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Article

Enforcement Issues in the Governance of Ships' Carbon Emissions

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Abstract: The shipping industry, although relatively carbon-efficient, is projected to produce rising carbon emissions in the future as a consequence of increasing world trade. A number of candidate regulations designed to mitigate these emissions have been canvassed by the UN's International Maritime Organisation and by the European Commission. Many of these schemes are focussed on the use of market measures—emission trading schemes or fuel levies. This paper draws on observational and interview data gathered to examine enforcement issues associated with the control of ships' sulphur emissions in order to consider the possible enforcement problems that might be associated with projected market measures to control ships' carbon emissions. Enforcement problems are shown to be associated with the globalised character of the industry and its polycentric governance structure.

Keywords: carbon emissions; shipping; polycentric governance; market measures; emission trading; fuel levy; enforcement; port state control

1. Introduction

The topic of controls on carbon emissions from the shipping industry has received relatively little public policy attention, although international shipping's greenhouse gas emissions are greater than the total emissions of many countries, including for example, the UK [1]. The UN regulatory agency, the

International Maritime Organisation (IMO) estimates that, for the period 2007–2012, on average, shipping accounted for approximately 3.1% of annual global CO₂ and that, in 2009 shipping accounted for approximately 3.1% of global CO₂ emissions [2]. Moreover, international shipping emissions are increasing. The IMO study concluded that the expected continuous growth in shipping is likely to bring an annual rise in shipping's CO₂ emissions of between 1.1%–3.4% for the period 2007–2050. Emission scenarios show that by 2050, in the absence of regulatory policies, emissions from shipping may grow by between 150% to 250%, compared to 2007 levels [3,4]. Despite this and, as the House of Commons Environmental Audit Committee 2009 [1] pointed out, progress in framing international regulations to control ships' carbon emissions has been slow, although a number of candidate schemes have recently been deliberated in the IMO or put out to public consultation by the Commission of the European Communities (European Commission). However, effective governance requires effective enforcement, and globalised industries (of which the shipping industry can be said to be an exemplar) are recognised as posing particular enforcement problems [5], so enforcement issues should be prominent among the criteria for choosing between different governance approaches for the regulation of ships' carbon emissions. Although approaches to carbon regulations are still being debated, the IMO has introduced new regulations to control ships' sulphur emissions. Current efforts to address carbon emissions are focusing upon the use of market instruments, in particular taxation and emission trading schemes, although emphasis is also being placed on encouraging the shipping sector to contribute to climate change mitigation through self-regulation and voluntary environmental performance agreements. This paper seeks to derive from the experience of enforcement of sulphur regulations a greater understanding of the possible enforcement issues facing the future governance on ships' carbon emissions. We hope that this understanding will, in turn, cast light on the conditions necessary for ensuring that market instruments can play an effective role in the governance of climate change within the sector.

Fearnely *et al.* [6] have argued that it is important to cultivate compliance culture and have enforcement and oversight mechanisms in place to deter non-compliance, while also dealing swiftly and effectively with abuse. However, while the importance of enforcement action is recognised especially in the literature on corporate governance [7], a recent review of environmental monitoring and enforcement in Europe [8] has pointed out, firstly, that monitoring and enforcement have received rather little academic attention, compared to regulation, and secondly, that most empirical studies of monitoring and enforcement have low “construct validity”, being based on indirect measures of pollution activity or on the perceptions of the regulated communities. Instead, this study is one of that small group of studies [9,10] based on direct observation of monitoring/enforcement practice and the perceptions of the monitors/enforcers, as well as the regulated communities. It may be of particular interest insofar as it concerns the pollution activities of ships, self-evidently highly mobile industrial plants, very capable of regulatory flight, and “off-shore” not just in the literal sense, but also frequently subject to lax and opaque off-shore jurisdictions. Governance processes in such circumstances are still little understood [11].

The global shipping industry is vital to the capitalist world economy, carrying more than 80% of international trade by volume. It is also comparatively carbon-efficient: although there is some uncertainty about the overall amount of ships' carbon emissions [12], one estimate is that in 2007 shipping contributed 3.5% of global CO₂ emissions [2] and shipping emits less than half the CO₂ in grams per tonne/km of road transport and only 4% of the CO₂ in grams per tonne/km of air freight ([13], pp. 86–93). Additionally, the IMO has recently introduced a series of measures designed to address the issue of ships' carbon

emissions, including a mandatory energy efficiency design index (EEDI) for new-built ships and a future requirement for all vessels to carry a Ship Energy Efficiency Management Plan covering matters such as improved voyage planning and hull maintenance. However, the IMO's own Greenhouse Gas (GHG) Working Group has stressed that these anticipated improvements in design and operational efficiency will not, of themselves, bring about a reduction in total vessel carbon emissions because of the expected continuing growth in world trade (and therefore in increased shipping activity): additional market-based measures (such as a fuel levy or an emissions trading scheme) are required if shipping is to contribute to a global reduction in carbon emissions [14]. Ten different schemes for market-based measures to reduce ships' carbon emissions were proposed at the 60th session of IMO's Marine Environment Protection Committee and were reported on by the GHG Working Group in 2011, half of them variants on a fuel levy or an emissions trading scheme. To date, no decision on the adoption of market-based measures has been made, but discussions are continuing.

The GHG Working Group at IMO was first established in 1997 and concern about the lack of progress at IMO led the Directorate-General for Climate Action (DG Clima) of the European Commission to establish a public consultation in 2011 on four policy options for a regional European scheme to reduce ships' carbon emissions. These options also embrace variants on emissions trading schemes and fuel levies [15], but there is no timetable for a decision on a regional European Union (EU) scheme and the Transport Commissioner has described the DG Clima policy options, rather lukewarmly, as "conceptual discussions" [16]. In the meantime, the European Commission has announced plans to require all vessels over 5000 tonnes entering or leaving EU ports to monitor, report and verify their carbon emissions (proxy-measured by their fuel consumption); this is designed to provide necessary baseline data on carbon emissions that could be used to inform future IMO market-based measures [17].

The heavy fuel oil burnt by most ocean-going vessels is a cheap refinery by-product. When burnt, it releases sulphur and nitrogen compounds (SO_x and NO_x) which have been the most important source of "acid rain" in Northern European coastal areas [18], and it releases fine particulate matter which are implicated in an estimated 27,000 premature deaths per annum across Europe due to pulmonary and coronary diseases [10,19]. The IMO introduced regulations to control sulphur levels (and thus associated emissions of particulate matter) in 2005, with revisions in 2010. A world-wide sulphur cap was initially set at 4.5%, reducing to 3.5% in 2012. A further world-wide reduction to 0.5% is projected for 2020. Of particular present importance are the designations of Emission Control Areas (ECAs) in the Baltic (2006), the North Sea/English Channel (2007) and the coasts of North America (August 2012). Initially, the sulphur limit on fuel in the ECAs was set at 1.5%, reducing to 1.0% in 2010 and further reduced to 0.1% in 2015. The EU has introduced some additional sulphur restrictions (notably the requirement on vessels to burn 0.1% sulphur fuel while in port), as have some Nation-States, for example, Sweden's "fairway dues" (charged to cover ice-breaking costs and navigation lights) are lower for vessels which attest to continually burning low-sulphur fuel and/or have NO_x-efficient engines. The costs of compliance with these regulations are considerable, with fuel costs easily outstripping crewing costs on non-passenger vessels. At the end of 2012, the price difference between 3.5% sulphur heavy fuel oil and 1.0% sulphur fuel (a blend of heavy fuel oil and distillate) was around \$22 dollars per tonne; the price difference between the 3.5% heavy fuel oil and 0.1% sulphur fuel (distillate) was around \$320 per tonne. Unscrupulous operators can therefore gain a strong competitive advantage through regulatory avoidance,

with the temptation to regulatory avoidance currently being reinforced by disastrously low maritime freight rates [20,21].

The shipping industry's governance structure corresponds to that described by Black [22] as "polycentric"—it is fragmentary, complex, multi-level and overlapping in character (*cf.* [23]). Fragmentation can have a very negative impact on the performance of any governance system, and can give rise to legal obstacles that hamper effective outcomes [24,25]. In addition, it can also cause norm conflict. Thus, for example, while the climate regime of United Nations Framework Convention on Climate Change (UNFCCC) is based on the key principle of "common but differentiated responsibility", the IMO is driven by the principle referred to as "no favourable treatment". This norm difference continues to cause blockages in negotiations over emission reductions from the shipping sector, making it difficult to integrate climate change regulations into sector policy [3]. Fragmentation must thus form a crucial consideration when assessing which type of governance arrangements are best placed for effective governance of carbon emissions [26]. Policy making in the shipping sector is derived from an institutional framework dating from the early twentieth century, centred upon the state as the main actor [24]. At the same time, shipping is a highly internationalized industry, working in an increasingly globalized environment [27]. Despite this, however, policy-making in shipping continues to be formulated within a traditional nested hierarchy of jurisdictions that pays little attention to new relationships between jurisdictional levels, interested parties, and across different locations [28]. Traditionally, enforcement of international law was the responsibility of the flag-State, the national maritime administration with which the vessel was registered. However, "Flag-State Control", as it was termed, has become less effective with the transfer of many ship registrations to laxer off-shore jurisdictions ("flagging out"), such as landlocked Bolivia and Mongolia, which "have little intention of fulfilling their fundamental responsibilities" because this would lessen their market attractiveness to "less scrupulous owners" ([29], p. 90). This turns our attention to the links between good governance, environmental compliance and enforcement. A framework encompassing the principles of good governance forms the basic building block upon which policies to protect the environment can be developed and appropriate legislation respected [30]. The inadequacies of Flag-State Control led to the formation of regional alliances of port-States ("Port State Control") which sought to enforce international regulations on ships berthing in their ports, regardless of flag, by a common methodology of ship inspections (*cf.* [10]). Ships berthing in European and Canadian ports are subject to an inspection regime overseen by the office of the Paris Memorandum of Understanding on Port State Control, based in The Hague. Other enforcement agents may exercise jurisdiction besides the flag and port-States: the association of oil majors, the Oil Companies International Marine Forum (OCIMF) has a vigorous inspection regime to vet vessels in the tanker trade; local port authorities may make environmental health checks; the Water Police in Germany and Holland inspect vessels in river and estuarine ports; and the International Transport Workers Federation (ITF) has an inspectorate to check on the labour standards on those vessels where it has negotiated agreements. However, the main burden for enforcement of the low-sulphur regulations lies with Port State Control. While the IMO has developed a regulatory framework for international shipping, it does not directly enforce its regulations [31].

It is in this context that we investigate the use of market-led tools for the effective governance of carbon emissions from the shipping sector. Following a report of the methods of the study, the paper

considers, firstly, the enforcement problems of regional and global emissions trading schemes for the shipping industry, and secondly, the enforcement problems of a regional and a global fuel levy.

2. Methods

The data for this paper were collected in an Economic and Social Research Council-funded study of enforcement issues in the governance of ship emissions. The study was focused both on the enforcement of current regulations on ships' sulphur emissions and, relatedly, on possible enforcement issues for future regulations on ships' carbon emissions. The study was comparative between the UK and Sweden. The data comprise observational data on 16 port-State control ship inspections in Sweden and the UK, and 50 audio-recorded, semi-structured interviews with Port-State Control Officers, officials of national and international regulatory agencies, and industry stakeholders representing a wide range of interests (fleet management, industry associations, bunker suppliers, classification societies, port management, trade unions and NGOs concerned with shipping and the environment). As is normal in studies of this type, all the interviews were conducted under the promise of anonymity and ethical approval for the study was granted on this understanding. Accordingly, where interviewees are quoted, only their occupation is reported. The interviews were transcribed and the transcripts and the observational field notes were both indexed (using the same index codes) and systematically analyzed using analytic induction [32].

3. Enforcement of Emissions Trading Schemes

As previously noted, a large number of different market-based measures (global and regional) have been tabled for reducing ships' carbon emissions, so our discussion of enforcement problems is organised under two headings—problems with generic emission trading schemes, and problems with generic fuel levies. Some potential enforcement problems are specific to a shipping Emissions Trading Scheme (ETS), whereas others have previously been identified as general problems with an ETS that could also apply to shipping. Taking the latter general problems first, three main issues are apparent—bogus “offsetting” projects, distortions in carbon markets, and additional reporting and workload costs.

Offsetting projects occur where ETSs allow companies to invest in emission-saving projects elsewhere as an alternative to cutting their own emissions. Under the Kyoto Protocol, off-setting investments can be in developing countries under the Clean Development Mechanism (CDM) or in other developed countries (in practice, frequently in transitions states in Eastern Europe) under Joint Implementation (JI) projects. It is not clear whether an EU ETS for shipping would be part of the existing EU ETS, or would be a stand-alone scheme for the industry. If the former, then the existing EU ETS allows companies to off-set their emissions by investments in CDMs and JIs. In respect of a global ETS for shipping, it seems that inclusion of CDM projects in the scheme could be crucial in persuading sceptical developing nations that a global shipping ETS is compatible with the principle of “common but differentiated responsibilities” in combating climate change.

However, it is clear that many of these off-setting projects are of dubious environmental value and others are demonstrably fraudulent (see, for example, [33]). George Monbiot, the environmental campaigner, described the CDM as “an exuberant global market in fake emissions cuts” [34]. Bogus off-setting projects continue to surface despite extensive and expensive verification processes: validation and registration of CDMs were reported to take an average of 572 days [35]. It is likely that, in the case

of a regional EU shipping ETS, operators of vessels which were only occasional or intermittent visitors to EU ports would seek to purchase the required carbon credits as cheaply as possible. And it is equally likely that some unscrupulous brokers would appear in the carbon market to meet that demand by offering cheap credits associated with bogus or dubious CDMs and JIs.

Speculative funds could themselves cause price fluctuations (and therefore harmful uncertainty) in the carbon credits market, but this could be addressed to some degree by limiting the quantity of credits that could be purchased relative to the tonnage controlled by the purchaser. More potentially serious are the price fluctuations in the current EU ETS due to criminal VAT/sales-tax frauds, made possible by the lack of harmonised tax regimes across the EU [36]. And perhaps most serious of all are computer hacking and phishing scams that have allowed the perpetrators to access very large amounts of EU ETS carbon credits and reduced confidence in the market among brokers who fear that they may be left holding illegally-obtained credits [37].

All ETS schemes entail some additional administrative costs. There are reporting costs, verification costs and trading costs. In respect of reporting in the aviation sector, Lufthansa claimed that the EU ETS had cost the company an extra 3.5 million euros in IT services [38]. Verification that a vessel's carbon credits matched vessel emissions would, in all probability, be conducted by specialist classification societies, like Lloyds Register, which already conduct regular audits of vessels to certify vessel compliance with other international regulations (on behalf of the flag-State), but there would be a likely additional charge for this verification service. And while large ship operators might conduct the purchase (and sale) of surplus credits in-house, most operators would probably contract out such work to specialist brokers who would of course charge a fee for their services. Such third-party charges will always be unpopular in shipping company offices, especially so when (as previously mentioned) maritime freight rates have fallen and many companies are losing money:

“...in the examples that were given to us, there seemed to be so many other additional parties involved that the cost of administering such a system seemed illogically high [...]” [shipping industry representative interviewee].

Beyond these generic difficulties associated with ETSS, there appear to be a number of further problems specific to a shipping ETS, namely those of the “responsible entity”, of flag-State allocation, verification and enforcement, of reliance on the Bunker Delivery Note for evidence of fuel consumption, and of variation in Port State Control practice. In respect of the responsible entity issue, contractual responsibility for fuel purchases (taken as a proxy for carbon emissions, and to be matched against carbon credits) often currently lies with the vessel charterer, although many charters can relate to just a single voyage. In part because of such short-term “spot” charters, legal action for non-compliance is more readily conducted against the ship operator:

“...we have a problem to get a legal entity, I mean we have to get something with a legal entity to be liable or responsible under the scheme for ETS. I doubt that it could be the charterer. Because the charterer could be [for] a single voyage, full stop. [...] people in [charge of] the conduct of the operation of the ship seems to be the most appropriate for us.” [regulator interviewee].

However, legal actions, such as detention of the vessel for not having the required carbon credits, could very possibly penalise the ship operator or the ship-owner for the sins of the charterer. In principle, charter documents in an ETS era could be drafted differently to make charterers responsible for obtaining the necessary carbon credits: ship operators could thus obtain redress for vessel detentions from charterer through the courts. But there is also the possibility of legal challenges from operators to the detaining authority, the port-State.

The difficulty of flag-State allocation, verification and enforcement arises because of those afore-mentioned open registries which do not meet their international obligations. A considerable portion of the world fleet is registered with open registries. Indeed, Panama (the first such open registry, set up by American shipping interests nearly a hundred years ago to avoid what were regarded as onerous American crewing standards) has the largest registered tonnage of any country. Not all open registries are havens for unscrupulous operators—some seek to position themselves as quality flags offering an efficient service—but some registries have become notorious within the industry for the lack of oversight they exercise over sub-standard ships. The Annual Report of the Paris Memorandum of Understanding (MoU) on Port State Control lists the ship detentions (for serious deficiencies) in European ports, by the vessels' flag-States. In the 2011 report, Moldova, for example, which was willing to register applicant vessels within a single day, clocked up 88 detentions (15%) out of 590 port-State inspections, 2009–2011. The equivalent percentage for UK-flagged ships was 1% [39]. In 2012 Moldova, following US pressure, had to remove a number of newly-registered Iranian-connected ships from its flag, in compliance with UN sanctions on Iran [40]. Many more examples of poor flag-State performance could be cited. Of the 84 different flags commonly trading in and out of European ports, 18 are on a Paris MoU “blacklist” as being associated with sub-standard ships and a priority target for port-State inspections [39]. This does not bode well for an ETS with flag-State allocation of carbon credits, verification and enforcement. Of course, many commercial registries would contract out their ETS responsibilities to class societies (aka “registered organisations”). But not all class societies are well-reputed organisations. The Paris MoU maintains a blacklist of poorly performing “registered organisations” too: currently top of the list is the Phoenix Register of Piraeus, Greece [39].

Interviewees with expertise in this area had different viewpoints on the seriousness of the problems for an ETS posed by poorly performing flag-States:

“...as long as the flag-States in the larger proportion of the world [fleet] enforce the scheme consistently, you're OK. Even if you lose a few ships down the side [...]. As long as you've got China in the right end of the scheme.”

An opposite view:

“You have nearly 1500 ships changing flag every month world-wide [...]. So if we start to base our work on the flag [State], then we will have difficulty.”

And, as it were, in reply:

“...once you've re-flagged your ship with a flag that isn't very good at enforcing it [ETS], then you are really permanently attached to that flag—right? You can't flag back in. You can't sort-of-flag-out of Bahamas or Panama—to take two open flags—into something that is temporary [...]. And then flag back in. Because if I was Bahamas or Panama, I wouldn't

let you back in, until you were in compliance [...]. And there are market penalties for re-flagging [...]. I would really worry about that ship being impounded in another port because of that flag-State being known for not enforcing.”

Bahamas and Panama are both commercial registries that maintain quite high standards in their flag-State inspections (the Bahamas has a particularly good record). The interviewee is suggesting that both registries would enforce the ETS, and that ships which exited responsible registries in order to avoid ETS costs would either suffer more port-State inspections and detentions because they were now flying a “blacklisted” or a “greylisted” flag which was targeted by inspectors, or they would have to come back into compliance at the flag-State inspection in order to be readmitted to the Bahamas/Panama flag.

A further difficulty with flag-State allocations in an ETS should also be mentioned. It is commonly accepted that any revenues from an ETS scheme should be re-invested, either in CDMs (or similar) in developing countries, or in researching technologies to further reduce shipping’s carbon footprint. But this would involve the hypothecation of revenues, to which a number of States (the UK among them) are opposed as a matter of principle. This in turn has raised fears in the shipping industry that States would simply treat ETS as a form of corporation tax:

“...we recognise that the shipping industry has got to pay for its CO2 emissions [...] in some way, but we believe that [...] the money that is generated should be used [...] to mitigate climate change, not to line the coffers of the governments that choose to collect funds from an emissions trading scheme” [shipping industry representative interviewee].

As a matter of practical politics, it is difficult to see the flag-States (which form what is in effect the constituent assembly of the IMO) voting for a global ETS which would vest powers of allocation, verification and enforcement in a central body, rather than themselves. Certainly, at the moment IMO does not possess such central powers and lacks the capacity to exercise them. At a regional level, the EU’s European Maritime Safety Agency could perhaps be vested with the necessary powers for administering an EU ETS, but this might be thought to conflict with the EU principle of subsidiarity, whereby functions which *can* be conducted by individual Member States *should* be conducted by Member States. With 170 Member States in the IMO, it seems clear that the scope for criminal phishing schemes (such as have already dealt a blow to confidence in the EU ETS) would be very considerable in a global shipping ETS, where allocation of carbon credits would be in the hands of 170 different administrations.

The Bunker Delivery Note (BDN) represents a potential enforcement difficulty for an ETS because, although there is technology available to directly measure ship emissions and transmit those measurements to a central database (already in use in respect of power station emissions), the cost of purchasing and installing such technology on the existing world fleet makes that technology currently impractical. Thus, carbon emissions must be calculated instead by using a proxy of fuel consumption as represented by the BDN. However, this entails using a commercial document for a statutory purpose and it is a moot point whether the BDN in its current form is up to the job. The ship’s copy is a carbon copy and, like all carbon copies, it is not always readable, particularly after a period of storage. Fuel quantities on the BDN are frequently hand-written and so particularly vulnerable to forgery. The BDN is frequently supplied by a sub-contractor and (although all bunker firms must be registered with the national maritime administration)

the registration number does not appear on the BDN. These are problems frequently recognised by interested parties:

“documents which are purely commercial, if we want to use them [for a statutory purpose], we should make them more robust” [regulator interviewee].

Examples of apparent fraud/forgery have been found in the course of enforcement of the new low-sulphur regulations where the level of sulphur content recorded on the BDN was quite different from that found when fuel samples were lab-tested. The Swedish Maritime Administration samples and tests fuel oil from around 200 vessels per annum on a quasi-random basis; the *Grande Mediterraneo*, inspected at Wallhamn on 10/11/2010 had a BDN recording fuel with 0.98% sulphur content (*i.e.*, compliant), while the lab test result shown that the actual sulphur content was 1.68% sulphur (*i.e.*, clearly non-compliant) [41]. The use of the BDN for ETS enforcement would provide a financial incentive for collusion between the bunkerer and the purchaser to under-report bunkering quantities. Detection of such fraud would depend on the investigator being able to estimate, for comparison, what quantity of bunkers a ship of that size and type would actually require over its previous tracked voyages; indeed, close estimation would also require knowledge of the vessel’s speed over those voyages. As one expert interviewee put it, such investigations would be “a nightmare for port-States”. Where, despite these nightmare difficulties, fraud was detected it would be difficult to take effective sanctions against offending bunker firms, since IMO does not exercise statutory control over the bunker industry, except insofar as it requires national maritime administrations to keep a register of bunkering firms. Member States vary considerably in the extent to which they regulate bunker operations:

“If you see the bunker industry in Singapore, the way it’s regulated, for me it’s the perfect system. And look at the European system—it’s in the pre-historic age compared to this [...]—who is controlling the bunker provider?” [regulator interviewee].

How far variation in Port State Control practice is an enforcement difficulty for a global shipping ETS depends very largely on which of the candidate trading schemes is adopted. If it is a requirement of the scheme that a vessel be continuously in credit (*i.e.*, that its carbon credits should always exceed its emissions), then Port State Control has a very large role. If it is a requirement only that a vessel should be historically in credit (*i.e.*, in credit at the last accounting period), then the major enforcement role would lie with the classification societies, acting on behalf of the flag-States. Some of the infirmities of Flag State Control have already been discussed and need not be revisited here. And, of course, Port State Control arose out of the perceived need to address those infirmities, but that is not to say that enforcement by Port State Control is unproblematic. Indeed, the difficulties for Port State Control in detecting fraudulent under-reporting of bunkers have already been touched upon. But there are a number of other Port State Control enforcement issues that are equally salient.

One such salient issue is the unequal resourcing of Port State Control. Resources are tight in developed countries: in the UK, the Maritime and Coastguard Agency (which includes Port State Control among its functions) had to find 22% budget cuts over the period 2011–2015 [42], with further retrenchment envisaged. But resources are tighter yet in the developing world and in some failing States Port State Control Officers supplement their salaries by extortion [43]. Another salient issue is the discretionary practice of Port State Control Officers. Inspections are not meant to be exhaustive and Port

State Control Officers are meant to be selective in their choice of operations and equipment for inspection: Port State Control is intended to use a sampling methodology. Likewise, officers are required to exercise their discretion in deciding the appropriate penalties for non-compliance. Thus, the likelihood of both detention for non-compliance (a serious reputational matter for ship operators, potentially affecting the market rates that vessels can command—[10]) and detection of non-compliance will vary from officer to officer, port to port and nation to nation. The variable effectiveness of Port State Control is likely to influence compliance patterns and the amount of so-called “carbon leakage”. Such variation in effectiveness will of course be greater on a global basis than a regional basis and so might be thought to pose more problems for a global ETS than a regional ETS. But this seeming advantage for an EU ETS is off-set by the likely requirement for Port State Control in an EU ETS to have to try to calculate the carbon credits owed by vessels which only entered EU waters on an occasional basis:

“Administering that is going to be a bit tricky. I guess it is going to be down to tracking the vessel, knowing when it entered European waters, try and make some sort of assumption on how much it has emitted during that period, converting that into whether it has got to pay for [credits]” [class society interviewee].

4. Enforcement of a Fuel Levy

Many in the shipping industry, including the International Chamber of Shipping, prefer a fuel levy to an ETS, with the levy possibly being used in part for climate change mitigation projects, and possibly in part for development funds for projects to reduce ships’ carbon emissions through technological innovations. The most frequently expressed reason for this preference is the seeming simplicity of a levy, compared to the seeming complexities of an ETS. But such simplicity may be illusory. Thus, while the most straight-forward payment point for a levy would be at the refinery, there seems little likelihood of this occurring. Refineries in oil producer states like Saudi Arabia (opposed to controls on ships’ carbon emissions) would probably not be allowed to participate and refinery owners elsewhere are uncommitted. Thus, in all the levy schemes where the payment point is specified, it is located at the point-of-sale between the bunkerer and the ship operator or charterer. But the sheer numbers of bunkering points and bunkering operations suggests that fraud could be a considerable problem. The possibility of fraud perpetrated by bunkerers has long been a live issue for ship operators and, revealingly, as a deterrent to fraud, the great majority of the larger ship operators already go to the considerable expense of routinely sending samples to commercial laboratories for testing from every bunkering operation:

“...there is a perception amongst people who are on the customer side, if you like, in the bunker business that most suppliers are crooks...” [oil industry interviewee].

“Traditionally, bunkering disputes are centred much more on quantity than quality. The master [of the vessel] claimed that a bunkerer operating in a non-European port required the crew [of the bunker barge] to keep a log of the fuel that had been ‘saved’ on each delivery. [...] it is difficult for the buyer crew to check on quantity as the volume of fuel depends on its temperature.” [fieldnotes 8/11/2010].

Additionally, the potential for the detection and punishment of fraud in respect of a fuel levy is thought to be quite limited in some jurisdictions:

“how do you control a levy being taken on a bunker in Nigeria?” [trade union interviewee].

Further, it is the ship operator or charterer that is the party that is legally responsible for paying the levy, but the actual remittance would be made by the bunkerer. In order to ensure that the levy is in fact remitted, it would seem that it would only be necessary to alter the standard terms of the contract with the bunkerer, so that, if the vessel should be detained because the levy was not remitted, the operator/charterer should be able to claim damages in the civil court. However, the legal position may be complicated by the large-scale use of sub-contractors to deliver the fuel. For example, a sub-contracted bunkering operation was observed on an 8000 tonne roll-on-roll-off cargo vessel:

“Bunkering took place from a road tanker driven onto the cargo deck. Bunker fuel samples were obtained [for commercial purposes] by drip-collection from the delivery pipe at the bunkering manifold, but not following [IMO] recommended procedure” [fieldnotes 4/10/10].

In the view of the Port State Control Officer who observed the bunkering operation, sub-contractors had no strong knowledge of IMO regulations, nor any interest in observing them.

Bunker ships and bunker barges are frequently used for deliveries to larger vessels and can operate in quite heavy swells. In the case of an EU fuel levy it would therefore be technically possible for vessels, wishing to evade the levy, to take delivery from off-shore bunker barges, operated from outside the EU. An EU fuel levy would also incentivise vessels to use bunker ports outside but adjacent to the EU:

“...all ships would start to bunker elsewhere—the market would be as swift as lightening then” [shipping industry representative].

“Ships in the Mediterranean, for example, they would bunker in Turkey, they would bunker in North Africa [...]. Russian Baltic ports could cash in on it” [oil industry representative].

An analogous geographical shift in bunkering trade was documented in 1992, when bunker fuel sales in the ports of Los Angeles and Long Beach were said to have fallen by 60% following the introduction of an 8.25% sales tax on bunker fuels in California in 1991 [44].

It is also the case that a number of the enforcement problems associated with an ETS are also found with fuel levy schemes. Thus, just as some governments are opposed to hypothecation of revenues, so some governments are also opposed to international taxation. Ship operators may suspect that, if governments are in receipt of the levy revenues, then the revenue may be used for other purposes as part of general taxation revenues. And, once again, the crucial document in respect of bunker purchases is the BDN, with exactly the same problems of readability and of vulnerability to fraud and forgery.

One arguable advantage of a levy over an ETS is that, as one interviewee put it, “the flag-State has nothing to do with it”. But enforcement of fuel levy regulations would pose considerable problems for Port State Control. The IMO expert group, commenting on candidate schemes for market-based measures, was clear that Port State Control Officers would need to check for fraudulent under-reporting of fuel purchases on the BDNs, by comparing the BDNs with the ship’s Oil Record book and the ship’s log “which may require additional appropriate training for Port State Control Officers and additional inspection time to undertake” ([2], p. 55). As in all Port State Control work, not all berthing vessels would be inspected, and not all of those inspected would be subject to checks on the fuel levy payments. And in some parts of the world such additional checking work could lead to extortion or bribery.

5. Conclusions

First of all, a couple of disclaimers: it is not being suggested that choices over market-based measures to reduce shipping's carbon footprint should be based wholly on the relative enforcement problems associated with the different schemes. Nor is it being suggested that a particular market-based measure would necessarily be ineffective in its goal of climate change mitigation if its operations were associated with a certain amount of carbon "leakage".

It seems clear that a focus on the enforcement aspect of governance does suggest that some of the candidate schemes being proposed face insuperable practical difficulties. Many of these arise because the fragmented nature of the sector makes for difficulties in effective governance. Beyond the particular issue of controlling ships' carbon emissions, there is also a broader lesson to be drawn on the continuing importance of the sovereign State in the enforcement of supra-national regulations. The maritime sector is far from immune to governance failures [45] and our findings confirm Jessop's view that governance failure is pervasive if it is based wholly on market forces [46].

To be sure, some port-States are too poorly resourced (and are too open to bribery/extortion) to fulfil their obligations, but these are not the port-States where international trade is concentrated. Just as the burden of enforcing the new regulations on ships' sulphur emissions has fallen on Port State Control [41], so also most of the proposals for market-based measures to control ships' carbon emissions rely on Port State Control. This also acknowledges that markets do not in practice replace but *co-mingle* with traditional, hierarchical governance [47]. In the case of a global ETS where a vessel's carbon account was only required to be balanced annually, then the main policing function would fall to classification societies and Port State Control's function would be limited to checking that the vessel's classification society certificate had not expired. But in the case of a global fuel levy, and in the case of an EU ETS, a very large enforcement burden would fall on Port State Control. It is timely to recall this critical enforcement role for sovereign States at a time when the enforcement agencies of many those sovereign States are facing cuts in resources.

Yet there is a paradox here. A global ETS could hardly operate successfully if carbon credit allocations were in the hands of 170 flag-States, rather than a single central authority: unscrupulous operators would migrate to lax administrations, and those multiple individual administrations would also present irresistible targets for phishing attacks by hackers. While the sector's failure to self-regulate justifies giving strong regulatory powers to agencies responsible for protecting the public interest [48], flag-State Control is, as Lord Donaldson [49] put it, "a broken reed". Mongolia, 850 miles from the sea has granted a license to a Singaporean businessman to operate the Mongolian Ship Registry, the same businessman whose license to operate the Cambodian Registry was eventually withdrawn following international protests at Cambodia failure to police its ships [50]. The failure of Flag-State Control has led, following a series of disastrous marine pollution incidents, to the re-assertion of sovereign State oversight via the inauguration of Port State Control, whereby individual port-States coordinate their efforts to enforce international regulations on all berthing ships in their ports, regardless of flag. While we argue that meta-governance through the sovereign state is important here, the sector provides a clear example of the need to strengthen governance capacity across multiple scales. This includes not just within enforcement agents operating as "street level bureaucrats", but upwards to the EU and

international levels. Strengthened capacity could be achieved for example by a common training programmes for Port State Control Officers on ETS enforcement by the Paris MoU.

Strengthening these multi-level interdependencies help ensure effective governance of the shipping sector, as is increasingly the case in other sectors [47]. This acknowledges that, as globalization and Europeanization contribute to the changing context of state policymaking [51], governance has become less a process of top-down steering from the centre, and more an interactive process involving multiple actors and levels, that sees displacement of political and institutional policy capacity *downwards* in the political system, *outwards* to agencies and networks and *upwards* to trans-national institutional systems such as the EU and the UN [52].

Port State Control has only been able to redress the failures of Flag State Control by elaborate collaboration between sovereign port-States: European port-States operate a common inspection methodology, a common system of penalties, and a common targeting methodology, overseen by the supra-national office of the Paris Memorandum of Understanding (MoU) on Port State Control; the countries of the Pacific Rim are similarly overseen by the office of the Tokyo MoU. A regional EU fuel levy would be subject to widespread avoidance (and associated bunker market distortion) through recourse to bunker facilities outside the EU and potential recourse to off-shore bunker barges operating from outside the EU. In the absence of close international collaboration in the governance of the shipping sector across higher scales of governance, international trade would be seriously disrupted as some vessels were repeatedly inspected and others were repeatedly missed, as operators found themselves subject to different inspection systems across different ports, and as incentives to conformity were eroded by uncertainties about the penalties for regulatory avoidance.

With IMO lacking the capacity to act as an enforcement agency and the continuing fragmentation implicit in a polycentric governance structure, it is essential that international regulations to mitigate the shipping industry's contribution to climate change are framed with due regard to the particular enforcement challenges that would be associated with any projected regulatory change. Good global governance for the shipping industry may be a chimera, but adequate global governance will require attention to mechanisms of enforcement across all governance scale, as well as a comprehensive regulatory framework.

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Authors Contributions

Bloor took responsibility for the UK field work, data analysis and initial write up. Baker took responsibility for the analytical framework and the production of the paper for publication; Sampson provided comments and input on drafts; Dahlgren took responsibility for the Swedish field work and data presentation.

Conflicts of Interest

The authors declare no conflict of interest.

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