An Assessment of the Contribution of Shippers to the Decarbonisation of Deep-Sea Container Supply Chains

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Abstract:

This paper summarises the results of an interview survey of large shippers which enquired about their possible role in reducing carbon emissions from global supply chains containing a deep-sea container movement. It focuses on four 'decarbonisation' parameters that they can influence: channel structure, container fill, backloading of empty containers and logistical adaptation to slow steaming. Numerous examples were found of companies applying efficiency measures which cut carbon emissions as well as cost.

Key words: deep-sea container shipping, global supply chains, shippers, carbon emissions

1. Introduction

This paper is one of a series examining the role of shippers in efforts to reduce the level of carbon emissions from the movement of international trade in containers. Until recently their role in the process was largely neglected as attention focused on the design and operation of ships (e.g. AEA Technology, 2008; Bauhaug et al, 2009). This is understandable as in most deep-sea container supply chains the vessel is by far the largest source of CO_2 emissions. The shipper (or cargo owner) can, nevertheless, exert some leverage on total emissions from the maritime supply chain. The research project on which this paper is based has assessed the nature and scale of this leverage within a 'decarbonisation framework' built around a series of key parameters (Woolford and McKinnon, 2011). Altering these parameters can decouple carbon emissions from the volume of containerised trade.

Previous papers have reviewed the relevant literature on this subject (Woolford and McKinnon, 2011), reported the results of an online questionnaire survey (McKinnon, 2012) and explored the effect of shippers' port-centric logistics (PCL) strategies on carbon emissions (McKinnon and Woolford, 2011). This one discusses the provisional results of a set of interviews with senior logistics executives in a mixed sample of ten large manufacturers, retailers and distributors which make heavy use of deep-sea container services. The semi-structured interviews have provided a deeper insight into the decisions shippers make which affect the level of carbon emissions from their maritime supply chains. These decisions relate to the seven parameters in the decarbonisation framework:

1. Choice of transport mode for port feeder and transcontinental container movements
2. Choice of carrier for hinterland transport and deep-sea container service
3. Average number of links in the maritime supply chain
4. Average length of links in the chain
5. Average container loading
6. Repositioning of empty containers
7. Energy efficiency of the container supply chain

Because of space limitations, this paper will focus on decisions relating to parameters 4 -7. Parameters 4 and 5 are combined as they are essentially structural variables determining the overall configuration of the deep-sea container supply chain. To what extent can shippers restructure the chain to reduce its carbon intensity? The fifth parameter, container fill, can be either directly or indirectly influenced by the shipper. The sixth, involving the movement of empty containers, is more the responsibility of other agencies but can create backloading opportunities for shippers. The seventh parameter, energy efficiency, is strongly correlated with the speed of container movement, particularly on the deep-sea leg. Although shippers are not the instigators of 'slow-steaming' its acceptability and longer term sustainability depends on shippers adapting their global production and distribution systems to significantly longer transit times.

The interview survey has shed light on the ability of shippers to manipulate these key parameters, the factors constraining their actions and evidence of initiatives that have cut carbon emissions, even if that has not been their prime objective.

2. Restructuring the Deep-sea Container Supply Chain

2.1 *Number of links in the chain*: Figures 1 and 2 show the range of channel structures for containerised imports and exports used by the companies surveyed. In each case the channel extends from a point of production to a customer's premises, in many cases a retail outlet. The nodes perform production, storage and / or goods handling functions. (Intermodal terminals have been excluded from these diagrams.) Altogether there are eight possible supply chain configurations comprising between three and six links. The thickness of the lines indicate the relative use of the different channels based on qualitative assessment made by the managers interviewed. It shows that the majority of containerised trade flows through channels with four links. Reducing the average number of links and thereby streamlining the maritime supply chain might, superficially, be considered a carbon-reducing strategy. Since the start and end points in the chain can be regarded as fixed, reducing the number of links entails eliminating or co-locating intermediate storage, consolidation or container stuffing / de-stuffing points.

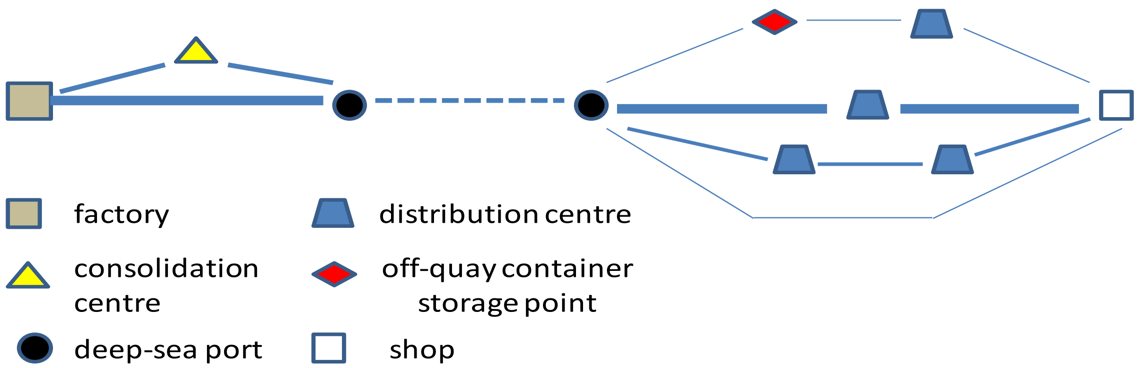

Figure 1: Possible channel structures for the door-to-door movement of containerised trade.

The interviews revealed that cutting the number of nodes and links in the chain could be counter-productive. The addition of a node to the chain can be justified in carbon, and financial terms, where it increases the degree of load consolidation and hence container fill. Although this adds an extra freight journey, usually increasing the total distance travelled by the products, the total number of container movements and total container-kms can be significantly reduced. The retailers in the survey reported that the proportion of imported product being channelled through separate consolidation centre in foreign markets had been increasing, though sometimes from a low base. One major UK retailer had increased this proportion from 3% to 9% over the past 4 years. These consolidation operations are generally organised by freight forwarders or logistics providers and paid for by the suppliers as the FOB or FCA terms on which the retailers purchase the goods exclude responsibility for logistics within the foreign market. Major exporters in the automotive, food and industrial products sectors routinely use consolidation centres to bring together output from several plants partly to improve container fill but also to be able to provide internal and external customers with mixed orders. Deconsolidation centres are sometimes used in the destination market to reverse the consolidation process and fulfil a similarly beneficial function in financial and carbon terms. Large retailers with several distribution centres (DCs) in the UK have also been concentrating inventories of imported goods at fewer locations and, in some cases, dedicated 'import centres'. This not only increases inbound consolidation opportunities; it can also reduce the need to cross-ship imported goods between DCs thereby removing a link from the chain.

Among the companies surveyed, little use was made of ‘off-quay container storage’ facilities where containers are held for a few days or weeks, usually prior to their inbound delivery to a DC. Demand for such storage tends to be seasonal and arises in the monthly leading up to Christmas. Two of the major container storage sites in the UK are located close to the direct route between the country’s largest deep-sea container ports and the main geographical concentration of retail DCs.

Only one instance was found of a retailer delivering container loads of imported goods directly to shops, thus bypassing the DC. Only 3% of its annual volume of deep-sea containerised imports moved directly to store. This only occurred on the weeks prior to Christmas and applied to a range of Christmas merchandise sold in sufficient volumes to permit direct containerised distribution to shops. In moving to this form of direct shipment, the retailer had to sacrifice some container fill. Health and safety regulations at shop level restricted load height to 1.9 metres, 25% lower than the normal load height of 2.5 metres. For other retailers the inability of shop reception facilities to handle containers precluded direct shipment from the port.

The average number of links in the chain is also being reduced by the co-location of activities**.** The main example of this trend is the development of port-centric logistics (PCL), where companies base distribution centres (or production facilities) at ports (Mangan and Lalwani, 2008). The effects of PCL on carbon emissions from maritime logistics operations are discussed in an earlier paper (McKinnon and Woolford, 2011). The discussion here will be confined to new insights on the subject gained from the interview survey. None of the companies surveyed had adopted a PCL model. One large retailer is planning to open a DC at a UK port, while two others have investigated the PCL option and decided it is not appropriate given their current configuration of their UK logistics system. Reasons offered for rejecting this option included:

- It would entail supplying the retail chain from an off-centre, and hence less efficient, location. If a DC stored and handled only deep-sea imports, a port-based location might be acceptable. For companies combining inventory sourced from deep-sea markets with that originating in the UK and EU had a preference for more central DC locations.
- Establishing a DC at a particular port would commit the retailer on a longer term basis to using shipping lines calling there. These shipping lines might also switch services to another port. The related risks and loss of flexibility were considered major disadvantages.
- For low-density, loose-packed product, de-stuffing the container at the port, palletising the loads and transferring them to articulated trucks significantly increased the number of trips, raising transport costs and carbon emissions.

In summary, the most pronounced trends observed were (i) the growth in the proportion of retail imports passing through consolidation centres in the countries of origin and (ii) the concentration of inbound containers at a smaller number DCs in the destination countries . Although (i) adds a node and link to the chain, it helps to cut carbon emissions. PCL and direct shipment to stores can also cut carbon emissions but there was little evidence of either across the sample of companies interviewed.

2.2 Average length of the supply chain link: Shippers have no control over the length of the maritime leg, but can influence the distance that their imports and exports travel within the port hinterland. The main determinants of this distance are the choice of deep-sea port and locations of any intermediate storage, handling or intermodal transfer points used.

All the respondents confirmed that port choice was dictated by the choice of shipping line and that proximity to port was of relatively minor importance in this latter selection. Interview responses confirmed the results of previous research that the choice of deep-sea operator is dominated by service frequency, transit times, reliability and freight rates (Kent and Parker, 1999). Port specialisation by trade-lane also limits a shipper’s options. Only two instances were reported of companies switching traffic to a nearer port, which, although done primarily for economic reasons, would have yielded a carbon saving. One retailer diverted containerised imports of a heavy class of product from Felixstowe to Portbury to reduce the distance to the DC from 181 km to 47 km, cutting road transport costs by approximately 60%. A global distributor of wines and spirits switched some of its inbound container movements from Rotterdam to Tilbury, eliminating a North Sea feeder movement and trunking them by rail from Tilbury to a major bottling plant in the south west of England,.

This latter example highlights the inter-relationship between length of haul and modal split within port hinterlands. The greater the distance to the port the more competitive become lower-carbon alternatives to road haulage i.e. rail and water-borne services. Total emissions from a long haul by rail to a distant port can be lower than a short haul by road to a nearby port. In the UK, for example, where the carbon intensity of container transport by rail is roughly 3-4 times lower than that by road (DEFRA / DECC, 2011) a rail-served port could be 3-4 times further away than a local one served by road with little net increase in hinterland transport emissions. It is important therefore to analyse the trade-offs between length of haul and modal split when assessing the carbon intensity of hinterland transport options.

3. Improving Container Utilisation

Container fill can be measured relative to three maxima: maximum permitted weight of the container, maximum floor area covered (also known as 'load length) and maximum cubic capacity. The choice of utilisation metric depends on the density and stackability of the product. Shipping lines, ports and logistics providers can monitor the proportion of containers 'weighing out', but only shippers and their suppliers and customers can know the extent to which containers 'cube out' or 'floor out'. All the interviewees stated that deep-sea containers moving to and / or from their companies' premises were very well utilised. Container utilisation directly influences deep-sea transport costs and managers were under intense pressure to minimise these costs. As one manager explained, 'container fill has a very direct, tangible cost impact'. Although the main driver for improving container fill is unquestionably cost, corporate environmental objectives reinforce efforts to raise average fill rates.

All the companies claimed to attach high priority to the maximisation of container loading and closely monitor the average level of fill. Fill is measured in various ways. All the exporters and most of the importers had access to consignment manifest data on the weight and cubic dimensions of the load. Export data was assumed to be accurate. Data on inbound loads was provided by foreign suppliers and could be subject to inaccurate measurement. One major retailer had measured the sizes of a large sample of imported cases and found only a small discrepancy with the supplier quoted figures (on average within 4-5%). Dividing the actual size and/or weight load of a container load by the maxima yielded a utilisation percentage. Several companies supplemented this computerised measurement with photos taken at various stages in the container load building process. Some of the exporters in the sample used software packages to improve space utilisation in their containers.

Two major UK retailers were prepared to provide data on fill rates for inbound containers, mainly from the Far East. One of these companies' inbound containers carry an average of 53 cubic metres of product. The vast majority of these containers are standard 40ft boxes with a maximum cube of 67 cubic metres, suggesting an average fill rate of 79%. This average fill rate was distorted, however, by the arrival of a significant proportion of the company's imports in 20ft, 40ft high cube and 45ft containers. It was also depressed by a small percentage of containers which 'weighed out' before the cube limit was reached. Excluding these containers from the calculation raised the average volume per container by 6% to 56 cu metres. The other company quoted average utilisation rates for the different sizes of container it received (Table 1), in all cases very high.

Table 1: Average container fill in different sizes of inbound container: *major UK retailer*

Container dimensions	maximum cubic capacity (m^3)	actual load cube(m^3)	% fill
Standard 40ft	67	58	86.6
High-cube 40ft	76	65	85.5
High-cube 45ft	86	82	95.3

In examining the opportunities for improving container loading and the related constraints, it is important to make two distinctions: between (a) internal company movements and external supply chain links and (b) inbound from outbound flows.

(a) The sample included three global manufacturers which use deep-sea container services to transfer products between their own plants and warehouses around the world. Although their regional and national production and sales operations have a high degree of autonomy, efforts are made to co-ordinate deep-sea container movements to minimise cost. One global food company, for example, had a policy of distributing factory output to its sales organisations in 'deep-sea' markets in full-loads. The foreign sales offices, which are normally responsible for the transport costs, have to approve the despatch of containers that fail to meet this requirement. Companies can exert more control over the loading of containers on these internal transfers than on movements to and from external suppliers and customers.

(b) Generally speaking, exporters exert greater influence on container fill than importers as they directly load them. They are still constrained, however, by the ordering practices of their overseas customers, which affect the total size, composition and scheduling of orders. Most companies have 'business protocols' and / or pricing policies which promote the full loading of outbound containers, though these are sometimes relaxed by sales staff in an effort to maximise foreign revenue, particularly during periods of recession. Large importers, on the other hand, can exert substantial indirect influence on the loading of their inbound containers. The retailers consulted source their inbound supplies on an FOB- or FCA-foreign port basis, thereby incurring the cost of the deep-sea movement and having a strong incentive to minimise the number of containers shipped per £1 million of imports. They indirectly influence container loading in several ways:

(i) Buying in container-load quantities: one of the largest UK retail importers of containerised goods gives its buyers data on the cube of the orders they place, effectively translating their orders from particular suppliers into container loads. Although their buying decisions are still driven largely by merchandising and inventory considerations, they are made aware of their implications for container flows and transport costs. Another retailer gave its buyers a target of achieving 95% fill on inbound deep-sea containers.

(ii) Consolidating less than container (LCL) loads in foreign markets: This is now a common practice among major retailers and generally involves channelling LCL orders through consolidation centres either *en route* to the port or at the port. One UK retailer now channels a third of its inbound supplies from India and 9% of its Chinese purchases through consolidation centres operated by logistics providers to improve container fill.

(iii) Centralising the reception of inbound goods from a particular foreign supplier or consolidation centre: One of the retailers currently receives containerised imports into three DCs, but if it concentrates inbound container flows at a single DC, as currently planned, it will achieve a much higher degree of load consolidation.

(iv) Specifying more space-efficiency forms of handling equipment: larger importers can exert more control over the type of transport packaging used, for example, getting suppliers to substitute slip-sheets for wooden pallets. A large proportion of the inbound containers carrying retail supplies from less developed countries, however, are 'loose loaded'. This can improve load fill in two ways: first by minimising the space used by unitised handling equipment (pallets etc) and, second, by packing goods more effectively into the available space. Several firms commented on the fact that low labour costs in emerging markets, relative to the costs of container shipping and handling, made it economical for suppliers based there to deploy large amounts of manual labour to 'hand-ball' goods and thereby maximise space utilisation. They also reported high levels of skill in the packing of containers, particularly with bulky, oddly-shaped products such as furniture. One manager claimed that the company's Chinese suppliers had 'got this down to a fine art'.

Two particular examples were found of importers achieving substantial improvements in container fill by radically altering the packaging of inbound consignments:

Garments: these products can be moved in three ways: boxed, hanging and vacuum-packed. Vacuum-packing is the most space-efficient, though the retailers importing garments currently receive very few in this form. It is considered to have an adverse effect on product quality and incurs additional unpacking and product preparation costs. It was also suggested that on a life-cycle basis the net carbon savings of vacuum-packing might be small once allowance was made for energy use in manufacture and disposal of the plastic packaging, the packing process, the unpacking and the restoration of the garment to its original condition. For the retailers consulted, the choice was essentially between the boxing and hanging of garments, with the latter offering significantly better cube utilisation. For three of the UK's major high-street clothing retailers the proportions of imported containerised garments arriving in hanging form were 33%, 20% and 8%, the differences partly reflecting variations in product mix and quality. The boxed : hanging ratios appear to be fairly stable at present. One retailer reported that buyers and merchandisers generally prefer the hanging garment option and this makes it difficult for inbound logistics managers to raise the boxed proportion.

Wine: The distribution of wine by deep-sea container vessel has recently undergone a major change which has greatly improved capacity utilisation and cut CO_2 emissions. This has involved the application of the so-called 'postponement principle' (van Hoek et al, 1988). Traditionally almost all wine was bottled near the point of production and the bottles shipped in cases. Today between 20-30% of wine is moved in bulk liquid form in iso-tank containers to the import markets where it is bottled close to the point of sale. The proportion of New World wine exported in bulk form has risen from 23% in 2001 to 43% in 2010 (Rabobank, 2011). Moving the wine in bulk increases the amount of product carried per unit of container space by a factor of roughly 2.0-2.5. The resulting carbon savings are not directly proportional to these improvements in cube utilisation, but they are still large. It has been estimated that 'shipping wine from Australia in bulk reduces CO2 emissions by 164g for each 75cl bottle, or approximately 40% when compared to bottling at source' (Waste Resources Action Programme, 2011 p.2). The pronounced trend to bulk distribution of wine has not been environmentally motivated. It is driven much more by the desire to cut costs and by the growth of retailer branding of wine, but the resulting CO_2 savings from the deep-sea container supply chain are an important secondary benefit.

Of the companies in the interview survey only those distributing wine and spirits moved container loads which normally weighed-out on 40 foot containers. In most cases the weight limit was imposed by the maximum weight carrying capacity of trucks. Even where the trunk haul to the port was by rail and subject to a higher weight limit, road feeder movements were required move containers to / from bottling plants or DCs making the truck limit a binding constraint. Raising the maximum weight limit of trucks would offer only limited consolidation opportunities, as many of the loads of drinks products also close to 'flooring out'.

One food manufacture currently mixes high and low density products in the same container to simultaneously maximise weight and cube utilisation. Another company producing a range of industrial products is exploring opportunities for doing the same. Much of its container traffic takes the form of internal transfers among in plants and distribution centres, giving it a large degree of control over these flows. It is therefore in a favourable position to exploit this 'mixed density loading'. It is not known how many other large users of deep-sea container services have this option and what carbon savings would accrue from its exploitation.

4. Backloading of Empty Containers

It has been estimated that in 2009 approximately 50 million TEUs moved empty in deep-sea vessels (UNCTAD, 2011). The majority of these containers will also have moved empty within the hinterlands of the deep-sea ports. Very few government statistics exist on the domestic movement of empty containers, though UNCTAD (2011) estimates that in 2009 it cost around $10 billion globally to move empty containers overland to and from ports. The associated emissions of CO_2 are also likely to be huge, though it appears that these have not yet been quantified. Almost all of the academic research on the empty movement of containers views the subject from the perspective of the shipping lines or transport companies working on their behalf (e.g. Ng, 2012; Song and Xu, 2012). This is to be expected as shipping lines own roughly 57% of deep-sea container capacity and control its movement (UNCTAD, 2011). There are, however, several ways in which shippers can influence the proportion of container-kms travelled empty, mainly within the port hinterland. The interview survey enquired about shippers' efforts to backload empty containers. Examples were found of two forms of backloading:

(i) *Backloading of inbound containers with exports originating from the same premises*: two companies, a large food and drink producer and a manufacturer of a broad range of industrial and consumer products were able to generate containerised backloads from within their own production and distribution networks. In the former case, this practice was quite rare, while, in the latter case, it was more common though confined to a few locations and backloaded only a small % of the inbound containers. The industrial consultation identified numerous constraints on this form of container backloading:

1. Use of different shipping lines for the inbound and outbound movements that are not prepared to exchange containers.
2. Inbound container may not be the right size and type to handle the export consignment.
3. For containers handling food products, there are concerns about possible cross-contamination. Shipping lines have responsibility for providing containers that are 'clean, dry and odour-free' for food movement and so, given this liability, prefer to control the supply of empty boxes for export loads.
4. It can be difficult to synchronise the inbound and outbound schedules, particularly as shippers are given only a short demurrage-free period in which to return the empty container.
5. The terms of trade (Incoterms) on which the imports and exports are bought and sold may be misaligned. For example, the imported goods may be purchased on a delivered price (DPP) basis and the foreign supplier responsible for the inbound movement not interested in the subsequent use of the container
6. Existence of an internal 'silo' structure within the shipper organisation. The procurement and inbound logistics departments, on the one hand, and the export department, on the other, typically have separate budgets, procedures and management priorities and thus seldom co-ordinate their container operations.

Most of these constraints are organisational and could be relaxed if businesses in the deep-sea container supply chain were prepared to modify internal processes and external working arrangements. It is likely, however, that only a small proportion of factories and warehouses offer any potential for container backloading.

(ii) Backloading the container with a domestic load bound for premises on the route back to the port: Examples of this practice were found among large retailers in the sample. One of them has recently begun to use empty containers to distribute supplies to shops on the return route to the port (the so-called 'restitution leg'). Another retailer has used empty containers to move stock between warehouses, while a third is planning to do so. Neither of these retailers see any prospect of using containers for store delivery. All three companies employ their own hauliers / vehicles to move containers to and from the ports (so-called 'merchant haulage' option) rather than entrust this hinterland transport to the shipping line ('carrier haulage' option). This gives them more control over the return journey and, as they are already paying for it, have an incentive to use it for internal inventory transfers. If the carbon emissions from these containerised deliveries are allocated to the companies' domestic carbon footprints, total emissions from the deep-sea container supply chain are correspondingly reduced. There are nevertheless several constraints on this type of shipper-led backloading:

1. Organising the store delivery within the demurrage-free period can be difficult given shop replenishment cycles and the limited range of products than can be carried in a container.

2. Inability of ISO containers to accommodate as many of the handling units used in retail logistics, particularly roll cages, as the box trailer of a conventional articulated truck.

3. Reception facilities at the rear of shops are unsuited to the handling of containerised loads. Indeed, one of the two retailers that have been backloading containers with shop supplies has recently discontinued the practice mainly because of this incompatibility problem.

All of the managers considered the repositioning of empty containers within the port hinterland to be one of the largest potential sources of carbon savings in the maritime supply chain. Those employing merchant haulage had 'visibility' of the movement of empty containers and claimed that the 'restitution' of empty boxes generally involved returning them to the deep-sea port. There was limited evidence of empty containers being routed via export locations to take advantage of 'triangulation' opportunities. Instead, exporters typically receive their empty boxes from the port, generating a separate two-way trip. There was a consensus among the interviewees that more could be done to rationalise the movement of empty containers across the port hinterland. They conceded, however, that there was little that they, as shippers, could do to achieve this and argued that this was mainly the responsibility of shipping lines, freight forwarders and haulage companies. Moreover, at present they have little incentive to cut the level of empty container movement and related CO_2 emissions.

5. Logistical Adaptation to Slow Steaming

The largest source of carbon savings in deep-sea container supply chains over the past few years has been the reduction in vessel speed by an average of 20-30% Cariou (2011) has estimated that as a result of so-called 'slow steaming' CO_2 emissions from deep-sea container shipping were approximately 11% lower in 2010 than would otherwise have been the case. This practice was implemented by container shipping lines to economise on fuel during a period of steeply rising fuel prices and deepening global recession. Although primarily a response to economic pressures, slow steaming has proved to be an effective carbon reduction measure. Shippers have had a passive rather than active role in its implementation. The interview survey enquired about their role and the changes they have had to make to their global logistics systems to accommodate longer maritime transit times.

All of the companies, without exception, reported that they had been able to adapt their systems to slow steaming with little disruption or additional cost. Managers claimed that 'they had been able to live with it', it had 'little or no impact on the inbound leg' and 'did not create an operational issue'. One large retailer explained that only 10% of its deep-sea imports were 'time-critical' and required some adjustment to internal processes. Another compiled data on average transit times on particular trade lanes on a three-monthly basis and entered it into the company's enterprise resource planning (ERP) system to give buyers and merchandisers advice on likely inbound lead-times. They had modified their ordering accordingly. As they were often placing overseas orders 3-6 months ahead, an extra 3-4 days on sea transits from the Far East had minimal effect. Several importers indicated that the keys to dealing with slow steaming were visibility of inbound container flow and prioritising the hinterland movement and reception of more time-sensitive orders. Two exporters claimed that they had adjusted production planning to take account of longer transit times on particular routes. Some shippers referred to other developments which have occurred in recent years to mitigate the effects of slow steaming. For example, one had increased its relative use of direct deep-sea services to the UK (replacing indirect movements via Rotterdam) saving ten days on door-to-door transit times and more than offsetting slow-steaming delays. Another company had detected a reduction in queuing at deep-sea ports, partly because of the decline in traffic volumes during the recession but also due the addition of more capacity. Two companies argued that slow-steaming had been associated with an improvement in service reliability, possibly explained by shipping lines have more slack in their schedules to make up lost time, though this was disputed by large automotive company which had experienced worsening service reliability on some of its major trade lanes.

Overall, very little reference was made to slow steaming adversely affecting product availability. On the contrary, two of the retailers and two major food and drink manufacturers that are heavily dependent on deep-sea container flows claimed that their levels of availability and customer service had significantly improved in recent years, despite slow steaming. This, of course, may have been at the expense of additional inventory in their global supply chains. All the companies acknowledged that the amount of inventory onboard slow-steaming vessels had increased. One retailer had quantified this at around 0.25% of inventory costs for its imported merchandise. Another noted that during the current period of low interest rates, the extra inventory financing costs are low. There is evidence too that the re-engineering of inbound processes, which has been partly induced by slow-steaming, has reduced inventory levels in other parts of the deep-sea container supply chain, offsetting the increase onboard the deep-sea vessels. On the other hand, no evidence was found of shippers compensating for the lengthening of maritime transit times by switching to faster, more carbon-intensive transport modes within port hinterlands. On the contrary, according to one company, slow steaming had facilitated its use of rail by improving the reliability of inbound container flows through the deep-sea ports.

The prevailing view of the shippers consulted was that the net effect of slow steaming on global logistics costs and profitability has been very small. There was also a general consensus that this practice would continue for the foreseeable future. This reaction by shippers to slow steaming was not necessarily predictable. Given the strength of companies' commitment to just-in-time, short order lead times and inventory minimisation, one might have anticipated much more resistance by shippers to slow steaming and greater willingness to pay higher freight rates to maintain previous vessel speeds and transit times. In terms of carbon reduction, the ease with which many shippers have been able to adapt their global logistics systems to a 20-30% reduction in deep-sea vessel speed is very encouraging, particularly as there do not seem to have been any major second order effects offsetting the carbon savings.

6. Conclusions

This paper has presented the provisional results of an interview survey of senior managers in ten companies that generate between 5,000 and 100,000 deep-sea container movements per anum. It provides further evidence that shippers can exert a significant influence on the carbon intensity of their deep-sea container supply chains. Space limitations have confined the discussion to their influence on four key 'decarbonisation' parameters: channel structure, container fill, backloading of empty containers and logistical adaptation to slow steaming. Their impact on three other parameters, freight modal split and their choice of hinterland and deep-sea carriers, will be examined in a future paper and shown to reinforce the beneficial carbon-reduction effects outlined in this paper.

The adoption of the numerous measures discussed in this paper is motivated primarily, and in many cases entirely, by a desire to cut cost. The related reduction in carbon emissions is a useful side-effect for which many companies like to claim environmental credit. No instances were found of companies incurring additional cost or sacrificing profitability to reduce the carbon footprint of their deep-sea container supply chains. Most of the companies consulted, however, have made a corporate commitment to cut their carbon emissions and, given the Incoterms on which they trade, this invariably applies to most if not all of their global supply chains. Pressure to comply with future climate change policies may force shippers to give greater priority to carbon reduction in their management of these chains.

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