ACCOUNTING FOR AND INFLUENCING SHIPPING EMISSIONS AT A SUB-GLOBAL LEVEL

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ABSTRACT
Concern about climate change has come somewhat late in the day for shipping for a combination of reasons: more obvious local pollutants; its omission from national inventories within the Kyoto Protocol; its importance in globalisation; its reputation as the most energy efficient transport mode. However, if national governments take heed of the scientific evidence underpinning the global 2°C temperature target, all sectors must be accounted for to ensure rapid decarbonisation over coming decades. Although the global nature of shipping likely requires some global policy solutions, pressure from the EU to consider sub-global policies is growing. This paper investigates opportunities and barriers around accounting for shipping emissions at a sub-global level and, going one stage further, explores aspects of the shipping system over which the UK in particular can have influence. The paper highlights that although establishing a baseline for international shipping emissions using apportionment enables the effort required across other sectors to be quantified, it is not a pre-requisite for directing mitigation policies at shipping. Instead, the urgency implied by a commitment to 2°C provides an evidence base for aiming mitigation policies at aspects of the system that can be influenced. Focus on the full logistics supply chain, considering potential for mitigation within national waters, ports and consumption in addition to beginning a process of data gathering would be a practical first step towards this commitment.
Keywords: shipping, climate change, apportionment, sub-global, emissions, targets

1. INTRODUCTION

The Copenhagen Accord, EU and UK Government's all recognise that global mean temperatures should not rise by more than 2°C above pre-industrial levels. To convert this temperature threshold into meaningful emission targets for developing both mitigation and adaptation policies, a range of cumulative emission budgets for the 21st century can be ascertained given the long-lived nature of some of the most important basket of 6 greenhouse gases – carbon dioxide and nitrous oxide. Taking a cumulative emissions approach, as opposed to a focus on a long-term end-point target (such as an 80% cut in emissions by 2050), highlights the importance of taking measures urgently to reduce emissions across the aggregate of all sectors (Anderson et al., 2008b).

While the cost of abatement opportunities will likely result in some sectors making more rapid or deeper cuts than others in the first instance, complete decarbonisation of the global energy system is required by around 2050 for a reasonable to high chance of avoiding the 2°C rise (Anderson et al., 2008a). This is in part due to the relative ease of reducing emissions of carbon dioxide from energy compared with the more intractable problem of cutting methane and nitrous oxide emissions associated with food production for a growing population (Hedenus, 2010; Anderson et al., 2011; Roeder et al., 2011). The implications for sectors producing their emissions primarily within national boundaries are challenging enough. However, sectors explicitly crossing national boundaries or associated with international supply chains pose further obstacles to decarbonisation. This paper explores the particular barriers to change for the shipping sector, and considers ways in which sub-global mitigation policies could accelerate its pathway to a low carbon future.

2. COMPLEXITY OF THE SHIPPING SYSTEM

A considerable body of research has now built up around assessing the potential and barriers to mitigation for the aviation sector (Bows et al., 2005; Greener by Design, 2005; Cairns et al., 2006; Bows et al., 2007; Bows et al., 2009). Research on the equivalent barriers and potential for the shipping sector tends to be more recent (Eyring et al., 2005; Corbett et al., 2008; Buhaug, 2009; Eyring et al., 2010) as previously the focus was largely on non-greenhouse gases emitted by ships, including sulphur dioxide.

Coarsely comparing the aviation and shipping sectors, it is immediately apparent how they differ in terms of their complexity. In aviation, there are two major manufacturers, in shipping, numerous. Flights tend to be direct or via one of the major hubs, shipping voyages depend on the type of service, with some ships tramping the seas seeking business. National airlines tend to be based within their host nation, whereas ships may be registered anywhere in the world, using the 'flag of convenience'. And so it goes on. Aside from raising interesting research questions with regard to the organisation of the shipping sector, implications for

implementing and monitoring mitigation policy are highlighted. For instance, if wishing to apportion responsibility for emissions to a nation, or aspect of the shipping system, areas of concern include multi-port routing, freight ownership, ship ownership, fuel ownership etc. Within air travel, it is clear that a direct flight between the UK and Italy could attribute 50% of the emissions to the UK and 50% to Italy. Such an approach is clearly not viable for many types of shipping voyage. Figure 1 illustrates one way in which the shipping system can be visualised to highlight the key actors involved.

3. TO APPORTION OR NOT TO APPORTION?

To understand the scale of greenhouse gas emission production by a sector that transcends national boundaries, an apportionment regime can be employed to attribute those emissions to a nation. By doing so, a proportion of the emissions produced by the global international shipping sector are apportioned on the basis of pre-defined rules. For instance, emissions can be apportioned to a nation on the basis of the fuel purchased by ships from that nation. Similarly, they can be apportioned to a nation on the basis of the goods imported by that nation. Apportionment therefore attributes a level of emissions to a nation in relation to what is considered to be *'national shipping activity'* – a highly debated construct. Table 1 summarises the range of apportionment regimes considered in the literature in relation to the shipping system. Further detail can be found in Gilbert et al., (Gilbert et al., 2010). In an international context, national emissions allocated using an apportionment regime would, when aggregated, ideally result in the total global international shipping emission figure. However, it is possible to apportion a greater share of the emissions to a nation which if applied across the board, would lead to double counting. Although industry stakeholders argue that taking responsibility for more than a fair share is unreasonable, it could be argued that given the scale of the challenge faced, such double counting is appropriate until a global cap is in place.

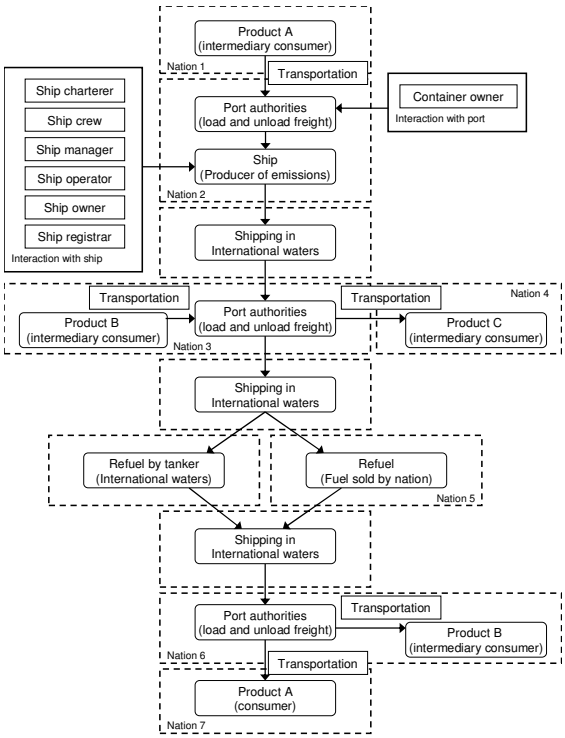

Figure 1: A schematic of the shipping system: an example for the shipping of goods between two landlocked nations

Although international shipping emissions produced by a nation or 'national' shipping emissions are not formally reported to the United Nations Convention on Climate Change (UNFCCC), they are recorded as a memo item under 'bunkers'. Bunker fuel sales figures are used to estimate the associated greenhouse gases from international shipping activity. As a result, figures can vary widely from nation to nation depending on whether they happen to be conveniently located on a shipping route for refuelling, or are selling cheap fuel. For example, around 1% of global marine bunker fuel sales are apportioned to the UK under this scheme, whereas 10% are apportioned to the Netherlands (p.45 Gilbert et al., 2010). The fact that the population of the Netherlands is considerably smaller than the UK highlights the inequity of apportioning using fuel sales, if per capita consumption is to be considered an important driver of growing shipping emissions.

3.1 'NATIONAL SHIPPING ACTIVITY'

Debate over the 'correct' apportionment regime for use in shipping is ongoing, with many within the industry arguing that apportionment is unnecessary, as global as opposed to regional or national-scale policy measures are likely to have more influence. This argument is supported to some extent by the nature of the shipping system as highlighted in Figure 1.

Table 1: Apportionment regimes proposed within the literature

Apportionment regime	UNFCCC[a]	Entec[b]	Anderson et al[c]
No apportionment	■		
Reported bunker fuel sales	■	■	
Reported fuel consumption		■	
National emissions (as a proportion of global emissions)	■	■	
Location of emissions (within 12-mile and 200-mile zones)	■	■	
Nationality of the transporting company ship registration	■	■	
Freight tonnes loaded or unloaded		■	
Port of departure or destination of cargo and passenger	■	■	
Exporter (producer) or importer (consumer) of cargo[1]	■		
Owner of the cargo[2]	■		
A nation's proportion of global GDP			■

[a] (UNFCCC, 1996a; Entec UK Ltd, 2005; Anderson et al., 2008a)

Moreover, nations within the industrial parts of the globe – known within the UNFCCC as Annex 1 nations – have emission reduction targets, whereas non-Annex 1 nations do not. As international shipping emissions are not 'produced' in the nation, they are omitted from these national emission reduction targets. How to set targets for a sector or system that has drivers worldwide, and in particular drivers from nations with no climate mitigation targets, is a challenging issue. The International Maritime Organisation was therefore tasked in 1992 by the UNFCCC to develop policies and measures to tackle shipping emissions. Yet slow progress has led to a commitment from the EU to implement a regional market-based measure, should no global agreement be reached by the end of 2011. In other words, shipping would be brought into the EU's Emissions Trading Scheme by the end of this year, as is already the case with international aviation.

Whether or not policies should be set at a sub-national scale, it is imperative from a climate change perspective to fully account for all greenhouse gas emissions. Nations, such as the UK, that base their own targets on a global temperature rise, do so through the links between global temperatures, concentrations of greenhouse gas emissions and cumulative emission budgets (Anderson et al., 2009). If some emissions are omitted from these calculations, then the desirable temperature threshold is more likely to be breached (Bows et al., 2007). Consequently, it is important for agreement to be reached on an apportionment regime to establish how significant cuts in other sectors will need to be, particularly if shipping emissions continue to grow. On the other hand, devising an appropriate regime for apportioning emissions does not necessarily provide a basis or useful indicator for mitigation policy.

3.2 MONITORING POLICY SUCCESS

When looking more closely at the types of apportionment regimes available, and how the emissions would be estimated using these regimes, it becomes clear that if it is to play a role in mitigation policy, a suitable regime must facilitate direct or indirect influence on the level of emissions, thereby capturing the responsibilities of that nation. It must also be able to monitor the progress of the mitigation policies put in place. For instance, if the apportionment regime chosen estimates national shipping emissions using a top-down share of the nation's of goods tonnes loaded compared with global tonnes loaded, to reduce the emissions using this measure, either the total global tonnes of goods needs to increase and/or the tonnes of goods loaded at the nation needs to decrease. Such bizarre incentives result from many of the apportionment regimes that require a top-down proxy to determine the value (Gilbert et al., 2010). Furthermore, none of these top down proxies would be adequate for monitoring policy success. Establishing the level of shipping emissions using bottom-up apportionment regimes that require the modelling of the shipping voyages undertaken from port of departure to port of arrival, while providing a more detailed estimate of shipping emissions, involves complicated modelling with limited data. Thus estimating emissions in this way on an annual basis to monitor the progress of any mitigation policy put in place could be very time and cost-

[1] In the UNFCCC report, regime 'exporter' is referred to as the country of departure or destination of the cargo or passenger

intensive. Nevertheless, the range of international shipping emissions generated using different apportionment regimes highlights the desirability of at least establishing a recent estimate for shipping emissions. Table 2 presents the range for the UK where estimates are possible. Whilst this range of estimates may be unsuitable for developing and monitoring mitigation policy aimed at shipping, it provides guidance to the UK's Committee on Climate Change in determining the scale of emission reductions necessary across all sectors to remain commensurate with their 2°C target.

Table 2: Top-down proxy apportionment regimes to determine UK's apportionment of CO2 emissions from international shipping

Apportionment regime	UK shipping emissions (% of global) (Mt CO_2)	
No apportionment		
Reported bunker fuel sales	1.00	7.05
Reported fuel consumption	*Not considered*	
National emissions	1.93	16.16
Location of emissions	*Bottom-up only*	
Flag of ship	1.23	10.30
Freight tonnes loaded	2.95	24.70
Freight tonnes unloaded	4.92	41.26
Port of departure or destination of cargo	*Bottom-up only*	
Exporter (producer) of cargo	3.75	31.40
Importer (consumer) of cargo	5.02	42.05
Owner of the cargo	*Bottom-up only*	
National GDP	4.98	41.76

It also illustrates that the regime used currently within the memo item reported to the UNFCCC, bunker fuel sales, gives the lowest of all of the estimates. Regimes that have a closer link to the amount of shipping activity serving UK consumers, e.g. freight tonnes loaded or unloaded, or exporter or importer of cargo, estimate emissions at three to six times that of the bunker fuel estimate.

3.3 CARBON LEAKAGE

Leaving aside for an instance the debate over what constitutes *'national shipping activity'*, the other side of the coin is considering what, if anything, can nations like the UK influence in order to reduce greenhouse gas emissions within the shipping sector. The logic here would be that the UK is committed to avoiding the 2°C threshold between 'acceptable' and 'dangerous' climate change. It is aware of the link between this temperature threshold and cumulative emissions, and therefore understands that the sooner emissions are reduced, the lower the chance of breaching the threshold. The UK has already put mitigation policies in place aimed at aspects of the energy system that it has influence over, in order to mitigate emissions. Therefore, what would be the argument for not attempting to influence emissions from international shipping, if it is possible to do so?

One argument could relate to carbon leakage (Peters et al., 2008; Wood et al., 2010). If mitigation policy aimed at a sector leads to a part of that sector leaving the UK to a nation where it avoids paying a higher cost due to a carbon price, then this would be considered to be carbon leakage. At present, there is little evidence to suggest that this has happened in other sectors, but one clear consequence of the outsourcing of UK manufacturing, is that the greenhouse gas emissions produced in the UK have fallen (Helm et al., 2007). A counter argument could be that global negotiations continue to build towards the establishment of a more widespread limit to the production of greenhouse gas emissions, gradually reducing any incentive to relocate higher emitting sectors elsewhere. The risk of pushing high emitting sectors outside of UK law may or may not outweigh the risk of firstly directly influencing an emission reduction in some aspect of the shipping system and secondly the unintended but potentially constructive consequences that could follow, such as the establishment of similar policies in other seafaring nations. Moreover, the fact that it is likely that any global or even EU-scale comprehensive mitigation policy aimed at shipping will not be put in place prior to 2017 (CCC, 2011) highlights the need for exploring aspects of the shipping system that could potentially be influenced in the short-term, consistent with the urgency implied by the carbon budgeting approach.

4. INFLUENCING SHIPPING EMISSIONS

As an island nation, the UK is better placed than many to consider what aspects of the shipping system it can influence or control. Whilst the UK has undoubtedly lost its high ranking in relation to ship building, it remains at the forefront when considering the tonnes of goods per capita arriving by ship or even the number of ships calling at the UK. National pride in the shipping industry is deeply routed, and its representation at the IMO strong. Therefore, a focus on the practicalities of the UK in relation to the system itself can throw some light on potential policy options.

4.1 THE LOGISTICS SYSTEM

Returning to Figure 1, and building on a recent stakeholder workshop with shipping industry representatives, aspects of the shipping system that could, in theory, be targeted with policies aiming to

reduce emissions and out with the need for apportionment are:

- Port authorities
- Ship charterers
- Ship operators
- Consumers

Another way of approaching the problem, is to consider which aspects of the voyage the UK could influence. For instance:

- In port operations
- National waters operations
- High seas operations

The fact that the shipping system is complex points to no single aspect being isolated one from another. Therefore, even though the high seas are not within the jurisdiction of the UK, policies aimed to support alternatives to just-in-time arrival could have an influence over ship speeds, or the optimal design speed for ships. More direct influence, on the other hand, could be over ship operations in national waters or docking at national ports through the establishment of an energy or carbon efficiency threshold. A recent example came into being on 1st January 2011 when several Dutch ports adopted the World Ports Climate Initiative's Environmental Ship Index (ESI) (International Association of Ports and Harbours, 2010). The ESI is a voluntary system that distinguishes vessels based on environmental performance. It rewards vessels that perform above and beyond international legislation – with respect to CO_2 emissions.

Whilst the majority of greenhouse gas emissions produced by the shipping system are during the 'use-phase' of ships, and tackling port emissions is captured within the UK's national mitigation targets, encouraging and supporting comprehensive carbon management strategies at national ports could, in addition to encouraging renewably powered cold-ironing, help to influence the wider logistics system. This is particularly relevant when concerns are raised in relation to mitigation policies, such as a port-efficiency standard, that result in incentives for ships to dock outside of the UK, transferring goods onto road or rail transport for economic reasons. If this were to occur, complimentary policies targeting emissions across the whole logistics system could to some extent mitigate any such reaction. Moreover, tightening mitigation policy around the land-based logistics aspects would likely counter any move to avoid docking in the UK, given the much higher carbon intensity of road-based freight transport. The international shipping sector can not be considered in isolation from the higher carbon intensity, and wider logistics chain, but omitting such an intrinsically linked sector such as international shipping from the UK climate policy portfolio undermines its efforts to remain committed to the 2°C threshold.

4.2 THE ROLE OF THE CONSUMER

Even more challenging a debate is perhaps around the role of the consumer within the supply chain. Shipping and other modes of freight transport are a means to delivering either the wants and desires of the consumer and/or what the retailer wishes to supply to the consumer. If the consumer is considered to be a principal or at least important driver within the system, then a parallel debate to explore how policies can influence the quantity of and sources of goods imported (and exported) in to the UK should begin. However, influencing both the consumer and particular aspects of the shipping system still requires mechanisms for monitoring the success of the policies that are put in place.

4.3 MONITORING MITIGATION POLICIES

Rather than attempting to gather, on an annual basis, greenhouse gas emissions data produced by the entire UK-related shipping system, it may be more practical in the first instance, and while data is patchy, to establish indicators that can be used to monitor the progress of mitigation policies. For example, reporting of 'in-port' or 'national waters' fuel consumption, km travelled, time spent in port or national waters plus the frequency of port-callings and/or type/size of ship would provide an indication of operational changes such as slow-steaming or days waiting in port. It would also allow ship efficiency to be monitored, for ships calling at the UK, which, after a number of years, would indicate if global or sub-global measures were leading to any improvement in the emissions per tonne-km travelled. Beginning the process of policy development through data gathering and emission monitoring would be a valuable first stage in addressing the urgency with which emissions from all sectors should be tackled.

5. CONCLUSIONS

The UK's national commitment to the 2°C threshold is commensurate with a logic of urgency to reduce emissions across the aggregate of all sectors. Shipping is currently outside of the UK's carbon budgets and policies to reduce emissions, yet it is clear that the CO_2 emissions from shipping are a significant and growing portion of current emissions. Following the logic implied by a commitment to the 2°C threshold leads to a strong evidence base supporting the urgent mitigation of emissions where there is both an element of responsibility, and where it is possible. There are two aspects to this; one is to establish the level of shipping emissions associated with the UK, in order to adjust the carbon budget for other sectors. This requires the use of an apportionment regime. The other is to consider what can be influenced and monitored at a

national or sub-global level while a global cap on emissions is absent.
The link between some of the apportionment regimes and what can be reasonably considered to be *'national shipping activity'* can be rather weak. Following analysis of the various regimes (Gilbert et al., 2010), the useable range of estimates for the UK should omit the bunker estimate, level of national emissions and the flag of ship. This would narrow it down from around 7 $MtCO_2$ to 42 $MtCO_2$ to a range between 25 and 42 $MtCO_2$. This provides a guide for policymakers in understanding the current contribution of shipping to the overall emissions burden in the UK.

Knowing that the shipping sector is responsible for producing a significant share of UK emissions, and again following the logic implied by 2°C, mitigation policies aimed at shipping should begin in earnest. However, it is argued here that it is not necessary to establish a precise figure for the emissions associated with *'national shipping activity'* in order to do this. Furthermore, many of the apportionment regimes would be unable to capture the effect of shipping-specific mitigation policies. Instead consideration should be given to what the UK can influence and how it can monitor success. It is not therefore a pre-requisite to use apportionment for the purposes of developing mitigation policies, particularly given the complexity of the shipping system. Developing policies and measures that encompass the entire logistics chain is arguably a more effective way to tackle the emissions associated with international shipping. This would guard against the unintended consequences of policies targeting only shipping that may incentivise more land-based transfer of goods. Establishing mechanisms for influencing shipping in national waters, around national ports and the consumption of goods could yield positive knock-on effects down the logistics chain and wider shipping system, as long as the potential for the rebound effect is carefully thought through.

In short, establishing a baseline for international shipping emissions using apportionment enables the effort required across sectors to be quantified. It is not, however a pre-requisite for directing mitigation policies at shipping. Instead, the urgency implied by a commitment to 2°C provides an evidence base for aiming mitigation policies at aspects of the system that can be influenced. Focus on the full logistics supply chain, considering potential for mitigation within national waters, ports and consumption in addition to beginning a process of data gathering would be a practical first step towards this commitment.

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