Complementary Quantitative Stakeholders' Analysis: The Case Study of Namibia

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Executive Summary

Overview

Namibia, a coastal nation in the Southern African Development Community (SADC), relies heavily on maritime transport for exporting key commodities like uranium and fish and importing essential goods such as petroleum. The IMO's Revised Strategy on the Reduction of GHGs from Ships (IMO, 2023) has established a range of ambitious decarbonization objectives for the international shipping sector that includes the elimination of GHG emissions by 2050. To achieve these objectives, four leading policy architectures are currently under consideration at the IMO, each expected to result in significant economic impacts for states such as Namibia. This paper presents an analysis on the possible impacts of these four leading policy architectures on three of Namibia's most economically significant merchandise trades.

Aims and Objectives

The primary aim of this study is to assess the financial impacts of various GHG reduction strategies on Namibia's trade-reliant economy. It seeks to provide policymakers with the tools to balance economic resilience with environmental sustainability, ensuring Namibia's effective participation in international maritime policy discussions.

Method

The IMO-led Comprehensive Impact Assessment (CIA) process was undertaken throughout 2024 to understand the likely economic consequences resulting from the introduction midterm measures. Building on techniques pioneered throughout the CIA process, the analysis presented herein employed a structured six-step quantitative approach that includes the following steps:

1. Merchandise trade analysis of key commodities.
2. Identification of primary trade routes.
3. Selection of representative vessels and operational parameters.
4. Cost modeling under four policy scenarios considering vessel- and cargo-side cost assumptions.
5. Comparison with a Business-As-Usual (BAU) baseline to contextualize policy impacts.

Key Findings

- High Levy scenario imposes the highest medium-term costs, but these stabilize over time due to efficiency gains and technological advancements.
- The flexibility mechanism, and the feebate to a smaller extent, minimizes short-term costs but leads to higher costs in the long term.
- All scenarios indicate similar increased export costs in the long term, with the levy scenarios generating however substantial revenue which could compensate for those negative impacts.
- Petroleum imports are significantly impacted (up to 8.8% increase in the cost of imported goods), while fish (up to 4.3%) and uranium (up to 1.1%) are less impacted.

Implications

- **Economic Vulnerability:** Namibia's reliance on maritime trade for critical imports and exports makes it particularly susceptible to rising transportation costs under GHG reduction policies.
- **Policy Trade-offs:** While levy-based strategies encourage long-term economic stability and innovation, the flexible mechanism provides immediate financial relief at the expense of escalating costs over time.

Recommendations

- **Adopt a Balanced Policy Approach:** Combine levy-based strategies with flexible regulatory mechanisms to manage immediate costs while promoting long-term sustainability.
- **Enhance Capacity Building:** Strengthen Namibia's ability to effectively participate in international maritime policy debates, ensuring that national interests are well represented.
- **Develop Commodity-Specific Strategies:** Address the unique cost patterns and vulnerabilities of Namibia's key trade commodities, such as uranium, fish, and petroleum.
- **Advocate for Support Mechanisms:** Seek international financial and technical assistance to alleviate the economic burden of transitioning to low-carbon maritime trade policies. In this regard, the levy scenarios raise significant amount of revenue, which could be directed to addressing some of those impacts (see LEAP tasks 2 and 3 for further details).

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List of abbreviations

Abbreviation	Meaning
BAU	Business-As-Usual
DNV	Det Norske Veritas
GFI	Global Fuel Intensity
GHG	Greenhouse Gas
IMO	International Maritime Organization
MEPC	Marine Environment Protection Committee
OECD	Organization for Economic Co-operation and Development
UNCTAD	United Nations Conference on Trade and Development

1 Introduction

Global maritime trade is a cornerstone of economic activity, facilitating essential flows of goods worldwide and supporting economies reliant on commodity imports and exports, including those in Southern Africa (UNCTAD, 2020). Adopted in 2023, the IMO Revised GHG Strategy has established a goal of eliminating greenhouse gas (GHG) emissions from shipping by 2050 (IMO, 2023), with alternative policy architectures to achieve the strategy's targets currently under consideration by the MEPC. However, the economic incentives required to drive such deep structural change will come with high economic impacts across the maritime sector, making it urgent for countries such as Namibia to develop their political positions with respect to these objectives as soon as possible. As countries like Namibia are highly reliant on global maritime trade, the adoption of these GHG reduction measures presents both opportunities and challenges for their economies. The LEAP project is providing critical evidence-based analysis to help governmental stakeholders and IMO country delegates understand the potential impact of these policies on Namibia. This includes evaluating the trade-offs between economic growth and environmental sustainability as the IMO aims for a low-carbon future for global shipping.

The IMO's GHG Strategy is expected to be finalized by Autumn 2025, making it urgent for countries like Namibia to prepare their national perspectives in advance. This report builds upon the UNCTAD and Starcrest assessments produced as part of the IMO-led CIA process (UNCTAD, 2024a; Starcrest, 2024), applying analysis techniques pioneered in that research to understand the potential impacts of alternative decarbonization policy architectures on three of Namibia's most economically significant trade flows. By expediting this study, the LEAP project ensures that Namibia and other African nations are well-informed and ready to actively participate in the IMO debates, advocating for policies that balance their economic interests with the global push for environmental sustainability in maritime trade.

This report examines the potential economic impacts of four policy scenarios designed to mitigate GHG emissions in the maritime sector, with a focus on Namibia within the Southern African Development Community (SADC) region. The study evaluates three critical commodities—uranium, fish, and petroleum—under the following leading policy options: a flexible Global Fuel Intensity (GFI) compliance mechanism only (Scenario 24), a flexible GFI compliance mechanism in combination with a Low Levy of US$30-120 per tonne (Scenario 32), a High Levy of US$150-300 per tonne in isolation (Scenario 26), and a flexible GFI compliance mechanism in combination with a Feebate mechanism (Scenario 36). These scenarios, measured on a well-to-wake basis under a 'base' emissions trajectory, are assessed relative to a Business-As-Usual (BAU) baseline, assuming no mid-term GHG reduction measures (DNV, 2024). Each policy approach carries distinct implications for shipping costs, trade routes, and economic stability over time, influencing both short-term costs and long-term resilience.

Namibia, as a coastal Southern African Development Community (SADC) nation and an upper-middle-income economy heavily reliant on exports of raw materials, is particularly vulnerable to rising maritime costs and shifts in trade patterns resulting from GHG emission reduction policies. Increased costs for essential exports, such as uranium and fish, as well as critical imports like petroleum, could disrupt the economy. Namibia's reliance on maritime trade underscores its sensitivity to changes in shipping regulations, making it imperative to understand how these policies could impact its trade competitiveness and economic growth. Given that raw materials like salt, and minerals are central to

Namibia’s trade, any increase in maritime transportation costs could have significant consequences for the national economy (African Development Bank, 2019).

As international trade regulations increasingly reflect environmental priorities, evaluating Namibia’s position within this shifting landscape is essential. By analyzing the economic implications of various GHG emission reduction policies, this study provides insights into the trade-offs between immediate cost impacts and Namibia’s long-term economic resilience. These findings offer evidence-based recommendations for Namibia and the broader SADC region to adapt strategically to evolving maritime emission regulations, promoting both economic and environmental sustainability (Organization for Economic Co-operation and Development, 2020).

1.1 Aim and research questions

The goal of the study is to present a thorough examination of the financial effects of various GHG reduction strategies on Namibia's trade-dependent economy. The study aims to educate policymakers on how to strike a balance between economic resilience and environmental responsibilities, enabling Namibia’s interests to be appropriately represented throughout the critical MEPC negotiations taking place in 2025.

2 Methodology

The quantitative analysis for this report follows a structured six-step approach designed to assess the economic implications of potential GHG reduction policies on Namibia’s maritime trade. This methodology is closely aligned with the framework developed in (Starcrest, 2024), ensuring that the analysis is as consistent as possible with the official approach developed as part of the CIA process. Further details regarding the employed methodology can be found in Annex I.

This structured approach is intended to provide policymakers and government officials with clear, evidence-based insights that can inform their intervention notes and arguments at the IMO MEPC debates, ultimately contributing to effective and informed Afrocentric participation.

- **Merchandise Trade Analysis**: The first step involves analyzing Namibia's merchandise trade statistics to evaluate the annual values and volumes of key export commodities, such as uranium, fish, salt, copper, and diamonds. It also examines the extent to which these commodities rely on international shipping. This step is crucial for understanding the economic importance of these goods and their sensitivity to changes in global shipping regulations, including potential cost increases due to GHG reduction policies.
- **Selection of Key Commodity Flows**: Based on the initial trade analysis, three key commodity flows were selected for further in-depth examination. This step identifies the trade partners, annual traded values, and typical volumes associated with these commodities, helping to pinpoint which trade relationships are most critical to Namibia’s economy and could be most affected by the introduction of new maritime emission regulations.
- **Trade Route Identification**: The third step focuses on mapping the primary trade routes for each of the selected commodity flows. This includes identifying all relevant port stops and typical distances between them. Understanding the specific routes associated with Namibia's exports

is critical for assessing the potential impact of GHG reduction policies on shipping costs, as each route may be subject to different regulations and cost factors.

- **Vessel Selection and Speed Analysis**: For each identified trade route, a representative vessel type was selected, and its average design speed was evaluated. This helps estimate the time and fuel consumption required for shipments along these routes. The vessel type and speed analysis provide insights into the operational dynamics of shipping, which can influence fuel usage and the costs associated with meeting new emission reduction targets.
- **Vessel-Side Cost Assumptions**: In this step, vessel-side cost assumptions are made by applying the four policy scenarios selected from the DNV models under the CIA Task 2 process (DNV, 2024). Freight rates for each trade route were derived from the UNCTAD Trade and Transport Dataset (UNCTAD, 2024c), which offers a valuable source of experimental data on global shipping costs. These assumptions help calculate the potential increase in transportation costs that could result from stricter GHG regulations. It is important to note that the dataset used covers historical years up to 2021, and for the purposes of this study, we assumed that the rate remains constant from 2021 to the base year, 2023.
- **Cargo-Side Cost Assumptions**: The final step calculates cargo-side cost assumptions by estimating the interest, depreciation, and insurance rates for each commodity-route pair. Given the limited availability of specific data for Namibia, this applied the same basic assumptions as outlined in (Starcrest, 2024). These assumptions are designed to provide a general understanding of the costs incurred on the cargo side of the trade equation, which is essential for determining the full economic impact of new maritime regulations.

By combining the vessel-side and cargo-side cost assumptions, this methodology generates a comprehensive assessment of the overall cost impacts on Namibia's key commodity flows. This approach closely follows the methodology developed in (Starcrest, 2024), offering reliable data that can be used by policymakers and government officials to develop informed intervention notes for the IMO GHG MEPC debates. It ensures that Namibia's specific economic context is considered, while also aligning with global best practices, thereby providing a robust and credible analysis for the country's participation in international discussions on maritime emissions and trade sustainability.

2.1 Limitations and Assumptions

A number of limitations in the applied methodology do exist. Documented in full in Annex I, limitations include:

Data Availability: Because real-time variations or regionally unique elements are not fully captured, the use of historic ad-valorem freight rates and baseline assumptions for cargo-side costs may introduce inaccuracy to final cost estimations.

Static Interest Rates: By oversimplifying changes brought on by market conditions or policy shocks, the fixed interest, depreciation, and insurance rates may either overestimate or underestimate the effects on the cargo side.

Policy Situations: The scenarios examined use the assumption that policies are applied consistently across boats and routes, which may not accurately represent the varied effects on smaller economies such as Namibia.

Aggregated Cost Intensities: At the time of writing, the detailed DNV estimates of the cost-intensity changes were not available, so the aggregated results for the whole fleet were used.

Importer-Exporter Split: The model ignores which of the importer or the exporter will bear the cost increase. In practice, they would fall either on the importer or the exporter, or partly on both. This means that the results correspond to a worst-case scenario, where Namibia bears all of the price shock.

Domestic Transport: The modelling only covers the shipping leg of the supply chain to Namibia. Therefore, the results should be understood as the increase in costs of imported goods when they reach the port of imports.

Notwithstanding these drawbacks, the methodology provides a thorough framework that government representatives and policymakers can use with assurance to create intervention plans and promote Afrocentric viewpoints in IMO GHG negotiations. The paper offers a solid foundation for evaluating the economic effects of marine policy decisions for Namibia by firmly establishing the analysis in internationally accepted methodologies.

2.2 Data

To guarantee a thorough and contextually appropriate evaluation of Namibia's main trade commodities and the related economic effects, the analysis drew on a number of datasets and approaches.

Commodities were chosen based on their economic significance to Namibia. Given that uranium is one of Namibia's top exports and a major source of foreign exchange earnings, it was selected as a key commodity. Namibia is also a significant exporter of fish, which supports livelihoods and generates revenue, particularly in coastal communities. Petroleum was chosen as an essential import because of its role in powering the economy and supporting industrial and transportation sectors. Namibia's energy security and economic resilience are directly impacted by these commodities. The UN Comtrade database, which provided data on key origin and destination markets for Namibia's imports and exports, was utilized to identify trade partners for these goods (UNCTAD, 2024b).

Copilot AI was employed to identify critical port stops and typical distances between origin and destination pairs, allowing for the construction of representative trade routes for the selected commodities. Additional data from seadistances.org was incorporated. An online search was conducted to identify typical vessels used for the transportation of these commodities. Information from the 4th IMO GHG Study informed the selection of vessels, including their average design speeds (Faber et al, 2020). These measures ensured an accurate depiction of Namibia's trade flows and associated maritime activities.

The 'ad-valorem' freight rates for each trade route were sourced from the publicly available UNCTAD Trade and Transport dataset (UNCTAD, 2024c). Although this dataset covers only the years 2016–2021, the rates were assumed to remain constant through the base year 2023, acknowledging this as a limitation while maintaining consistency. Cargo-side cost assumptions, including interest, depreciation, and insurance rates, were replicated from the methodology employed in (Starcrest, 2024). By integrating these datasets and methodologies, the analysis provided a robust framework for calculating vessel-side and cargo-side cost impacts for each commodity-route pair. This approach ensures that the findings are both reliable and applicable for policymakers seeking to understand the implications of IMO GHG policies on Namibia’s trade and economy.

2.3 Scenarios Considered

Four policy scenarios were identified as representing the leading policy architecture options currently under consideration and selected for analysis of the three key commodities. The scenarios included:

GFI Flexibility Only (Scenario 24): A GFI compliance mechanism assigns an upper limit to the number of emissions produced by consumption of a fuel for a given amount of energy production, exceedance of which will result in financial penalties for the vessel's owner or operator. The term 'flexibility' refers to the possibility for the underperformance of vessels to be offset by aggregating compliance across a group of ships ('pooling') or the sale of compliance and remedial units.

Low Levy (Scenario 32): The Low Levy scenario introduces a flexible GFI compliance mechanism in combination with a tax of US$30-120 for each tonne of GHG emissions.

High Levy (Scenario 26): The High Levy scenario introduces a tax of US$150-300 per tonne of GHG emissions in isolation from a flexible GFI compliance mechanism.

Feebate (Scenario 36): A feebate mechanism first collects a fee on each tonne of GHG emissions generated by a vessel throughout the year, then calculates and redistributes a rebate to each vessel based on its uptake of eligible e-fuels. The Feebate scenario modelled here introduces a flexible GFI compliance mechanism in combination with a feebate mechanism.

Each policy scenario, measured on a well-to-wake basis under a 'base' emissions trajectory, is compared to a BAU baseline, which assumes no implementation of mid-term GHG reduction measures. The BAU scenario serves as a reference point, highlighting the cost and environmental implications of maintaining the status quo versus adopting proactive measures. These comparisons offer critical insights into the trade-offs and benefits associated with each policy, guiding stakeholders in making informed decisions about sustainable maritime practices.

3 Results

The results of the modelling undertaken in this research describe the likely change in total costs paid of a traded good, given as a percentage of the trade's value. Further details on the methodology and how the results may be interpreted are given in Annex I.

3.1 Uranium

In 2023, uranium had an ad-valorem freight rate of 0.90%. The analysis reveals that costs increase under all scenarios relative to this baseline.

The GFI Flexibility Only scenario results in an initial cost increase that gradually rises over time. While this scenario offers exporters short-term economic relief, its long-term cost burden intensifies significantly due to cumulative compliance requirements. The Low Levy scenario shows steady cost growth, with a predictable trajectory that provides exporters with a stable financial environment, supporting long-term planning. The High Levy scenario demonstrates the steepest medium-term cost rise. However, technological advancements and efficiency improvements help stabilize costs over time. Lastly, the Feebate scenario experiences moderate initial cost increases. This scenario strikes a balance between financial incentives and penalties, offering a viable pathway for exporters to meet environmental compliance targets.

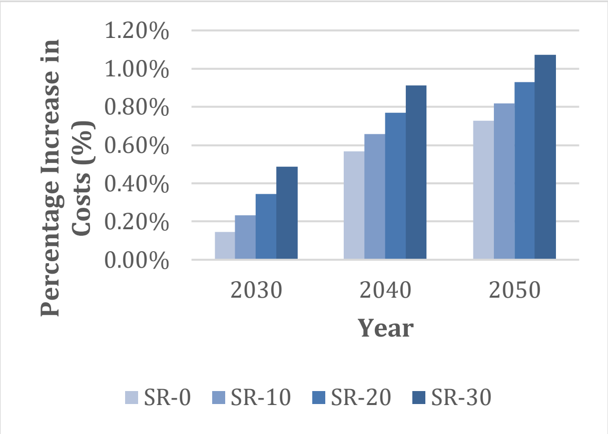

Figure 1: Impact of GFI Flexibility Only (Scenario 24) on uranium export costs.

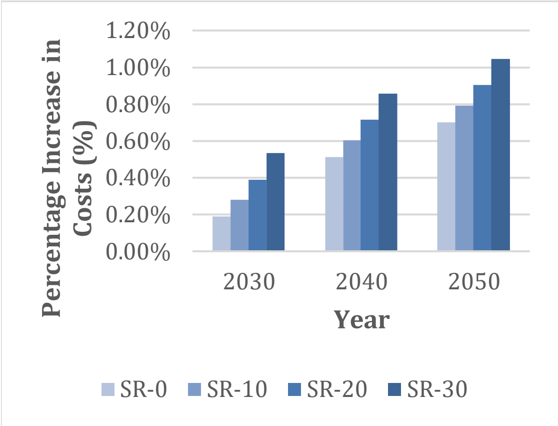

Figure 2: Impact of Low Levy (Scenario 32) on uranium export costs.

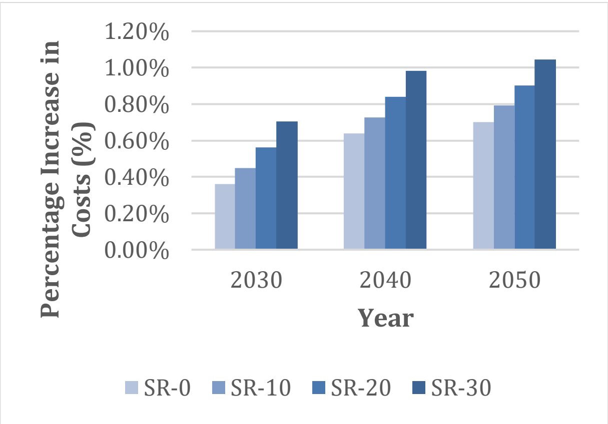

Figure 4: Impact of High Levy (Scenario 26) on uranium export costs.

Figure 3: Impact of Feebate (Scenario 36) on uranium export costs.

3.2 Fish

In 2023, fish exports had a higher ad-valorem freight rate of **4.80%**, making them particularly vulnerable to cost increases.

The GFI Flexibility Only scenario results in costs rising significantly over time. The long-term accelerated increase highlights the diminishing benefits of flexible regulatory approaches as time progresses. In comparison, the Low Levy scenario causes a steady cost increase, with a predictable trajectory that helps exporters manage financial impacts effectively. The High Levy scenario imposes the largest short- to medium-term cost increases. However, costs stabilize as low-emission technologies improve efficiency over time. The Feebate scenario provides a moderate increase, maintaining a balanced trajectory that makes it less disruptive for exporters.

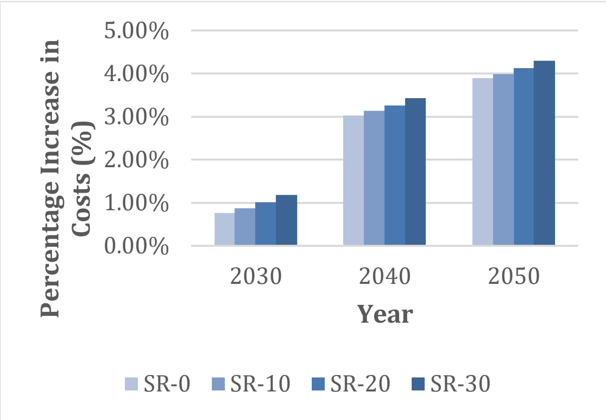

Figure 6: Impact of GFI Flexibility Only (Scenario 24) on fish export costs

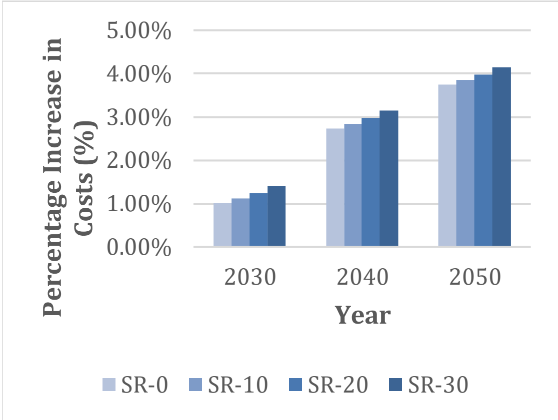

Figure 5: Impact of Low Levy (Scenario 32) on fish export costs.

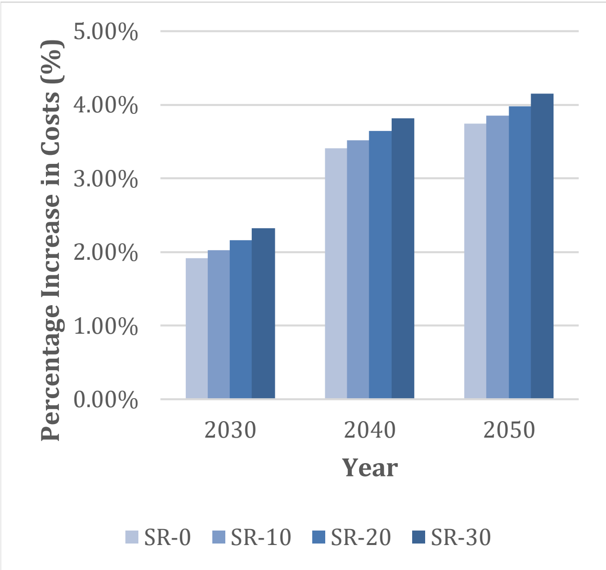

Figure 7: Impact of High Levy (Scenario 26) on fish export costs.

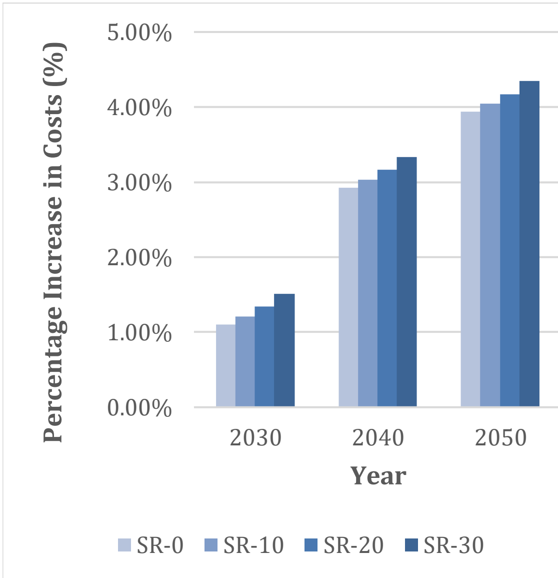

Figure 8: Impact of Feebate (Scenario 36) on fish export costs.

3.3 Petroleum

Petroleum imports, with the highest 2023 ad-valorem freight rate of **10.60%**, experience the most significant cost impacts under the GHG reduction policies.

The GFI Flexibility Only scenario leads to a significant increase in costs over time, rising sharply by 2050. This steep long-term growth presents challenges for the sustainability of this approach in petroleum-dependent sectors. The Low Levy scenario produces a gradual cost increase, with a predictable trajectory that supports financial planning for industries reliant on fuel. The High Levy scenario imposes the steepest medium-term costs, with a peak in the short-term. However, costs stabilize over time as efficiency improvements help mitigate the initial burden. The Feebate scenario results in a gradual cost increase, growing predictably over time. This balanced approach encourages emissions reductions while distributing costs effectively.

Figure 10: Impact of GFI Flexibility Only (Scenario 24) on petroleum import costs.

Figure 9: Impact of Low Levy (Scenario 32) on petroleum import costs.

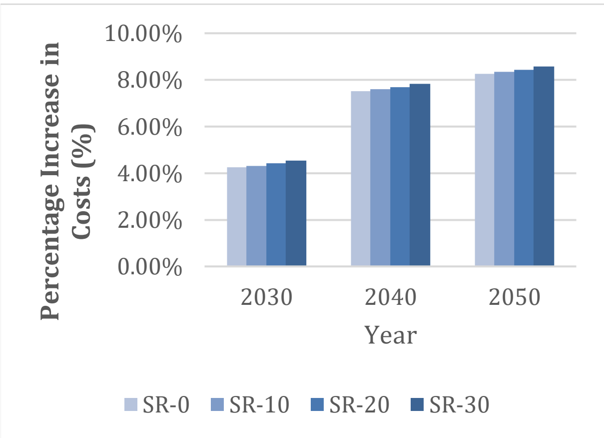

Figure 12: Impact of High Levy (Scenario 26) on petroleum import costs.

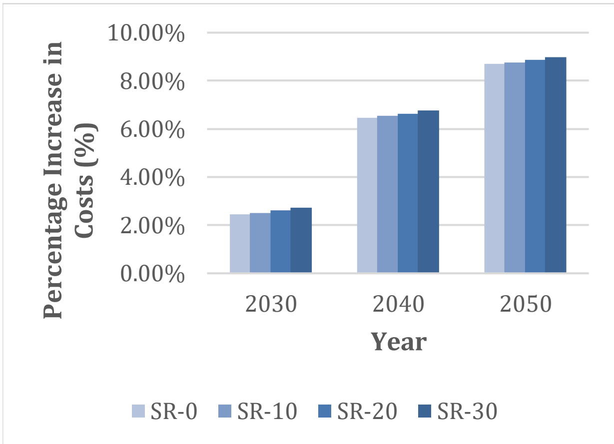

Figure 11: Impact of Feebate (Scenario 36) on petroleum import costs.

Evaluated across 0, 10, 20 and 30% speed reduction scenarios (SR-0 to SR-30), cargo-side cost impacts are observed to contribute relatively little to total cost impact compared to the vessel side. Exports of Uranium are the exception, driven by its small vessel-side cost impacts. Data from (DNV, 2024) indicates that vessel speeds are expected to reduce by between 6-20% in response to the introduction of midterm measures, with a median speed reduction just over 10%.

Across all scenarios, costs for uranium, fish, and petroleum increase due to GHG reduction policies, with the GFI Flexibility Only scenario offering short-term relief but imposing substantial long-term costs. The Low Levy and Feebate scenarios provide more predictable cost increases, supporting long-term planning, while the High Levy scenario creates the highest short- to medium-term costs but stabilizes due to efficiency gains. Each commodity faces unique vulnerabilities, necessitating careful policy consideration to balance economic and environmental objectives effectively.

4 Discussion

The findings underscore the economic complexities associated with implementing GHG reduction policies in Namibia's maritime trade sector. By analyzing uranium, fish, and petroleum, the study evaluates the trade-offs across four scenarios—GFI Flexibility Only, Low Levy, High Levy, and Feebate—and highlights their implications on the economy in the short, medium, and long term.

The results demonstrate that the four policy scenarios have varied and significant impacts on cost structures across Namibia's key export and import commodities. The findings reveal important implications for Namibia's economy, where the trade-offs between short-term cost savings and long-term economic stability are particularly pronounced.

4.1 Broader Implications of GHG Reduction Policies

While all scenarios lead to cost increases over time, the trajectory and intensity of these increases differ significantly. These variations reflect the underlying policy mechanisms and their economic effects. For instance, the GFI Flexibility Only scenario allows businesses to delay adopting costly emissions reduction measures, resulting in the smallest initial cost increases. However, the long-term acceleration of costs indicates that such flexibility could lead to greater cumulative burdens as compliance requirements intensify. This finding aligns with existing studies that caution against overly lenient regulatory approaches, which may defer rather than alleviate financial pressures.

Conversely, the Low Levy and High Levy scenarios impose steady and predictable cost increases, offering businesses a clearer financial landscape to plan for the future. While the High Levy scenario creates significant medium-term challenges due to stringent financial incentives, its stabilization in the long term suggests that technological advancements and operational efficiencies play a crucial role in mitigating costs. This is supported by studies that emphasize the role of innovation in offsetting emissions compliance costs. However, this scenario's short- to medium-term burden raises concerns about the ability of resource-dependent economies like Namibia to absorb such financial shocks without broader economic consequences.

The Feebate scenario presents a balanced approach by combining financial incentives and penalties. Its moderate cost increases and predictable trajectory suggest that it is well-suited for addressing the dual goals of reducing emissions and maintaining economic stability. This mechanism aligns with reports advocating for market-based approaches to environmental regulation, which promote efficiency and innovation without disproportionately penalizing stakeholders. However, the practical challenges of implementing a Feebate system, such as administrative complexity and ensuring equitable cost-sharing, must also be considered.

4.2 Impacts on Uranium and Fish Exports

Uranium and fish exports, both pivotal to Namibia's economy, show consistently rising cost intensities across all scenarios, although the rate of increase varies. First, the Uranium exports (up to 1.1% increase) are much less impacted than fish (up to 4.2% increase). Second, the GFI Flexibility Only mechanism initially imposes lower incremental costs for uranium and fish exports compared to the levy-based policies. This suggests that GFI Flexibility could provide economic relief in the short term, benefiting sectors sensitive to sudden cost increases. However, the cumulative effects of this mechanism lead to substantially higher costs by 2050. This outcome indicates that while GFI Flexibility can mitigate near-term economic pressures, its sustainability may be limited as cumulative GHG reduction requirements intensify over time.

In comparison, both Low Levy and High Levy policies create predictable, steady increases in export costs, allowing Namibian exporters to better plan financially. However, the High Levy imposes significant initial cost burdens, especially for fish, where the ad valorem rate (share of transport in commodity cost) is already higher. This scenario raises concerns about competitiveness in global markets despite long-term cost stabilization driven by efficiency gains. On the other hand, those scenarios have the potential to raise significant amounts of revenue, which could be used to alleviate some of those impacts. The effect of revenue distribution has not been included in this modelling exercise.

4.3 Petroleum Import Cost Dynamics

Petroleum, a critical import for Namibia, experiences substantial cost increases across all policy scenarios. The High Levy scenario results in the largest cost increments for petroleum in the short term (but the lowest in the long term), posing potential challenges to fuel-reliant sectors in the short term, including transportation and power generation. The policy scenario outcomes suggest that more aggressive levy strategies could affect Namibia's import balance and overall economic resilience in the short term. Given Namibia's fuel dependency, the low levy or flexibility mechanism scenarios, which moderately balances incentives for emissions reduction with cost-sharing mechanisms, might lead to smaller impacts, but those scenarios become similarly/more expensive than the high levy scenario in the long term, while generating significantly lower revenue, which can be used to address some of those negative impacts.

4.4 Juxtaposing Scenarios and Economic Impacts

From a short-term perspective, the GFI Flexibility Only scenario offers immediate relief, making it attractive for industries sensitive to sudden cost increases, such as fish and petroleum. However, its diminishing effectiveness over time and eventual cost convergence with other scenarios reduce its long-term viability. The Low Levy scenario, while less aggressive, provides a steady and manageable cost increase, supporting industries like uranium exports where stability is crucial for long-term planning.

In the medium term, the High Levy scenario imposes the most significant financial challenges, particularly for high-volume commodities like petroleum imports. While it drives rapid adoption of low-emission technologies, the high costs may undermine economic stability, particularly for countries heavily reliant on fuel-dependent industries. On the other hand, it generates significantly more revenue than the other scenarios, whose effects are however ignored in this report.

In the long term, both the High Levy and Feebate scenarios demonstrate stabilization, reflecting efficiency gains and technological advancements of the fleet and the adoption of cheaper technologies in the long term (DNV, 2024). However, their effectiveness depends on the ability of industries to adapt and invest in greener technologies. The GFI Flexibility Only scenario, despite its early advantages, becomes increasingly expensive as cumulative costs rise, so that it become more expensive at the end of the period than the levy scenarios, while generating very low revenue.

4.5 Policy Trade-offs and Strategic Considerations

The results underscore the trade-offs between immediate economic relief and long-term financial predictability. The GFI Flexibility Only mechanism or the feebate may be suitable for short-term adaptation but could lead to higher long-term costs, straining export sectors in the future. Conversely, the Low Levy and High Levy approaches, despite their cost intensity, offer stability and predictability that can support longer-term financial planning.

5 Conclusion

This study highlights the economic complexities associated with GHG reduction policies in maritime trade for Namibia. An important limitation lies in the study's reliance on assumptions about future technological advancements and inflation. While this study acknowledges the need to incorporate these variables in future research, their impact may differ based on a country's level of technological capacity, investment in green technologies, and infrastructure development. For example, Namibia's position as a developing nation may limit its ability to invest in cutting-edge green technologies in the short term, leading to higher costs compared to more industrialized nations or well-integrated economies that have greater access to international technology and innovation.

Each policy scenario presents unique cost implications, with trade-offs between immediate financial relief and longer-term economic stability. The GFI Flexibility mechanism provides cost efficiency in the short run but may accumulate higher costs over time, potentially burdening Namibia's export sectors by 2050. In contrast, levy-based policies impose higher costs initially but offer predictable impacts that may better support long-term economic resilience. They also generate revenue, which could be used to address some of the negative impacts, which were not modelled in this report (some discussions in LEAP tasks 2 and 3).

Whilst this study indicates that levy-based policies could provide a more stable financial environment in the long run, these policies may not be as easily implemented in developing countries such as Namibia without significant external support. Levy policies could face resistance in regions where cross-border transport is already expensive, and the financial burdens on the trade sector might stifle growth.

The results emphasize the broader implications for international maritime policy. Policymakers must consider the cumulative long-term impacts of GHG strategies on trade-dependent economies, striking a balance between environmental objectives and economic resilience. This study reinforces the need for region-specific strategies that align with global climate goals while safeguarding the economic stability of vulnerable nations like Namibia.

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Annex I – Technical Annex

Annex I presents supplementary information regarding the development of the modelling approach applied within the research above. Specifically, the Annex explores the assumptions and limitations of the modelling approaches associated with the 'official' Task 4 methods employed under the IMO-led Comprehensive Impact Assessment of short-term and midterm measures, as well as those of the 'unofficial' approach developed by UCL for the purposes of assessing midterm measure impacts. Discrepancies between approaches are also explored, including those owing to differences in the availability of input data and those owing to uncertainties in the official IMO-led methodology.

I.i Official CIA Task 4 Methodology

The official approach seeks to understand the potential impacts of the midterm measures on three or more specific commodity flows.

<u>Commodity, Route and Vessel Selection</u>

Analysis of merchandise trade context and selection of the individual commodity flows for analysis constitute the first two steps of the method and both primarily make use of the Comtrade platform for this data. The third and fourth stages of the methodology identify the trade routes and vessels that facilitate the commodity flow, including the number and location of any port stops, the minimum, maximum and average distances associated with each assumed voyage leg and the types, sizes and transit speeds of vessels that operate on the route.

<u>Vessel-side Cost Calculations</u>

The vessel-side cost-calculation makes use of the two variables presented below:

1. **Ship-side Task 2 cost intensity (CI) Change, %** - Ratio of projected Cost Intensity in a future year (2030, 2040 or 2050) versus the reference BAU cost intensity in that year, differentiated by vessel type, size class and age range. Unit: Dimensionless.
2. **Ad-valorem Freight Rate, %** - Typical percentage of value paid for transportation of the goods and compared with the value of the goods themselves. Unit: Dimensionless.

The product of the two variables, referred to as the 'Ship-side Task 2 Freight-rate Adjusted Commodity Cost Intensity (FRACCI)', is used to represent the final vessel-side cost estimate, and is evaluated as described in Equation O1.

Ship-side Task 2 Freight-Rate Adjusted Commodity Cost Intensity (FRACCI) =
Ship-side Task 2 CI Change, % x Ad-valorem Freight Rate, % *[O1]*

<u>Cargo-side Cost Calculations</u>

The cargo-side cost-calculation makes use of five variables which are presented and discussed below.

1. **Delay10|20|30** - Number of days of delay caused by slow-steaming, given in relation to a 10%, 20% or 30% speed reduction scenario. <u>Unit</u>: days.

2. **ValueTrade, CIF** - Annually traded value of the commodity associated with the specific route. Unit: US$.
3. **Cint** - Cost of finance/interest, as a percentage of cargo value per day of delay. A value of 5% is typically assumed. Unit: Per day.
4. **Cdep** - Cost of depreciation, as a percentage of cargo value per day of delay. The following depreciation rates are typically assumed: i) 5% for dry bulk cargo; ii) 10% for non-perishable containerised cargo; or iii) 30% for perishable cargo. Unit: Per day.
5. **Cins** - Cost of insurance, as a percentage of cargo value per day of delay. A value of 2% is typically assumed. Unit: Per day.

The spreadsheet model released as part of (APEC, 2019) demonstrates that cargo-side cost per day of delay is evaluated in alignment with Equation O2a below.

*Commodity-side Task 4 TCCIsr Change, % (daily) = Delay10|20|30 * ValueTrade, CIF * (Cint + Cdep + Cins) / 365.25 [O2a]*

Multiplication of Equation O2a by the projected time delay (in days), Delay10|20|30, results in Equations O2b and O2c representing the total expected cargo-side cost change.

*Commodity-side Task 4 TCCIsr Change, % (total) = Delay10|20|30 * Commodity-side Task 4 TCCIsr Change, % (daily) [O2b]*

*Commodity-side Task 4 TCCIsr Change, % (total) = (Delay10|20|30) 2 * ValueTrade, CIF * (Cint + Cdep + Cins) / 365.25 [O2c]*

Total Cost Calculation

The total cost calculation makes use of the vessel-side and cargo-side cost components evaluated above:

1. **Ship-side Task 2 Freight-Rate Adjusted Commodity Cost Intensity (FRACCI)** - Expected total vessel-side cost change. Unit: Dimensionless.
2. **Commodity-side Task 4 TCCIsr Change, % (total)** - Expected total cargo-side cost change. Unit: Dimensionless.

The total cost calculation is evaluated as the sum of the vessel-side and cargo-side cost components presented above, in alignment with Equation O3.

Total Expected Cost Intensity Change, TCCI =
Ship-side Task 2 Freight-Rate Adjusted Commodity Cost Intensity (FRACCI) + Commodity-side Task 4 TCCIsr Change, % (total) [O3]

I.ii Unofficial UCL Task 4 Methodology

The unofficial approach mirrors the official approach in seeking to understand the potential impacts of the midterm measures on three or more specific commodity flows.

Commodity, Route and Vessel Selection

Analysis of merchandise trade context and selection of the individual commodity flows for analysis constitute the first two steps of the method and both primarily make use of the Comtrade platform for this data. The third and fourth stages of the methodology identify the trade routes and vessels that facilitate the commodity flow, including the number and location of any port stops, the minimum, maximum and average distances associated with each assumed voyage leg and the types, sizes and transit speeds of vessels that operate on the route.

Vessel-side Cost Calculations

The same vessel-side cost calculation is applied in the unofficial method, making use of two variables:

1. **Ship-side Task 2 CI Change, %** - Ratio of projected Cost Intensity in a future year (2030, 2040 or 2050) versus the reference BAU cost intensity in that year, differentiated by vessel type, size class and age range. Unit: Dimensionless.
2. **Ad-valorem Freight Rate, %** - Typical percentage of value paid for transportation of the goods and compared with the value of the goods themselves. Unit: Dimensionless.

The product of the two variables, referred to as the 'Ship-side Task 2 Freight-rate Adjusted Commodity Cost Intensity (FRACCI)', is used to represent the final vessel-side cost estimate, and is evaluated as described in Equation U1.

Ship-side Task 2 Freight-Rate Adjusted Commodity Cost Intensity (FRACCI) =
Ship-side Task 2 CI Change, % x Ad-valorem Freight Rate, %   [U1]

Cargo-side Cost Calculations

The 'unofficial' cargo-side cost-calculation makes use of the same five variables:

1. **Delay10|20|30** - Number of days of delay caused by slow-steaming, given in relation to a 10%, 20% or 30% speed reduction scenario. Unit: days.
2. **ValueTrade, CIF** - Annually traded value of the commodity associated with the specific route. Unit: US$.
3. **Cint** - Cost of finance/interest, as a percentage of cargo value per day of delay. A value of 5% is typically assumed. Unit: Per day.
4. **Cdep** - Cost of depreciation, as a percentage of cargo value per day of delay. The following depreciation rates are typically assumed: i) 5% for dry bulk cargo; ii) 10% for non-perishable containerised cargo; or iii) 30% for perishable cargo. Unit: Per day.
5. **Cins** - Cost of insurance, as a percentage of cargo value per day of delay. A value of 2% is typically assumed. Unit: Per day.

However, a modification is made to the commodity-side cost calculation, in-line with the qualitative method described by Starcrest. The commodity-side cost per day of transit delay is expressed as Equation U2a below:

*Commodity-side Task 4 TCCIsr Change, % (daily) = ValueTrade, CIF * (Cint + Cdep + Cins) / 365.25   [U2a]*

Multiplication of Equation U2a by the projected time delay (in days), Delay10|20|30, results in Equation U2b representing the total expected cargo-side change.

*Commodity-side Task 4 TCCIsr Change, % (total) = Delay10|20|30 * ValueTrade, CIF * (Cint + Cdep + Cins) / 365.25 [U2b]*

Total Cost Calculation

The 'unofficial' total cost calculation remains unchanged from the 'official' methodology, making use of the vessel-side and cargo-side cost components evaluated above:

1. **Ship-side Task 2 Freight-Rate Adjusted Commodity Cost Intensity (FRACCI) -** Expected total vessel-side cost change. Unit: Dimensionless.
2. **Commodity-side Task 4 TCCIsr Change, % (total) -** Expected total cargo-side cost change. Unit: Dimensionless.

The total cost calculation is evaluated as the sum of the vessel-side and cargo-side cost components presented above, in alignment with Equation U3.

Total Expected Cost Intensity Change, TCCI =
Ship-side Task 2 Freight-Rate Adjusted Commodity Cost Intensity (FRACCI) + Commodity-side Task 4 TCCIsr Change, % (total) [U3]

I.iii Discussion

It should be noted that the finalised methodology developed by Starcrest for the economic impact assessment undertaken for Task 4 of the midterm measures CIA has not been made publicly accessible as was the case for the short-term measures CIA, even after request by member states of the IMO. The 'official' methodology presented in this Annex therefore represents a best-available interpretation based on the qualitative descriptions provided in Starcrest's final Task 4 report (Starcrest, 2024). Whilst intended to mirror the 'official' methodology as closely as possible, comprehensive validation has been infeasible. This interpretation of the methodology is used to understand its limitations and utilised in the development of the alternative methodology applied in this research.

Commodity, Route and Vessel Selection

Both the 'official' and 'unofficial' methodologies utilise the Comtrade platform (UNCTAD, 2024b) for analysis of merchandise trade and selection of three or more commodities. Where trade statistics have been reported to the platform by the country of interest, these trade records are likely to be reliable. If data hasn't been reported to the database, accuracy can be diminished as records instead tend to be compiled from 'partner-reported' records of the same trade flow. Overall, identification of the merchandise trade statistics from the Comtrade database is thought to introduce minimal uncertainty into final results.

Both methodologies make use of online resources to identify the routes and vessels which facilitate the selected commodity flows. The 'unofficial' methodology assumes a single trade route and vessel for each commodity of interest and represents a simpler approach to route and vessel selection as compared to the 'official' methodology where all identified routes are modelled and results are weighted accordingly. Some margin of uncertainty with respect to this data can therefore be expected, a margin likely exacerbated for smaller scale routes and countries.

Vessel-side Cost Calculations

The vessel-side cost-calculation makes use of two variables which are presented and discussed below:

1. **Ship-side Task 2 CI Change, %** - Ratio of projected Cost Intensity in a future year (2030, 2040 or 2050) versus the reference BAU cost intensity in that year, differentiated by vessel type, size class and age range. Unit: Dimensionless.

DNV's disaggregated data of modelled Ship-side Task 2 CI Change, % across details vessel classes was made available to the UCL team, facilitating application of differentiated Ship-side Task 2 CI Changes, % by vessel type, size class and age range, as opposed to the application of generalised rates. Other sources of uncertainty also exist within DNV's Task 2 modelling and include assumptions on fuel prices, feedstock supply, carbon storage capacity, technology costs, retrofit and newbuild capacity and modelling of the GFI flexibility mechanism. These uncertainties are discussed further in (DNV, 2024).

2. **Ad-valorem Freight Rate, %** - Typical percentage of value paid for transportation of the goods and compared with the value of the goods themselves. Unit: Dimensionless.

Calculation of the Ad-valorem Freight Rate, % was conducted by UNCTAD and is documented in (UNCTAD, 2022). These rates have been primarily based on CIF-FOB margins recorded in the Comtrade database, specifically featuring infilling of FOB values they are missing, using modelling trained on other areas of presenting data. In this sense, the majority of the ad-valorem rates featured in the Trade-and-Transport database are therefore estimated 'synthetic' data.

Ship-side Task 2 Freight-Rate Adjusted Commodity Cost Intensity (FRACCI) = Ship-side Task 2 CI Change, % x Ad-valorem Freight Rate, %

The product of the two variables, referred to as the 'Ship-side Task 2 Freight-rate Adjusted Commodity Cost Intensity (FRACCI)' and evaluated in accordance with Equations O1 and U1, is used to represent the final vessel-side cost estimate. The two entities are both dimensionless, ensuring that consistency is maintained between units when multiplied, however combination of the two terms is not totally logical. The Ship-side Task 2 CI Change, % refers to a change in cost intensity relative to the BAU scenario, where cost intensity itself is defined as 'annual total cost divided by the total transport work in a specific year', with units of US$/tonne-mile (DNV, 2024). The Ad-valorem Freight Rate, % is defined by the total costs paid for transportation of the goods compared with the value of the goods themselves, where both cost and value are provided in US$. Therefore, the dimensionless units of the former are (US$/tonne-mile) / (US$/tonne-mile), whilst the latter are (US$/US$).

The discrepancy is magnified when considering what each entity represents. The Ship-side Task 2 CI Change, % considers vessel-side costs such as those associated with required investments into energy efficiency and propulsive technologies, retrofits and compliance. The Ad-valorem Freight

Rate, % is defined in the official Task 4 methodology as ‘the transportation cost percentage of a commodity’s total cost’, i.e. the CIF-FOB margin divided by the CIF value. These values are sourced from UNCTAD’s Trade-and-Transport Dataset (UNCTAD, 2024c) who’s underpinning methodological note (UNCTAD, 2022) describes the application of CIF-FOB margins to derive transport cost projections. The CIF-FOB margin captures all cost elements along the transport supply-chain between exporter (FOB-valued) and importer (CIF-valued), accounting for more costs exogenous to those considered in DNV’s Task 2 analysis such as port dues, fees and profit margins, cargo handling charges, customs duties etc. Referring to this transport cost rate as the Ad-valorem Freight Rate, % is therefore inaccurate as it implies that the rate represents freight charges alone.

In evaluating the product of these entities, the Ad-valorem Freight Rate, % is scaled by a quantity that essentially considers less transport cost components and is therefore comparatively exaggerated. Detailed breakdowns of transport costs into their distinct components (for example share of freight costs in the CIF-FOB margin) are not currently available, however, and so the assumption is instead made that the magnitude of a change in the Ad-valorem Freight Rate, % will equate to the projected Ship-side Task 2 CI Change, %, ultimately leading to a systematic overestimation of the impact on the vessel-side. The cargo-side calculation method doesn’t make use of the Ad-valorem Freight Rate, % and is therefore not exposed to this error.

In addition, UNCTAD typically refers to ad-valorem rates as the division of the CIF-FOB margin by the FOB value, whereas the changes in ‘commodity cost’ imply a change in relation to a good’s CIF value. There is therefore the potential for uncertainty when quoting the modelling results of an order of magnitude roughly equal to the ‘ad-valorem’ transport cost rate itself (i.e. for an ad-valorem rate of 6%, the uncertainty would be around 0.5% is using a denominator at FOB value rather than CIF).

Cargo-side Cost Calculations

The primary consideration of the cargo-side cost calculation module is to understand the likely economic impacts of vessels slow-steaming in response to the introduction of midterm measures. There are multiple time-dependent inventorying cost components associated with any cargo in transit, each that would exert significant economic impacts should slow-steaming be utilised as a compliance mechanism.

Economic impact, or shippers' additional expenses, due to extra travel days is based in three variables, interest cost, depreciation cost and insurance cost. Variables used to measure the economic impact of slow steaming are:

- **Time delay:** number of hours or days that slow steaming will delay the cargo arrival at the destination port compared with total voyage days under current vessel speed (Transit $Times_{GSA\text{-}X}$ = Distance # / $Speed_{GSA\text{-}X}$). Time delay is dependent on vessel speed assumptions; any changes in GSA will automatically modify the voyage time. Changes in speed are to be made in Module 1 – GHG Impacts, tab "Analysis Matrices", column D", rows 15 to 23.
- **GDP impact**: the reduction of product exports is measured as an impact on total economy Gross Domestic Product (GDP) (GDP Impact = Commodity Total Export Value / Economy GDP). An economy's GDP is labelled blue; thus, the user can update and modify it.
- **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. (here assumed to be 5%) (Interest Cost = (Export Value x Interest Rate) * (Time Delay/365.25)). Interest rate is labelled in blue font; thus, the user can modify it.
- **Depreciation cost**: is defined as the cost allocation of a product over its useful life. (for this economic analysis, it is assumed as 10% for containerized cargo, 30% for fresh perishable products, and 5% for dry bulk cargo) (Depreciation Cost = (Export Value x Depreciation Rate) x (Time Delay/365.25)). The depreciation rate is labelled in blue font; thus, the user can modify it.
- **Insurance cost**: a cost paid by the shippers to protect their goods while in transit. (the percentage used in the economic analysis is 2%) (Insurance Cost = (Export Value x Insurance Rate) x (Time Delay/365.25)). The insurance rate is labelled in blue font; thus, the user can modify it.

Figure 1 – Explanation of cargo-side calculation methodology provided in (APEC, 2019).

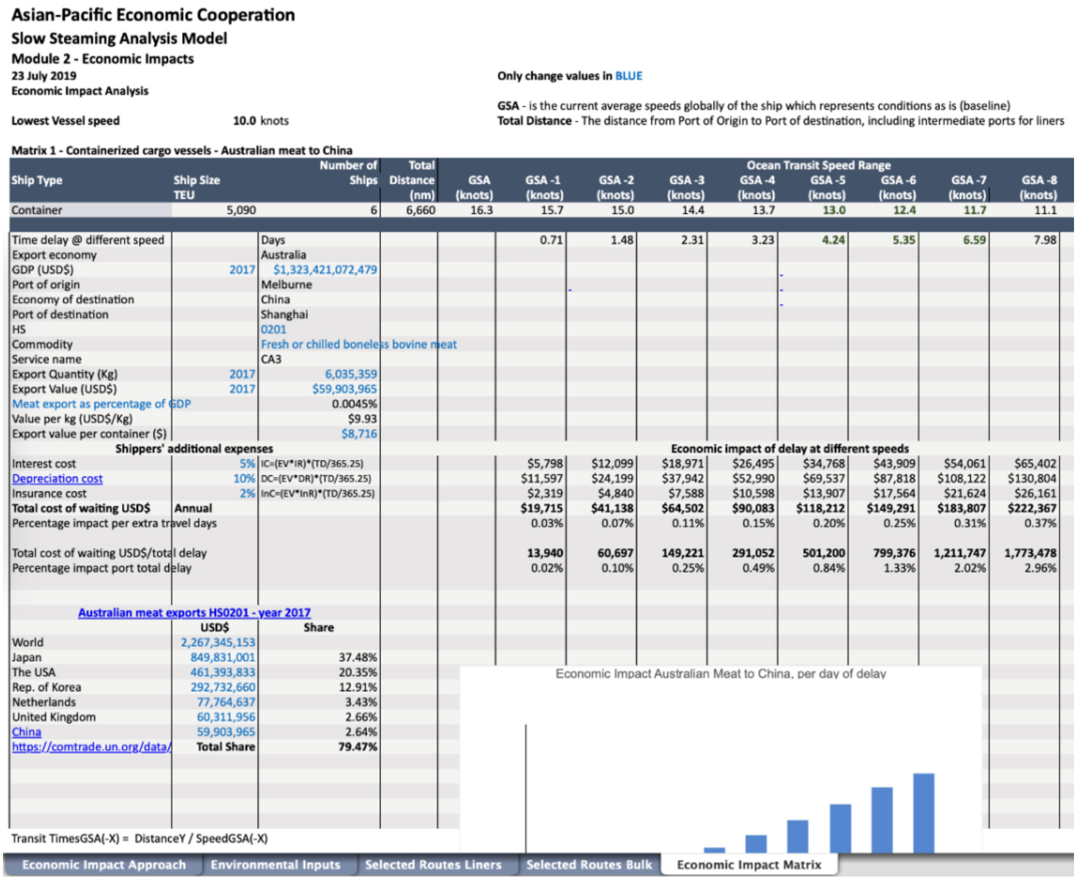
The official Task 4 method considers the costs of interest, depreciation and insurance, assuming that each results in a percentage loss of cargo per day of delay. (APEC, 2019) states that "the interest, depreciation and insurance cost estimates were developed by multiplying the rates for each of the three cost items by the total [value] amount of products/commodities exported that year (2017) to each economy of destination, then dividing by 365.25 days per year to obtain the daily cost during the transit or during any extra voyage days due to slow steaming." The implication of this statement in terms of a calculation is presented below:

*Commodity-side Task 4 TCCIsr Change, % (daily) = ValueTrade, CIF * (Cint + Cdep + Cins) / 365.25*

Multiplication by the projected time delay (in days), Delay10|20|30, therefore results in the following expression for the total expected cargo-side change:

Commodity-side Task 4 TCCIsr Change, % (total) = Delay10|20|30 * ValueTrade, CIF * (Cint + Cdep + Cins) / 365.25

However, it's clear that a deviation from this calculation method has been implemented in the publicly accessible model presented in (APEC, 2019).



Asian-Pacific Economic Cooperation
Slow Steaming Analysis Model
Module 2 - Economic Impacts
23 July 2019
Economic Impact Analysis

Only change values in BLUE

GSA - is the current average speeds globally of the ship which represents conditions as is (baseline)
Total Distance - The distance from Port of Origin to Port of destination, including intermediate ports for liners

Lowest Vessel speed **10.0** knots

Matrix 1 - Containerized cargo vessels - Australian meat to China

Ship Type	Ship Size TEU	Number of Ships	Total Distance (nm)	GSA (knots)	GSA -1 (knots)	GSA -2 (knots)	GSA -3 (knots)	GSA -4 (knots)	GSA -5 (knots)	GSA -6 (knots)	GSA -7 (knots)	GSA -8 (knots)
								Ocean Transit Speed Range				
Container	5,090	6	6,660	16.3	15.7	15.0	14.4	13.7	13.0	12.4	11.7	11.1

			GSA -1	GSA -2	GSA -3	GSA -4	GSA -5	GSA -6	GSA -7	GSA -8
Time delay @ different speed		Days	0.71	1.48	2.31	3.23	4.24	5.35	6.59	7.98
Export economy		Australia								
GDP (USD$)	2017	$1,323,421,072,479								
Port of origin		Melburne								
Economy of destination		China								
Port of destination		Shanghai								
HS		0201								
Commodity		Fresh or chilled boneless bovine meat								
Service name		CA3								
Export Quantity (Kg)	2017	6,035,359								
Export Value (USD$)	2017	$59,903,965								
Meat export as percentage of GDP		0.0045%								
Value per kg (USD$/Kg)		$9.93								
Export value per container ($)		$8,716								
Shippers' additional expenses						**Economic impact of delay at different speeds**				
Interest cost	5%	IC=(EV*IR)*(TD/365.25)	$5,798	$12,099	$18,971	$26,495	$34,768	$43,909	$54,061	$65,402
Depreciation cost	10%	DC=(EV*DR)*(TD/365.25)	$11,597	$24,199	$37,942	$52,990	$69,537	$87,818	$108,122	$130,804
Insurance cost	2%	InC=(EV*InR)*(TD/365.25)	$2,319	$4,840	$7,588	$10,598	$13,907	$17,564	$21,624	$26,161
Total cost of waiting USD$	**Annual**		**$19,715**	**$41,138**	**$64,502**	**$90,083**	**$118,212**	**$149,291**	**$183,807**	**$222,367**
Percentage impact per extra travel days			0.03%	0.07%	0.11%	0.15%	0.20%	0.25%	0.31%	0.37%
Total cost of waiting USD$/total delay			**13,940**	**60,697**	**149,221**	**291,052**	**501,200**	**799,376**	**1,211,747**	**1,773,478**
Percentage impact port total delay			0.02%	0.10%	0.25%	0.49%	0.84%	1.33%	2.02%	2.96%

Australian meat exports HS0201 - year 2017

	USD$	**Share**
World	2,267,345,153	
Japan	849,831,001	37.48%
The USA	461,393,833	20.35%
Rep. of Korea	292,732,660	12.91%
Netherlands	77,764,637	3.43%
United Kingdom	60,311,956	2.66%
China	59,903,965	2.64%
https://comtrade.un.org/data/	**Total Share**	**79.47%**

Transit TimesGSA(-X) = DistanceY / SpeedGSA(-X)

Figure 2 – Screenshot of the Economic Impact Matrix model for Australian Meat to China from (APEC, 2019).

As presented above, the 'daily cost during the transit or during any extra voyage days', TCCIsr, is scaled by the delay term, Delay10|20|30, therefore resulting in the following equation:

*Commodity-side Task 4 TCCIsr Change, % (daily) = Delay10|20|30 * ValueTrade, CIF * (Cint + Cdep + Cins) / 365.25*

Multiplication by the projected time delay (in days), Delay10|20|30, would therefore result in the following expression representing the total expected cargo-side change:

*Commodity-side Task 4 TCCIsr Change, % (total) = Delay10|20|30 * Delay10|20|30 * ValueTrade, CIF * (Cint + Cdep + Cins) / 365.25*

*Commodity-side Task 4 TCCIsr Change, % (total) = (Delay10|20|30) 2 * ValueTrade, CIF * (Cint + Cdep + Cins) / 365.25*

The implication of this deviation away from the stated methodology is that the commodity-side cost calculations are being evaluated proportionally to the 2nd power of the time delay for a given speed reduction. This leads to projections of a non-linearly increasing commodity-side cost component, resulting in inflated commodity-side cost impact projections, where interest, insurance and depreciation rates are not constant over time as is stated in the qualitative methodology note.

Table B.21: Economic Impact Module Matrix inputs and outputs

Matrix 1 - Containerized cargo vessels - Australian meat to China

Ship Type	Ship Size TEU	Number of Ships	Total Distance (nm)	GSA (knots)	GSA -1 (knots)	GSA -2 (knots)	GSA -3 (knots)	GSA -4 (knots)	GSA -5 (knots)	GSA -6 (knots)	GSA -7 (knots)	GSA -8 (knots)
					Ocean Transit Speed Range							
Container	5,090	6	6,660	20.0	19.0	18.0	17.0	16.0	15.0	14.0	13.0	12.0
Time delay @ different speed		Days			0.73	1.54	2.45	3.47	4.63	5.95	7.47	9.25
Export economy		Australia										
GDP (USD$)	2017	$1,323,421,072,479										
Port of origin		Melburne										
Economy of destination		China										
Port of destination		Shanghai										
HS		0201										
Commodity		Fresh or chilled boneless bovine meat										
Service name		CA3										
Export Quantity (Kg)	2017	6,035,359										
Export Value (USD$)	2017	$59,903,965										
Meat export as percentage ofGDP		0.0045%										
Value per kg (USD$/Kg)		$9.93										
Export value per container ($)		$8,716										
Shippers' additional expenses					Economic impact of delay at different speeds							
Interest cost	5%	IC=(EV*IR)*(TD/365.25)			$5,988	$12,642	$20,079	$28,445	$37,927	$48,763	$61,266	$75,854
Depreciation cost	10%	DC=(EV*DR)*(TD/365.25)			$11,977	$25,285	$40,158	$56,890	$75,854	$97,526	$122,533	$151,708
Insurance cost	2%	InC=(EV*InR)*(TD/365.25)			$2,395	$5,057	$8,032	$11,378	$15,171	$19,505	$24,507	$30,342
Total cost of waiting USD$	**Annual**				**$20,361**	**$42,984**	**$68,268**	**$96,714**	**$128,951**	**$165,795**	**$208,306**	**$257,903**
Percentage impact per extra travel days					0.03%	0.07%	0.11%	0.16%	0.22%	0.28%	0.35%	0.43%
Australian meat exports HS0201 - year 2017												
	USD$											
World	2,267,345,153											
Japan	849,831,001	37.48%										
USA	461,393,833	20.35%										
Rep. of Korea	292,732,660	12.91%										
Netherlands	77,764,637	3.43%										
United Kingdom	60,311,956	2.66%										
China	59,903,965	2.64%										
https://comtrade.un.org/data/	**Total Share**	**79.47%**										

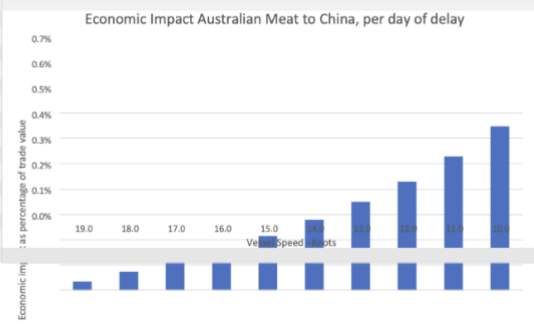


Figure 3 – Alternative screenshot of the Economic Impact Matrix model for Australian Meat to China presented unreferenced as the penultimate page of Appendix B in (APEC, 2019).

Finally, included as an unreferenced figure in the penultimate page of (APEC, 2019) is the screenshot presented in Figure 3. The screenshot shows a similar spreadsheet model as Figure 2 in projecting impacts for Australian meat exports to China. However, final cost impacts are observed to be calculated via the 'non-linear' approach as described qualitatively in (APEC, 2019) and presented in Figure 1. It's believed that the differences between Figures 2 and 3 demonstrate that there has been some uncertainty in the 'official' methodology to be applied in Task 4. Given these considerations, the former set of equations (Equations U1-U3) representing a linear application of cargo-side cost components, aligned with the qualitative methodology statement presented in Figure 1 and model presented in Figure 3, are implemented in the 'unofficial' analysis approach.

Final Cost Calculation

The 'official' methodology therefore provides results in terms of a change in 'cost intensity' that necessitates detailed transport work information to interpret. Conversely, the 'unofficial' methodology evaluates both vessel- and commodity-side costs in proportion to the trade value itself (i.e. in 'ad-valorem' terms). Their summation to represent total cost impacts is therefore logical and enables easier interpretation of the results.

Consequently, the 'unofficial' methodology mildly overestimates vessel-side costs whilst simultaneously not inflating cargo-side impacts to the same degree as the 'official' methodology. The combination of these two factors results in results derived from the 'unofficial' methodology being driven by vessel-side costs, with minimal contribution from the cargo-side. In reality, a more balanced contribution across vessel-side and cargo-side cost impacts can be expected.