and related to cost sensitivity and time sensitivity. Member State responses often included insights into competitiveness factors, the impact of disruptions such as Covid-19, future low carbon fuels and other factors for each of their commodities.

The Qualitative questions were developed by building upon the 12 questions from the STM, which focused on sensitivities associated with longer transit times due to vessel speed reduction. These and two additional questions posed by Starcrest relating to the MTM were provided to the Member States for comment. The Member States were invited to submit additional questions related to the MTM, focusing on sensitivities related to transportation cost intensity increases. Member States suggested two additional questions for a total set of 16 questions for each commodity. The Member States then took these questions to their national resource teams to provide input for each commodity. Responses were received during May and June 2024. The full qualitative question set is provided in Table A.3.

Table A.3: Full qualitative question set

IMO CIA MTM Task 4 Qualitative Questions	
Vessel speed reduction and cost sensitivity questions	
1	For time sensitive products, as for example, perishable, fashion, or high-value cargo, could the effectiveness and efficiency of transport be impacted negatively by speed reduction? How are these two factors measured? Is there any indicator to define/determine them? Are they different by commodity type? What would be an acceptable/or a critical delay?
2	If the perishable products can tolerate more refrigerated transport time, how much additional surcharge to the freight rate and/or energy will be necessary to keep them refrigerated during the trip? Would a delay alter the taste and texture of the products?
3	If the products tolerate more refrigerated time, how would this alter the taste and texture of the products?
4	What will be the likely impacts of speed reduction on the supply chain? How will the prices of the products be affected if they arrive late to a market? For bulk commodities that are supplying industrial feedstocks?
5	Would speed reduction in transportation lead to distortions in terms of competitiveness or result in loss of market share?
6	Would there be the possibility of changing the mode of transport from maritime transport to air transport? What would be the impact of a change to air or air-sea operations?
7	If the demand for a product is for a particular date or period, such as Christmas, New Year or Easter: What would be the impact of a speed reduction on that product? Would it be different from the impact on another product whose production and demand is more continuous or permanent?
8	What was the impact of COVID 19 in terms of logistics, and the availability of containers, port, and cargo delivery delays?
9	Is there any positive impact (such as energy savings or other benefits) of the implementation of a speed reduction requirement from the exporter point of view?

10	Did the change in shipping speed affect the cost of freight? If the cost changed, who received that cost?
11	Will paying for GHG emission affect the cost of freight, and who in the value chain will bear that cost (freighter, importer, exporter, producer)?
Fuel, vessel capacity, and other questions	
12	Are there current activities to produce future maritime fuels in the Member State? If so, are there plans to produce for national bunkering demands? Are there plans for export of future maritime fuels?
13	What will be the likely impacts of reduced capacity ships due to the lower energy density of future fuels compared to conventional fossil fuels? Can bigger ships be used? Will more ships be needed?
14	What are the potential implications for the commodities evaluated if the green future fuels are not available in country?
15	What are the implications of higher transport costs, tied to distance, on servicing existing & new export markets? What influence will trade agreements have, if any?
16	What questions should we have asked to more fully understand the impacts of potential vessel greenhouse gas reduction requirements on shipping, your population and your economy? Please give a reply to that question.

The qualitative information packages from the Member States were compiled and reviewed. The SWOT (which stands for Strengths, Weaknesses, Opportunities and Threats) framework was suggested by the SC as a modelling tool for the qualitative analysis and was included in the Task 4 ToR. The qualitative analysis focused on the two key themes; illustrating sensitivities to freight cost intensity changes, and potential longer transit times associated with slow steaming. The SWOT framework provides a standard structure to present strategic issues and organizes findings in a manner that is readily accessible by the reader. These are normally presented in a 4-box analysis structure, and were adapted for Task 4 in the following manner:

- **Strengths** – A strength is a resource or capacity the entity can use effectively to achieve its objectives.
- **Weaknesses** – A weakness is a limitation, fault, or defect that may keep the entity from achieving its objectives.
- **Opportunities** – An opportunity is any favorable situation in the entity's environment.
- **Threats** – Threats are situations or events where the entity could lose business.

The focus of each SWOT grid is to present how the MTM might impact the key issues that have been identified – costs and time. To accomplish this the opportunities section was defined as opportunities to mitigate weaknesses or risks related to the MTM and Threats (e.g., through planning or other operational improvements).

For each Member State, two SWOTs were used to compile responses across the selected commodities. For Argentina and the Cook Islands, which both had more than three commodities, commodities were grouped by type or illustrative commodities were selected to highlight the range of findings. An example is provided in Table A.4.

Table A.4: Example SWOT Analysis grid for qualitative responses

SWOT analysis: Chile, Cherries (simplified example)	
Strengths ➢ The Chilean growing season aligns with holidays in the northern hemisphere ➢ Cherry color is attractive to many cultures	**Weaknesses** ➢ Cherries are perishable and must arrive timely and in perfect condition ➢ Long shipping distances to markets (Asia, Europe) vs some potential competitors ➢
Opportunities (to adapt or mitigate) ➢ Seek modified atmosphere reefers to delay ripening. ➢ Seek earlier ripening breeds or growing areas ➢ Use funding from MTM to….	**Threats (Risks)** ➢ El Niño periodic storms jeopardize production and shipments ➢ Canal closures/restrictions threaten routes to some markets ➢ IMO GHG criteria may increase shipping costs more than some potential competitors

To provide consistency in data review the following process was established:

1. Data analysis
    a. For each Member State, qualitative information provided for each commodity was assessed based on commodity type (essential or trade good), cost sensitivity, and time sensitivity.
    b. Within each of those categories capture the types of sensitivities and how its impact is felt by the economy, the society and individuals.
    c. As the information was reviewed examples and quotes were captured that portray the impacts of these factors.
2. Identify the sensitivities for each Member State (through its representative commodities) to the cost and time impacts of the MTM options.
3. The Individual analysis results include modified SWOT analyses for time and cost sensitivities.
4. The final Trends and Conclusions section (Section 14) aggregates the impacts for similar commodities and similar types of Member States (SIDS, global south etc.) to highlight similarities, differences and other important factors.
5. The results are presented in a streamlined way with the purpose being to inform the evaluation of the quantitative results on MTM impacts and selections.

In Task 4, qualitative information was assessed based on commodity type (essential or trade goods), cost sensitivity, and time sensitivity. Within these three categories the types of sensitivities expressed in the Member States narratives were captured along with explanations as to how impacts will be felt economically, socially and at an individual level. Risks and opportunities to mitigate those risks were identified.

The overall report includes a section for each Member State which includes a qualitative section (designated as _.4). The Qualitative sections begin with a leading paragraph, noting that the information has been provided by the Member State. This paragraph also lists organizations that contributed to the answers and which commodities had qualitative responses provided. The Qualitative responses from each Member State are published in their entirety in the Appendices for that Member State and reviewed in a structured way to provide consistency to the results. Tools such as "SWOT" and their application for this study are described below under Use of analysis tools.

The qualitative section of each Member State analysis is organized to include the following:

- ***Transportation cost sensitivities***
  This section informs, for each country and their identified commodities, what the impacts are and any concerns and level of severity expressed in comments related to increased transportation costs. A SWOT is provided to illustrate findings consistently.

- ***Transit time sensitivities***
  This section informs, for each country and their identified commodities, what the impacts are and any concerns and level of severity expressed in comments related to increased ship transit times. A SWOT is provided to illustrate findings consistently.

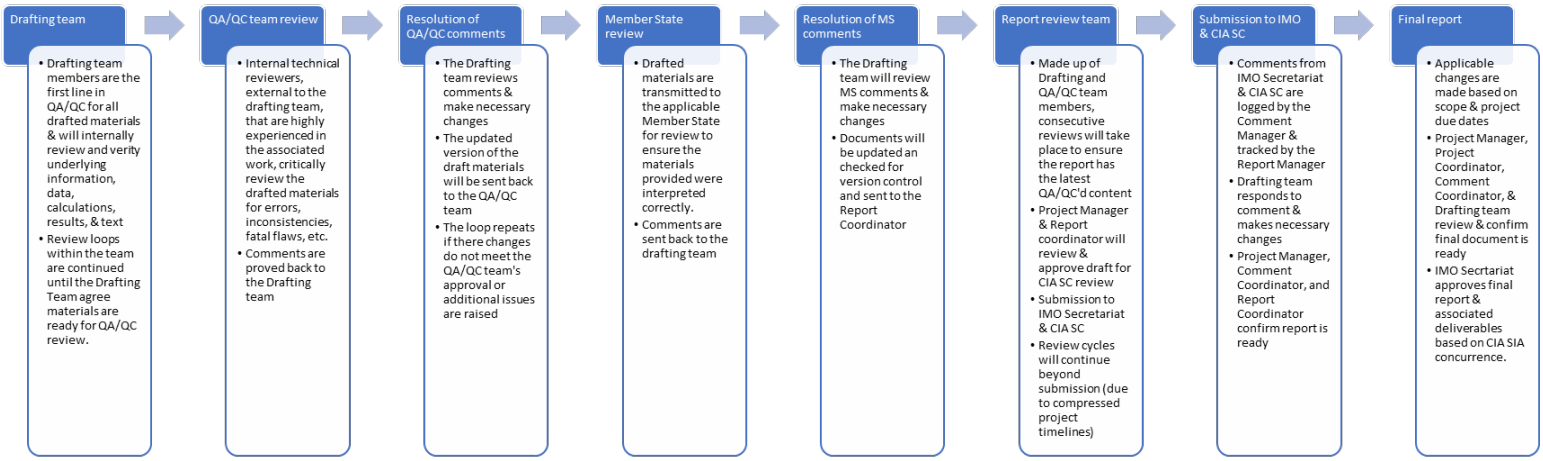
- ***Key findings***
  This section highlights the key findings collected from the Member State questionnaires and the analyses listed above. Key findings are those details that are critical in the understanding of issues, challenges, solutions and opportunities that aren't found in any of the other CIA Tasks. These will be relevant and constructive to the conversations at IMO related to the MTM, their potential impacts, and other relevant conversations.

Where views expressed by stakeholders are reported, Starcrest is documenting the views provided. Starcrest has not sought to check the validity of these views.

Quality assurance and control

Starcrest implemented its multi-review cycle quality assurance and control (QA/QC) approach for the conduct and completion of Task 4 deliverables. The approach ensures that information, data, calculations, results, and drafted sections of the analysis are reviewed multiple times from within the Drafting team, from an internal team of QA/QC experts outside the Drafting team, from the Member States that provided input, and ultimately the IMO. The QA/QC process is illustrated in Figure A.4.

Figure A.4: Illustrative QA/QC process for Task 4 deliverables



The Project team is grouped into teams and key individual positions who all ensure that the QA/QC approach is carried out.

- Drafting teams – these are members working on specific aspects of the project. Drafting teams are comprised of at least two individuals as no one is allowed to work unilaterally.
- QA/QC teams – are made up of two groups:
  - Draft teams reviewing content outside of their report contributions
  - Individuals reviewing content, but otherwise not contributing to the report
- Document Coordinator – person responsible for the assembly of the document, formatting, and tracks document versioning, supports comment incorporation, and other document related tasks.
- Comment Coordinator – person responsible for maintaining the current list of comments, responses, and status of the comments.
- Member State Coordinator (external) – responsible for regular coordination with the participating Member States and tracks deliverable status from Member States.
- Project Manager – responsible for overall Project outputs, working priorities, ensures that all the teams are working together, project timeline, communications with Member States, IMO, and CIA Steering Committee.

As noted in the proposal to the IMO Secretariat, the Starcrest Project Team members are made up mostly of highly experienced experts ranging from 30 to over 40 years of direct maritime industry experience, and are joined by junior support members ranging from 2 to over 10 years' experience.

For each aspect of the project, the Project Manager and the Starcrest Project Team scope out approach, sources of information to be used for each aspect, timeline, level of effort, and scheduling. Project Team members that are most suitable for the subject matter being discussed are selected to form a Drafting Team.

Drafting teams, as noted above, work on specific aspects of the project and they have at least two people involved. One individual may lead or all may lead, or one leads and the other is the first line reviewer.

Once materials are reviewed and approved by the drafting team to move up to next level of critical review, those materials go to the QA/QC team. The first QA/QC team review cycles are led by people with knowledge of the materials being drafted, but who are working on other Drafting teams. The materials are critically reviewed, comments and discussions ensue, and revisions are made by the Drafting team. This cycle ends when there are no more comments.

The materials are then submitted to the QA/QC team for the second round of critical review, this time by members that are not in any Drafting team. This could be one to many reviewers, each critically reviewing the materials and providing comments and feedback to the Drafting team. Necessary changes are made until there are not comments. The final materials are then sent to the Document Coordinator for inclusion in the report.

This happens across all project aspects until the report is assembled. Once it is assembled, all Drafting team members, Project Manager, Comment Coordinator, and selected QA/QC team members review the report. Comments are sent to the appropriate Drafting team, reviewed, and the necessary changes are made. This continues until there are no comments.

Unique to this project, there are 10 Member State sections that are based on information provided by the participating Member State. The Member State reviews took place ahead of the QA/QC team reviews, mostly due to the constrained project timeline.

The client, the IMO Secretariat and the CIA Steering Committee reviewed and submitted extensive comments to the report.

Uncertainties

The following are key uncertainties associated with this analysis:

- Since Task 4 integrates both the outputs of Task 2 and the data from Task 3, ***all the uncertainties with those two reports are applicable to this study*.**
- ***Ad valorem*** rates for each Member State were based on the detailed UNCTAD Trade and Development dataset that underlie Task 3's modelling of State impacts. There are no specific rates for Cook Islands nor Tonga, and an aggregated 'Pacific SIDS' rate was use. The uncertainty around those aggregated rates compared to the actual situation for each of those States is unknown.
- Related to Task 4, future ship-side cost impacts from Task 2 are aggregated by ship type, size, and age combinations. There are uncertainties associated when to apply the ship-side impacts of an aggregated combination when analyzing a limited number of specific ships. This is especially true when ships have similar aspects across to another ship type, size, and age combination. This becomes a '*boundary issue*.' For example, the two general cargo ships servicing the Cook Islands and Tonga are classified as general cargo 5,000 – 9,999 deadweight tonnes, that are 17 years old, hold just over 500 teus, design speed of 15 knots, and have cranes. In the Task 2 model there is also a category of container 0 – 999 teu with the same age group, which these ships also fit in with an average design speed of 15 knots, and may also have cranes. These ships operate solely in the Pacific, and in discussions with DNV, it was agreed that the impacts of the MTMs would be driven by compliance pooling options and the latter group was more representative.
- Related to Task 4, again when trying to apply aggregated cost impacts for specific ships, one of the key cost impacts is related to if the ship joins a compliance pool or not. At the global level this is not an issue, but when looking at specific ships, this becomes an uncertainty.

- Joining a ship pool to meet compliance of MTM. Compliance pools under the flexibility mechanism and while it is voluntary to join a pool, you must comply with the regulations. The modelling has shown that it is more cost effective to join a pool. DNV have not been able to ascertain the correct price.[215]
- There was no cross referencing/validation of stakeholder qualitative responses with publications, papers, or to confirm the response is consistent with economic or industrial theories. Similar to the CIA STM, the stakeholder input was to provide context from the national level from professionals and experts in the Member State that were associated/highly familiar with the trade. It was outside the scope of the Task 4 Work Plan to cross reference all the input received for the potential that respondent(s) is trying to 'influence' policy decisions.

Data gaps

The following data gaps were identified:

- *Ad valorem* rates specific to the Cook Islands and Tonga were not available on the UNCTAD Transport Cost Data website, so the Pacific SIDS group of *ad valorem* rates were used.
- Sectoral GDP data was only reviewed for Member States that directly provide it, as the compressed project schedule proved prohibitive of additional data aggregation.
- Arrival delay tolerances, for commodities that are sensitive to time delays, were provided by some of the Member States for some of the commodity case studies, but not all the time sensitive commodity case studies have that information related to their country/commodity.
- Updated information regarding commodity interest, depreciation, and insurance rates we received late and not in time for this publication. A sensitivity analysis will be conducted and presented to GHG EW-5.

[215] Email exchange with Tore Longa, Project Manager Task 2, 18 July 2024

Appendix B – Bibliography of selected resources

Appendix B – Bibliography of selected resources

Below is the list of selected references, bibliography, and literature reviewed

Allianz, Cargo risks with green ship schedules. *Allianz Global Corporate & Specialty, Risk Bulletin*, *No. 45,* Feb 2014.
https://web.archive.org/web/20180508105609/https://www.agcs.allianz.com/assets/PDFs/risk%20bulletins/Allianz%20Risk%20Control%20Bulletin%20-%20Cargo%20Risks%20web.pdf

de Almeida, Luiza Antoun; Guo, Si; Schaechter, Andrea; *Making Chile's Economy More Dynamic, Greener, and Inclusive,* February 2024*,* International Monetary Fund.
https://www.imf.org/en/News/Articles/2024/02/15/cf-making-chiles-economy-more-dynamic-greener-and-inclusive

APEC, *Analysis of the Impacts of Slow Steaming for Distant Economies,* submitted by Chile, ISWG-GHG 7/2/17, 7/2/25, Starcrest, December 2021.
https://www.apec.org/Publications/2019/12/Analysis-of-the-Impacts-of-Slow-Steaming-for-Distant-Economies

Australia Unlimited, *The APEC region trade and investment, 2016,* Australia Government - Department of Foreign Affairs and Trade.
www.dfat.gov.au/about-us/publications/Documents/apec-region-trade-investment.pdf

Carson, J. K.; Kemp, R. M.; East, A. R.; Cleland, D. J.; *The Impact of Slow Steaming on Refrigerated Products from New Zealand,* ICR 2015, August 16-22, Yokohama, Japan.

Cepeda, Maricruz A. F. S.; Guimares Marujo, Lino; Assis, Luis Felipe; Caprace, Jean-David, Effects of Slow Steaming Strategies on a Ship Fleet. 26º, 2016, Congresso Nacional de Transporte Aquaviário, Construção Naval e Offshore – SOBENA.
www.researchgate.net/publication/311262105_Effects_of_Slow_Steaming_Strategies_on_a_Ship_Fleet

Centre for International Economy, Ministry of Foreign Affairs*, International Trade and Worship, Argentine trade exchange – First five months of 2024*.
https://cancilleria.gob.ar/en/cie/news/argentine-trade-exchange-first-quarter-2024

Cook Islands News, Article: *People are Leaving the country and not coming back,* 20 February 2021, Caleb Fotheringham.
https://www.cookislandsnews.com/internal/features/weekend/people-are-leaving-the-country-and-not-coming-back/

DGFT, *Belize, Belize Trade Performance*, Trade Intelligence Unit.
https://www.dgft.gov.bz/belize-trade-performance/

DNV, *Comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures, Task 2: Assessment of Impacts on the Fleet, (CIA Task 2 Report), June* 2024.

Elzarka, Sara; Morsi, Maha, *The Supply Chain Perspective on Slow Steaming*, 2014, College of International Transport & Logistics, Arab Academy for Science, Technology & Maritime Transport, Alexandria, Egypt.

(A)Encyclopedia Britannica, *Belize | History, Map, Flag, & Population*, July 2024, O. Nigel Bolland, William J. Griffith.
https://www.britannica.com/place/Belize

(B)Encyclopedia Britannica at *Brazil | History, Map, Flag, & Population*, July 2024, Ronald Milton Schneider, Richard P. Momsen.
https://www.britannica.com/place/Brazil

(C)Encyclopedia Britannica at *Chile | History, Map, Flag, & Population*, July 2024, César N. Caviedes, Marcello A. Carmagnani.
https://www.britannica.com/place/Chile

(D)Encyclopedia Britannica, *South Africa – Economy, Mining, Manufacturing*, July 2024, Randolph Vigne, Christopher C. Lowe.
https://www.britannica.com/place/South-Africa/Economy

(E)Encyclopedia Britannica, *Economy of South Africa*, July 2024, Colin J. Bundy, Andries Nel.
https://www.britannica.com/place/South-Africa/Economy

(F)Encyclopedia Britannica at *US, History, Map, Flag, & Population*, July 2024, Adam Gopnik, Harold Whitman Bradley.
https://www.britannica.com/place/United-States

Evgenitaki, Maria-Eñeftjeria, *Slow steaming: economic and legal impacts*, 2015, University of the Aegean.
www.core.ac.uk/download/pdf/44289816.pdf

Faber, Jasper (CE Delft); Nelissen, Dagmar (CE Delft); et.al., *Regulated Slow Steaming in Maritime Transport, an assessment of options, costs and benefits*, 2012.

(A)Finnsgård, C.; Kalantari, J., Raza, Z. et al. J. shipp. trd. (2018) 3: 8.
www.doi.org/10.1186/s41072-018-0033-2

(B)Finnsgård, C.; Kalantari, J.; Roso, V.; Woxenius, Johan, *Slow Steaming from shippers perspective*, 2015, Chalmers University of Technology

FREIGHTOS, *Ocean Freight Shipping,* 23 February 2023.
https://www.freightos.com/freight-resources/ocean-freight-explained/

Gemini Shippers Group, IMO 2020 - *What every shipper needs to know*, 2019, IHS and JOC white paper.
www.seaburycapital.com/wp-content/uploads/2019/02/GeminiWhitepaper2019-v2b-abbb.pdf

Gov.br, *Brazil recorded a trade surplus of USD 2 billion in the fourth week of March*, Presidência da República, April 2024.
https://www.gov.br/planalto/en/latest-news/2024/04/brazil-recorded-a-trade-surplus-of-usd-2-billion-in-the-fourth-week-of-march

(A)Government of the Cook Islands, *Census of Population and Dwellings 2021-2022*, CISO.
https://stats.gov.ck/2021-census-of-population-and-dwellings/

(B)Government of the Cook Islands*, Cook Islands Economic Development Strategy 2030,* MFEM.
https://www.cookislands.gov.ck/images/ECON/2-EDS_Submission_Summ_Jan21_15.pdf

(C)Government of the Cook Islands, *International Merchandised Trade Statistics*, CISO.
https://stats.gov.ck/overseas-trade/

Halim, Ronald A.; Smith, Tristan; Englert, Dominik; Understanding the Economic Impacts of Greenhouse Gas Mitigation Policies on Shipping. What is the State of the Art of Current Modeling Approaches, 2019, World Bank Group.
www.documents.worldbank.org/curated/en/215561546957017567/pdf/WPS8695.pdf

Hong Liang, Lee, *The Economics of Slow Steaming. Seatrade Maritime News*, 2014, and comments by Ma Shou, professor at World Maritime University, Sweden.

IBGE, *Censo 2022 Panorama*, May 2023.
https://censo2022.ibge.gov.br/panorama/

INE of Chile, *Population and Housing Censuses*, 2017.
https://www.ine.gob.cl/statistics/social/population-and-housing-censuses

INEI, *Información estadística*.
https://www.gob.pe/inei

(A)INDEC*, Índice de precios al consumidor. Cobertura nacional. Mayo. Índices de precios. Vol. 8, nº 18,* 2024.
https://www.indec.gob.ar/uploads/informesdeprensa/ipc_06_24AF3B6493C2.pdf

(B)INDEC, Complejos exportadores. Año 2022. *Informe Comercio Exterior vol. 7, n° 4*, 2023.
https://www.indec.gob.ar/uploads/informesdeprensa/complejos_03_2309E029401F.pdf

International Monetary Fund, IMF DataMapper, *Togo*.
https://www.imf.org/external/datamapper/profile/TGO

Kalimeris, George; *The viability of slow steaming from a supply chain perspective though a break-even bunker price analysis, Master* Thesis, 2015-2016, Erasmus University Rotterdam.

Karampampa, Iro Christina, *The impact of slow steaming on shippers and on their supply chains: a window of opportunity for other transportation modes*, Case Study on China-Europe Route, 2014, Erasmus University Rotterdam.

Kingdom of Tonga, *Getting Around Tonga*, 2011, Tonga Visitors Bureau.
https://thekingdomoftonga.com/getting-around-tonga/

Kloch, Lars, *Is Slow Steaming Good for the Supply Chain?* April 2013, Inbound Logistics.

Kowalak, Przemysław, Chief Engineer's Hands-On Experience of Slow Steaming Operation, 2015, Maritime University of Szczecin, Poland.

Lee, Chung-Yee; Lee, Hau L.; Zhang, Jibeng; *The impact of slow steaming on delivery reliability and fuel consumption*, 2013, The Hong Kong University of Science and Technology.

Lending Tree, *Assuming a line of credit 5%*.
https://www.lendingtree.com/business/rates/

Lynn, Htut; Wai, Thet; Impact of Slow Steaming on Shipper's Inventory, 2014, Bachelor Thesis - Erasmus University Rotterdam.

Maggs, John; Hemmings, Bill; *Transport & Environment Members of the Clean Shipping Coalition. Slow steaming saves money and the climate*, No. 3m, October 2012, Acid News.

Mallidis, Ioannis; Eleftherios Iakovou; et.al., *The impact of slow steaming on the carriers' and shippers' costs: The case of a global logistics network*, 2018, Elsevier: Transportation Review Part e: Transportation and Logistics Review.

Maolni, Michael; Paul, Jomon A.; Gigor, David M.; Maritime Economics & Logistics, *Slow steaming impacts on ocean carriers and shippers*, 2013.
https://link.springer.com/article/10.1057/mel.2013.2

(A)MARAD, *Office of Ports and Waterways*, February 2024.
https://www.maritime.dot.gov/ports/office-port-infrastructure-development/office-port-infrastructure-development

(B)MARAD, *Trading Economics, United States Balance of Trade*, May 2024, Bureau of Economic Analysis.
https://tradingeconomics.com/united-states/balance-of-trade

Marine Benchmark, Advanced Maritime Data Analytics.
https://www.marinebenchmark.com/

Marine Insight, *8 Major Ports in Chile*, 3 May 2022, Shilavadra Bhattacharjee.
https://www.marineinsight.com/know-more/8-major-ports-in-chile/

MFAITW, *Argentine trade exchange – First quarter of 2024*, CEI.
https://cancilleria.gob.ar/en/cie/news/argentine-trade-exchange-first-quarter-2024

Michigan Journal of Economics, *The Economic Geography of the United States*, March 2021, Nicolas Costa.
https://sites.lsa.umich.edu/mje/2021/03/09/the-economic-geography-of-the-united-states/

Ministry of Public Utilities, Energy, Logistics, and E-Governance, Belize, *Belize Annual Energy Report 2022 Edition*, Energy Unit, 2023.
https://www.mpuele.gov.bz/wp-content/uploads/2023/09/Energy-Report-2022-Final_25-Aug-1.pdf

Mundo Maritimo, *Shipping companies and NGOs express support for IMO to regulate the speed of navigation*, 2019.
www.mundomaritimo.cl/noticias/navieras-y-ongs-expresan-apoyo-a-la-omi-para-regular-la-velocidad-de-navegacion

Pacific Community, *Improving the Availability of Maritime Transport Cost Data in the Pacific: Tonga Country Report*, 2022, MTCC Pacific.
https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/SPC Country reports/Transport cost data_04_Tonga.pdf

(A)Peru Information, *Mineral Industry of Peru*.
https://www.peruinformation.org/mining

(B)Peru Information, *Agriculture*.
https://www.peruinformation.org/agriculture-c1x01

Port of Belize, *About Us*
https://www.portofbelize.bz/about-us

Psaraftis, Harilaos N., *Optimization for Sustainable Shipping,* Chapter 10, 2019, Technical University of Denmark. Provided by CHILE.

The CoolStar.
www.theloadstar.com/coolstar/cost-hampers-iot-monitoring-in-perishables-supply-chains-despite-airline-efforts/

Putzger, Ian, *Cost Hampers IoT Monitoring in Perishables Supply Chains, Despite Airline Efforts*, 2019.

Raj, Anita; Throughput Inc., *Supply Chain Costs: A Definitive Guide for 2024, December 2023.*
https://throughput.world/blog/supply-chain-costs/

Regulated Slow Steaming in Maritime Transport, *An Assessment of Options, Costs and Benefits*, 2012, CE Delft, Univ. of Southampton, and the ICCT, commissioned by Transport and Environment and Seas at Risk.
www.cedelft.eu/publicatie/regulated_slow_steaming_in_maritime_transport/1224

(A)Republic of South Africa, *Census Dissemination*, 2022, SSA.
https://census.statssa.gov.za/#/statsbytheme

(B)Republic of South Africa, *Geography and climate*, South African Government.
https://www.gov.za/about-sa/geography-and-climate

(C)Republic of South Africa, *People of South Africa*, South African Government.
https://www.gov.za/about-sa/south-africas-people

Science Direct, *Chile: On the road to global sustainable mining*, June 2023, Juan Ignacio Guzmán.
https://www.sciencedirect.com/science/article/abs/pii/S0301420723003975

SIB, *Key Findings of the 2022 Population and Housing Census*, 2023.
https://sib.org.bz/census/2022-census/

Smith, T. W. P.; Jalkanen, J. P.; B. Anderson, et. Al, Third IMO GHG Study 2014; IMO London, April 2015.
www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/Third%20Greenhouse%20Gas%20Study/GHG3%20Executive%20Summary%20and%20Report.pdf

(A)Smith, Tristan; Hoffman, Jan; Elgert, Dominik; Halim, Ronald, World Bank Webinar on Effects of GHG Reductions on Shipping, 2019.

(B)Smith, Tristan; Jan Hoffman; Dominik Elgert; Halim, Ronald; Maritime Transport Costs and Trade Flows, 2019, Discussion paper for the International Transport Forum. World Bank Group, Open Learning Campus.
www.drive.wps.com/d/ADaR7836_7shloCA_f_dEA

Stopford, Martin; *Maritime Economics 3e*, 2008, Routledge.
https://www.taylorfrancis.com/books/mono/10.4324/9780203891742/maritime-economics-3e-martin-stopford

Tezdogan, Tahsin; Atila Incecik, *Assessing the Impact of a Slow Steaming Approach on Reducing the Fuel Consumption of a Containership Advancing in Head Seas*, Vol. 14, 2016, Elsevier: Transportation Research Procedia.

Thomas, Jasper Faber; Huigen; Dagmar, Neilssen; *Regulating speed: a short term measure to reduce maritime GHG emissions*, 2017, Delft University.
www.cleanshipping.org/download/Slow-steaming-CE-Delft-final.pdf

Times Books Group, *The Times comprehensive atlas of the world,* 1999, pp. 88–89, various authors.

Todts, William, *Smarter Steaming Ahead. Transport & Environment,* 2017.
www.transportenvironment.org/publications/smarter-steaming-ahead

(A)Togo Statistics Department, *Population and Housing Factsheet 2021,* October 2022.
https://tongastats.gov.to/census-2/population-census-3/census-report-and-factsheet/

(B)Togo Statistics Department, *National Accounts Division*, March 2023.
https://tongastats.gov.to/statistics/economics/national-accounts/

UN, *Comtrade database*.
https://comtradeplus.un.org/

(A)UNCTAD, *Argentina: Transforming port management for sustainable development*, May 2024.
https://unctad.org/news/argentina-transforming-port-management-sustainable-development

(B)UNCTAD, *Comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures, Task 3 Assessment of Impacts on States, Final Report*, July 2024.

(C)UNCTAD, General and Maritime Profiles: *UNCTAD Statistics - General Country Profiles*, April 2024.
https://unctadstat.unctad.org/CountryProfile/en-GB/index.html

(D)UNCTAD, *Transport Cost Data*.
https://unctadstat.unctad.org/EN/TransportCost.html

UNECE-UNCTAD, *Climate Change Impacts on International Transport Networks*, 2010.
www.studylib.net/doc/10567803/climate-change-impacts-on-international-transport-networks

Vale, *Vale and Port of Açu sign agreement to develop a Mega Hub for the decarbonization of steelmaking*, 26 September 2023.
https://vale.com/w/vale-and-port-of-acu-sign-agreement-to-develop-a-mega-hub-for-the-decarbonization-of-steelmaking

(A)World Bank Group, *The World Bank - 170 Countries*.
https://www.worldbank.org/en/where-we-work

(B)World Bank Group, *Togo*, 2024, DataBank.
https://data.worldbank.org/country/TG

Worldometer, *Countries in the world by population*, July 2023. (Projections based on *2022 Revision of World Population Prospects, UN DESA Population Division.*)
https://www.worldometers.info/world-population/population-by-country/

Zanne, Mariana; Pocuca, Milojka; Bajec Patriciaja, *Environmental and Economic Benefit of Slow Steaming,* 2013, University of Ljubljana.