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REDUCTION OF GHG EMISSIONS FROM SHIPS

Report of the Steering Committee on the comprehensive impact assessment of the basket of candidate GHG reduction mid-term measures
Executive summary of the report on Task 3 (Impacts on States)

Submitted by the Secretariat

SUMMARY

Executive summary:	This document contains the executive summary of the report on Task 3 (Impacts on States) of the comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures.
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.4, MEPC 82/INF.8, MEPC 82/INF.8/Add.1, MEPC 82/INF.8/Add.2, MEPC 82/INF.8/Add.3 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). At its eleventh meeting, the Steering Committee endorsed the moderator's suggestions on the outcome of Task 3 (Impacts on States), as set out in paragraph 27 of document MEPC 82/7/4. This document provides the executive summary of the report of Task 3 on the assessment of the impacts on States conducted by UN Trade and Development (UNCTAD), set out in the annex. The full report on Task 3, together with the collation of substantive comments by members of the Steering Committee and external quality assurance and quality control (QA/QC) reviewers and responses provided by UNCTAD, is set out in document MEPC 82/INF.8/Add.2.

Action requested of the Committee

2 The Committee is invited to consider, in conjunction with document MEPC 82/7/4, the executive summary of Task 3 (Impacts on States) of the comprehensive impact assessment of the basket of candidate GHG reduction mid-term measures, taking into account the full report and the collation of substantive comments by members of the Steering Committee and external QA/QC reviewers contained in document MEPC 82/INF.8/Add.2, and to take action as appropriate.

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ANNEX

Disclaimer

1 This report has been completed by UN Trade and Development (UNCTAD). It contains the report on Task 3 on the assessment of the impacts of the candidate measures on States of the comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures.

2 While 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 IMO or the Steering Committee on the comprehensive impact assessment of the basket of candidate mid-term measures.

3 This comprehensive impact assessment of the basket of mid-term GHG reduction measures consists of five distinct but interrelated tasks for which different reports have been prepared. Task 3 of the comprehensive impact assessment of the basket of candidate mid-term GHG reduction measures is being undertaken solely to assist 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.

4 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.

Executive summary

Introduction

5 This final report sets out the main findings of Task 3 modelling and analytical work conducted in accordance with the IMO Revised work plan for the conduct of the comprehensive impact assessment of the basket of mid-term measures (MEPC 81/7, annex 3) and with the *Revised procedure for assessing impacts on States of candidate measures* contained in MEPC.1/Circ.885/Rev.1.

6 The Steering Committee (SC) requested that UNCTAD focus its assessment on the ten policy scenarios featured in table 1.[1] Four out of the ten scenarios include three different revenue disbursement options and one option with no revenue disbursement. As a result, the overall number of simulation runs was set at 22.

[1] The policy scenarios are conceptual. They do not represent the specific proposals that have been made for IMO mid-term measures.

Table 1: Task 2 policy scenarios selected for analysis under Step 2 of Task 3

Scenario number	Emission trajectory	Seaborne trade growth	Policy code	GFI scope	GFI flexibility		Levy		Feebate(% of gap)	Revenue disbursement modelling
					RU[2] (% of price)	SU[3] (% of price)	Levy ($/tCO$_2$eq)	Reward (% of gap)		
21	Base	Low	X.1	TtW	No flexibility		No levy		None	-
22	Base	Low	Y.1	WtW	No flexibility		No levy		None	-
23	Base	Low	X.4	TtW	120 %	80%	No levy		None	-
24	Base	Low	Y.4	WtW	120 %	80%	No levy		None	-
26	Base	Low	Y.2	WtW	No flexibility		150-300	90-65% to 2040	None	Yes
31	Base	Low	X.5	TtW	120 %	80%	30-120	105% to 2040	None	Yes
32	Base	Low	Y.5	WtW	120 %	80%	30-120	105% to 2040	None	Yes
36	Base	Low	Y.6	WtW	120 %	80%	No levy		105% to 2040	-
43	Strive	Low	X.4	TtW	120 %	80%	No levy		None	-
46	Strive	Low	Y.2	WtW	No flexibility		150-300	90-65% to 2040	None	Yes

7 UNCTAD's modelling builds on the outputs of Task 2, produced by DNV. The report by DNV defines two greenhouse gas (GHG) emission trajectories to 2050: Base and Strive trajectories, both on the well-to-wake (WtW) basis. The Base trajectory targets a 20% reduction of the total annual GHG emissions from international shipping by 2030 and a 70% reduction by 2040, compared to 2008 levels. The Strive trajectory targets a 30% reduction by 2030 and 80% by 2040. Of the ten scenarios, eight assume a Base GHG emissions trajectory (scenarios 21, 22, 23, 24, 26, 31, 32 and 36), whereas two (scenarios 43 and 46) assume a Strive GHG emissions trajectory.

8 The examined policy scenarios employ a low seaborne trade growth projection (consistent with Task 2 modelling), and may address WtW GHG emissions or tank-to-wake (TtW) GHG emissions with sustainability criteria.

9 Four scenarios include a levy, with a higher levy price applied in scenarios 26 and 46 compared to a lower levy price in scenarios 31 and 32, which also incorporate a GHG fuel intensity (GFI) flexibility compliance mechanism. The lower-levy scenarios differ in their GFI scope: TtW under scenario 31 and WtW under scenario 32. The higher-levy scenarios both follow a WtW GFI scope but differ in their GHG emissions trajectory. All ten scenarios include a GFI requirement. Six scenarios include a GFI flexibility compliance mechanism (scenarios 23, 24, 31, 32, 36 and 43). One scenario includes a feebate mechanism (scenario 36). Across the scenarios used, there are systematic variations between the scenario specification parameters, allowing to gain insights into the sensitivity of the outputs and the impacts to flexibility mechanisms, feebate mechanisms, a levy (at one lower and one higher price), and variations in revenue disbursement (as well as emissions trajectory and GFI scope).

2 Remedial unit, i.e. Emission units purchased by ships with negative compliance balance from the Revenue body at a set price under the GHG Fuel Intensity flexibility mechanism.

3 Surplus unit, i.e. Emission units sold by ships with positive compliance balance to the Revenue body at a set price under the GHG Fuel Intensity flexibility mechanism.
Source: DNV (2024a).

10 The present report describes the applied methods and presents the simulated percentage impact on imports, exports, gross domestic product (GDP) and consumer prices due to the increase in shipping time and maritime transport costs at three points of time, namely 2030, 2040 and 2050, in response to the hypothetical policy measures and due to the disbursement of the hypothetical revenues generated. Throughout this report, impacts on imports, exports and GDP are reported as impacts on real GDP and on import and export volumes or quantities.

11 Results presented in this report are aggregated by groups of economies with particular focus on the developing economies, the least developed countries (LDCs) and the small island developing States (SIDS), in accordance with the Terms of Reference of Task 3. The results for the world total are reported for comparison purposes. Detailed results at the level of States or, in some cases, slightly broader aggregates, are provided in the annex.

12 For each of the scenarios featuring a levy, the impacts of three different hypothetical revenue disbursement schemes are considered: (1) with revenues disbursed to all States, (2) with revenues disbursed to developing economies, SIDS, and LDCs only, (3) with revenues disbursed exclusively to SIDS and LDCs as well as one intermediate scenario without any revenue disbursement. Under the three schemes, disbursements per State are proportional to the impact of the policy measure before revenue disbursement on GDP, and to population size. Meanwhile, the scheme without disbursement of revenues serves as a control scenario to separate the effects of different components. Note that there has been no IMO decision or recommendation as to whether any, some or all of any revenues raised by any measure would be disbursed directly to States.

13 As it is not possible to cover with a sufficient amount of detail all scenarios in this executive summary, a selection of scenarios is presented to illustrate different policy options. These illustrations do not imply any judgement by UNCTAD about preferences or priorities. Furthermore, the interpretation of the GTAP modelling results presented in this report should be interpreted while taking into account the main assumptions and limitations that were identified, including the assumptions of fixed structure of economies and instantaneous revenue distribution and benefits in the GTAP, among others.

Methodology

14 The impacts of the policy measures on GDP, imports, exports and consumer prices were modelled in accordance with MEPC.1/Circ.885/Rev.1, specifically paragraph 18 on "the assessment of impacts on States consists in translating the impacts on fleet to impacts on States (e.g. trade and GDP changes)". As specified, the modelling incorporates both a computational general equilibrium model, and transport/logistics modelling with the structure as follows (figure 1):

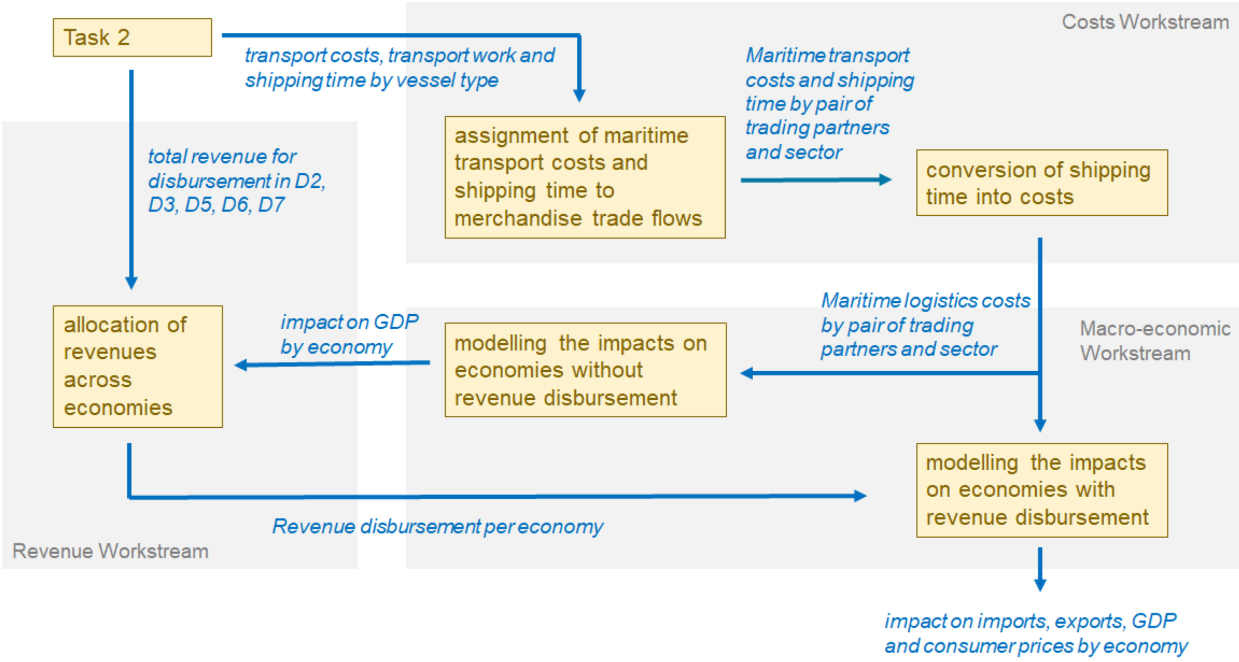

Figure 1: Main modelling steps and data flows

15 The *Costs Workstream* (see figure 1) uses the data on maritime transport costs, shipping time and transport work compiled under Task 2 and combines them with Marine Benchmark data on individual ship voyages and MDS Transmodal data on bilateral merchandise trade. The aim was to compile mean maritime transport costs and shipping time per metric ton of traded goods, differentiated by commodity group and pair of trading partners. Changes in shipping time are subsequently converted into their cost equivalents and added to the changes in maritime transport costs. Maritime transport costs and the cost equivalent of shipping time are then combined to generate one single variable measuring the change in maritime logistics costs. This variable is fed into the *Macro-economic Workstream* to simulate impacts on economies' total imports and exports, GDP and consumer prices. The *Macro-economic Workstream* used the GTAP (Global Trade Analysis Project) model, a widely used computational general equilibrium (CGE) model designed to analyse international trade policies and their economic impacts.

16 For certain scenarios that lead to the accumulation of revenues, the *Revenue Workstream* was run. Revenues remaining after rewarding eligible fuels were allocated to eligible countries according to the magnitude of the negative impacts (reductions in GDP relative to BAULG) of the measures without revenue disbursement and taking into account the income per capita. Three disbursement scenarios distinguished three groups of eligible countries: all countries; all developing countries; and, exclusively, SIDS and LDCs.

17 Under the *Cost Workstream* that focused on shipping costs and time, available data allowed UNCTAD to present results for 175 economies. Under the GTAP modelling, available data and computational constraints required UNCTAD to group some economies into aggregates, mostly regional groupings, reporting results for 111 economies and groups of economies.

18 The above actions set out under the various work streams are executed for every selected policy scenario (table 1), and, where applicable, taking into account the three different revenue disbursement schemes and one control case, for each of the following time horizons: 2030, 2040 and 2050. Throughout the analysis, in line with Task 2, impacts on monetary values are measured as percentage changes in constant prices.

Limitations

19 Given the tight project timelines, the modelling work that simulated the impact on States, under a range of policy scenarios, was only feasible by making several assumptions and simplifications. The policy scenarios are conceptual and not based on, or representing, specific proposals that have been made for IMO mid-term measures.

20 Several limitations characterize the methods that have been described above. Many of these limitations are common to all scenarios and should have a minimal consequence on the comparative analysis of scenarios. However, some are specific to how a given scenario has been modelled – particularly in relation to how scenarios with revenues are modelled. It is therefore critical to bear in mind some of the underlying limitations when using the results of the present impact assessment for any further purposes.

21 Forecasting uncertainty affects the time trends in the target variables, which increase over time. Hence, within the present report, these target variables are not displayed in great detail. The GTAP simulations use a static approach, making the assessment of impact methodologically independent from time trends. Even if future actual values differ from projections, the relative impact of GHG reduction measures remains unaffected by forecast errors. The focus is on impacts rather than changes in absolute values over time, with most tables showing relative impacts compared to BAULG, rather than comparing time trends under different scenarios. It is still useful to set the impact in perspective with the trend over time, as GDP may be negatively impacted by GHG reduction measures but still show growth.

22 Given the significant differences between the world economies and taking into account relevant literature, in its analysis, UNCTAD divided the shock equally between importers and exporters, allocating 50% of the shock from the increase in maritime logistics costs to axs (exports) and 50% to ams (imports) (see section 4.6.1 for more information regarding the methodology). The 50/50 modelling approach strikes a balance between these impacts. Therefore, there is a possibility that the impacts have been either overestimated or underestimated. A sensitivity analysis conducted to ensure scientific conference indicates the possible magnitude of the impact.

23 The transport costs database used in GTAP 11 employs estimated modal shares, calculated based on the fractional share of the transport margin attributable to air, maritime, and other transport modes. This can lead to some inconsistencies in maritime transport costs and modal share data, especially for economies with poor or unavailable trade data.

24 DNV modelling work under Task 2 incorporates an exogenous projection of maritime transport demand from the Fourth IMO GHG Study. The BAULG scenario projects the changes in maritime transport costs based on DNV's modelling and serves as a benchmark in the GTAP model. In the GTAP model, transport costs are determined by the interaction between transport supply and demand, with demand changing in proportion to commodities being transported from one country to another. Therefore, the current assessment not only allows for the analysis of changes in transport demand and supply at the detailed commodity- and partner-specific levels, but also at the global level. In turn, changes in route-specific as well as global transport demand and supply affect maritime logistics costs and revenue.

25 The GTAP model does not reflect potential technological change, for example, the impact of climate change mitigation efforts taking place outside of the maritime sector, or other potential changes that result from developments such as climate change or geopolitical changes. This assumption is neither optimistic nor conservative, as economies could grow faster or slower than assumed. Climate-vulnerable economies might experience lower growth, making them more susceptible to higher maritime logistics costs and rendering the estimates optimistic.

26 The model simulations only consider changes in maritime transport costs, excluding potential modal shifts to alternatives like air or land transport, leading to conservative impact estimates. This is appropriate since reliable economic estimates of modal shifts are limited, with such estimates being typically not significantly different from zero and implying limited scope to substitute against maritime transport services. It also excludes secondary impacts on emissions from international shipping and the wider economy. The assumption that all sectors will reduce their GHG emissions by 2050 implies that secondary impacts on emissions will not be significant. However, if not all other sectors reduce their GHG and significant shifts in transport demand to more GHG intensive modes (e.g. aviation) or less GHG intensive modes (e.g. electrified rail and road) take place, then the implications of this assumption can be significant.

27 As GTAP is solved in each time-step as a static model, to find an equilibrium it must disburse all the revenues to economies within each time-step. Therefore, instantaneous distribution is assumed with benefits from revenue disbursement to economies accruing instantaneously in the time-step. In practice, it is conceivable that revenue distribution could lag the process of collection, given the various models or administrative steps associated with distribution.

28 Revenues generated under Task 2 are aggregated and distributed to households in GTAP, thereby stimulating economic activity without specific sectoral allocation. The model does not distinguish between in-sector and out-of-sector revenue use; this likely leads to an overestimation of the benefits compared to more constrained revenue uses.

29 Aggregations can introduce bias in the results, potentially inaccurately representing the unique economic characteristics of individual economies. There is also an additional consequence in the reliability of results for certain economies. For aggregated economies, individual impacts are estimated but as a disaggregation of the GTAP output. This limitation means that if an economy is well represented by the aggregation, obtaining its results in this way should be reliable. However, if the economy's circumstances differ significantly, then the disaggregated result is more likely to be less reliable. This is particularly important when interpreting the impacts for SIDS and LDCs, as these economies are more likely to be aggregated within the GTAP model.

30 One of the key inputs to the Task 3 modelling is the cost intensity data relating to the impacts on fleets of different scenarios. These are subject to uncertainties in several key assumptions e.g. relating to future projections of technology cost, fuel/energy prices, investment decision-making etc. Because the variations in the maritime logistics costs between scenarios in Task 3 are significantly driven by these inputs, the limitations and Quality Assurance/Quality Control associated with Task 2, should also be considered when interpreting the results of Task 3, particularly the comparisons between scenarios.

31 This modelling does not consider the implications of any other future national or international GHG reduction or air pollution measures.

Impacts

Impacts on maritime logistics costs

32 Globally, the effects of policy measures on maritime logistics costs (the sum of transport costs and time costs converted into monetary equivalents), in constant prices, are estimated to increase over time.

33 By 2050, these costs are expected to rise and range between 34.7 and 36.8% across the different scenarios analysed compared to BAULG, irrespective of the GHG emissions trajectory or the policy scenario. This aligns with Task 2 findings, where cost components were comparable across all scenarios in the long run. The increase in maritime logistics costs occurs earlier and more strongly in higher-levy scenarios than in lower-levy scenarios. For the non-levy scenario, the increase is slower by 2030, increasing significantly by 2050 to approximately the same levels as the levy scenarios.

34 In the short run, to 2030, scenarios with a higher GHG price as well as a GFI requirement (scenarios 26 and 46) increase by the highest amounts (19.1% higher than BAULG in scenario 46 and 15.8% higher than BAULG in scenario 26). In contrast, under the lower-levy scenarios 32 (WtW GFI scope) and 31 (TtW GFI scope with sustainability criteria), the increase is simulated to be 7.3% and 6.4%, respectively. This is similar to the increase in maritime logistics costs in the scenarios that do not include a levy, namely scenarios 23 and 24 which see an increase of 6.32 and 5.78, respectively. Of all scenarios, scenario 24 has the lowest short-run increase in maritime logistics costs.

35 In the long run, to 2050, the increase in maritime logistics costs for the base GHG reduction trajectory is consistently lower in scenarios that include a levy as well as a GFI requirement.

36 The relative size of maritime logistics cost increases across scenarios are both consistent with, and explained by, the findings of Task 2. For example, bearing in mind the cost intensities in Task 2, differences in maritime logistics costs can arise from both the increase in maritime transport costs (which can differ depending on fuel/energy and energy efficiency incentivization that vary across the different policy scenarios) as well as the differences in ship speed (shipping time costs). Scenarios which have higher speeds have lower shipping time costs and vice versa.

37 Developing economies and LDCs are simulated to experience, on average, relatively higher impacts on the maritime logistics costs of their imports. LDCs are simulated to face higher impacts on the maritime logistics costs of their exports relative to developing economies, developed economies, and SIDS.

Impacts on gross domestic product

38 At a global level, all modelled scenarios consistently result in a reduction in GDP compared to BAULG, i.e. the impact is negative. In the long run (2050), the impact on GDP varies from -0.08 to -0.16%, depending on the scenario. Scenarios with a levy and revenue distribution in combination with a GFI requirement result in the smallest impact (-0.08 to -0.14%) on the world GDP compared to the BAULG. All scenarios without a levy and revenue distribution have similar long-run impacts on GDP ranging from -0.15 to -0.16% compared to BAULG.

39 Figure 2 presents the development of real GDP under BAULG and a subset of scenarios, including scenario 22. By 2050, the results of scenario 22 show the largest impact (-0.16%) on the world real GDP compared with GDP under the BAULG.

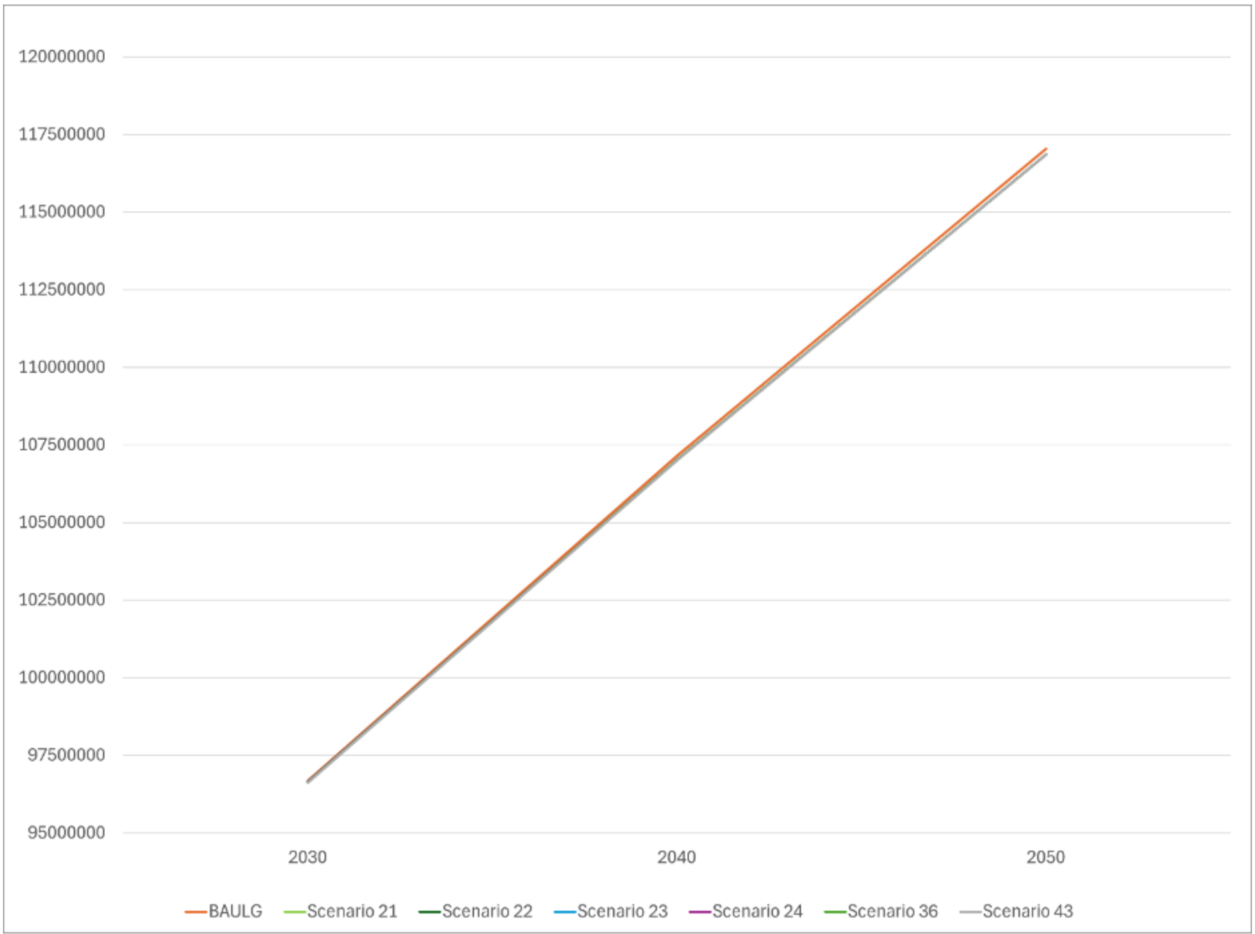

Figure 2: World real GDP values in different scenarios
(Millions of dollars in 2017 prices)

Note: The GDP value in 2017 is based on the GTAP database. The BAULG have been based on the forecasts by the International Institute for Applied Systems Analysis (IIASA), SSP2, released in January 2024, combined with the development of transport margins as recorded in BAULG. Values are in constant 2017 US dollars. These values do not represent an economic projection by UNCTAD or any of the authors and were used solely to model the impact in GTAP.

40 Table 2 presents results for all scenarios showing both the short-run (2030) GDP impacts and the long-run (2050) impacts. Results are presented for all four variations of revenue distribution, including no revenue distribution.

41 In the short run (2030), impacts on the world GDP vary between -0.03 to -0.07 per cent with reference to BAULG, depending on the scenario. Scenarios with a GFI requirement in combination with a high levy price and revenue disbursement have a larger impact in the short run, particularly if also under a Strive scenario (scenario 46). In the long run (2050), GDP impacts vary between -0.08 to -0.16% with reference to BAULG, depending on the scenario.

42 The difference in absolute GDP between BAULG and the lowest and highest GDP impact scenarios varies between US$ 95.9 billion (of 2017) for Scenario 26 (revenues disbursed only to SIDS and LDCs), and US$ 188.6 billion (of 2017) for scenario 22.[4]

43 These results also show that in the scenarios with a GFI requirement combining a low levy price (scenarios 31 and 32), the impact on real GDP, in the short run, can be similar to other scenarios, even when there is no revenue distribution. In the long run (2050), scenarios that envisage a levy have a smaller impact.

44 These findings are consistent with and explained by the differences in maritime logistics costs that have been observed between scenarios. This, in turn, is consistent with and explained by Task 2 results. The findings are novel and may at first seem to differ from other literature. For example, key references in the existing literature (e.g. Sheng et al. (2018), Pereda et al. (2023)) have focused on understanding GDP impacts that occur due to carbon pricing relative to a BAU scenario, but have not considered the relative impacts of carbon pricing compared to a fuel standard or any other measure achieving an equivalent GHG reduction trajectory as is studied in the present report.

Table 2: Summary table of key GDP impacts (world aggregate only)[5]

Policy scenario	Levy	Revenue disbursement	Group of beneficiary economies	Feebate	GFI Flexibility	GFI scope	GDP impact by 2050 (world) compared to BAULG	GDP impact by 2030 (world) compared to BAULG
21	No	No	None	No	No	TtW	-0.16%	-0.04%
22	No	No	None	No	No	WtW	-0.16%	-0.04%
23	No	No	None	No	Yes	TtW	-0.16%	-0.04%
24	No	No	None	No	Yes	WtW	-0.16%	-0.03%
26	Yes	No	None	No	No	WtW	-0.15%	-0.08%
	Yes	Yes	All economies	No	No	WtW	-0.09%	-0.05%
	Yes	Yes	Developing economies, LDCs, SIDS	No	No	WtW	-0.09%	-0.05%
	Yes	Yes	LDCs, SIDS	No	No	WtW	-0.08%	-0.05%
31	Yes	No	None	No	Yes	TtW	-0.15%	-0.04%
	Yes	Yes	All economies	No	Yes	TtW	-0.14%	-0.03%
	Yes	Yes	Developing economies, LDCs, SIDS	No	Yes	TtW	-0.14%	-0.03%
	Yes	Yes	LDCs, SIDS	No	Yes	TtW	-0.14%	-0.03%
32	Yes	No	None	No	Yes	WtW	-0.15%	-0.04%

4 According to the United States Bureau of Labor Statistics, US$ 1 in 2017 is equivalent to US$ 1.28 in 2024 (US Bureau of Labor Statistics, 2024). Therefore, extrapolating to 2024 US$, the net impact would range between US$ 122.7 billion and US$ 241.4 billion.

5 Presents aggregated results, with impacts weighted according to each economy's share in the world GDP. In contrast, figure 3 shows results for all economies, where the median and mean displayed are unweighted, meaning each economy is given equal weight. The differences arise because some larger economies, which carry more weight in table 2, tend to experience relatively lower impacts or a smaller reduction in real GDP. For this reason, it is important to look at both sets of results when interpreting the findings relating to impacts.

Policy scenario	Levy	Revenue disbursement	Group of beneficiary economies	Feebate	GFI Flexibility	GFI scope	GDP impact by 2050 (world) compared to BAULG	GDP impact by 2030 (world) compared to BAULG
	Yes	Yes	All economies	No	Yes	WtW	-0.14%	-0.04%
	Yes	Yes	Developing economies, LDCs, SIDS	No	Yes	WtW	-0.14%	-0.04%
	Yes	Yes	LDCs, SIDS	No	Yes	WtW	-0.14%	-0.04%
36	No	No	None	Yes	Yes	WtW	-0.16%	-0.04%
43	No	No	None	No	Yes	TtW	-0.16%	-0.04%
46	Yes	No	None	No	No	WtW	-0.15%	-0.10%
	Yes	Yes	All economies	No	No	WtW	-0.11%	-0.07%
	Yes	Yes	Developing economies, LDCs, SIDS	No	No	WtW	-0.11%	-0.07%
	Yes	Yes	LDCs, SIDS	No	No	WtW	-0.10%	-0.07%

45 The modelling of impacts on economies and groups of economies indicates that there is significant variation between different groups of economies. In every scenario and for each of the years under consideration, namely 2030, 2040 and 2050, the developing group of economies sees a larger impact on its GDP compared to the group of developed economies. In many scenarios, LDCs and SIDS see the largest impact on their GDP compared to all other groups of economies. However, in scenarios with a GFI requirement and a levy, particularly in those with a higher levy price, or when revenues are disbursed to SIDS and LDCs only, SIDS and LDC groups of economies experience smaller impacts on their respective GDP compared to the other groups of economies (e.g. developed and developing).

46 Figure 3 shows the variation in the impact on the real GDP of individual economies across the different economy groupings, in the long run (2050), relative to the BAULG. For illustration purposes, four scenarios are presented, including two scenarios which combine a levy with a GFI requirement (scenarios 26 and 32). For both these scenarios, results are shown only for the case in which revenues are disbursed to all developing economies (including SIDS and LDCs). The four scenarios are comparable in that they all assume the Base emissions trajectory and use the WtW GFI scope. These variations reflect whether they include a GFI requirement with a flexibility mechanism (scenarios 24 and 32), a levy in combination with a GFI requirement (at high price in scenario 26 and low price in scenario 32), a GFI requirement in combination with a flexibility mechanism and a feebate mechanism.

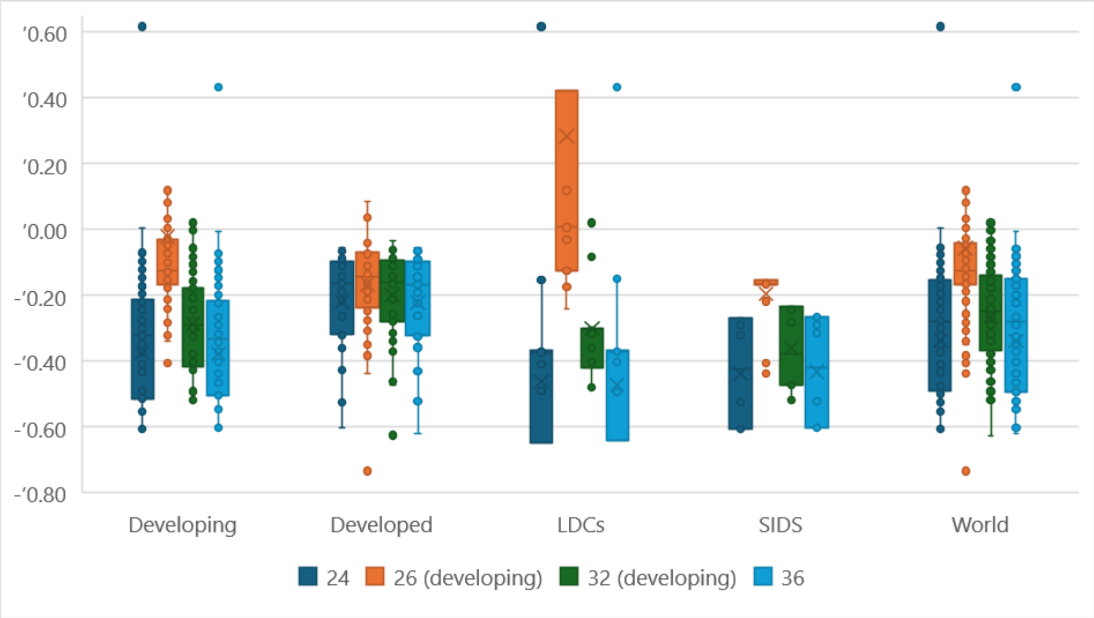

Figure 3: Real GDP impact in 2050 by economy, sample of four scenarios (Percentage difference to BAULG)

Note: Scenarios 26 and 32 are combined with revenue distribution. For the purposes of this illustration, the option of revenue distribution to developing economies was considered. For the underlying data, see annex 4, annex 8, annex 11 and annex 13.

47 The patterns in figure 3 confirm the general findings about the impact of the aggregate results, in particular that in scenarios that do not include a levy, developed economies see the smallest impact on their GDP while LDCs and SIDS experience the largest impact. However, they also show that, for scenarios that include a levy and a GFI requirement (scenarios 26 and, to a more limited extent, 32), relatively smaller impacts on GDP – sometimes even increases in GDP compared to the BAULG – are seen in the case of LDCs, relative to scenarios 24 or 36. The results also show that for both the world and all groups of economies, the impacts on GDP are relatively smaller in the scenario with the higher levy price (scenario 26), even when revenues are allocated only to developing economies.

Impacts on trade

48 By 2050, the impact on global import volumes ranges between -0.23% and -0.97% compared to the BAULG. The largest impact on import volumes occurs in scenario 26. By 2030, impacts range from -0.05% to -0.51%. Scenarios with levies show more variable patterns; LDCs often see increases in import volumes compared to BAULG, while developed economies and SIDS see reductions compared to BAULG.

49 A reduction in export volumes is observed across most scenarios by 2050, with reductions reaching up to 36% in the case of LDCs, relative to BAULG. The exceptions were scenarios 26 and 46, in which revenues are disbursed to SIDS and LDCs only. These lead to slightly positive effects (up to 0.08%) on the developed economies' total export volumes. By 2030, scenarios without levies generally show a reduction in export volumes relative to BAULG, across the various groups of economies, except for SIDS which see small increases ranging from 0.02% to 0.03%. Scenarios with levies show inconsistent patterns, with some leading to increases in SIDS' export volumes.

50 The impact on the price and the quantity of the agricultural products imported is of relevance for food security. It should be noted that food security entails more than one dimension. These include the availability of food which is determined by factors such as the level of food production, stock levels and trade. Economic and physical access to food is another dimension of food security and is determined by factors such as markets, prices and transportation. Meanwhile, food utilization is related to factors such as energy and nutrient intake by individuals. The stability of these three dimensions over time is also a dimension of food security. In this context, the impact on the quantity of agricultural products imported and their prices simulated in the present assessment report provides some insights into food availability and access. However, the assessed impact on agricultural product trade volumes and prices provides a partial view as to the potential implications for food security as it does not reflect all the dimensions of food security (e.g. food utilization and stability) nor cover all the food-related items and products that contribute to improving food security. This is because while agricultural products are key for food security, other food items and products are also important and are carried in containers (e.g. processed food items, equipment used in agricultural production or food processing) as well as raw material (e.g. fertilizers). These products are not captured by the heading "agricultural products".

51 Under most policy scenarios, the world mean CIF price of agricultural product imports increases by up to 2.5% by 2050 relative to BAULG in response to the GHG measure in individual economies. In some extreme cases, the rise in import prices of agricultural products in some economies reaches more than 10.0% relative to BAULG when revenues are disbursed to SIDS and LDCs only. The reduction in the quantity of agricultural product imports is simulated to reach up to 6.2% in 2050, relative to BAULG except in a few outlying cases, depending on the policy combination.

Impacts on consumer prices

52 Nearly all the policy scenarios modelled lead to increases in the consumer price index (CPI) relative to the BAULG for the years considered (2030, 2040, and 2050) and across all groups of economies. By 2050, the global CPI is simulated to rise between 0.20 per cent (scenarios 21, 22, 23, 24, 36 and 43) and 0.39% (scenario 26 with revenues disbursed to all economies) compared to the BAULG. In the short run (2030), CPI changes in percentage terms vary across scenarios. Under scenarios that combine a GFI requirement with higher-levy prices with a Strive GHG emissions trajectory (scenario 46), global CPI increases by 0.13 %. Under a Base GHG emissions trajectory (scenario 26), the global CPI increases by 0.11%. Scenarios which combine a GFI requirement with a lower GHG price, show a CPI increase of 0.06% under scenario 32 and 0.05% under scenario 31, relative to BAULG.

53 LDCs experience the largest CPI increases. Revenue disbursement roughly doubles the CPI increase globally compared to scenarios without revenue disbursement. With revenue disbursement, recipient economies have more revenues to spend for consumption thereby increasing demand and driving consumer prices higher. This complements the effect that increased prices also reflect a higher cost environment resulting from the increased maritime logistics costs.

54 Developed economies see a reduction in their consumer prices resulting from revenue disbursement (even when revenue is not disbursed to developed economies). To some extent, this offsets the effect of the increased maritime logistics costs, unlike developing economies, SIDS, and LDCs, where revenue disbursement adds to the consumer price increase.

Sensitivities to different policy parameters

55 Sensitivity analysis undertaken by comparing the results of scenarios in which only one parameter is varied, reveals that long-term impacts on world GDP are comparable for both the TtW and WtW scenarios. By 2050, WtW scenarios see relatively larger impacts on GDP. Short-term impacts (by 2030) are also comparable for the TtW and WtW scenarios. Long-term (by 2050) impacts are not consistently larger under the Strive scenarios compared to Base scenarios as both trajectories include the ambition to reach net zero GHG emissions by or around 2050. Some Strive scenarios show larger impacts on GDP, while others show smaller impacts. Short-term impacts by 2030 are larger under the Strive scenarios.

56 Introducing flexibility mechanisms leads to similar smaller impacts (-0.16% in scenarios 23 and 24) on global GDP in the long run (2050) compared to comparable no-flexibility scenarios (-0.16% reduction in scenarios 21 and 22). However, introducing flexibility mechanisms can lead to relatively larger impacts on the world GDP in the short run (2030) (-0.03% in scenario 24 which includes a flexibility mechanism, compared with -0.04% in comparable scenario 22 which does not include a flexibility mechanism). Including a feebate mechanism leads to a smaller difference in impact on long-run world GDP compared to scenarios without feebate.

57 Scenarios which include a levy in combination with a GFI requirement have consistently smaller GDP impacts in the long run (2050) compared to scenarios with a GFI requirement but without a levy. In the short run (2030), the impact on the world GDP can be larger under the Strive scenario with a higher GHG price (scenario 46). Differences in GDP impacts on States also occur when revenues generated from a levy scenario are distributed to different groups of economies (modelled as three different variations of scenarios 26, 31, 32 and 46). For example, when revenues are distributed to all economies, or developing economies, including SIDS and LDCs, the simulated impacts on the world GDP, as well as the GDP of developed and developing economies and SIDS, are comparable. When revenues are distributed only to SIDS and LDCs, the reductions in GDP relative to the BAULG are smaller or the increases in real GDP relative to the BAULG are larger compared to when revenues are distributed to a larger group of economies (all economies or developing economies including SIDS and LDCs).

58 Results across all scenarios show that LDCs are experiencing larger sensitivity to differences in revenue disbursement specifications. In some scenarios (scenarios 26 and 46, LDCs experience positive impacts, *i.e.* GDP increases relative to the BAULG. In other revenue distribution scenarios (variants of scenarios 31 and 32), LDCs see smaller negative impacts on GDP (-0.1% to -0.32% reductions relative to the BAULG), when compared with scenarios that include a GFI requirement without a levy (scenarios 21, 22, 23, 24, 36 and 43).

59 In sum, the assessment reveals that GHG reduction measures have an adverse effect on global GDP, import and export volumes, and global CPI. These impacts vary in their magnitude across scenarios and timelines depending on whether levies, flexibility mechanisms, and revenue disbursement schemes are included or not. Results relating to scenarios with a GFI requirement and higher levy prices have shown that some negative impacts on the world GDP could be reduced/offset by revenue distribution schemes to some extent.

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