

Research to assess impacts on developing countries of measures to address emissions in the international aviation and shipping sectors

Final Report

6 February 2013

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Contents

Executive summary	4
1. Introduction	12
1.1 <i>Policy context and background</i>	12
1.2 <i>Aim and scope of the project</i>	13
2 Mitigating Undesired Impacts of Carbon Reduction Policies on Case Study Economies	16
2.1 <i>Introduction</i>	16
2.2 <i>Proposals to mitigate undesired impacts</i>	16
2.2.1 Adjustment of the coverage of the MBM	16
2.2.2 National collection of revenues	18
2.2.3 Offsets	19
2.2.4 Selective disbursement of centrally collected revenues	20
2.3 <i>Are revenues sufficient?</i>	22
3 Impacts of Carbon Reduction Policies for International Aviation and Shipping	25
3.1 <i>Methodology</i>	25
3.2 <i>Main results</i>	29
3.3 <i>The impacts of revenues and using offsets</i>	35
4 Conclusions	39
References	42
Annex: Summary of impacts by Case Study Economies	44
<i>Mexico</i>	44
<i>China</i>	45
<i>India</i>	45
<i>Trinidad and Tobago</i>	46
<i>Togo</i>	47
<i>Kenya</i>	47
<i>Maldives</i>	48
<i>Samoa</i>	48
<i>Cook Islands</i>	49
<i>Chile</i>	49

List of figures

Figure 1	CO ₂ emissions and emissions reductions from international aviation due to global MBMs	7
Figure 2	CO ₂ emissions and emissions reductions from international shipping due to global MBMs	7
Figure 3	Changes in GDP due to global emissions trading schemes for international shipping and aviation in 2025 (15% auctioning, 100% cost pass through, \$30 (USD 2010) per tonne of CO ₂ , auctioning revenues are used to reduce employers' social security contributions)	8
Figure 4	Changes in GDP due to implementation of Global Offsetting for international aviation and GHG Fund for international shipping in 2025 (\$30 (USD 2010) per tonne of CO ₂ + \$3 levy per tonne of CO ₂ ; revenues are used to reduce employers' social security contributions)	8
Figure 5	Changes in GDP due to the global emissions trading schemes for international shipping and aviation in 2025 and the impact of receipts for CDM credits (15% auctioning, 100% cost pass through and \$30 (2010\$) per tonne of CO ₂)	9
Figure 6	Changes in GDP in 2025 due to a Global ETS for international shipping and aviation (100% auctioning, 100% cost pass through, \$30 (USD 2010) per tonne of CO ₂ , revenues used to reduce social security taxes, impacts of CDM receipts are not considered)	9
Figure 7	Changes in tourist expenditure and subsequent reductions in GDP due to the global emissions trading scheme for international aviation in 2025 (100% auctioning, 100% cost pass through and \$30 (2010\$) per tonne of CO ₂)	10
Figure 8	Revenues and impacts of MBMs in Aviation in 2025 (billion USD, price level 2010)	23
Figure 9	Revenues and impacts of MBMs in Shipping in 2025 (billion USD, price level 2010)	23
Figure 10	Inputs and models used in the study	28
Figure 11	Impacts of MBMs in aviation on GDP in 2025 i.e. 10 years after implementation (% change from BAU) without the impacts of revenue usage and investments from CDM projects	31
Figure 12	Impacts of global MBMs in shipping on GDP in 2025 i.e. 10 years after implementation (% change from BAU) without the impacts of revenue usage and investment effects from CDM projects	32
Figure 13	Percentage change in Domestic Consumption in CSEs in 2025 i.e. 10 years after implementation of MBMs (carbon price \$30 (2010\$) per tonne of CO ₂ , auctioning and levy/contribution revenues are not used and there are investments effects from CDM projects)	33
Figure 14	Changes in tourist expenditure and subsequent reductions in GDP due to the global emissions trading scheme for international aviation in 2025 (100% auctioning, 100% cost pass through and \$30 (2010\$) per tonne of CO ₂)	34

Figure 15 Percentage change in Trade Balance of CSEs in 2015 i.e. 10 years after implementation of MBMs, auctioning and levy/contribution revenues are not used	34
Figure 16 Percentage change in GDP in CSEs in 2025 due to the Global Emissions Trading Schemes (100% auctioning, 100% cost pass through and \$30 (2010\$) per tonne of CO ₂) for international shipping and aviation without the impact of auctioning revenue usage and without the impacts of the receipts for CDM credits.	35
Figure 17 Changes in GDP in 2025 due to a Global ETS for international shipping and aviation (100% auctioning, 100% cost pass through, \$30 (USD 2010) per tonne of CO ₂ , revenues used to reduce social security taxes, impacts of CDM receipts are not considered)	36
Figure 18 Changes in GDP in 2025 due to MBMs for international shipping and aviation (\$30 (USD 2010) per tonne of CO ₂ , revenues used to reduce social security taxes, impacts of CDM receipts are not considered)	36
Figure 19 Changes in GDP due to global emissions trading schemes for international shipping and aviation in 2025 (15% auctioning, 100% cost pass through, \$30 (USD 2010) per tonne of CO ₂ , auctioning revenues are used to reduce employers' social security contributions)	37
Figure 20 Changes in GDP due to Global Offsetting for international aviation and GHG Fund for international shipping in 2025 (\$30 (USD 2010) per tonne of CO ₂ + \$3 levy per tonne of CO ₂ , revenues are used to reduce employers' social security contributions)	37
Figure 21 Changes in GDP due to the global emissions trading schemes for international shipping and aviation in 2025 and the impact of receipts for CDM credits (15% auctioning, 100% cost pass through and \$30 (2010\$) per tonne of CO ₂)	38
Figure 22 Changes in GDP due to market-based measures for international shipping and aviation in 2025 (100% cost pass through and \$30 (2010\$) per tonne of CO ₂) with revenue recycling by reducing employers' social security contributions, no impacts of CDM revenues are considered	44

Executive summary

Key findings:

- 1) Economic impacts of Market Based Measures (MBMs) for International Shipping and Aviation on Developing Countries considered in this study, and globally, are small. The reductions in GDP are less than 0.01% on average and less than 0.2% for all but a few of the case study countries. MBMs which raise more revenues have a larger impact.
- 2) The volume and certainty of CO₂ reductions achieved by the MBMs considered for the timeframe (2015-2025) in this study are comparable to each other, although emission reductions from project based emissions reductions (offsets) are the most significant. In the longer term, innovations in fuel-efficiency may decrease in-sector emission reductions costs and the associated in-sector CO₂ reductions could be more significant.
- 3) In most cases, Aviation MBMs have larger economic impacts than those associated with the implementation of Shipping schemes. Aviation has larger impacts on tourism, and shipping is less responsive to price increases and less carbon intensive.
- 4) Countries with a higher dependency on tourism and trade are likely to experience greater economic impacts. Some of these countries are small island developing states that are also vulnerable to climate change impacts.
- 5) Undesired economic impacts can be addressed. However, since the factors that cause these vary between countries, applicable measures vary as well. Instead, a combination of appropriate measures could be taken to address the impacts in question. Exemptions, lump sum rebates, investments in infrastructure efficiency and into the development of more efficient ships and aircraft could be considered.

Background

International shipping and aviation account for approximately 5% of annual anthropogenic CO₂ emissions and this is projected to increase in the coming decades. To address these emissions, market-based measures (MBMs) have been proposed to the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO) by some of their Member States.

As MBMs raise the costs of aviation and maritime transport, they impact economies due to increased prices for passenger travel and exported and imported goods. The main objectives of this study were to:

- (i) Assess the economic impacts of a number of MBMs on selected case study countries and globally; and
- (ii) Determine the possible, and most effective and efficient tools to address or reduce these impacts, where they are deemed undesirable.

This study focuses on a selection of case study countries which, based on their economic structure, were anticipated to be negatively impacted by MBMs for international shipping and aviation. These case study economies include: Mexico, China, India, Trinidad and Tobago, Togo, Kenya, Maldives, Samoa, Cook Islands and Chile. The policy options studied were Global Emissions Trading (for aviation and shipping), Global Mandatory Offsetting complemented by a Revenue Generation Mechanism (aviation), an International Fund for Greenhouse Gas Emissions (shipping) and the European Union Emissions Trading System (EU-ETS) for aviation and shipping. Scenarios related to the implementation of MBMs have been modelled in such a way that they limit international aviation emissions to 10% below their 2005 levels and international maritime transport emissions to 20% below their 2005 levels. These targets are consistently applied as part of applicable modelling exercises for the designated analytical timeframe, namely 2015 to 2025. The business as usual (BAU) emissions follow IMO and ICAO medium scenarios (A1B and CAEP-M scenarios, respectively), implying that the actual CO₂ emissions from international aviation and shipping can also be lower or higher if they follow any other IMO or ICAO emissions scenario.

Summary of findings

The implementation of all schemes as outlined above will achieve the specified CO₂ emissions reduction targets. In all global schemes aviation emissions are limited to 10% below their 2005 levels and maritime transport emissions to 20% below their 2005 levels through a combination of CO₂ mitigation measures corresponding to specific sectoral emissions sources (in-sector emissions), and through offsetting from 2015 to 2025. Throughout the study period the majority of emission reductions are achieved by offsetting emissions through the purchase of carbon credits from Clean Development Mechanism (CDM) projects in developing countries. For the EU ETS for aviation and shipping the cap is set at 95% of the average 2004 - 2006 emissions and 15% of CO₂ emission allowances are auctioned, and the rest is allocated for free.

In 2025 a Global Emissions Trading scheme (where carbon is traded at \$30 per tonne of CO₂) for shipping and aviation as outlined in this study reduces net emissions for both sectors relative to business as usual by 1267 MtCO₂ (57% of expected emissions), with 11.8 MtCO₂ (1.5% of expected emissions) and 2.4 MtCO₂ (0.2% of expected emissions) coming directly from reductions in international aviation and shipping emissions respectively. The remainder (1252.8 MtCO₂) is offset. At the current time, in sector contributions comprise a small percentage of overall mitigation, and vary depending largely on carbon price, scheme design and coverage. As indicated in column D of Table 1, in sector reductions from aviation in 2025 range from 2.7 to 19.3 MtCO₂ (0.3 - 2.4% of expected emissions) 0.8 and 9.8 MtCO₂ (0.1 - 0.7%

of expected emissions, variable 2d) for shipping. The remainder of emissions are assumed to be offset. The emission reductions from within the aviation and shipping sectors within the short timeframe considered in this study reflect both the small price increase per tonne of goods or passenger carried and its low impact on demand; and the availability of relatively few technological abatement opportunities, especially for shipping after the improvements from EEDI. The low responsiveness of international transport to price increases from MBMs is in line with the findings from other studies. This study assumes that the offset price and carbon price are exactly the same and when the abatement cost increases above carbon price the sectors pay for carbon reduction in other sectors that carry out cheaper emission reductions. In the longer term, innovations in fuel-efficiency may decrease in-sector emission reductions costs and the in-sector CO₂ reductions could be more significant. If the abatement potential from the international transport sectors is greater than estimated in this study, this would imply greater emission reductions from these sectors and lower overall economic cost and impacts.

Global emissions trading schemes for both shipping and aviation together are likely to have a very small impact on GDP globally. Figure 3 presents the impacts for a version of the Global ETS where 15% of CO₂ allowances under the emissions target are auctioned (Alternatively, for example, none or all allowances could be given to participating companies for free) and all auctioned CO₂ allowance costs plus the costs of free allowances and offsets are passed on to consumers through increased transport prices ('100% cost pass through'). Some of the Global ETS impacts on GDP are mitigated by 'revenue recycling', i.e. returning the auctioning revenues raised by the MBMs back to countries, which can then be used by their Governments to achieve domestic objectives, for instance to lower social security taxes.

Table 1 CO₂ emissions and emission reductions from international transport due to global MBMs in 2025 (MtCO₂)

	Business as usual (BAU) emissions in 2025 [a]	Target [b]	Emission reduction [c] c=a-b c=d+e	In-sector emissions reductions [d]	Emissions offset [e] e=c-d
1. Aviation	810 ¹	325	485	3 - 19	466 - 482
2. Shipping	1418 ²	636	782	1 - 10	772 - 781
3. Aviation+ Shipping	2228	961	1267	4 - 29	1238 - 1263

¹ CAEP8-M - AERO modelling emissions for ICAO CAEP Most Likely (central) air traffic growth scenario (CAEP- SG/20082-IP/02).

² A1B scenario (1485 MtCO₂) of the Second IMO GHG Study 2009 (Buhaug *et al.*, 2009) minus the estimated emissions reductions from EEDI. Buhaug *et al.*, 2009 estimates CO₂ emissions of international shipping ranging from 500 MtCO₂ to 2000 MtCO₂ in 2025.

Figure 1 CO₂ emissions and emissions reductions from international aviation due to global MBMs

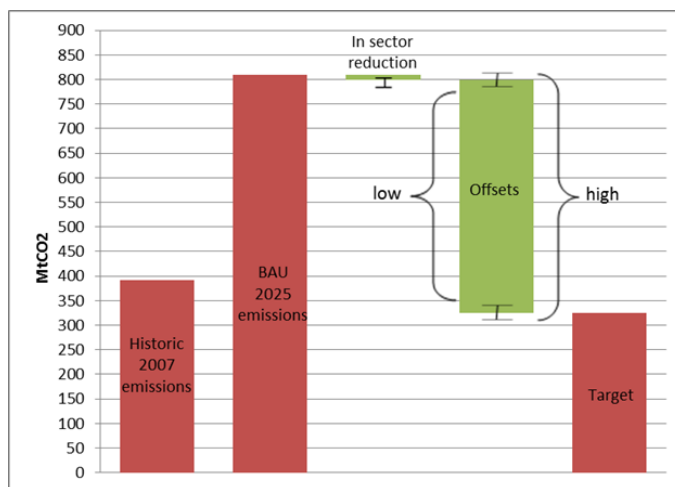
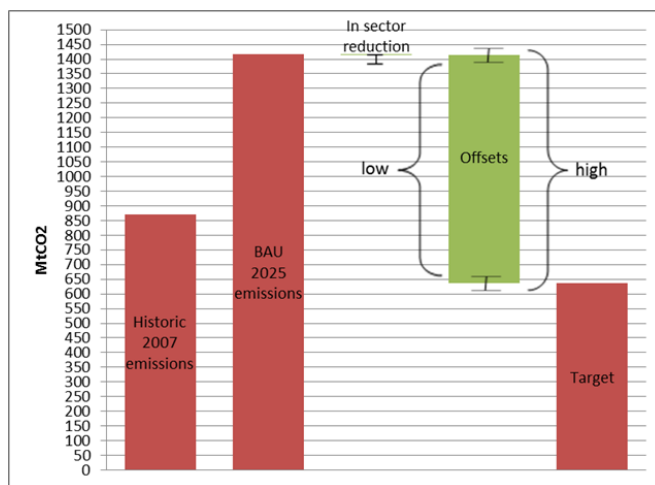


Figure 2 CO₂ emissions and emissions reductions from international shipping due to global MBMs



The impacts of MBMs on individual economies depend on the importance of air and maritime trade to the economy, shares of imports in domestic consumption, tourism contributions to GDP and overall trade balance. For the results from the EU ETS scenario, the trade and tourism between the case study country in question and the EU is a determining factor.

Comparing the GDP impacts in Annex I and Non-Annex I countries shows a slightly greater negative impact on Annex I countries (0.009% below the baseline in 2025) than on Non-Annex I

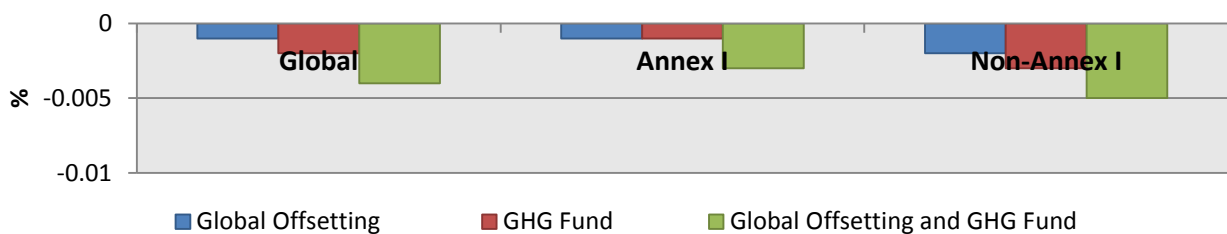
countries (0.007% in 2025). However despite the fact that these impacts are close to zero for both Annex I and Non-Annex I countries as a whole, these impacts vary greatly across countries and regions given relative dependencies on trade and tourism.

Figure 3 Changes in GDP due to global emissions trading schemes for international shipping and aviation in 2025 (15% auctioning, 100% cost pass through, \$30 (USD 2010) per tonne of CO₂, auctioning revenues are used to reduce employers' social security contributions)



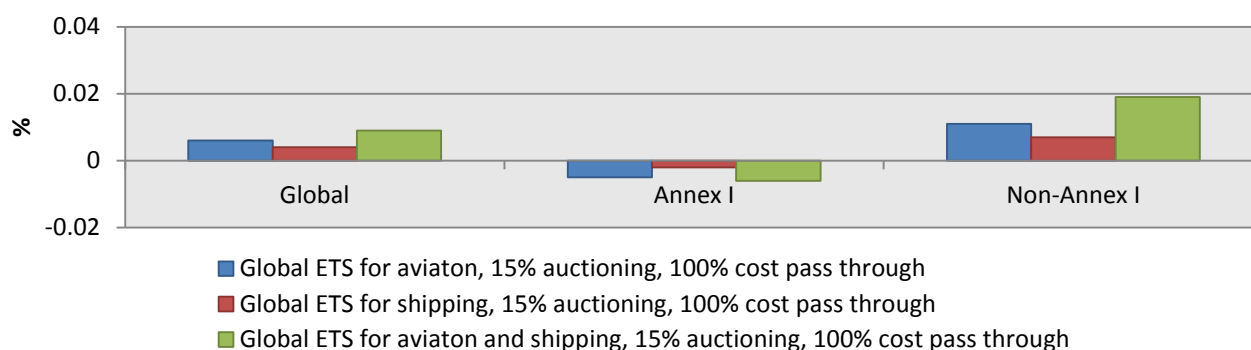
The combined impact of a Global Mandatory Offsetting complemented by a Revenue Generation Mechanism for aviation and an International Fund for Greenhouse Gas Emissions from shipping is expected to be small on GDP in Annex I and Non-Annex I countries' as country groupings (See Figure 4). Impacts may be slightly larger in Non-Annex I countries given the growth in aviation and shipping emissions associated with the rapid growth of these sectors particularly in emerging economies.

Figure 4 Changes in GDP due to implementation of Global Offsetting for international aviation and GHG Fund for international shipping in 2025 (\$30 (USD 2010) per tonne of CO₂ + \$3 levy per tonne of CO₂; revenues are used to reduce employers' social security contributions)



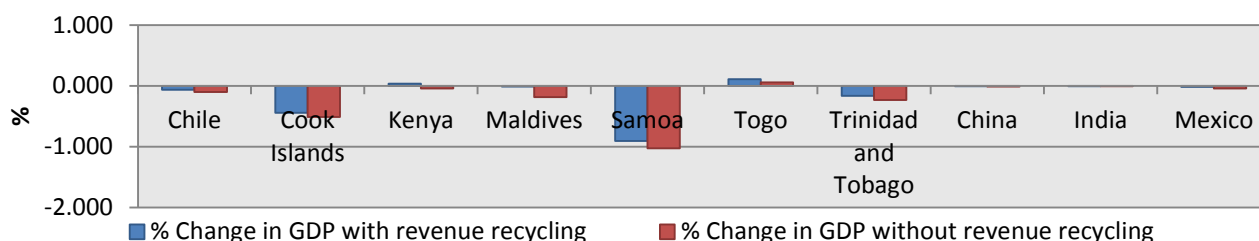
All MBMs considered in this study rely on offsets to achieve the net emissions target, and as a result they increase demand for offsets. As many offset projects are located in developing countries, these countries benefit from this increased demand. For project host countries, the negative impacts of a market-based measure are reduced or converted into benefits when the increased demand for offsets is taken into account (Figure 5).

Figure 5 Changes in GDP due to the global emissions trading schemes for international shipping and aviation in 2025 and the impact of receipts for CDM credits (15% auctioning, 100% cost pass through and \$30 (2010\$) per tonne of CO₂)



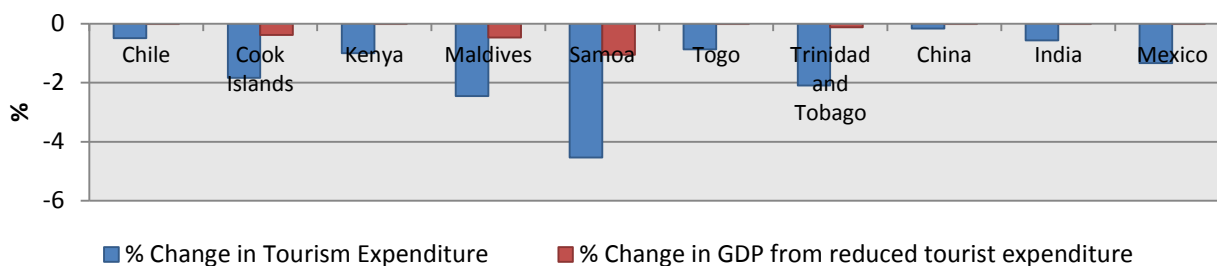
The impacts on GDP in the case study countries are about 1% of GDP or less for all countries and MBMs considered, and lower than 0.2% of GDP for all but a few of the case study countries. Figure 6 shows the estimated impacts of the Global ETS for aviation and shipping on GDP. The figure does not encompass the benefits resulting from the implementation of CDM projects and the possibility that additional carbon finance could compensate for reductions in GDP for host countries such as Mexico, India and China (as it is in this study). The figure shows that remote economies with a large tourism sector are affected most, whereas large economies, economies with land transport links and more diversified economies are impacted less. The small positive impact on the GDP of Togo and Kenya are attributable to reductions in the trade deficit where imports are greater than exports (negative trade balance).

Figure 6 Changes in GDP in 2025 due to a Global ETS for international shipping and aviation (100% auctioning, 100% cost pass through, \$30 (USD 2010) per tonne of CO₂, revenues used to reduce social security taxes, impacts of CDM receipts are not considered)



The main factor influencing GDP reductions in small island states is the reduction in international tourist expenditure across these countries, driven by reduced numbers of tourists arriving by air in response to increases in flight costs and thus ticket prices (Figure 7).

Figure 7 Changes in tourist expenditure and subsequent reductions in GDP due to the global emissions trading scheme for international aviation in 2025 (100% auctioning, 100% cost pass through and \$30 (2010\$) per tonne of CO₂)



Any MBM for international transport may have undesired impacts on the poorest countries even after revenue recycling and receipts from offsetting projects. Since these impacts arise from multiple causes, any single measure to address them is likely to create greater benefits for some countries than for others. A range of measures can be considered to mitigate undesired impacts. All of these have significant benefits to some countries:

1. Exempting certain routes reduce the MBMs impacts for those routes, although not completely. This is because passengers that transfer and cargo that is transhipped are likely to be only partly exempted and in shipping exemptions may give rise to avoiding the scheme by changing routes. Exemptions can be an effective way to reduce impacts on remote economies where rerouting travel and goods is less feasible.
2. Shifting CDM projects towards the most affected LDCs, by defining the eligibility criteria of some or all offsets used, would be one way of mitigating the MBMs' impacts. This will benefit these affected LDCs economies, but could also be less cost effective given the potential for small scale reductions and a higher cost to abatement ratio in these countries.
3. Revenues of MBMs can be used for several purposes:
 - a. They can be redistributed as lump sum payments to the countries that face negative impacts to their economies, although it is hard to find a perfect redistribution key. Countries can use these receipts, for example, to lower income and social security taxes, which would boost economic growth. While this would not reduce the increase in import values or export costs, it would generate additional income that allows economies to meet the cost increase. This would be an effective way to mitigate impacts on all countries.
 - b. The revenues can be used to improve port and airport efficiency, thus lowering transport costs. This is an effective way to mitigate undesired effects as it can offset the transport cost increase. This would be attractive for countries whose ports and airports are currently operating inefficiently.

- c. They can be used for climate finance. Because the largest impacts are experienced amongst states that are the most vulnerable to climate change, allocating revenues towards finance for climate adaptation could be a way to reduce undesired impacts. This would be an effective way to reduce impacts on vulnerable countries.

1 Introduction

1.1 Policy context and background

International shipping and aviation account for approximately 5% of anthropogenic CO₂ emissions and this share is projected to increase in the coming decades (UNEP, 2011). Market-based measures for addressing greenhouse gas emissions from international aviation and maritime transport have attracted attention for two reasons. First, the projected rapid increase of emissions is a cause for action. Second, such instruments could provide a source for climate finance.

In the last 15 years, many proposals to address these emissions have been discussed in context of negotiations within the United Nations Framework Convention on Climate Change (UNFCCC), the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO). However, apart from energy efficiency measures for ships, agreed to by the IMO in 2011, no measures have been agreed upon.

One reason underlying the relatively slow progress, is the presence of seemingly conflicting principles between ICAO and IMO on the one hand, and the presence of similar conflicts within the. ICAO and IMO policies are based on equal treatment of all ships and aircraft, regardless of their nationality and despite nationally and regionally differentiated policies (e.g. on emissions or noise). In contrast, one of overarching principles of the UNFCCC, is that countries should act in accordance with their Common but Differentiated Responsibilities and respective capabilities, with the Kyoto Protocol instructing only Annex I countries to limit their emissions. Simply applying this principle to shipping, by specifying that only ships flying an Annex I flag would have to reduce their emissions, is widely agreed to be ineffectual given the ease with which ships can change their flags.

At the same time, it is widely recognised that developing countries need financial support to carry out climate policies, both with respect to adaptation and mitigation. The UNFCCC has encouraged the uptake of both types of policies in developing countries, however these are unlikely to materialise without new sources of climate finance. In the current economic and financial circumstances, and public funding constraints, market-based instruments in international transport have been highlighted as one of the possible sources (AGF, 2010; World Bank 2011).

The EU included aviation in its Emissions Trading Scheme from 1 January 2012. Some non-EU countries have opposed this measure, and in order to allow ICAO to make progress, the European Commission has proposed temporarily limiting the scope of enforcement to flights within and between EU Member States.

Several proposals have been made for market-based measures (MBMs) which address greenhouse gas emissions from aviation and maritime transport, while also raising

revenues that can be used for climate finance (for example, Müller and Hepburn, 2006; IMERS, 2011; Anger et al., 2009; Faber et al., 2012). This report assesses the impacts of the proposed MBMs on the international transport sectors, on the global economy and economies of selected developing countries.

By increasing the cost of emitting greenhouse gases, MBMs raise transport costs and are thus likely to impact on economies. The magnitude and direction of these impacts will depend on the trade and tourism intensity of an economy as well as on changes in relative prices due to carbon reduction policies.

1.2 Aim and scope of the project

This project aims to quantify the impacts of carbon reduction policies for the international shipping and aviation sectors (MBMs discussed in detail in Annex I) on the global economy, on country groups and on 10 selected developing country case study economies (CSEs). It further assesses ways to mitigate undesired impacts of the MBMs.

The CSEs have been selected because they are expected to be impacted more significantly by the implementation of global MBMs - either due to their dependence on these transport modes, on airborne tourism, or their remoteness. The CSEs chosen are as follows:

1. Mexico
2. China
3. India
4. Trinidad and Tobago
5. Togo
6. Kenya
7. Maldives
8. Samoa
9. Cook Islands
10. Chile

This study looks at impacts of five market-based measures - two for shipping, two for the aviation sectors and one unilateral policy, as outlined below. Besides the European Union Emissions Trading System (EU ETS) for aviation, the proposals mentioned above have not been implemented and are still being developed. There is still a lot of debate around the introduction and operation of such schemes, and all proposals lack detailed information on design elements such as CO₂ emissions targets and/or price levels. Therefore the study had to make assumptions about the designs of the MBMs to be able to incorporate these into the various modelling exercises.

1. Policy proposals: shipping

IMO member states have proposed ten market-based measures to reduce CO₂ emissions from international shipping, including three variants of an emissions trading scheme. This study looks at the following two, which would both raise significant revenues if implemented.

The International Fund for Greenhouse Gas emissions from ships (GHG Fund)

The GHG fund would establish a global emissions target for international shipping. Emissions above the target line would be offset largely by purchasing approved emission reduction credits. The offsetting activities would be financed through contributions from ships on every tonne of bunker fuel purchased. It is envisaged that contributions would be collected through bunker fuel suppliers or via direct payment from ship owners. The proposal foresees contribution rate adjustments at regular intervals to ensure that sufficient funds are available to purchase project credits to achieve the agreed target line. Any additional funds remaining are potentially available to regulators for climate change mitigation and adaptation purposes. In this study, it is assumed that the offset price remains the same over time and hence there is no need to adjust the contribution. However, there is an additional 10% levy on each offset purchased generating additional revenue for the countries participating in the GHG Fund, or for a central body that collects and distributes revenues.

The Global Emission Trading System for International Shipping (GETS)

The GETS would set a sector-wide cap on net emissions from international shipping and establish a trading mechanism. Ships would be required to surrender one Ship Emission Unit (CO₂ allowance), or one recognised out-of-sector allowance or one recognised out-of-sector project credit (offset, CDM credit), for each tonne of CO₂ they emit. The use of out-of-sector credits allows for further growth of the shipping sector beyond the cap. A number of allowances (Ship Emission Units) corresponding to the cap would be released into the market each year via a global auctioning process. The IMO proposal envisages using auction revenues to provide for adaptation and mitigation (additional emission reductions) activities outlined through UNFCCC processes and for the R&D of clean technologies within the maritime sector. In this study the auctioning revenues are returned to the participating countries.

2. Policy proposals: aviation

ICAO has proposed three measures to reduce CO₂ emissions from international aviation, one of which is global offsetting which will not raise revenues. This study thus considers the following two options:

Global Mandatory Offsetting complemented by a Revenue Generation Mechanism (GMO)

The GMO for aviation would be similar to the GHG fund for shipping. All emissions above the target line are offset and an additional 10% of revenues would be raised for climate finance purposes. In this study these revenues are returned to the participating countries.

Global Emissions Trading System for International Aviation (GETS)

The GETS for aviation would be similar to the GETS for shipping.

3. Unilateral policy for aviation and shipping

European Union Emissions Trading System (EU ETS)

Flights to and from the EU are incorporated in to the EU ETS, with a cap set at 95% of the average 2004 - 2006 emissions with 15% of allowances auctioned and the rest allocated for free. Aircraft operators need to surrender allowances for CO₂ emissions on their flights within the scope of the system. Similarly, ships sailing to and from EU ports would be incorporated in the EU ETS.

This study addresses CO₂ emissions from international aviation and shipping only. Therefore we assume that domestic emissions from aviation and shipping are covered by national policies and are not modelled as a part of this study.

For the quantitative analysis, our general framework is that policies result in cost changes in aviation and maritime transport, which in turn impact on import values, export costs (in short trade) and domestic consumption which may vary per sector. For the analysis we use the E3MG, AERO, and Ship Freight Costs and Emissions models and ad-hoc economic analysis.

This study adopts a baseline scenario for international shipping CO₂ emissions based on Buhaug et al. (2009) and the A1B scenario. For international aviation we use the CAEP8 Medium Growth scenario. A baseline scenario for each of the CSE economies, globally and for Annex I and Non-Annex I countries in which a path of economic development has been set up to 2025, but with no MBMs for international transport.

2 Mitigating Undesired Impacts of Carbon Reduction Policies on Case Study Economies

2.1 Introduction

MBMs will limit or reduce greenhouse gas emissions and consequently lower the costs of adapting to climate change. When the carbon price in the MBM is the same as the carbon price in other parts of the economy, the cost-effectiveness of mitigation will be optimal (CE Delft 2010). MBMs will increase transport costs, which may cause an increase in import values and export costs, and a decrease in foreign tourism and associated receipts (see Chapter 2).

This chapter aims to identify ways to mitigate undesired impacts, and qualitatively assess their impacts on case study economies, their environmental impacts, their impacts on the shipping and aviation sectors, and on their ability to raise revenues for climate finance.

2.2 Proposals to mitigate undesired impacts

Of the large number of proposals to address undesirable impacts in general, we distinguish four main ways in which undesired impacts can be mitigated:

1. Adjustment of the coverage of the MBM;
2. National collection and usage of revenues;
3. Use of offsets;
4. Selective disbursement of centrally collected revenues.

2.2.1 Adjustment of the coverage of the MBM

One possible way to mitigate undesired impacts would be to exempt certain transport routes, as proposed by Norway (MEPC 60/4/22), from MBMs. For example, voyages or flights to and/or from Small Island Developing States (SIDS) and/or Least Developed Countries (LDCs) could be exempted. As a result, operators of these voyages or flights would not face the costs imposed by MBMs. Whether these countries are impacted by MBMs and whether exemptions are therefore needed depends on market circumstances (see Section 0). For aviation, exempting certain countries may encourage the development of new airports that may help to shorten flight distances between two cities where there is currently rerouting (hence it could in some cases reduce CO₂ emissions) and encourage economic activity in these countries.

Other exemptions are possible, but less attractive for various reasons. Exempting emissions in certain areas would require simultaneous monitoring of emissions and position, which is costly and could be less environmentally effective if the high seas or international airspace are exempted. Exempting ships or aircraft below a certain size would lead to distortions in markets where ships or aircraft of different sizes compete.

Exemptions of passengers or cargo on the basis of their nationality would require a very detailed and probably costly administration. The least desirable exemptions would be based on the nationality of ships and aircraft. This would not only distort the market, but also result in ships changing their flag to exempted countries, thus undermining the environmental effectiveness of the MBM³ (CE Delft et al., 2008).

Exemptions of routes will not offset the increase of import values completely when trade is transhipped in a country that is not exempt, or if passengers transfer in such a country. For example, if a container is shipped from A to C with a transshipment in B, and emissions on voyages to C are exempt but emissions on voyages to A and to B are not. As such, the costs of the voyage from A to B would increase, but the voyage from B to C would not. As a result, the costs of transporting the container from A to C would still increase, but not to the same extent if C were not exempted. It is not possible to give a generalised estimation of the percentage of cost increase that could be offset by granting exemptions. This depends on the distance of a country to a transshipment hub and on the amount of imported and exported cargo that is transhipped.

Currently, emissions on ship voyages to LDCs account for 1% - 2% of global maritime emissions (CE Delft et al. 2010). Emissions on voyages to SIDS account for 9% of global emissions, probably due to the fact that Singapore is both a major shipping hub and a SIDS. This means that if shipping routes were to remain the same, the environmental effectiveness of a system would only be marginally affected by exempting voyages to and/or from LDCs, but that exempting all SIDS would have a larger impact on environmental effectiveness. For aviation, flights from LDCs are projected to amount to 1% of global emissions in 2025, and to SIDS 6% (AERO-MS, CAEP 8M scenario).

However, depending on the cost of compliance, exemptions may result in changes in shipping routes or aviation networks (CE Delft et al. 2009). When carbon costs are high and the costs of making a detour and an additional port call are low, it could be worthwhile to exempt a share of the emissions by making an additional port of call in an exempted country. This can also occur for aviation, although the value that passengers assign to time probably makes this only attractive for full freight flights. The extent to which avoidance will occur depends on the availability of (air)port capacity along major trading routes. For example, on the shipping lines from East Asia to Europe, there are several deep sea ports in developing countries such as Vietnam, Djibouti and Pakistan. If voyages to these low income countries were exempted, it could be attractive for ships sailing between Asia and Europe to make an additional port of call simply to reduce the amount of allowances that would need to be surrendered or the levy that would need to be paid. The same is true for less important shipping routes, such as along the African coast or through the Caribbean. This means that a blanket exemption of ships sailing to LDCs, SIDS or low income countries would probably result in avoidance of the system and

³ For legal reasons, changing the nationality of an aircraft operator or the registry of an aircraft is harder and may have implications where the aircraft can be operated.

undermine the environmental effectiveness, but can have a positive impact on these countries' economies if the port taxes are paid and local services used. On the shipping lines from East Asia to North America the situation is different; there are several remote islands, but few currently have large ports. Likewise in aviation, major hubs in LDCs or low income countries do not currently exist.

In conclusion, exemptions could reduce the impact of MBMs on countries, but not annul them, especially where flights involve a transfer or cargo is transhipped. A risk of exemptions is that they offer scope to avoid an MBM and hence reduce the environmental effectiveness. This is a higher risk in shipping than in aviation, because avoidance costs time and the value of time is higher in aviation. An exemption of flights to or from LDCs would reduce the environmental effectiveness by 1% (5 Mt CO₂ in 2025). For shipping, if exemptions to LDCs could be defined that could not be easily avoided, then the emission savings would be reduced by 1% (7 Mt CO₂ in 2025). However it is not clear that a system of exemptions that would not easily be avoided for a significant number of emissions is possible. Exemptions to SIDS would have a larger impact on the environmental effectiveness (by 6% in the case of aviation), although this is mainly due to the fact that a major shipping and aviation hub is located in a SIDS.

2.2.2 National collection of revenues

Approaches to the collection of revenues may provide countries with the means to mitigate undesirable impacts. Most policy instruments analysed here are based on central international collection of revenues. In such a case, revenues could be redistributed centrally to mitigate impacts, as discussed below, but countries would not have direct receipts. However, for the shipping instruments, alternative proposals have been made that involve national collection of revenues. Similar instruments are conceivable for aviation.

The UK proposal for the Global ETS in shipping involves countries auctioning allowances, but the proposal does not specify how the amount of allowances auctioned is set for each country. In principle, any amount can be chosen, but the impacts differ if the revenues stay with the country (Faber et al., 2012).

Allocating allowances on the basis of the share in maritime trade or on an equal per capita basis have been tested in this report and appear to have very similar results for the CSEs considered here. Per capita allocation is slightly more favourable for China and India as it reduces the economic impacts by a very small amount, but for all other CSEs it gives slightly more negative economic impacts. Recycling the revenues through lower social security taxes would mitigate the economic impacts to some extent (see Chapter 2). Allocating allowances on the basis of bunker fuel sales would create an uneven

distribution, as five countries have over half of the global trade in marine bunkers (IEA, 2012).⁴

The Jamaica proposal for a Port State Levy (PSL) requires countries to impose a levy on ships in their ports on the basis of the reported or modelled emissions for their last voyage. Receipts from such a levy would be equal to the increase in import values for goods that are not transhipped. For goods that are transhipped, receipts would equal the cost increase on the final part of the voyage but not on earlier parts. The extent to which impacts would be mitigated has not been quantified in this report.

In aviation similar proposals are conceivable. Emission allowances can be allocated to countries on the basis of bunker fuel sales, or on reported or modelled emissions for departing or arriving flights, but the differences in the number of allowances received would not be large (Lee et al., 2005).

National collection of revenues would allow states to mitigate a share of the undesired impacts by using the receipts to achieve domestic objectives, for instance to reduce taxes, invest in infrastructure or take other actions that increase income for affected groups or decrease import values or subsidise exporting sectors. It provides states with the flexibility to use the revenues in the way that is most beneficial to their countries (it goes beyond the scope of this report to analyse how each country can do this best).

The environmental effectiveness of a contribution or levy-based MBM could change when revenues are collected nationally. The incentive to reduce emissions through improved fuel efficiency and reduced demand would be the same, but the amount of offsets acquired would depend on the decisions of the national governments concerned. A global ETS with national collection of revenues would be as environmentally effective as an ETS with central collection. Without a central fund, there would not be an opportunity to direct the collected revenues to the countries that are impacted by MBMs most, although as noted below, such mitigation could occur through allocating more allowances to the affected countries for auctioning.

2.2.3 Offsets

Offsets are an essential element of all MBMs considered in this study. The proposals for the GHG Fund and the GETS for maritime transport explicitly mention using Clean Development Mechanism (CDM) credits - offsets that are generated through projects in developing countries. Because these projects require investments from abroad, this study shows that there are positive economic impacts in the host countries (see also Wang et al., 2009). Moreover, projects can result in technology transfer, which can have further positive impacts on economic development (Popp, 2011).

⁴ These countries are Singapore, US, China (including Hong Kong), The Netherlands and The United Arab Emirates.

CDM projects may not directly affect import values or export costs, and therefore the benefits may accrue to different groups than the costs of the MBM. The costs are borne by importers and exporters, while the benefits accrue to the domestic sectors involved in the CDM projects.

Currently, CDM projects are concentrated in a small number of countries. China, India, Brazil and Mexico account for the largest number of projects and also the majority of credits generated (UNEP Risø Institute, 2012), although recent rules on eligibility for compliance in the EU ETS (the main buyers of CDM credits) are expected to shift a proportion of future supply to Least Developed Countries (LDCs).

It would be possible to define rules on eligibility of offset compliance so demand for CDM projects is shifted towards countries that are worst affected by the MBMs. While this would help to reduce the adverse impacts of a MBM on these countries, it may cause economic inefficiencies, because the projects carried out in these countries might not be the least cost ones. In general, CDM projects have been carried out in countries that have an attractive investment climate, as witnessed by their high level of foreign direct investment (Zhu, 2012). In addition, the capacities of the host country administration appear to be a relevant factor.

This study demonstrates that for CDM project host countries, the negative impacts of MBMs are reduced and in some cases converted into benefits when the economic impacts of increased offset flows are taken into account. None of the smaller CSEs included in this study currently have registered CDM projects.

2.2.4 Selective disbursement of centrally collected revenues

Centrally collected revenues can be disbursed to mitigate undesired impacts, for example by:

- a. Allocating revenues to certain countries so that they can mitigate undesired impacts;
- b. Allocating revenues to reduce the costs of maritime trade or aviation in countries which experience undesired impacts;
- c. Allocating revenues to the improvement of the fuel-efficiency of aviation or maritime transport so that the impacts will be reduced;
- d. Allocating revenues to climate finance and directing the funds to countries which experience undesired impacts;
- e. Allocating revenues to additional offsetting and directing those offsets to countries most affected by the MBM.

The Rebate Mechanism proposal (MEPC 63/5/6), originally proposed by the IUCN and currently supported by WWF, proposes a way to mitigate undesired impacts (or rather, to

ensure compatibility with the principle of common but differentiated responsibilities and respective capabilities) by providing developing countries with a rebate that is proportional to the share of their imports from non-neighbouring countries in world trade. Other keys for allocating revenues are conceivable. For example, revenues could be allocated in accordance with emissions on routes to countries (CE Delft et al., 2010). Another option would be allocation in accordance with countries' populations.

A lump sum rebate would offer states the possibility to reduce taxes or increase government spending, much in the same way as national collection of revenues would. A lump sum rebate would, however, not necessarily offer any climate benefits or benefits specifically aimed at international transport sectors. The eligibility of countries for the lump sum rebate is an open question.

A second way to mitigate undesired impacts could be to improve the efficiency of maritime transport and/or aviation, thereby minimising increases in transport costs. This is often understood as improving the fuel efficiency of ships and aircraft, but it also offers other, more country-specific possibilities. For example, the efficiency of ports is an important determinant of a country's international trade (Clark et al., 2004, Sanchez et al., 2003, Blonigen and Wilson, 2008). Countries with more efficient ports have significantly lower transport costs and tend to engage more in trade. For example, Clark et al. (2004) have shown that a port that moves from the 25th percentile to the 75th percentile on port efficiency sees a 12% reduction in import or export costs. This is larger than the cost increase from MBMs, which is estimated in this report to vary between approximately 0.4% and 3% on average. Lower shipping costs would increase a country's ability to engage in international trade.

This suggests that allocating revenues to increase port efficiency could specifically mitigate the negative impacts that an MBM may have on maritime trade, although the costs of increasing port efficiency are unclear. Similar effects can be expected from increasing port capacity, if that is a constraint to allowing larger (and more fuel efficient) ships to enter a port. The effectiveness of these measures would likely depend on the specific situation of a country and trade-intensive countries are likely to benefit most.

In aviation, air navigation procedures may be altered to improve efficiency. Smaller improvements are possible in powered gates and towing aircraft to and from runways, which would also reduce CO₂ emissions. Allocating revenues to improve the efficiency of the maritime transport system and the aviation system could offer opportunities to offset the increasing costs of aviation and maritime transport directly by reducing other cost items.

This study covers the impacts of selected MBMs from 2015 to 2025 and shows relatively small CO₂ reductions options by the international aviation and shipping sector. However, in the longer run, investments in R&D which improve the fuel efficiency of ships and aircraft will reduce the economic impact of MBMs on countries. Ships, for example, can

become 25 - 75% more efficient than they currently are by applying a range of operational and technical improvements (Buhaug et al., 2009). To the extent that these efficiency improvements are not the result of autonomous developments, they could offset some of the cost increases induced by MBMs.

The analysis of economic impacts shows that MBMs for international transport have the largest impact on small, remote and often low-lying islands. These countries are also amongst the most vulnerable to climate change. This presents an opportunity to mitigate undesired impacts on the most impacted countries by using the revenues for adaptation purposes, for example for building sea defences and for increasing the capacity of local communities to cope with climate change impacts. The Green Climate Fund (or other multilateral funds) could be used for this, if they were to receive a share of the revenues of the MBMs.

2.3 Are revenues sufficient?

No proposal suggests using all revenues to address undesired impacts. The World Bank claims that 30% of the revenues would be sufficient to ensure 'no-net-incidence'. Other sources estimate that between one and two thirds of revenues would be needed to mitigate undesired impacts on all developing countries.

Figures 8 and 9 illustrate how revenues generated by the MBMs weigh up against the losses in GDP in Non-Annex I in 2025. As can be seen for both figures, if this impact measure is used the total revenues of the MBMs are much larger than the GDP impacts on developing countries, in monetary terms. However, not all Non-Annex I countries would suffer significant losses from MBMs and the revenues should be directed toward the most vulnerable. The revenue raised in the EU-ETS is a fraction of the revenues raised in the Global ETS (ranging from 0.3 billion US\$ in the low carbon price scenario to 1.3 billion US\$ in the high carbon price scenario in 2025), but the total impacts are of course negligible as air traffic from the EU to Non-Annex I countries is relatively small.

Figure 8 Revenues and impacts of MBMs in Aviation in 2025 (billion USD, price level 2010)

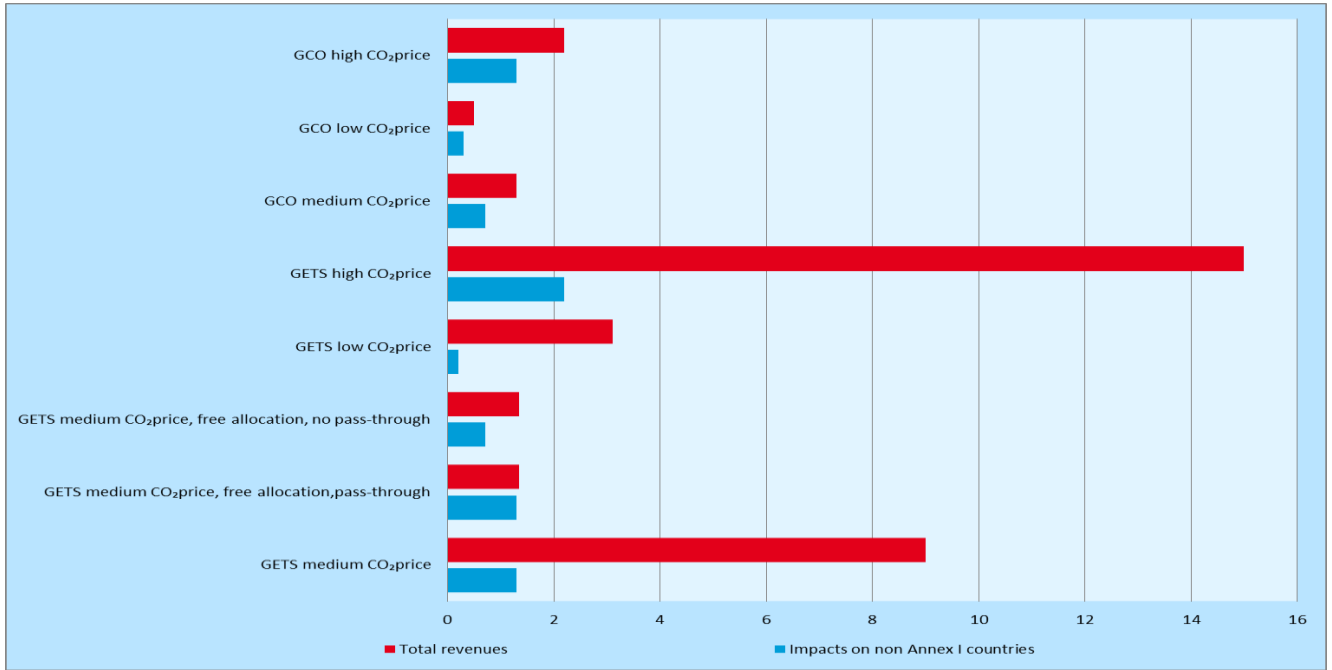
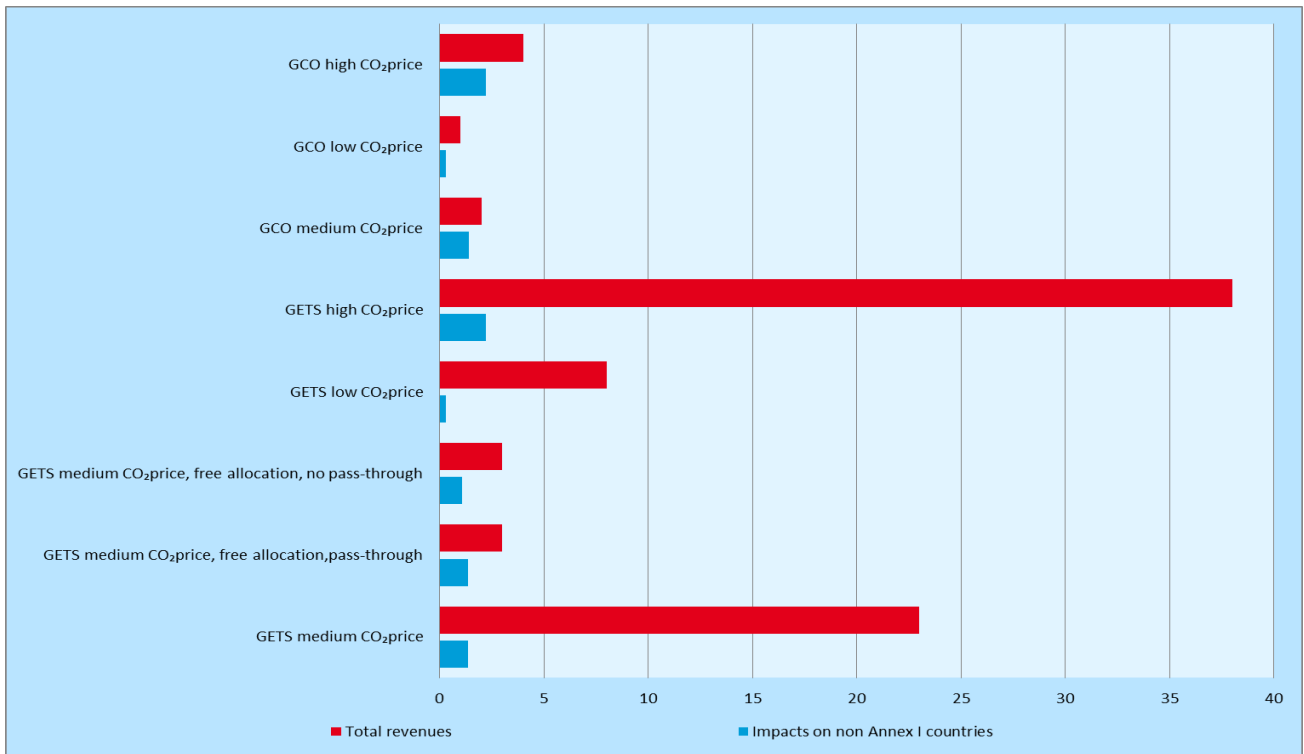


Figure 9 Revenues and impacts of MBMs in Shipping in 2025 (billion USD, price level 2010)



According to UNCTAD the least developing countries (LDCs) accounted for about 1% of Global GDP and 1% of global trade in 2011. The average real GDP growth rate in coming years is expected to be 5.6% and this study assumes that this continues up to 2025. Based on shares of GDP, it is likely that the impact of the Global Emissions Trading Schemes for international aviation and shipping (carbon price \$30 (2010\$) per tonne of CO₂, auctioning revenues are not used) on the GDP of LDCs without revenue recycling is somewhere between \$0.1 - \$15 billion, with the lower range assuming impacts are in line with the wider Non-Annex I impacts, and the upper end of the range assuming that all LDCs have an impact similar to that of Samoa (the most affected case study country). This figure is very likely to lie towards the lower end of this range because only 9 LDCs are island states that could in theory be affected similarly to Samoa and their share in LDCs GDP is small.

The next chapter quantitatively analyses two remedies, to consider the impact of increased demand for offsets on developing countries' GDP and the impact of national collection of revenues or a rebate from the central revenues fund equal to the increase in the price of aviation fuel sold and, for shipping, equal to the share in global trade.

3 Impacts of Carbon Reduction Policies for International Aviation and Shipping

The modelling methodology and the impacts of the different proposals for MBMs in international shipping and aviation on consumption, tourist expenditure, trade and GDP of the CSEs are discussed in this chapter.

3.1 Methodology

The three MBMs for aviation (GETS, GMO and EU ETS) and three for shipping (GETS, GHG Fund and EU ETS) that are considered in this study affect the aviation and maritime sectors and case study economies in different ways. All schemes studied bear cost increases for airplane and ship operators either in the form of offset/allowance cost or contribution/levy. For emissions trading schemes transport costs are further influenced by the extent to which the price of freely allocated CO₂ allowances is passed through into transport costs (“opportunity cost pass through”). Higher transport costs result in higher import values that can be reflected in price increase of imported goods, higher export costs and a decrease in demand for aviation and shipping, all of which may impact economies. These impacts may to some extent be offset by higher demand for domestic products. The price increase of traded goods due to MBMs for international shipping and aviation has been found to be small by previous studies (for example, see Vivid, 2010 and Anger et al., 2009).

In reality, cost increases may not always be passed through. The impact of MBMs on freight rates and ticket prices depend on market circumstances. If markets are competitive, freight rates reflect costs and MBMs result in higher rates. If, however, routes are not competitive, freight rates do not reflect costs and exemptions are not a guarantee that freight rates or ticket prices do not increase (Hummels et al., 2009). Many routes to small developing countries are not competitive and operators on these routes may be able to extract monopoly rents. In such a circumstance, the introduction of a MBM may reduce these monopoly rents, rather than affecting the local economies. We have not been able to model this, however, due to lack of information on the market power of operators on routes to the selected case study economies, and have assumed that all costs are passed through.

As the MBMs considered in this study are directly related to CO₂ emissions that stem from burning fuel in engines, these CO₂ costs can be treated as increases in fuel costs, as per this modelling exercise. Our analysis did not include the usage of biofuels that are considered to have carbon neutral CO₂ emissions and therefore these emissions are not covered by MBMs.

The Ship Freight Costs and Emissions Model analyses the impacts of fuel and carbon prices on the fuel efficiency of ship types and emissions. It has been used to calculate the

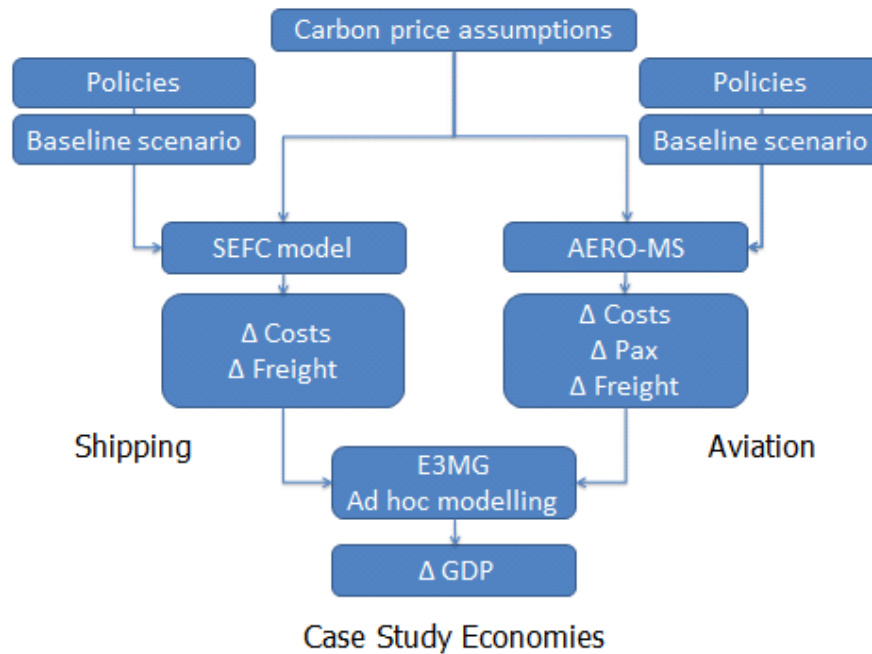
impact of an increase in the fuel prices on transport costs, import prices and the demand for international shipping for each MBM. The AERO-model is a detailed aviation model incorporating flight routes and airplane types, and has been used to calculate the impact on transport costs, import prices and the demand for international aviation, including the impact on inbound passenger numbers. Reliable data sources from reputable publications are used (IEA, CAEP-ICAO, IMO) to project crude oil prices, aviation demand and shipping demand. For modelling purposes, the study assumes that all MBMs are implemented in 2015 and the results are reported for the year 2025. It is likely that the relative results are similar with other implementation dates.

The Energy-Environment-Economy Model at the Global level (E3MG)⁵ was used to assess the macroeconomic impacts on the global economy and larger CSEs (China, India and Mexico). To calculate the impacts for the smaller CSEs a separate ad-hoc macroeconomic model was built. E3MG modelling results incorporate direct and indirect impacts and feedback from other industries and countries' economies as a response to increases in transport prices from MBMs. However, due to limited data availability, the simple structure of the models and treatment of countries in isolation, the ad-hoc modelling includes direct impacts from increases in export and import prices and declines in tourist numbers only. The macroeconomic impacts, presented below, include percentage changes in imports, exports, domestic consumption, tourist expenditure and GDP.

⁵ <http://www.e3mgmodel.com>

Figure 1010 shows how the different input assumptions and models are used to calculate the macroeconomic impacts.

Figure 10 Inputs and models used in the study



To explore how changes in variables might impact the modelling results, a sensitivity analysis covering selected policy design elements and modelling assumptions was conducted. Different scenarios are adopted for each MBM to cater for the uncertain development of carbon prices (10, 30 or 50 US\$ (\$2010) per tonne CO₂). Further scenarios were developed to explore the differences between the free allocation of allowances and auctioning, and for the pass through of the opportunity costs of freely allocated allowances (in the case of the GETS and EU ETS) See Annex II and Annex III for more details. The main assumptions of the modelling are summarised below, and Error! eference source not found. summarises international transport emission targets set for this study.

Main assumptions

- 1) All schemes start in 2015 and the impacts are reported for 2025
- 2) The business as usual (BAU) emissions follow IMO and ICAO medium scenarios (A1B and CAEP-M scenarios, respectively), implying that the actual CO₂ emissions from international aviation and shipping can also be lower or higher if they follow any other IMO or ICAO emissions scenario.
- 3) Net international aviation emissions in the global MBMs considered are limited to 10% below their 2005 level from 2015 and remain constant until 2025; net international shipping emissions are 20% below their 2005 level from 2015 to 2025.
- 4) For the EU ETS for aviation and shipping the cap set at 95% of the average 2004 - 2006 emissions while 15% of allowances are auctioned and the rest is allocated for free.
- 5) Three global carbon allowance prices - \$10, \$30 and \$50 per tonne of CO₂. The carbon prices equal the costs of offsets in all modelling scenarios
- 6) Two pass through rates for free allowance costs ('opportunity costs') for the global emissions trading schemes - 0% and 100%
- 7) Two levels of auctioning for the global emissions trading schemes - 15% and 100% of the target emissions
- 8) In offsetting schemes (GHG Fund for shipping and Global Mandatory Offsetting for aviation), a levy is raised on top of the revenues needed to buy sufficient offsets, in order to raise revenues for mitigating undesired impacts. The magnitude of the levy is assumed to be 10% of an offset price
- 9) When revenues are raised nationally or allocated lump sum to countries, countries use them to reduce social security taxes i.e. employers' social security contributions.
- 10) Offsetting is used to complement the reductions in emissions from decreased demand and efficiency improvements
- 11) Distribution of offsets generally follows the pattern of historic CDM projects.

Table 2 International transport CO₂ emissions and targets for global MBMs in MtCO₂

	Business as usual (BAU) in 2025	Target	Difference (BAU-target)
Aviation	810 (CAEP-M ⁶)	325 (10% below 2005)	485
Shipping	1485 (IMO A1B ⁷)	636 (20% below 2005)	849
Shipping +EEDI	1418	636 (20% below 2005)	782

3.2 Main results

The following presents the impacts of the MBMs on CO₂ emissions and case study economies based on our modelling.

All schemes with the caps/targets (aviation emissions 10% below their 2005 levels and maritime transport emissions to 20% below their 2005 levels) as outlined above (Table 2) will achieve the MBMs CO₂ emissions reduction targets through a combination of CO₂ reductions in the sector and offsetting (Table 3). For example in 2025 a Global Emissions Trading scheme (\$30 per tonne of CO₂) for shipping and aviation as outlined in this study

⁶ CAEP8-M - AERO modelling emissions for ICAO CAEP Most Likely (central) air traffic growth scenario (CAEP- SG/20082-IP/02)

⁷ A1B scenario of the Second IMO GHG Study 2009 (Buhaug *et al.*, 2009)

is likely to reduce net emissions relative to business as usual by 1267 MtCO₂ (57% of expected emissions), with 11.8 MtCO₂ (1.5% of expected emissions) and 2.4 MtCO₂ (0.2% of expected emissions) coming directly from reductions in international aviation and shipping emissions respectively. In 2025 for the studied global aviation MBMs the inside industry CO₂ reductions in aviation emissions range from 2.7 to 19.3 MtCO₂ (0.3 - 2.4% of expected emissions) and under global shipping MBMs the reductions (in addition to EEDI) are between 0.8 and 9.8 MtCO₂ (0.1 - 0.7% of expected emissions) depending on scheme design and coverage. The remainder of emissions are assumed to be offset.

The emissions reductions from within the aviation and shipping sectors for the short timeframe considered in this study reflect: the small price increase per tonne of goods or passenger carried and its low impact on shipping or travel demand; and the relatively few technological abatement opportunities, especially for shipping after the improvements from EEDI. . The low responsiveness of international transport to price increases from MBMs is in line with the findings from other studies (for example, Anger and Köhler, 2010, CE Delft et al., 2010 and Anger et al., 2009) However, for specific trades and routes the impacts can be significant even if the average impact is low (for example, Vivid, 2010). This study assumes that the offset price and carbon price are exactly the same and when the abatement cost increases above carbon price, the sectors pay for carbon reduction in other sectors that carry out cheaper emission reductions. In the longer term, innovations in fuel-efficiency may decrease in-sector emission reductions costs and the in-sector CO₂ reductions could be more significant. If the abatement potential from the international transport sectors is greater than estimated in this study, this would imply greater emission reductions from these sectors and lower overall economic cost and impacts.

Table 3 Emissions reductions (in MtCO₂) due to global MBMs for international aviation and shipping in 2025

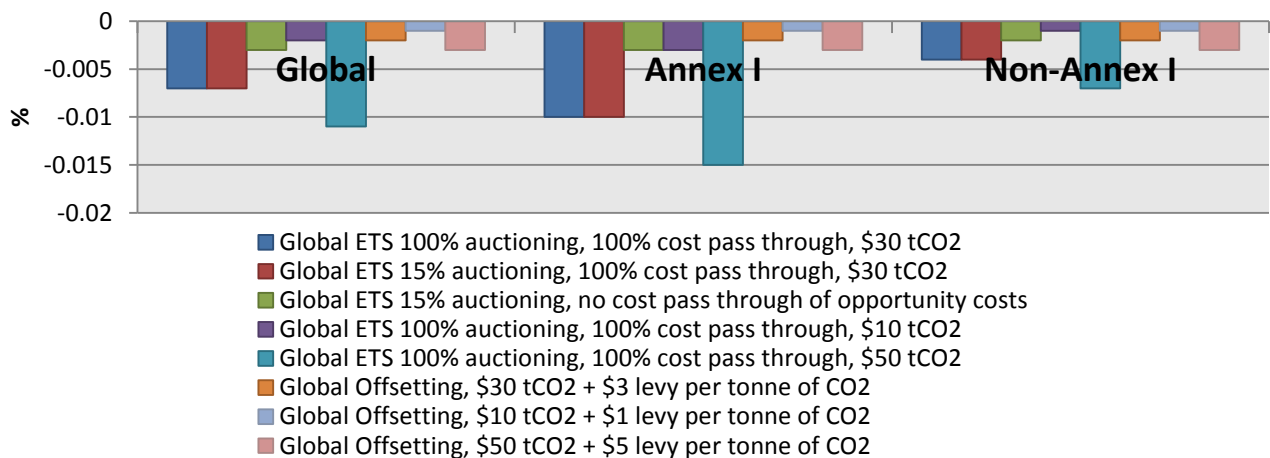
	In-sector emissions reductions	Emissions offset	Total emissions reductions (in-sector plus offsets)
Aviation	3 - 19	466 - 482	485
Shipping	1 - 10	772 - 781	782
Aviation+Shipping	4 - 29	1238 - 1263	1267

Firstly, the economic impacts of the MBMs are presented assuming that the auctioning and tax revenues are collected but not used. The same applies to CDM credits that are bought by the aviation and maritime sector, but where the monies are not invested in to CDM projects in host countries. These results are not realistic and should be used to analyse the variation of the impacts and the underlying factors. For the countries that do not host CDM projects in this modelling exercise the results demonstrate impacts before the revenues are returned to the countries that participate in the MBMs. Thereafter, results shown include the use of revenues to lower social security taxes and the benefits

of increased demand for offsets. Other uses of revenues, such as climate finance and investments in transport infrastructure efficiency, have not been analysed for lack of a distribution key and data. If these could be taken into account, negative impacts would be reduced and positive impacts increased.

For the hypothetical scenario where revenues would be raised but not used, Figure 11 illustrates the impact of the Global ETS, the Carbon Offset Mechanism and the EU ETS for aviation on GDP in Annex I and Non-Annex I Countries. The medium CO₂ price scenario (\$30 (\$2010) per tonne CO₂ plus \$3 levy on every tonne offset) for the Carbon Offset Mechanism leads to smaller impacts on global GDP than the medium CO₂ price scenario for the Global ETS. The reason for this is that the levy is only intended for offsets above the emissions target, whereas the allowances in the Global ETS are auctioned for emission rights below the cap and the emissions above the cap are covered with allowances bought from other sectors or with offsets. Hence, the ETS extracts more revenues from the international transport sectors and when these are not used, as in this scenario, the impacts on GDP are larger. Four out of five Global ETS scenarios in Figure 11 present a case whereby 100% of auctioned CO₂ allowance costs plus the costs of offsets and/or freely allocated allowances are passed on to consumer prices ('100% cost pass through'). Transport costs and impacts are more comparable in the scenario where 85% of allowances in the Global ETS are allocated freely with no pass-through of the costs of free allowances (opportunity costs) in transport costs, meaning that similar levels of emissions are priced.

Figure 11 Impacts of MBMs in aviation on GDP in 2025 i.e. 10 years after implementation (% change from BAU) without the impacts of revenue usage and investments from CDM projects



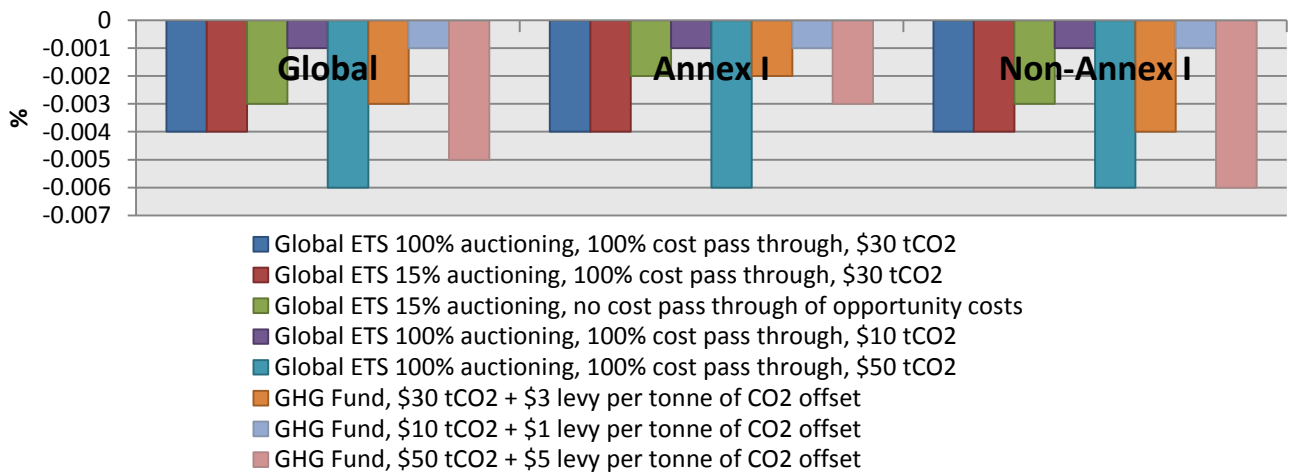
In these hypothetical scenarios, in 2025 the estimated global reduction in GDP below the BAU levels is very small and amounts to 0.007% in the case of the Global ETS and 0.002% in the case of the Carbon Offset mechanism in aviation with the carbon price at 30 US\$. Twenty nine percent (Global ETS) to 39% (Carbon Offset mechanism) of the losses are

borne by Non-Annex I countries. The total global losses in 2025 amount to 0.011% of GDP at the most, when the Global ETS is adopted and when the carbon price is at 50 US\$.

Again for the hypothetical scenario where revenues would be raised but not used, Figure 12 illustrates the impact of the Global ETS and the GHG Fund for shipping on the GDP of Annex I Countries, Non-Annex I Countries including LDCs and SIDS.

The same patterns that are visible in Figure 11 reappear in Figure 12. The impact of a Global ETS is larger than that of the Carbon Offset Mechanism for shipping, unless the majority of allowances (i.e. 85%) are allocated freely to shipping operators and when they do not pass on the opportunity costs (potential gains from selling the freely allocated allowances) to the transport costs. The impact of a Global ETS is once again seen to depend heavily on the carbon price. The GHG Fund is likely to have slightly higher impacts on Non-Annex I countries' GDP compared to the Annex I countries because Non-Annex I countries are experiencing higher economic growth and hence their maritime and air transport sectors need to grow at a rate above the target line.

Figure 12 Impacts of global MBMs in shipping on GDP in 2025 i.e. 10 years after implementation (% change from BAU) without the impacts of revenue usage and investment effects from CDM projects

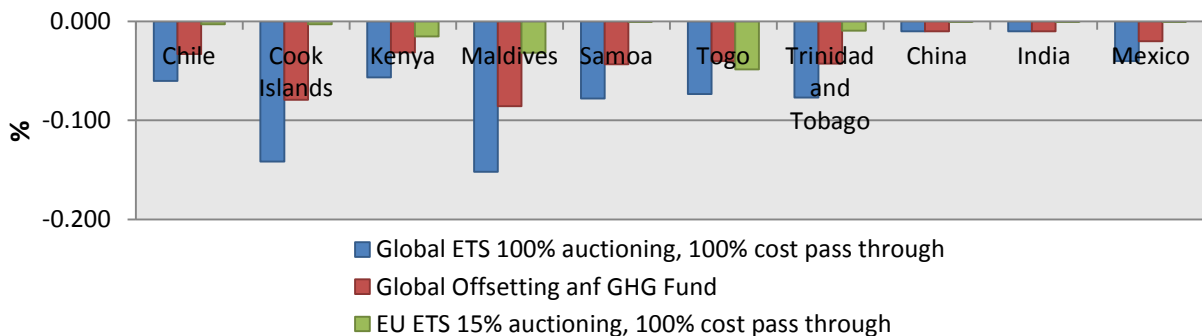


Not shown in Figure 11 and Figure 12 are the impacts of the EU ETS auctioning mechanism on global GDP. As the number of air and maritime trips to and from the EU is a fraction of the global number, the impacts of the EU ETS will likewise be a fraction of the impacts of the Global ETS. The impacts of the EU ETS on aviation and shipping have been calculated globally, for Annex I and Non-Annex I and for the ten CSEs under four different scenarios, alongside the five scenarios for the Global ETS and three scenarios for the Carbon Offset Mechanism. Impacts analysed include the percentage change in domestic consumption and tourist expenditure, the percentage change in exports and imports and the percentage change in GDP of the ten CSEs in 2025. The full results for all twelve scenarios are listed in Annex V.

For the hypothetical scenario where revenues would be raised but not used, Figure 13 illustrates the impacts of the MBMs in the aviation and shipping sectors on domestic consumption in all ten CSEs for the medium carbon price scenario of \$30 per tonne of CO₂. Figure 13 shows the impacts on consumption from increased import prices only. Impacts on tourist expenditure are demonstrated below. For CSEs other than China, India and Mexico the numbers presented include only direct effects from declined demand for imported products due to increases in import prices and do not take into account, for example, impacts of possible shifts toward consuming more domestic products and consequent increases in domestic production or the effects of decreased exports on disposable income.

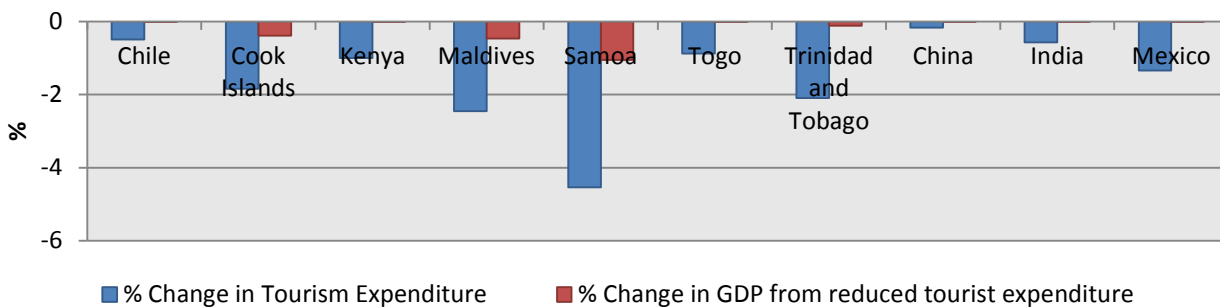
The impact on domestic consumption is important to assess because it can indicate how local consumption could be affected by MBMs for international shipping and aviation, especially where people depend on imported food and where income levels are low. The fall in domestic consumption, which is due to the increase in import values of goods that are part of the domestic consumption, is small even in the most extreme scenarios, where carbon prices are at their highest and 100% of allowance costs (including the potential gains from free allowances) are passed on to transport costs. The reason is that imports are mostly just a small fraction of domestic consumption, and transport costs are generally a small fraction of import values. In 2025 the impact amounts to a -0.14% fall in domestic consumption for the Cook Islands and -0.15% for the Maldives in the Global ETS (GETS) medium carbon price (\$30) scenario. The impacts of the EU ETS on domestic consumption are small compared to those of the other MBMs for most countries, and for most of the SIDSs (Small Island Developing States: Cook Islands, Samoa and Trinidad & Tobago) in particular, as trade flows from Europe to the CSEs in question are small. One of Togo's main trade partners is the EU and hence the EU ETS has a slightly higher impact on Togo's domestic consumption compared to other CSEs.

Figure 13 Percentage change in Domestic Consumption in CSEs in 2025 i.e. 10 years after implementation of MBMs (carbon price \$30 (2010\$) per tonne of CO₂, auctioning and levy/contribution revenues are not used and there are investments effects from CDM projects)



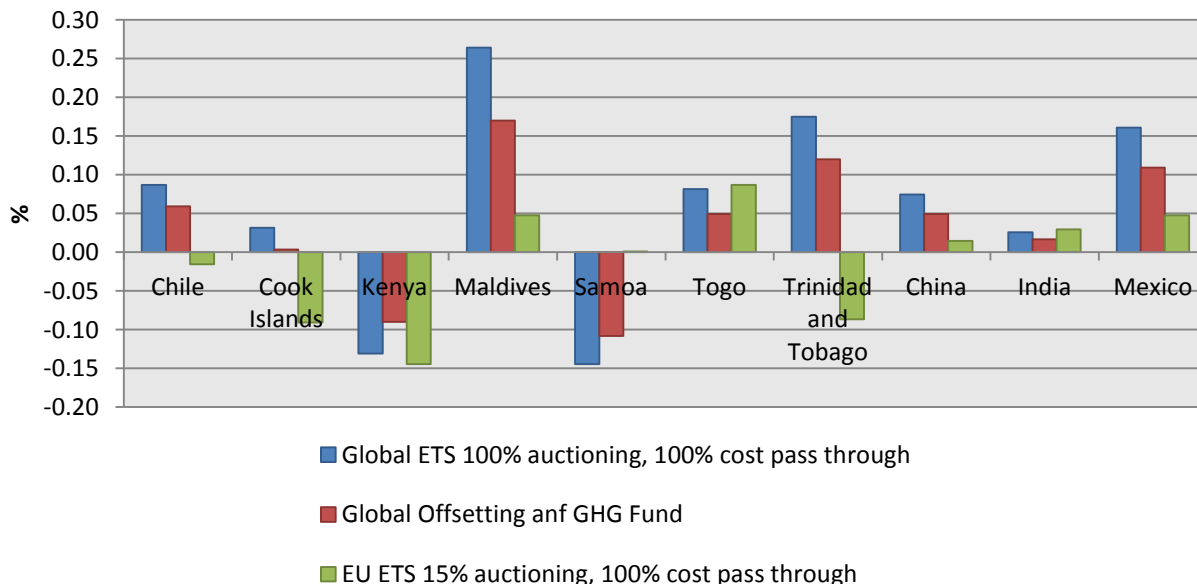
The main factor influencing GDP reductions in SIDS is the reduction in international tourist expenditure across these countries, driven by reduced numbers of tourists arriving by air in response to increases in flight costs and thus prices (Figure 14).

Figure 14 Changes in tourist expenditure and subsequent reductions in GDP due to the global emissions trading scheme for international aviation in 2025 (100% auctioning, 100% cost pass through and \$30 (2010\$) per tonne of CO₂)



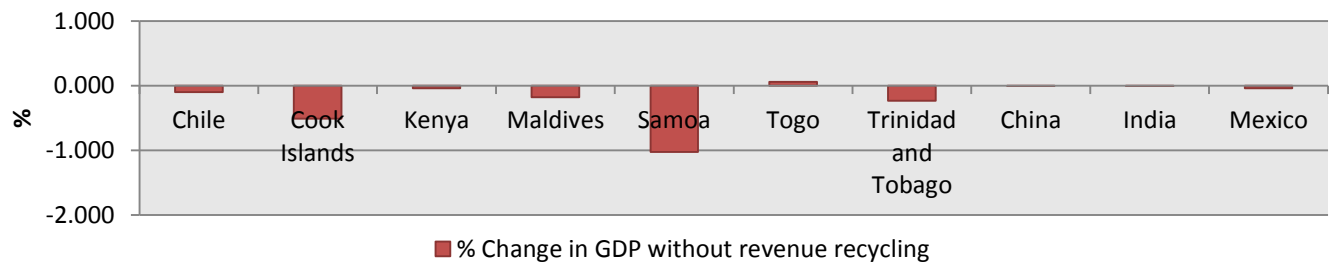
The impacts on trade balance (i.e. exports minus imports) are illustrated in Figure 15, again assuming that revenues are raised but not used. Most CSEs see their trade balance improve when the Global ETS or the Carbon Offset Mechanism is implemented. This means that their imports are reduced more than their exports due to MBMs. This should not necessarily be considered a positive impact on their economies. For example, Togo, a country that currently has a large trade deficit, will see its imports fall by 0.45% as its exports decrease by 0.34% in the medium carbon price scenario for the EU-ETS.

Figure 15 Percentage change in Trade Balance of CSEs in 2015 i.e. 10 years after implementation of MBMs, auctioning and levy/contribution revenues are not used



The combined impacts of the MBMs for international aviation and shipping on GDP in the CSEs are illustrated in Figure 16 for the hypothetical scenario where revenues would be raised but not used. Economies whose domestic consumption is not so dependent on foreign trade and tourism, such as China and Chile, hardly feel the impact of the MBMs on their GDP. It is the small and remote economies without land transport connections that are estimated to be hit hardest, mainly through the impact on air-based tourism, but also on goods traded by sea and air. Changes in GDP in the small island economies studied range from a very small decrease (0.064%) in GDP in Maldives when the carbon price is at 10 US\$, to close to a 1.7% decrease in Samoa when the carbon price rises to 50 US\$. At the time of completing this analysis (February 2013) the EU ETS allowance price was close to \$5 per tonne of CO₂; hence at those carbon prices the impacts would be lower than those estimated in the low carbon price scenario where the carbon price was \$10 per tonne of CO₂. These losses are almost entirely due to the drop in the number of air passengers. The small rise in some countries' GDP comes about mainly through a reduction in domestic demand for imported goods.

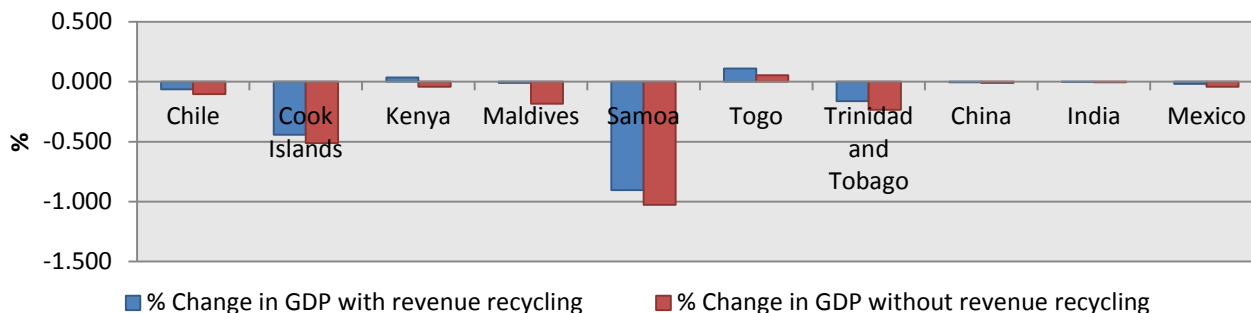
Figure 16 Percentage change in GDP in CSEs in 2025 due to the Global Emissions Trading Schemes (100% auctioning, 100% cost pass through and \$30 (2010\$) per tonne of CO₂) for international shipping and aviation without the impact of auctioning revenue usage and without the impacts of the receipts for CDM credits.



3.3 The impacts of revenues and using offsets

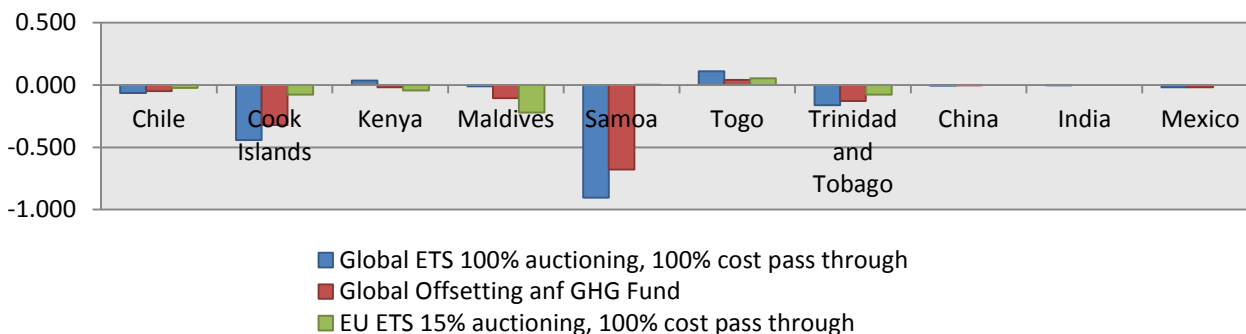
Figure 17 shows the estimated impacts of the Global ETS for aviation and shipping on GDP with and without revenue recycling. Some of the impacts are mitigated by recycling revenues, i.e. returning the receipts of the MBMs revenues back into the economies to lower employers' social security taxes ('revenue recycling'). For aviation the revenues are allocated to CSEs based CO₂ emissions of departing flights. For shipping the revenues are allocated to CSEs based on their share in global trade by value in 2011. Kenya is the only CSE where the estimated impact of the Global ETS is reverted by revenue recycling. For all other CSEs the negative impacts are reduced and in the case of Togo the positive GDP impact is increased further.

Figure 17 Changes in GDP in 2025 due to a Global ETS for international shipping and aviation (100% auctioning, 100% cost pass through, \$30 (USD 2010) per tonne of CO₂, revenues used to reduce social security taxes, impacts of CDM receipts are not considered)



If the EU ETS is used as an MBM for international shipping and aviation then the revenues are not recycled back to CSEs as it is assumed that the revenues stay with the EU Member States, hence there is no reduction of GDP impacts in CSEs. In the case of Maldives the EU ETS impacts are higher than for other MBMs (assuming the same carbon price for all schemes) because there are no revenues from auctioning or levy returned back to the economy (Figure 18).

Figure 18 Changes in GDP in 2025 due to MBMs for international shipping and aviation (\$30 (USD 2010) per tonne of CO₂, revenues used to reduce social security taxes, impacts of CDM receipts are not considered)



The case of Togo warrants special attention as it may well reflect the situation of other LDCs. Among CSEs Togo experiences least impacts in 2025 for all allowance cost pass through rates. Togo’s tourism expenditure is the smallest among the case study countries; Togo is dependent on domestic agriculture and its economy experiences a consistent trade deficit. The share of imports in domestic consumption is high (54%) but not as high as in the Maldives and the Cook Islands. Togo’s GDP is estimated to increase due to MBMs for international shipping and aviation as its imports, which in 2011 were 1.5 times higher than exports, are reduced more than exports, correcting a negative trade balance. Impacts on tourism industry are the smallest among case study countries. Our modelling does not distinguish between the goods that are traded and that are transported as aid and therefore we assume that both categories are impacted similarly.

Togo's domestic consumption is affected at a similar scale to the other CSEs and since Togo has the lowest per capita income and is most affected by poverty (please see Annex), the MBMs may have higher impact on the people of Togo. However it is outside the scope of this study to analyse these impacts in detail.

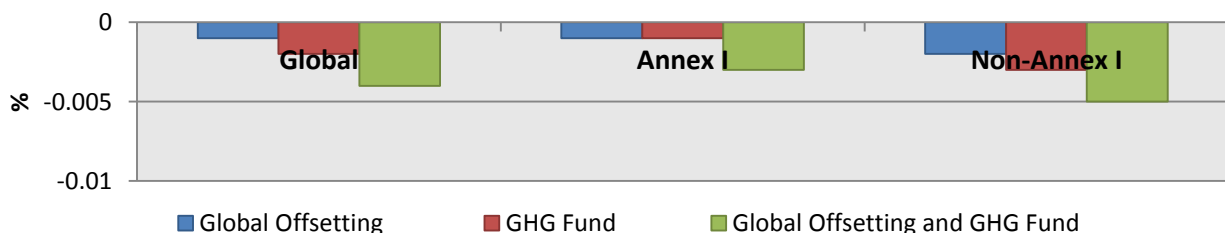
Comparing Annex I and Non-Annex I countries (Figure 19), global emissions trading schemes for both shipping and aviation together are likely to have a greater negative impact on the GDP of Annex I countries (0.009% below baseline in 2025) than Non-Annex I (0.007%) countries in 2025. However despite being close to zero globally and for Annex I and Non-Annex I countries these impacts vary across countries and regions depending on relative dependencies on trade and tourism.

Figure 19 Changes in GDP due to global emissions trading schemes for international shipping and aviation in 2025 (15% auctioning, 100% cost pass through, \$30 (USD 2010) per tonne of CO₂, auctioning revenues are used to reduce employers' social security contributions)



If a Global Mandatory Offsetting complemented by a Revenue Generation Mechanism (aviation) and International Fund for Greenhouse Gas Emissions (shipping) is implemented, the relative GDP impacts in Annex I and Non-Annex I countries are very small (Figure 20) but slightly larger in Non-Annex I countries due to higher growth in aviation and shipping emissions across Non-Annex I countries.

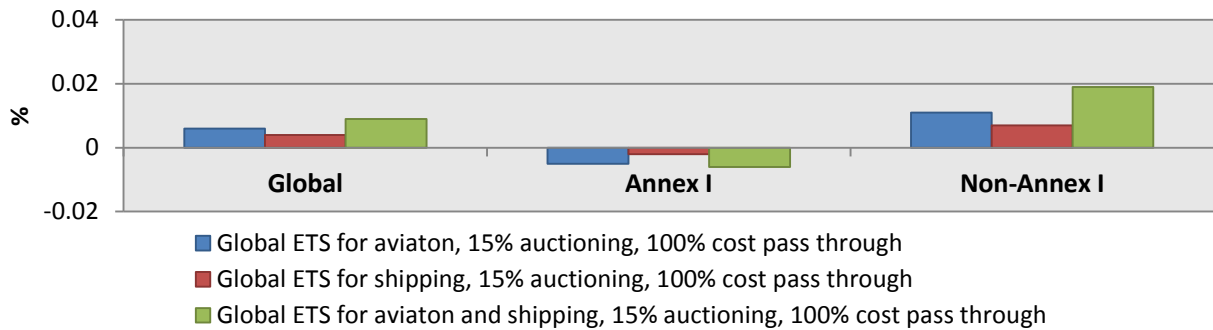
Figure 20 Changes in GDP due to Global Offsetting for international aviation and GHG Fund for international shipping in 2025 (\$30 (USD 2010) per tonne of CO₂ + \$3 levy per tonne of CO₂, revenues are used to reduce employers' social security contributions)



All MBMs considered in this study rely on offsets (here: CDM credits) to achieve the net emissions target, and as a result they increase demand for offsets in the global market. As all CDM based offset projects are located in developing countries, these countries benefit from this increased demand. According to the UNEP Risø Institute (2012) the vast

majority (very likely more than 50%) of the CDM projects currently in the pipeline will be carried out in China. India will provide about 30% of CERs followed by Mexico (about 3%) and Brazil (about 2%). The remainder of the CDM credits are provided by other the Non-Annex I countries. In this study we assume that this current trend will continue at least until 2025. It should be noted that the future supply of credits may vary, which would change the impacts on the case study countries. The negative impacts of a market-based measure are reduced (Annex I countries) or converted into benefits (Non-Annex I countries) when the increased demand for offsets is taken into account (Figure 21). Globally the increased investment in CDM projects results in a slight raise of global GDP above the BAU level in 2025.

Figure 21 Changes in GDP due to the global emissions trading schemes for international shipping and aviation in 2025 and the impact of receipts for CDM credits (15% auctioning, 100% cost pass through and \$30 (2010\$) per tonne of CO₂)



4 Conclusions

This study focuses on a selection of case study economies (CSEs) that, based on their economic structure, were anticipated to be negatively impacted by MBMs for international shipping and aviation. These economies include: Mexico, China, India, Trinidad and Tobago, Togo, Kenya, Maldives, Samoa, Cook Islands and Chile.

The policy options considered were Global Emissions Trading (for aviation and shipping), Global Mandatory Offsetting complemented by a Revenue Generation Mechanism (aviation), an International Fund for Greenhouse Gas Emissions (shipping) and the European Union Emissions Trading System (aviation and shipping). Scenarios related to the implementation of MBMs have been modelled to limit net international aviation emissions to 10% below their 2005 levels and net international maritime transport emissions to 20% below their 2005 levels. These targets are to be achieved through a combination of sectoral CO₂ reductions and offsetting. Compared to business as usual emissions in 2025 the total CO₂ emissions of the international aviation and shipping sectors are hypothetically reduced by 57%.

The global impacts of the above mentioned MBMs are estimated to be very small in 2025. The implementation of the Global Emission Trading Schemes for aviation and international shipping is expected to reduce global GDP by a maximum of 0.01% based on a carbon price of \$50 per tonne of CO₂ and that does not consider the macroeconomic benefits of CDM projects. Nevertheless, the impacts on individual CSEs vary significantly. Economies whose domestic consumption is less dependent on foreign trade and tourism, such as China, India, and Chile, experience a very small impact on their respective GDPs as a result of implementing MBMs. It is the small and remote economies without land transport connections that are estimated to be hit hardest (Samoa may lose up to 1% of its GDP), mostly through impacts on air-based tourism, but also on goods traded by sea and air. Even then the impacts vary on a case by case, depending on the share of imported goods and tourist expenditure as part of domestic consumption, and on the distances that passengers and goods are transported. Furthermore, the improvement in trade balance that some CSEs (for example, Togo) are estimated to experience is deceptive. In instances where the implementation of MBMs results in increased prices for imported goods, a proportional decrease in demand could be expected for their consumption among both tourists and the local population. As flights from Europe make up a small fraction of air traffic to CSEs, the EU ETS generally leads to smaller impacts on the CSEs than the other two MBMs⁸.

The macroeconomic impacts of shipping are estimated to be smaller than those for aviation for each MBM under every scenario. There are two reasons for this. Firstly, the increase in fuel and carbon prices causes the sector to reduce emissions through

⁸ In order to allow ICAO to make progress, the European Commission has proposed temporarily limiting the scope of enforcement to the flights in and between the EU Member States.

increased fuel efficiency, which is larger in the shipping sector than in aviation. This moderates the rise in transport costs due to the introduction of an MBM. In addition, shipping is less responsive to price fluctuations, given that fuel costs usually make up a smaller fraction of transport costs per item/passenger shipped than in aviation thus rendering it less sensitive to carbon reduction policies.

Hence, while the MBMs studied clearly have environmental benefits for all countries, they raise transport costs for the least developed countries (LDCs). At the same time, MBMs increase the demand for offsets, which generates investments in developing countries and thus has a positive macro-economic impact in countries that host offset projects. Currently, CDM projects are concentrated in a small number of countries. China, India, Brazil and Mexico account for the largest number of projects and also the majority of credits generated (UNEP Risø Institute, 2012). Shifting CDM projects towards LDCs will benefit their economies, but could also be less cost effective given the potential for small scale reductions and a higher cost to abatement ratio in these countries.

Since the economic impacts can be attributed to a number of factors, which are different for every country, it will be necessary to implement a suite of applicable measures that respond to the impacts in question, although this could add to the complexity and administrative costs of any MBM.

Firstly, in cases where certain routes are exempted, such as routes to and from remote economies, undesired effects could be mitigated thereby reducing transport costs for the routes concerned. However, as imports and exports are often transhipped, and passengers often transfer in countries that cannot be exempted without undermining the environmental effectiveness of the system, exemptions are very unlikely to reduce all impacts on import values, export costs and ticket prices. In aviation, exempting emissions on routes to and from all LDCs would reduce environmental effectiveness by 1%. In shipping, the environmental effectiveness may also be undermined to a larger degree if exemptions induce rerouting to avoid complying with the system.

Secondly, the increased demand for offset projects caused by the MBMs could be steered towards worst affected countries. Investments associated with offset projects could reduce the macroeconomic impacts of MBMs significantly. However, this option could reduce the efficiency of offsetting.

Thirdly, all MBMs studied here raise revenues which appear to be sufficient to mitigate undesired impacts. This study shows that the GDP loss to Non-Annex I countries ranges from less than 10% of the available revenues for ETS with full auctioning, to a little over 60% for the offsetting MBMs. The difference stems mainly from the fact that most of the revenues raised through levies in the offsetting MBMs are used to acquire offsets. Only a small fraction of the revenues is available to mitigate undesired economic impacts, climate finance, and other purposes. Revenues could be directed to the most affected countries in at least three ways:

- By central redistribution of revenues;
- By central redistribution of allowances;
- By national collection of revenues, in which case methodological guidance for assigning emissions to countries would be needed.

In the first two cases, the redistribution could be lump-sum, leaving it up to the recipient countries to decide on the use of the revenues for specific purposes. Lump-sum redistribution would be an effective way to mitigate undesired impacts. It would, however, need to be based on a redistribution key. Several keys have been proposed, but none provide an equal reduction in impacts across countries. Hence, using a single redistribution key would result in some countries receiving amounts that do not reflect relative impacts.

Revenues or allowances could also be redistributed for specific purposes (which, incidentally, could also be funded by countries from lump-sum receipts). The benefits would accrue to specific countries. In comparison with lump-sum redistribution, this would allow for better targeting so that undesirable impacts can be mitigated but in a way that would only benefit those experiencing severe impacts. Specific purposes include:

1. Allocating revenues towards finance for climate adaptation. The largest economic impacts are experienced by states that are vulnerable to the impacts of climate change. Financing measures that reduce this vulnerability could have the benefit of both addressing impacts from MBMs, whilst also improving their capacity to respond to climate change. This would not reduce the increase in import values or export costs, but it would reduce the actual expenditure required to adapt to climate change
2. Port and airport efficiency can often be improved, thus lowering transport costs. This is an effective way to mitigate undesired effects as it can offset transport cost increases. It is only feasible for countries whose ports and airports are currently operating inefficiently, many of which are located in the poorest countries. The economic impact would depend on the ability of the country to engage in international trade.

Finally, in order to increase the rate of innovation, ship and aircraft efficiency can be improved through R&D funding. In the long run, once more efficient ships and aircraft enter a given fleet, the economic impacts of MBMs on all countries could be reduced.

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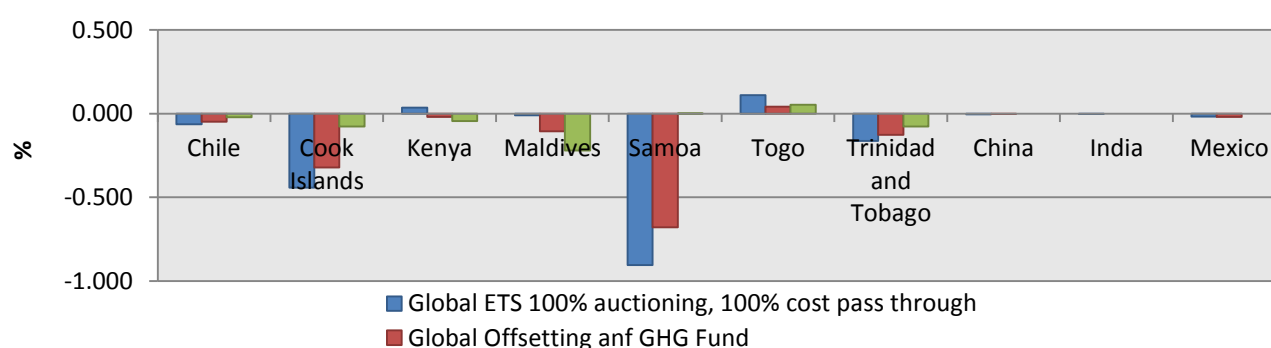
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Annex: Summary of impacts by Case Study Economies

Figure 22 shows the modelling results for the ten case study economies for the policy options considered, and these results are discussed in detail along with a brief summary of the economic context for each CSE. Model results considered in these summaries are from the MBM1a scenario, which refers to the Global Emissions Trading Scheme, 100% auctioning and 100% cost pass-through, and a CO₂ price of \$30/tonne. A full description of each CSE can be found in Annex VI.

Figure 22 Changes in GDP due to market-based measures for international shipping and aviation in 2025 (100% cost pass through and \$30 (2010\$) per tonne of CO₂) with revenue recycling by reducing employers' social security contributions, no impacts of CDM revenues are considered



Mexico

Mexico has strong trade relations with the USA - the destination for 71% of its exports. The majority (88%) of freight destined for the USA and Canada travels by truck, meaning terrestrial transport is a significant sector; however, air freight by tonnes-km has grown rapidly since 2008. Mexico's trade intensity is significant, contributing 60% to GDP. Tourism accounts for around 3% of GDP, and has been declining since 1995.

The modelling results of the MBM1a scenario foresee a relatively small impact on the national GDP of Mexico, totalling a 0.042% contraction of GDP. The majority of this contraction (-0.035%) is through impacts on the aviation sector, with the remainder (-0.008%) from shipping. The limited impact on Mexico's GDP would relate to the country's proportionately high dependence upon overland trade and shipping, with aviation-based trade accounting for a smaller fraction of imports and exports than in many of the other case study economies considered. In addition to this, a declining contribution of tourism to national GDP may be a factor in buffering the impact of MBMs.

Mexico is currently a minor host country of CDM projects. Unless this changes, the increased demand for offsets induced by the MBMs will not mitigate the impact on Mexico's economy. Using revenues to improve transport infrastructure efficiency or provide for adaptation finance would, however, mitigate the impacts.

China

Manufactured goods dominate China's exports, and the nation has a trade surplus of USD 0.2 trillion. China's export value in merchandise trade far outweighs that of all the other case study economies. Despite extensive land borders, most trade is through aviation and shipping, with the majority by sea. Tourism is increasing by numbers of visitors per year, but relative contribution to the national economy has been falling for the last 15 years, with receipts from tourism currently accounting for 3% of total exports.

Results from the MBM1a scenario predict a small (-0.009%) contraction in China's GDP, with aviation and shipping contributing -0.005% and -0.004% respectively. The magnitude of wealth tied up in China's economy, the size of its trade surplus and of its exports may explain the limited relative impact of MBMs on Chinese GDP. A declining contribution of tourism to national GDP may contribute to buffering impacts of increased aviation prices.

China is currently a major host country of CDM projects. Hence it is likely that the increased demand for offsets induced by the MBMs will positively impact on China's economy. Our modelling shows that including additional demand for offsets would raise China's GDP by 0.023% above the business as usual scenario in the case of the Global Emissions Trading System (100% auctioning, 100% costs pass through to prices and \$30 per tonne of CO₂). Using revenues to improve transport infrastructure efficiency or to provide adaptation finance would further increase the positive impacts.

India

The Indian economy has experienced rapid growth in recent decades. Aviation, including that for tourism, contributes 1.5% to GDP and accounts for 5% of Indian foreign trade. The rest of imported and exported goods are transported mostly by sea, and by weight maritime trade has doubled over the last decade. However, trade intensity remains modest at 32%.

The MBM1a scenario predicts that the reduction in India's GDP will be relatively small at -0.005% - smaller than impacts on all other case study economies bar Togo. Of the modelled reduction in India's GDP, the majority of this (-0.004%) is through the maritime sector, with the additional 0.001% from impacts on aviation. India's dependence upon maritime transport for trade and limited dependence upon air-based trade can go towards explaining this distribution of results. Furthermore, significant dependence upon

land-based transport, a modest trade intensity and a rapidly growing economy can explain the relatively small predicted impacts on national GDP.

India is currently one of the major host countries of CDM projects, and thus increased demand for offsets induced by the MBMs will provide impetus to the Indian economy. Our modelling shows that including additional demand for offsets would raise India's GDP by 0.055% above business as usual scenario in case of Global Emissions Trading System (100% auctioning, 100% costs pass through to prices and \$30 per tonne of CO₂). Using revenues to improve transport infrastructure efficiency or to provide for adaptation finance would further increase the positive impacts.

Trinidad and Tobago

Trinidad & Tobago is one of the wealthiest and most developed economies in the Caribbean. Its economy is primarily industrial, with industry contributing to more than half of GDP in 2010. Fuels and manufactured goods are T&T's most important exports, and the nation has a positive and growing trade surplus. Merchandise trade contributes 82% to GDP, and the USA is T&T's most important export destination. Tourism, traditionally important, has been declining in terms of relative contributions to GDP, down from 6% in 1997 to 2% in most recent estimations.

The modelling results for the MBM1a scenario predict a negative impact on T&T's economy, totalling -0.234% of GDP. Impacts from the aviation and maritime sectors contribute -0.083% and -0.151% respectively. This is a modest but significant impact and the fourth largest of the ten CSEs considered here. These results are likely due to the relatively high trade intensity of Trinidad and Tobago, with merchandise trade contributing over 80% to GDP. However, these projected impacts are smaller than other small island states considered here. The reasons for this would relate to T&T's higher wealth and lower (and declining) dependence upon tourism, the latter of which is an important difference when compared to other small island states. Moreover, since maritime transport is less price elastic than aviation, an economy relying heavily on maritime transport is less severely impacted than an economy relying more on aviation. Note, however, that our ad-hoc modelling of small CSEs does not include trade substitution between different countries.

According to UNEP Risø, Trinidad and Tobago currently does not host CDM projects. Unless this changes, the increased demand for offsets induced by the MBMs will not mitigate the impact on Trinidad and Tobago's economy. Using revenues to improve transport infrastructure efficiency or provide for adaptation finance would, however, mitigate the impacts.

Togo

The GDP per capita of Togo, at just over USD 1,000, is the lowest of all CSEs considered. The Togolese economy is defined by a very high dependence upon agriculture, both in terms of employment and GDP, with agricultural products making up three quarters of exported goods. Over the last decade Togo has experienced a growing trade deficit, and the nation is heavily reliant upon international aid. Merchandise trade, largely agricultural, makes up close to 80% of GDP, and around 40% of this is transported overland to neighbouring countries. Receipts from international tourism are traditionally low but have risen recently to around 4% of total exports.

Results from the modelled MBM1a scenario predict an overall positive impact on Togolese GDP of 0.055%. Impacts from aviation and shipping are both positive with aviation contributing the majority of this impact at 0.038%, with the remaining 0.017% from the maritime sector. This distinguishes Togo from the other CSEs considered here, which have all been predicted to experience negative impacts on GDP.

This result is due to Togo's current and significant trade deficit and dependence upon international aid that is assumed to persist to 2025. A predicted decrease in imports resulting from increased import costs and thus a reduced demand for imported goods would lead to a reduction in domestic consumption. About 13% of Togo imports are food products and anticipated increases in import costs and commodity costs would have negative impacts particularly on low income groups, and those with a high dependency on imported goods or incomes from exports.

According to UNEP Risø, Togo currently does not host CDM projects. Unless this changes, the increased demand for offsets induced by the MBMs will not mitigate the impact on Togo's economy. Using revenues to improve transport infrastructure efficiency would mitigate impacts to an extent. Using revenues to provide for adaptation finance would probably have a positive impact on Togo's economy.

Kenya

Agriculture is a significant part of Kenya's economy, contributing to 23% of GDP and employing 61% of the population. The service sector, however, contributes 58% to GDP, and tourism has grown to become Kenya's largest foreign currency earner. Kenya's imports outweigh its exports and a trade deficit has been growing since 1995.

Results from the MDM1a scenario predict a small impact of -0.043% on GDP, with aviation making up -0.048% which is offset slightly by a small positive impact from the maritime sectors (0.005%). Whilst initially surprising given the significance of tourism for the Kenyan economy, as in the case of Togo this is a reflection of the current trade deficit in

Kenya. A predicted increase in costs of imports leading to an import decline will go some way towards reducing the national deficit, thus explaining the very limited negative impacts of MBMs and the positive anticipated impacts on the maritime sectors. The high dependence upon national agricultural production and a strong overland trade basis would also limit impacts, along with significant overland tourism.

Kenya currently hosts a small number of CDM projects. Unless this increases significantly, the increased demand for offsets induced by the MBMs will not mitigate the impact on Kenya's economy. Using revenues to improve transport infrastructure efficiency or provide for adaptation finance would, however, mitigate the impacts.

Maldives

The Maldives' geography, as a collection of sparsely populated and isolated atolls, and its associated high dependence upon aviation and more specifically tourism, are significant features of its economy. Tourism contributes to 28% of GDP and over 60% of foreign trade receipts. Maldives has operated under a trade deficit since 2004, partly due to a dependence upon imported fuel.

Modelling results from the MBM1a scenario predict a negative impact on GDP of -0.182%. The impact from aviation (-0.22%), likely through lower tourism receipts, is offset by a predicted positive impact on maritime (0.038%), which probably results from a lower trade deficit due to higher import values and higher export costs. These predictions are lower than might be expected given Maldives' high dependence on tourism, making up nearly 30% of GDP given its dependence on air travel. However, a trade deficit present since 2004 may explain the lower than anticipated impact on GDP, with reductions in negative trade balances masking negative impacts from tourism.

According to UNEP Risø, the Maldives currently does not host CDM projects. Unless this changes, the increased demand for offsets induced by the MBMs will not mitigate the impact on the Maldives' economy. Using revenues to improve transport infrastructure efficiency would mitigate impacts. Using revenues to provide for adaptation finance for this low-lying archipelago would probably have a positive impact on the Maldives' economy.

Samoa

The economy of Samoa has traditionally been dependent upon development aid and agriculture, with agriculture employing two-thirds of the labour force and contributing 90% of exports. Tourism is an expanding sector, currently accounting for 25% of GDP.

Modelled results predict an impact of -1.026% on Samoa's GDP from the MBM1a scenario, the highest seen across the CSEs. Aviation accounts for the majority of this, at -1.08%, whilst a positive maritime impact of 0.054% offsets the total to a small extent. The high dependence of the Samoan economy on tourism, which currently accounts for 25% of GDP, and the nation's isolation and thus dependence upon long haul aviation for tourism, can explain the magnitude of impact predicted here.

According to UNEP Risø, Samoa currently does not host CDM projects. Unless this changes, the increased demand for offsets induced by the MBMs will not mitigate the impact on Samoa's economy. Using revenues to improve transport infrastructure efficiency and especially provide for adaptation finance would, however, mitigate the impacts.

Cook Islands

The relative isolation of the group of atolls named the Cook Islands limits access to foreign markets. A heavy dependence upon the tourism industry increasingly dominates the national economy, accounting for around 67% of GDP and employing up to 50% of the population of the largest island. Reliance upon development aid is also significant.

Results from the MBM1a scenario predict a -0.513% contraction of national GDP, the majority of which (-0.504%) is from the aviation sector, with just -0.008% from shipping. The second largest impact of the CSEs considered, after Samoa, this can be explained by the very significant dependence of the Cook Islands economy on aviation-based tourism, with the tourism industry making up two thirds of national GDP in recent years.

According to UNEP Risø, the Cook Islands currently does not host CDM projects and so the increased demand for offsets induced by the MBMs will not reduce these negative impacts on the Cook Islands economy. Using revenues to improve transport infrastructure efficiency would go some way towards mitigating these impacts, especially if it can be targeted towards aviation infrastructure. Using revenues to provide for adaptation finance for this low-lying archipelago would have a positive impact on the Cook Islands economy.

Chile

Chile's economy is heavily dependent upon international trade and is supported by strong ore and metals exports. Trade accounts for 62% of GDP, and Chile has benefitted from a growing trade surplus since 1999. The extensive coastline lends to a competitive maritime sector, with some of its 46 ports amongst the busiest in the Americas.

The MBM1a scenario predicts a medium impact on Chile's GDP, at -0.102%, placing it in the middle in terms of impact of all the CSEs considered. The majority of this impact (-0.10%) is from the maritime sector, contrary to most cases considered, with aviation -

normally the sector impacted more significantly - contributing just -0.002%. The Chilean maritime sector is the second most impacted through the MBM1a scenario after Trinidad and Tobago. This reflects the significance of the maritime sector in trade for the Chilean economy, and the limited reliance upon tourism, which makes up just 1.2% of GDP.

Chile is currently a minor host country of CDM projects. Unless this changes, the increased demand for offsets induced by the MBMs cannot significantly mitigate these impacts on the Chilean economy. Using revenues to improve transport infrastructure efficiency or provide for adaptation finance would, however, offer some impact mitigation.