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Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development **25-Apr-2008**

English - Or. English

TRADE AND AGRICULTURE DIRECTORATE
TRADE COMMITTEE

TAD/TC/WP(2008)10
For Official Use

Working Party of the Trade Committee

CLARIFYING TRADE COSTS IN MARITIME TRANSPORT

17-18 June 2008

Purpose of paper and action required: This initial paper informs Delegations on the newly compiled OECD Maritime Transport Cost database and includes an initial analysis of the data. It is submitted to Delegates for discussion, with a view to its extension to a fuller analysis of maritime transport costs and their impact on trade.

Timing: This paper will be revised taking account of comments and submitted for declassification. On this basis, a second stage of this analysis looking more widely at maritime transport costs and their effects on trade on the one hand, and the impact of different components of maritime transport costs on variations in those costs on the other, will be presented to the Working Party of the Trade Committee in Fall 2008.
On the basis of the present paper, a scoping note is also under preparation for the meeting of the Joint Working Party on Agriculture and Trade on 19 May, proposing to examine maritime transport costs and their effects on trade in agricultural goods. If approved, the study foreseen in that scoping note will be presented to the JWP in October 2008.

Link to the programme of work and resource implications: This paper responds to PWB output result 3.1.1.3.3 under Advocacy for Freer Trade and has been carried out with the designated resources under Part I of the budget.

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JT03244797

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EXECUTIVE SUMMARY

This project aims to improve understanding of the factors contributing to trade costs by examining costs in the area of maritime transport and their impact on trade. The present paper represents the first part of this project: it describes the maritime transport sector and some of the determinants of shipping costs, and outlines some of the findings from an extensive new database compiled on maritime transport rates. This information shall be used in a second paper which will have a two-fold objective: i) To examine the impact of transport costs on trade, and ii) To examine the impact of different components of transport costs on the level of these costs.

Maritime transport matters. Ninety percent of world trade by volume is carried by ship. Maritime traffic in 2007 was almost double its 2003 level. Operation of merchant ships now generates an estimated annual income approaching US$ 380 billion, equivalent to about five percent of total world trade.

There are a number of clearly-defined determinants of maritime transport costs. The most studied is distance from major markets. Recent evidence suggests that distance is imperfectly correlated with transport costs: their relationship seems to be non-linear and is influenced by many factors. A more closely correlated component of transport costs is the time spent getting goods to market. Other components of maritime costs that are less widely studied and understood are trade imbalances, volume of trade, port infrastructure, competition among shippers and risk. Rising fuel prices are also a determinant of shipping rates, and a particularly important one in recent years. Many of the determinants of shipping rates are intertwined and their combined effect on transport costs is complex.

In order to analyse evolutions in the maritime transport sector and the impact of transport costs on trade, a database has been compiled from a variety of sources. This is the most comprehensive dataset on maritime transport rates known to date and includes original customs data as available and detailed data estimated from shippers' actual rates. The data set now compiled includes 2.9 million data points for products at the HS-6 digit level for 20 importing countries from all 218 countries of the world from 1991 to 2006.

At this stage, a number of insights can be gleaned from the dataset.

- Maritime transport rates have fallen only slightly overall in the last 2-1/2 decades despite the vast changes in the technological and competitive environments. The picture varies however in the different market segments of maritime transport costs and by country.

- It costs more to ship to developing countries than to developed countries – eight percent of the price of final goods in developing countries as opposed to five percent overall for developed countries. A small number of countries, mostly remote nations with very small markets, face such high transport costs to reach their markets that they represent a significant drag on most exports.

- For most countries, the cost of hauling a container has dropped. The cost of sending a container to China has fallen particularly rapidly – on average by nine percent per year over the last 15 years. The cost of shipping manufactures and processed agricultural products is between one and seven percent ad valorem on average for the countries in the dataset.

- The cost of shipping grains is large for all countries in the dataset. On average, maritime transport costs equal 10-20 percent ad valorem for bulk agricultural products. For some countries, transport of these products reaches 23 percent. This may be compounded by an additional overland cost of transport which is not included in the dataset. In addition, since many of these products are already subject to significant tariffs, the transport cost of these products further increases potential barriers to trade.

- One reason for the high cost of shipping grains and other bulk agricultural commodities is the increase in demand for bulk carriers to transport industrial raw materials to China and South-East Asia. Smaller bulk ships traditionally used to transport grains have been reserved to haul ores, coal and other industrial products for which there is a constantly growing demand in Asia.

- One of the most unusual aspects of the shipping industry is the importance of trade cost asymmetries. Particularly for the container market, the cost of eastbound vs. westbound routes or northbound vs. southbound legs of routes differ on average by 100 percent. It is therefore twice as expensive to ship a container one-way on any given route compared to the return trip. Part of the asymmetry in transport costs can be attributed to differences in the volume of goods transported in containers. This phenomenon is not likely to disappear as the freight rate imbalances between eastbound and westbound legs of shipping routes have increased in 2007 over 2006 on almost all routes, sometimes very significantly.

- Although the above would suggest that distance is of limited importance as a component of transport costs, it may become more significant in future. With the rising price of oil, one of the important variable components of transport costs is increasing. Since the fuel cost component of transport costs is directly correlated with distance, maritime transport costs may in turn become more closely correlated with distance in future.

The findings of this paper will be used in the next stage to ascertain more fully the impact of maritime transport costs on trade flows. This will shed light on the importance and evolution of this trade cost and also call into question some of the methodology used in gravity models to simulate the effects of policy phenomena on trade.

Glossary and List of Abbreviations

Backhaul: To haul a shipment back over part of a route which it has already traveled; a marine transportation carrier's return movement of cargo, usually opposite from the direction of its primary cargo distribution.

Bulk cargo: Loose cargo (dry or liquid) that is loaded (shoveled, scooped, forked, mechanically conveyed or pumped) in volume directly into a ship's hold; e.g., grain, coal and oil.

Cabotage: Shipment of cargo between a nation's ports is also called coastwise trade.

Capesize: cargo ships that are too large to traverse either the Suez Canal or Panama Canal. To travel between the oceans, such vessels must traverse either the Cape of Good Hope or Cape Horn.

Carbon footprint: a measure of the impact of human activity on the environment in terms of the amount of green house gases produced, measured in units of carbon dioxide.

CIF: cost, insurance, freight. Refers to the valuation of imported goods, i.e., including international transport and insurance costs.

Conferences: shipping conferences refer to shipping companies that have formed an association to agree on and set freight rates and passenger fares over different shipping routes.

Container: A box made of aluminum, steel or fiberglass used to transport cargo by ship, rail, truck or barge. Common dimensions are 20' x 8' x 8' (called a TEU or twenty-foot equivalent unit) or 40' x 8' x 8', called an FEU. In the container industry, containers are usually simply called boxes.

Containerization: The technique of using a container to store, protect and handle cargo while it is in transit. This shipping method has both greatly expedited the speed at which cargo is moved from origin to destination and lowered shipping costs.

Dead Weight Tonnage (DWT): Maximum weight of a vessel including the vessel, cargo and ballast.

FOB: free on board. Refers to the valuation of exported goods, i.e., excluding international transport and insurance costs.

Handysize: dry bulk vessels with a deadweight of about 15000-35000 tonnes. Handysize ships are flexible because their small size allows them to enter smaller ports, and in most cases they are 'geared', i.e., fitted with cranes which means they can load and unload in ports that lack cargo handling systems.

Panamax: ships classified as Panamax are of the maximum dimensions that will fit through the locks of the Panama Canal. These dimensions are 294.1 m in length by 32.3 m. in width by 57.91 m. in height measured from the waterline to the vessel's highest point. Such vessels typically transport 5000 TEU.

Post-Panamax: or "over Panamax" refers to ships that are larger than Panamax (see above), which do not fit in the original canal.

Stevedoring: the loading and unloading of ships. Also referred to as longshoring.

Tonnage: a measure of the size or cargo capacity of a ship. It refers specifically to the calculation of the volume or cargo volume of a ship and not the weight of a loaded vessel.

Tramp: A ship operating with no fixed route or published schedule**.**

Transshipment: The unloading of cargo at a port or point where it is then reloaded, sometimes into another mode of transportation, for transfer to a final destination.

Twenty Foot Equivalent Unit (TEU): A unit of measurement equal to the space occupied by a standard twenty foot container. Used in stating the capacity of container vessel or storage area.

I. Introduction

1. The economic consequences of increasing globalisation of the world economy, that is, closer integration of production and markets, have been discussed intensively over the last decade. The growing interdependence of countries around the world has often been largely attributed to lower trade barriers and to a fall in transportation and communications costs. In some areas, this is obviously true – the revolution in information and communications technologies, for example, cannot be disputed. The lowering of tariff barriers, too, due in part to successive rounds of multilateral trade negotiations, is evident. As tariffs have fallen, other trade costs have taken on greater significance. However, the common knowledge and stylized facts that are widely accepted as regards lower tariffs are in direct contrast to the level of understanding of the evolution in other types of trade costs.

2. This project, which was scoped in *Clarifying Trade Costs: Maritime Transport, A Scoping Paper* [TAD/TC/WP(2007)13], aims to narrow that gap in the area of maritime transport and its impact on trade. The present paper represents the first part of this project: it describes the maritime transport sector and some of the determinants of shipping costs, and outlines some of the findings from an extensive new database compiled on maritime transport rates. This information shall be used in a second paper which will have a two-fold objective: i) To examine the impact of transport costs on trade, and ii) To examine the impact of different components of transport costs on the level of these costs.

3. Maritime transport matters. Ninety percent of world trade by volume is carried out by sea. Maritime traffic in 2007 was almost double its 2003 level (UNCTAD, 2007). Operation of merchant ships now generates an estimated annual income approaching US$ 380 billion, equivalent to about five percent of total world trade.[1] As a result of the technological advances in the sector, ships deployed today are now 2-½ times the size of the largest a decade ago.[2]

4. Not only is maritime transport a key economic sector, it is an important facilitator of world trade. Access to a global network of reliable, efficient and cost-effective maritime transport services is necessarily beneficial. This is particularly true of developing and least developed countries whose trade in price-sensitive goods often comprises a significant component of their export potential (WTO, 2003). A well-connected maritime transport sector implies vast positive spillovers in terms of increased trade. Given the importance of time delays and the growth in vertical integration worldwide, low cost and easy access by sea to suppliers and export markets necessarily has an add-on effect in terms of trade and growth.[3]

5. In light of the importance of trade costs in an increasingly integrated global economy, there has been a call among academics and some policymakers for a greater understanding of these costs. Obstfeld and Rogoff (2000) argue that the six major unresolved problems of international macroeconomics can be explained by explicitly accounting for trade costs. Anderson and van Wincoop (2004) specify that "Better measurement of trade costs is highly desirable … Transport cost data could … be improved greatly."

6. Gravity models, the "workhorses" of trade flow models used today, generally use distance as a proxy for transport and other trade costs. Some recent studies, corroborated with evidence in this study, have found that distance is imperfectly correlated with transport costs. In light of these suppositions, some

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[1] World Marine Markets, a report to WTSH by Douglas-Westwood Ltd., March 2005, http://www.wtsh.de/wtsh/en/teaser/maritime_potenzialanalyse_engl.pdf

[2] *Seeking new ways to deliver the goods*, Financial Times, 10 December 2007.

[3] A preliminary analysis of the effect of distance and other trade costs on vertical trade and FDI can be found in *Vertical Trade, Trade Costs and FDI: Preliminary results* [TAD/TC/WP/RD(2008)7].

trade analysts have very recently underlined the importance of obtaining better data on transport costs. Both Clark (Sept. 2007) and Martinez-Zarzoso and Nowak-Lehmann (Sept. 2007) find that distance is a poor proxy for transport costs and incite other analysts to refrain from using distance as a proxy for such costs in gravity models.[4] This project, which has compiled an original dataset bringing together a large amount of available data on maritime transport costs in new, inventive ways, is a response to this appeal.

II. Determinants of maritime transport costs

7. There is a growing literature on the determinants of transport costs. The most studied determinant of transport costs is distance from major markets. Some studies also include data or proxies for port infrastructure or for the time necessary to get goods to market. Less reviewed elements are trade imbalances, volume of trade, competition among shippers and risk involved in getting goods to market. Rising fuel prices are also a determinant of shipping rates, and a particularly important one in recent years. Findings in the literature regarding the determinants of maritime transport costs are reviewed here. This section will show that many of the underlying elements of shipping rates are intertwined – the effect of distance on trade costs is different depending on the size of ship used; port infrastructure in many cases determines what size ship can dock and thereby the extent of economies of scale, etc.

Distance

8. The effect of distance from one market to another is the most studied element of transport costs, and is the most widely used proxy for transport costs in gravity models that attempt to explain trade flows. The distance usually measured in these models is that between the capitals of each of the two countries in a bilateral trading pair. It shall be seen in this study that distance is in fact a highly inaccurate proxy for transport costs, particularly when modelled in a linear fashion.

9. Some of the early work on transport costs by Radelet and Sachs (1998) finds that an increase in sea distance of 10 percent implies an increase in shipping costs of 1.3 percent. The authors use CIF/FOB ratios from the IMF International Financial Statistics database as a proxy for shipping costs and distance by sea to the closest major market to measure distance. It shall be seen in the following section that CIF/FOB ratios are too imprecise to be used as a proxy for transport and insurance costs.

10. Limao and Venables (2001) find that shipping an extra 1000 kilometres by sea raises transport costs by US$ 190. They find a much larger increase in transport costs when the extra 1000 kilometres are overland. All in all, the authors find that using distance alone as a proxy for transport costs accounts for only 10 percent of its variation. Limao and Venables use a unique source of shipping data: they have obtained shipping quotes from the firm that ships World Bank employees' belongings from Baltimore, Maryland (United States) to selected destinations of the world. In order to generalize the data from/to Baltimore with rates experienced on other shipping routes, CIF/FOB ratios are used for bilateral trade between other countries.

11. Evidence that suggests that transport costs are only vaguely related to distance should not be confused with the finding that distance is correlated with trade flows. Indeed, Hummels (2006) notes that roughly a quarter of world trade takes place between countries sharing a common border and half of world trade occurs between partners less than 3000 kilometres apart. It is not clear however whether the effect of

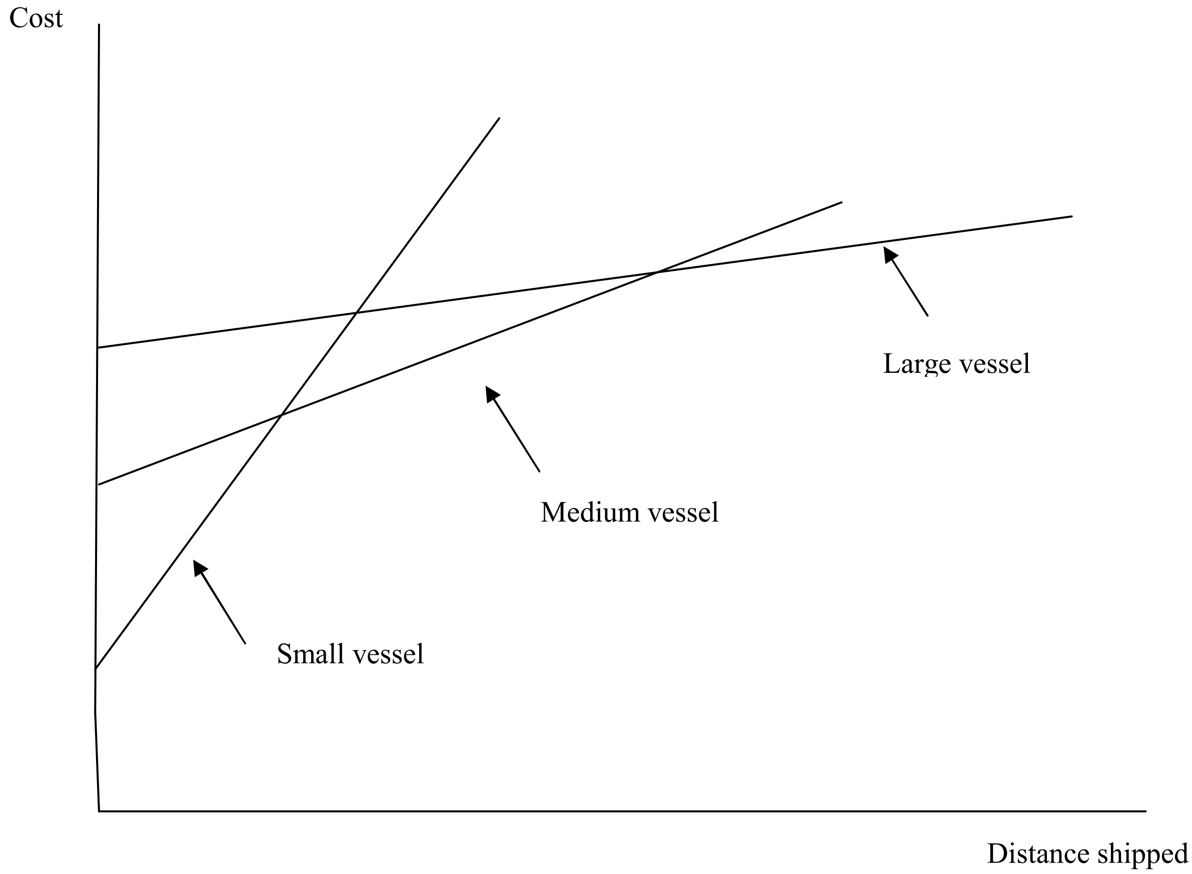
[4] Distance may be a proxy for other types of trade costs, however, and has the advantage of being truly exogenous of the volume of trade in goods.

distance on trade volumes can be ascribed to transport costs or to other trade determinants such as historical ties, cultural proximity or business networks.

12. The correlation of distance to transport costs has evolved over time due to technological innovation. As containerships have become more prevalent, and ships have become bigger and faster, economies of scale have been realized to substantially reduce the price per tonne-kilometre while the ship is at sea. They incur higher indirect costs when arriving in large ports, however, due to longer loading and unloading times and potentially more idle time spent in ports.

13. The trade-off between time spent at sea and at port implies that the effect of distance on the shipping cost is related to the size of ship bearing the exported goods. Smaller ships are more cost-efficient over short distances, and larger ships more cost-efficient over longer distances (Figure 1). The depth of the ports for loading and unloading also determines whether larger, faster ships can enter ports directly thereby increasing the efficiency of transfers of goods.

Figure 1: Technological Relationship: Shipping Cost and Distance



Source: Hummels (2001).

14. Other components of transport costs impact on the relationship between distance and transport costs. Some have a linear impact, like fuel costs for example, which increase proportionally with increases

in distance on a given vessel. Some elements have a non-linear effect – size of ship, for example, as seen in Figure 1 above. Some elements have a mixed effect: the cost of ship location for example, which is a function of the number of days spent at sea and at portside, which is somewhat related to distance between ports, but also depends on a number of other factors such as port infrastructure and the speed of loading and unloading. Some costs are fixed and somewhat related to distance – the cost of using Panama and Suez Canal services, for example, which is generally only an element of cost on long haul trips. Some elements of transport costs however are fixed and unrelated to distance at all such as the cost of loading and unloading at portside. The cost of loading and unloading is in turn a function of port infrastructure and determines the size of ship that will transport the cargo. The size of ship in turn determines (in a non-linear fashion) the effect of distance on transport costs. ***The aggregate effect of distance on transport costs is, to say the least, complex.***

15. Indeed, the use of distance as a proxy for transport costs is the subject of two recent articles, both of which come to the same conclusion. In an article entitled "Is Distance a Good Proxy for Transport Costs?", Martinez-Zarzoso and Nowak-Lehmann (Sept. 2007) find that it is not, and that it is a particularly poor proxy for maritime transport costs.[5] Clark (Sept. 2007) states clearly that "Theorists should re-evaluate the role of distance in trade models and refrain from using distance as a proxy for transport costs."

Time

16. It has been suggested that the time it takes for goods to get to markets is a better proxy for transport costs than is distance. "Trade costs have both a financial and a time dimension and the latter has become increasingly important. This is best understood at the firm level where non-core activities are increasingly outsourced to outside suppliers who are expected to deliver their inputs just in time" (Nordas et al, 2006).

17. Hummels (2001, 2006, 2007) estimates the effect of time in transit on transport costs. He estimates the tariff equivalent in transit is 0.8 percent per day which amounts to a tariff equivalent of 16 percent on a 20 day sea transport route, which is the average for imports to the United States. This represents a significant barrier to trade and is much higher than estimates for any trade policy variables. Hummels (2007) finds that every day in ocean travel that a country is distant from the importer reduces the probability of sourcing manufactured goods from that country by one percentage point.

18. Nordas et al. (2006) find that "geography … matters less when time for exports is controlled for, suggesting that geography matters partly because it is related to time. Countries can therefore to some extent overcome geographical disadvantages by reducing the behind the border time for exports."

19. Djankov et al. (2006) find that each additional day in transit reduces trade by one percent. Put another way, each additional day is equivalent to a country distancing itself from its trading partners by one percent, or about 70 kilometres. Goods that are determined to be "time-sensitive" are even more directly affected by delays: a 10 percent increase in the relative time of moving goods reduces relative exports of time sensitive goods by five percent.

[5] Martinez-Zarzoso and Nowak-Lehmann analyze maritime and road transport costs for Spanish exports to Poland and Turkey, markets for which maritime and road transport are competing modes. The choice of mode of transport is endogenous and depends on relative costs in terms of direct freight costs as well as cargo handling and time. They find that distance is not a good proxy for transport costs overall, and that it is a better proxy for road transport than for maritime transport costs.

20. Hoffman and Wilmsmeier (2007) find that transit time is more closely correlated with freight rates than is direct maritime distance. They attribute this to the necessity of transhipment to ports that are not hubs, therefore losing time that is not included in distance variables. The authors find that on average each additional day of transit leads to an increase in the freight rate of 56 US dollars.

21. In any case, shipping is necessarily a relatively slow process. Shipping containers from Europe to the Midwest United States requires 2-3 weeks; from Europe to Asia requires five weeks. Demand for some products is generally more elastic with respect to time in transit. Demand for goods that are shipped in bulk and for simple manufactures is less dependent on the time it takes to get to market; overall, however, transportation accounts for a larger share of the final price of these heavy goods.

Trade imbalances

22. Directional imbalance in trade between countries implies that many carriers are forced to haul empty containers on their return trips. As a result, the cost of shipping in one direction is not the same as the cost on the return trip. Fuchsluger (2000) shows that this phenomenon is observed in the bilateral trade between the US and the Caribbean. In 1998, for instance, 72 percent of containers sent from the Caribbean to the United States were empty. This excess of supply of containers on the northbound route implied that a United States exporter paid 83 percent more than a United States importer to ship the same type of merchandise between Miami and Port of Spain (Trinidad and Tobago). Similar phenomena occur in the Asia-US and the Asia-European trade routes, where excesses of supply mean that Asian exporters pay more than 50 percent in extra transport costs compared to suppliers in the United States and Europe (Table 1).

Table 1. Imbalance on freight routes: differences in average freight rates and cargo flows between eastbound and westbound legs of major trade routes, 2006

	Average freight rates ($/TEU)	Estimated cargo flows (mln TEUs)	Difference in freight rates between eastbound and westbound routes, pct[1]	Difference in cargo flows between eastbound and westbound routes, pct[1]
Asia-USA	1744	13.9		
USA-Asia	815	4.6	47	33
Asia-Europe	1475	12.5		
Europe-Asia	799	5.8	54	46
USA-Europe	1028	2.3		
Europe-USA	1819	3.9	57	59

Source: UNCTAD Secretariat from Containerisation International data, www.ci-online.co.uk. Asia refers to all major ports on the East Asian coast stretching from Japan and Korea to Indonesia. Europe refers to major European ports, including the Netherlands, the United Kingdom and Southern Europe. The United States is a weighted average of major US ports (West Coast, East Coast and Gulf ports).

1. Figures can be interpreted as follows: The cost of shipping a container from the United States to Asian ports in 2006 was on average 47 percent (i.e., less than half) of the cost of shipping a container of goods from Asia to the United States. The amount of cargo exported from the United States to Asia in 2006 was one-third (33 percent) that exported from Asia to the United States.

23. Table 1 shows that differences in price of containers between eastbound and westbound journeys are strongly determined by the volume of trade on the eastbound route as compared to the westbound one. The greatest trade imbalances occur on the US-Asia route where exports from the United States to selected ports in Asia were only one-third the volume of those on the return trip. Shipping rates to Asia were very much reduced as a result: the cost of shipping a container from the United States to Asia was 47 percent the price of moving a container the opposite way on the same route. The differences in one-way container rates on a given route seem therefore to be correlated with the differences in volumes being shipped in one direction as opposed to the return trip.

24. The importance of directional imbalances is one of the specificities of the shipping industry. This is particularly the case for container shipping as shippers must return not only the ship, but also all the containers ("boxes"). Shippers often lower prices below cost in order to bring containers back to their original port of loading. In order to partially cover costs, some shippers agree to ship goods with a negative value added. One of the largest exports from the United States to China is waste. Shippers typically charge 200 US dollars to transport a container filled with waste paper to China from the United States – an amount that does not come close to covering the cost of the journey. Often after transporting goods such as waste paper or scrap metal, however, a container needs cleaning, an extra step that slows down the turnaround time. Some shippers do not bother to fill the containers: a shipping executive of US Lines indicates that its ships almost always travel empty from the United States to China "because it is more lucrative to steam back quickly and unencumbered than to take on cheap and unprofitable cargo" (International Herald Tribune, 2006). Ships returning empty on the backhaul also use less fuel than those carrying cargo.

Trade volume and vessel size

25. An important determinant of transport cost is the volume of trade. Maritime transport is a classic example of example of an industry that faces increasing returns to scale. Alfred Marshall, neoclassical economist from the beginning of the 20th century said, "… a ship's carrying power varies as the cube of her dimensions, while the resistance offered by the water increases only a little faster than the square of her dimensions."[6]

26. Besides increasing returns at the vessel level, economies of scale may be captured at the seaport level. For instance, at the port of Buenos Aires (Argentina) the cost of using the access channel is $70 per container for a 200 TEU vessel but only $14 per container for a 1,000 TEU vessel (Clark, Dollar and Micco, 2004). In general, even though economies of scale are at the vessel level, in practice they are related to the total volume of trade between two regions. Maritime routes with low trade volumes are serviced by small vessels and those with large trade volumes by large vessels.

27. Trade value is also determined by trade composition. Because of the insurance component of transport costs, products with a higher unit value have higher charges per unit of weight. On average, insurance fees are between 1.5 and 2 percent of the traded value, and they represent around 15 percent of total maritime charges. Therefore, the insurance component of high value-added goods is higher than that of low value-added goods.[7]

Competition

28. Competition on routes is a major determinant of transport costs, and is closely related to the total trade volume. Trade growth along a route promotes firm entry with rival liner companies competing away

[6] Alfred Marshall quoted in Micco and Perez (2002).

[7] http://www.iadb.org/res/publications/pubfiles/pubB-2001E_3850.pdf.

transportation markups thereby lowering costs for importers and exporters. On some routes with especially low trade volumes, however, shippers are in a semi-monopolistic situation. In 2006, one in six importer-exporter pairs was served by a single liner service, and over half were served by three or fewer (Hummels, Lugovskyy and Skiba, 2007).

29. Shipping conferences, which were put into place to fix rates and are not subject to anti-trust legislation in major export markets, have lost in influence in recent years (see Appendix I for a fuller explanation of the workings of shipping conferences). Shipping companies have been forced to merge as a way of retaining their monopoly power, in addition to creating economies of scale and offering integrated services. Fink, Mattoo and Neagu (2002) still find, however, that a breakup of private carrier agreements would cause prices to decline by 25 percent implying a cost savings of 2 billion US dollars on goods carried to the United States alone. The authors draw clear policy implications from their findings. They suggest an end to the exemption of collusive agreements in the maritime sector from national competition law; and creating the right for foreign consumers to challenge anti-competitive practices by shipping lines in their own courts.

30. Restrictions and anti-competitive practices can induce inefficiencies and monopoly power in ports. Workers in many countries for example are required to have licenses for providing stevedoring services. In the cases that the granting of these licenses is accompanied by high fees or implemented in a non-transparent manner, they imply higher port costs and lower productivity.

Infrastructure

31. There is much literature on the importance of port infrastructure on transport costs. Port infrastructure is an important element of transport costs, also influencing the size of ship that can enter any given port and the time required to load and unload vessels. Additionally, however, this is one element of transport cost that can actually be changed through trade and infrastructure policy changes and increased investment.

32. A much-quoted finding is that of Limao and Venables (2000) for whom onshore infrastructure accounts for no less than 40 percent of predicted transport costs for coastal countries. They indicate that if a country with relatively poor infrastructure such as Ecuador or Brazil, ranked 75th internationally, were able to upgrade to the 25th percentile (the level of infrastructure in France or Sweden), it would reduce transport costs by between 30 and 50 percent. Clark, Dollar and Micco (2004) find that ports that are ranked 75th internationally are equivalent to being 60 percent farther away from markets for the average country than those ranked in the 25th percentile.

33. Wilmsmeier, Hoffmann and Sanchez (2006) examine six different port characteristics as possible determinants of international transport costs in Latin American countries. They find that port efficiency[8] is the most determinant element, followed by port infrastructure, private sector participation and inter-port connectivity. Doubling port efficiency in a pair of ports involved in bilateral trade has the same impact on international transport costs as halving the distance between them.

Piracy and other risk

34. Piracy is an unresolved threat to ship owners and mariners. The geography in the Strait of Malacca makes that region particularly susceptible to piracy. It was, and still is, an important passageway between China and India, and is used heavily for commercial trade. The strait is narrow, contains

[8] Port efficiency is defined as the perceived efficiency of the importing and exporting ports, respectively. The source of this indicator is the World Competitiveness Report (2003-04).

thousands of islets, and is an outlet for many rivers, making it an ideal location for pirates to hide and evade capture.[9]

35. The International Maritime Bureau (IMB) reports worldwide pirate attacks on ships at sea in 2006 fell to 239 vessels, down from 276 in 2005. The same trend was echoed in the Strait of Malacca where attacks dropped from 79 in 2005 to 50 in 2006. Nonetheless, in 2004, the region accounted for 40% of piracy worldwide. The IMB reported in October 2007 that Indonesia continued to be the world's most pirate-struck region with 37 attacks since January 2007, although this was an improvement from the same nine month period of 2006.[10] Although the numbers of ships actually attacked remains minimal, their potential risk exerts an upward pressure on shipping rates. An incident of pirate attack and hostage-taking of a French ship operated by shipping conglomerate CMA-CGM occurred off the coast of Somalia in April 2008, further spotlighting piracy problems in the Indian Ocean.[11] Ships pass near Somalia on the well-traveled route between Asia and Europe on their way to and from the Suez Canal. The risk of pirate attack in the region prompted the International Maritime Bureau to issue a warning to ships not to come closer than 200 nautical miles to the Somali coast.[12]

36. Shippers interiorize the risk of piracy in certain sea lanes in their transport costs. Exporters or freight forwarders may also purchase more insurance coverage when exporting through known pirate-infested waters, increasing overall transport costs. Similarly, weather risk brings greater costs to shippers which they presumably pass on at least in part to their clients. Even if maritime transportation has experienced remarkable improvements in its safety and reliability, maritime routes are still hindered by dominant winds, currents and general weather patterns. The North Atlantic and the North Pacific are subject to heavy wave activity during the winter that sometimes impairs navigation, and may cause ships to follow routes at lower latitudes, thereby increasing the length of time at sea. During the summer monsoon season (April to October), navigation may become more hazardous on the Indian Ocean and the South China Sea. Increased safety measures and the potential risk of being idle at portside during such seasons exert an upward push on transport prices.

Surcharges

37. Surcharges and ancillary charges applied by the shipper, covering a wide variety of adjustments, account for an average of 30 percent of the total freight costs.[13] In the past, these charges were collectively fixed by the conferences and were respected by conference members. Surcharges and ancillary charges are put into place in theory to pass through cost elements to shipping clients. A study by Global Insight however, shows that rates for surcharges and ancillary charges do not reflect actual costs incurred and are in fact used to generate extra profits.[14]

38. At the time of the writing of this paper, rising fuel costs are generating a significant surcharge to cover the cost of purchasing expensive fuel (Figure 2). Since exporters and shippers sometimes draw up

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[9] http://en.wikipedia.org/wiki/Piracy_in_the_Strait_of_Malacca

[10] *Pirate Attacks Surge Worldwide*, Associated Press, aol.com, 2007-10-16.

[11] Piraterie maritimes: des mers plus dangereuses, Le Monde, April 11, 2008.

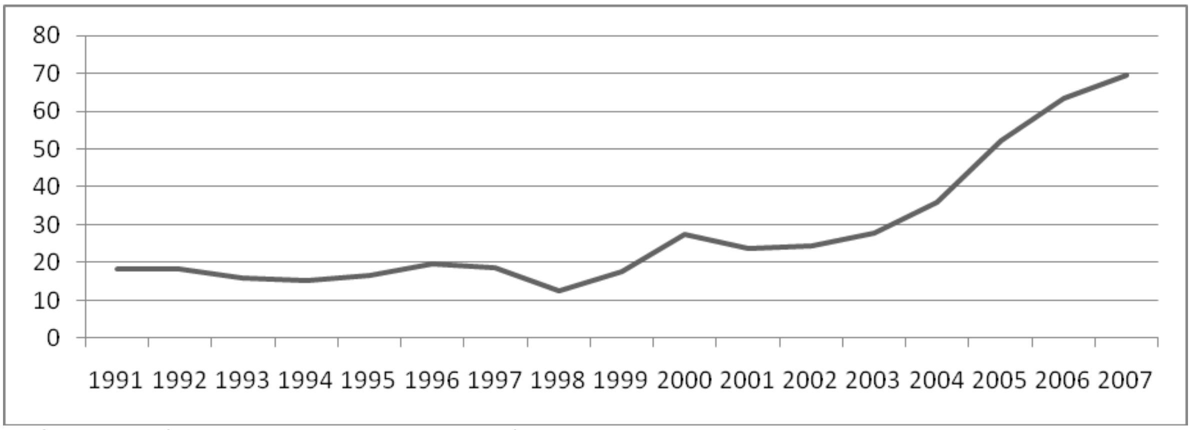
[12] http://newsinfo.inquirer.net/topstories/topstories/view/20080408-129113/6-Filipino-seafarers-among-30-seized-off-Somalia----DFA

[13] Cited in Commission of the European Communities, Commission Staff Working Document SEC(2005) 1641, Brussels, 14 December 2005.

[14] Ibid.

their contracts months or even a year or two in advance of their shipments, shippers cover increased fuel costs in times of high price volatility by adding a fuel surcharge.

Figure 2. Price of oil, US$/barrel



Note: Oil prices refer to simple monthly averages of Brent and Fatah-Dubai.

Source: International Energy Agency, Oil Outlook 2007.

III. Data collection

39. Transport costs are calculated in a variety of ways in the literature. Some early studies use export values (CIF) minus import values (FOB), i.e., mirror trade data, and assume the difference represents transport and insurance costs.[15] This approach is erroneous due to many statistical errors, and problems of mismatched mirror data. Indeed, the IMF suspended publishing these data in a readily accessible fashion so as to avoid this particular error.[16] More recent studies have attempted to use better estimates for transport costs. Hummels and Lugovskyy (2006) compare these mirror data with actual transport costs for US and New Zealand and find that the CIF/FOB ratios are "badly error-ridden in levels, and contain no useful information for time-series or cross-commodity variation."

40. Limao and Venables (2001) use transport data obtained from the moving company that re-locates World Bank employees. The firm in question provided the authors with the cost of moving one container (TEU) from Baltimore, United States to destinations to which Bank employees may be re-located. Although this is an inventive solution, its drawback is that the data does not exist for other countries of the world (which the authors then estimate econometrically).

41. Some more recent studies (e.g., Hummels, various years, and Bradford, 2006) use detailed data compiled by the US Census from customs records. These data indicate at the product level which products are imported by sea, rail or air, the transport costs, the quantity imported and its value by country of origin and by customs district of entry.

42. The cornerstone of this OECD project is an extensive data collection exercise that unites maritime transport cost data from a variety of different sources. The data base created here includes original customs data where available. These data provide full information – transport costs at the most detailed product level from all destinations. Product-level transport cost data is used for only those items that have arrived by sea. These data are available, however, only for a limited number of countries (Australia, New Zealand, and United States). The comprehensive data are then combined with shipping rates actually charged that are available at a more aggregated level (i.e., not for specific products) to estimate actual transport costs at the product level for imports into a number of other countries. These data have been compiled using the methodology outlined below to provide estimates at the detailed product level for ad valorem transport costs to and from as many countries of the world as possible. The data set includes 2.9 million data points for products at the HS-6 digit level for 20 importing countries in total (including all EU countries as a customs union[17]) from all 218 countries of the world from 1991 to 2006.

43. The challenges in compiling these data are numerous. They have been collected at a very detailed level – by country of origin and destination, by product and year: the dataset quickly becomes very large. More importantly, the most desirable form of the data is in ad valorem equivalents (i.e., transport costs divided by total import value). Data can therefore be used to calculate a tariff equivalent of transport costs, and can be compared with other trade costs such as tariffs in order to have a comparable measure of transport cost and its effect on the final price of traded goods. However, the data are not always in a form that can easily be used. The Containerisation International/UNCTAD series for trans-Atlantic and trans-Pacific rates are expressed as the price to transport one container ($/TEU) from one port to another. The underlying data of the Baltic Dry Index (BDI) of industrial raw material transport costs is expressed in terms of the cost per day to hire one ship to transport coal or iron ore in bulk. The challenge

[15] Radelet and Sachs (1998) for example use data calculated in this way.

[16] Discussions with OECD trade statisticians.

[17] Background data for estimating transport cost data are not available for individual European countries.

was to use these valuable data and transform them into a harmonized form that can be readily utilized for analysis of trade flows and costs.

44. This study makes use of detailed customs data for Australia, New Zealand and the United States (see Appendix II.A). These datasets record the export (FOB) value of goods, the cost of freight and insurance and the corresponding import (CIF) data for all imports from all destinations at the product level by mode of entry (ship, air or rail). In this way, the transport and insurance costs of only those imports that have arrived by ship can be analysed. The detailed customs data available for Australia, New Zealand and the United States are used to calculate transport unit costs (US$ required to transport one tonne of merchandise) as well as ad valorem equivalents of transport costs (% of the total import value (CIF) of the product[18]) at the product level.

45. Data that have been obtained through shippers and freight forwarders are of a different nature than the customs data described above for three countries. Freight rates are available for containerized data to and from a number of destinations. They are expressed however, in cost per container (TEU), and as such are difficult to combine with trade values and volumes. Container freight rates were obtained from three sources: Containerization International, a private firm that calculates rates on six major freight routes; Drewry Consulting, which calculates container rates on about 100 freight routes; and information from private shippers, which has been conceded confidentially. (See Appendix II.B for detailed information on data series for containerized data and Appendix Table II.1 for data availability).

46. In order to calculate the transport unit cost per containerized product and its ad valorem equivalent, a methodology was developed based on relative shipping rates and relative unit transport costs. The methodology consists of calculating a unit transport cost of every good on a given route (e.g., United States to the EU) using detailed import data to the United States. The relative price of transport of a container from the United States to the EU, in the example, is calculated as compared to the price of transporting a container from the EU to the United States. This comparison is used as a conversion factor and is multiplied by the transport cost per unit of merchandise imports into the United States to obtain the unit transport cost per product for the EU- United States route. An illustrative example of the methodology is included in Box 1.

[18] This study calculates the ad valorem equivalent of transport costs using the import values of goods, i.e., valued cif. This is in order to be consistent and comparable with calculations for other trade costs such as tariffs which are generally levied and valued CIF, although definitions are not strictly harmonized across countries. In any case, the ad valorem values calculated using this method would, if anything, underestimate the importance of shipping costs.

Box 1. Illustrative example using average transport cost data per container to calculate transport costs in ad valorem equivalents of exports of shoes from the United States to the EU

We have detailed data at the product level in the United States import data set. As an example, we use the data for a given product, say shoes, coming from a given destination, say the European Union. Assume the US data set is as follows:

Import value of shoes from the EU (FOB): $95,000
Import volume: 10,000 units
Transport cost: $5,000
Import value of shoes from the EU (CIF): $100,000

From this data, we can calculate:
Unit value: $10
Transport cost per unit: $0.50
Transport cost as a percent of the total value of the imports: 5%

The next step is to obtain a simple ratio of transport costs overall (for container shipping, in this case) for the return direction of trade (NB: this could be extended to third country origin/destinations –Japan to Madagascar for example, as long as we could compare the cost of shipping from Japan to Madagascar with the cost of shipping from the EU to the US). We know, from the UNCTAD/Containerization International data set that for the year in question, that container transport overall from the EU to the US is twice (2 times) the price of container transport from the US to EU.

We also know, from trade flow data in WITS or ITCS:
The import value of shoes to the EU from the US (CIF): $50,000
Import volume: 3333

We can therefore calculate the unit value: $15

Using the above information, we can calculate the transport cost per unit of shoes from the US to the EU: 2 * $0.50 = $1.00.
The total transport cost of shoes exported from the US to EU is therefore $1 * 3333 = $3333
The transport cost as a percent of the total value of the imports of shoes is $3333/$50,000 = 6.67% ad valorem equivalent.

A similar calculation can be done using transport costs overall for container shipping from any origin and destination, as long as they can be compared with the transport cost of imports to the United States from a given destination. The United States unit transport cost data have been used to estimate transport costs for all countries for which overall data for container transport rates exists.

47. As regards bulk shipping, transport cost data are available from two sources: the Baltic Dry Index for timecharter routes and shipping of industrial raw materials, and the International Grains Council (IGC) for grains shipped in bulk. Freight rates are expressed in US dollars per tonne for transport of grains, so the calculations outlined in Box 1 are not necessary. The ad valorem transport costs of imports of grains are simply calculated using the unit freight rates and import data for all countries for which data are available.

48. The data used in calculation of transport costs of industrial raw materials such as iron ore and coal are expressed in dollars per day to timecharter a Capesize ship. Calculations are then made for the tonnage shipped and the number of days in transit to arrive at a figure for maritime transport costs per tonne of merchandise. More details of the data coverage and manipulations to the bulk shipping data are included in Appendix II.C and Appendix Table II.1.

49. No calculations are made in this study to estimate data for transport costs of oil tankers. Although petroleum and petroleum products are important commodities in terms of both value and volume shipped, the tanker segment of maritime transport is subject to particular practices. Petroleum is generally traded on the spot market while in transit. The captain of a tanker fully loaded with oil from the North Sea, for example, often does not know where he is going when heading off to sea. The tanker may change course numerous times during its journey as its contents are bought and sold on the spot market. There is

also no known substitution effect of tankers with the other segments of the maritime transport industry (containers, "clean bulk" or "dirty bulk").

IV. Evolution in maritime transport costs

50. A number of factors have been contributing to the evolution of maritime transport costs. There have been significant technological advances in the shipping industry, not least of which the advent of containerisation and increasing automatization. Economies of scale due to the phenomenal growth in ships' size are evident over the past decades. These changes however mean that transport costs are more differentiated between hubs -- deep ports that host large ships and are fully automated -- and small out-of-the-way ports that are far from markets and have not benefitted from investments in infrastructure.

51. These evolutions also imply that the effect of distance on trade has changed in a variety of ways. Larger, faster ships are capable of transporting large volumes of merchandise long distances. Yet the possibility of larger ships may require different sea routes to avoid the Panama and Suez canals that restrict access based on ships' size. Since the greatest economies of scale will be realized on routes with very large volumes of trade, a greater gap is created between transport costs of large trading nations and small ones. At the same time, opportunities are created for countries that are located along major trading routes to act as hubs thereby creating value added through their maritime transport and logistics services, and facilitating access to markets for their domestic exporters and importers.

52. The new database on maritime transport costs can be used to shed light on these issues. In the analysis that follows, the entire database was used unless otherwise specified. (See Appendix Table II.1 for data coverage).

Have maritime transport costs fallen ?

53. One of the most pertinent questions regarding long-term trends in maritime transport costs is: have they fallen? Some of the information contained in previous chapters of this study would suggest this should be the case.[19] However, the question is more difficult to answer than it seems. There are two main ways to measure this: using transport costs measured in cost per kilo of merchandise (price data), or measured as a percent of the final cost of goods (ad valorem equivalents). Of course, over the long term, the components of both of these indicators have changed. Manufactured goods, for example, have become lighter over time. Heavy, cumbersome manufactures have often been replaced by smaller, lighter goods. Trade is being made up of more and more processed foods and light manufactures, thereby increasing the price per weight of goods.

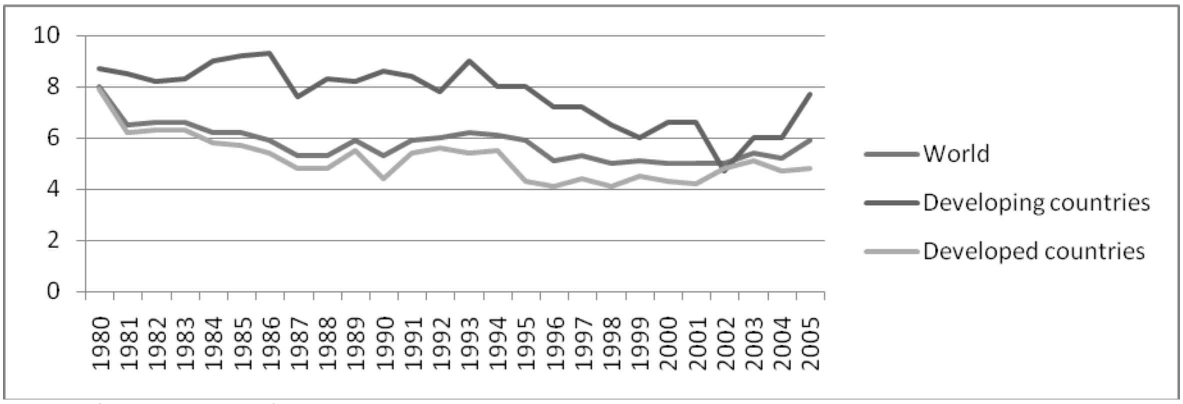
54. Concomitantly, the overall price of goods has evolved over time. The prices of some goods have dropped drastically due to evolutions in production processes such as vertical integration. On the other hand, better quality and more targeted branding and marketing of goods have contributed to an increase in the prices of other goods. The basket of goods imported by a given country, which necessarily evolves from one year to the next, therefore plays a large role in determining the extent and evolution of transport costs. Similarly, evolution in the country of origin of imports may change the results of any attempt to quantify changes in maritime transport costs over time.

55. Some of the literature counters the claim of the shipping industry that maritime transport freight rates have fallen steeply (in particular Hummels, various years). A broad overview of freight rates by UNCTAD indicates that maritime transport rates have fallen only slightly in the 25 years between 1980 and 2005. In 1980, maritime transport accounted for about 8 percent of the final cost of goods, and just

[19] See in particular Section II and Appendix I.

under 6 percent in 2005 (Figure 3). Corresponding figures for developed countries are 8 percent to 4.8 percent; developing countries saw their cost of maritime transport fall from 8.5 to 7.7 percent of the price of goods.

Figure 3. Maritime transport costs in the long term, ad valorem equivalent

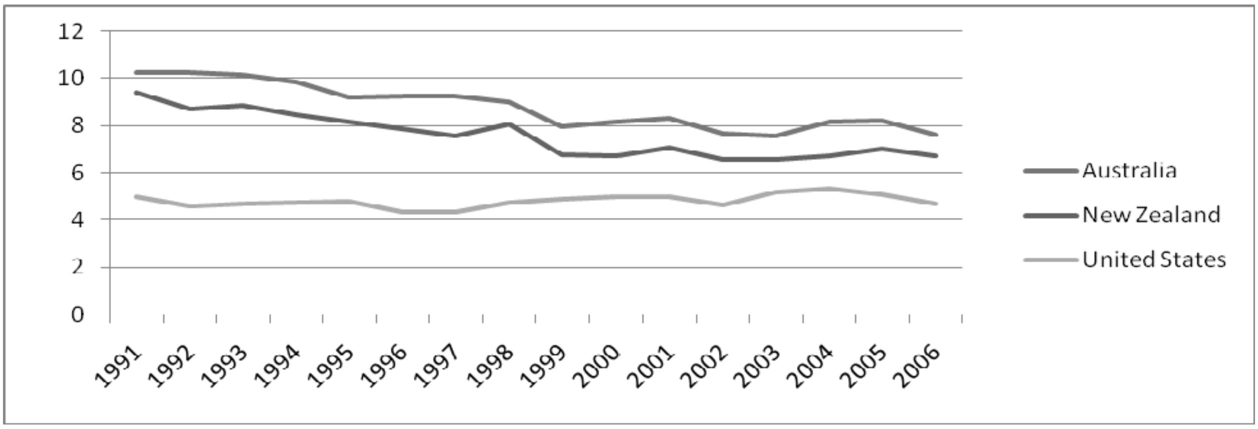


Source: UNCTAD, Review of Maritime Transport, 2007.

56. Hummels (2007) suggests that the answer to the question "have maritime transport rates fallen?" depends largely on the time period analysed. He maintains that both tramp and liner shipping prices have fallen very little since the early 1970s, deflated using a GDP deflator, a commodity price deflator, or a traded-goods price deflator.

57. Comparing the dataset compiled for this study for the three countries for which comprehensive data is available (since 1991 for all products on an ad valorem basis), overall shipping rates have fallen somewhat for Australia and New Zealand but very little for the United States. Over the fifteen year period from 1991 to 2006, the cost of freight entering Australia fell from 10.2 percent to 7.6 percent. Comparable figures for New Zealand were 9.4 percent to 6.7 percent; for the United States, rates overall from all destinations fell from 5 percent to 4.7 percent (Figure 4).

Figure 4. Cost of freight entering Australia, New Zealand and the United States, ad valorem equivalent

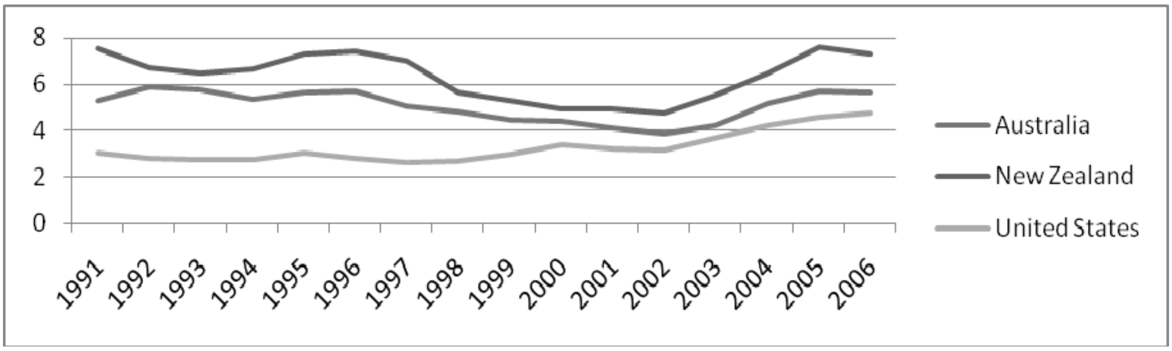


Note: Estimates for total maritime freight costs have been calculated and divided by the total CIF value of imports. These data are therefore equivalent to weighted average transport costs.

Source: OECD Maritime Transport Cost Database from original customs data. See Appendix II.A for data sources.

58. Considering the overall freight rates for the three countries in terms of transport costs per tonne of merchandise, the evolution is not overwhelmingly clear either. Over the 15 year period under review, the nominal cost of shipping a tonne of merchandise has increased for the United States from 3 to 4.7 dollars per tonne, has increased slightly for Australia from 5.3 to 5.7 dollars per tonne and has fallen slightly for New Zealand from 7.5 to 7.3 US dollars per tonne (Figure 5).

Figure 5. Cost of freight entering Australia, New Zealand and the United States, $/tonne of merchandise



Source: OECD Maritime Transport Cost Database from original customs data. See Appendix II.A for data sources.

59. It seems therefore in the period under review in this study that there is no overwhelming evidence of a large drop in maritime transport costs that might have been the result of the significant technological advances in the industry, or the important changes in the competitive environment. On aggregate, the evolution of transport costs is a more nuanced picture, with costs rising for some destinations, for some products, and for some types of transport (bulk, container, etc.), and falling for others. A more detailed analysis of transport costs needed to shed light on the question follows.

How do transport costs differ between countries and goods shipped?

60. There is a large difference in the level and evolution of the different "markets" within maritime transport: containers, carrying manufactures and processed food products; "clean bulk" carrying grains; and "dirty bulk" carrying industrial raw materials. Supply and demand for different types of carriers to and from different destinations have evolved over time.

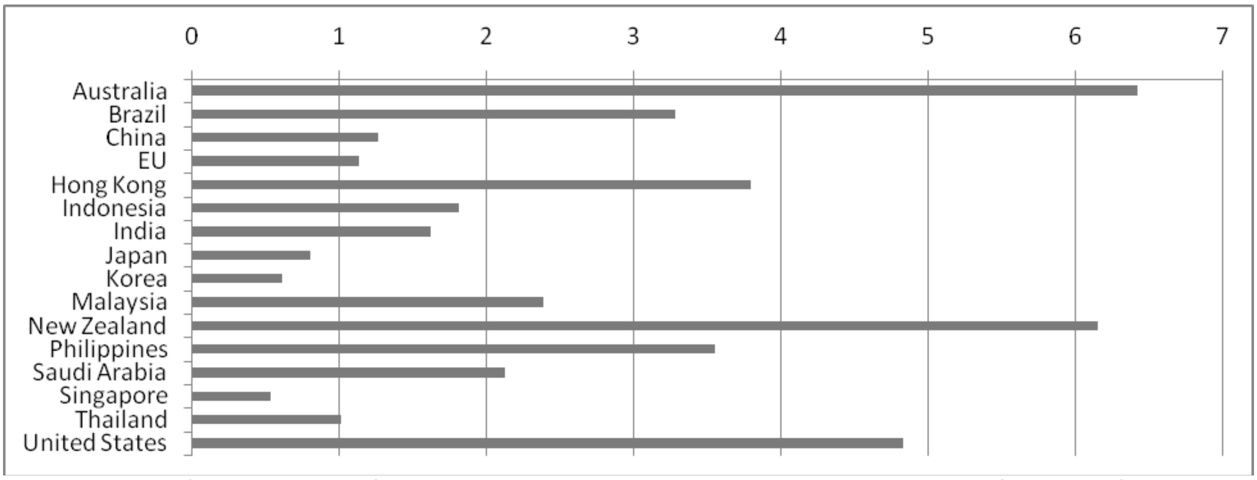
61. Container traffic, hauling manufactures and processed agricultural products, has increased most of the three market segments during the 15 years analysed in this study. Although the cost of transporting goods in containers has generally decreased, the evolution varies according to importing country. For most countries for which data has been calculated or estimated, the cost of hauling a container has dropped by between one and three percent per annum. This is true for Australia, New Zealand, the European Union, Japan, Korea, Singapore and Thailand. The cost of sending a container to China has dropped most rapidly – on average a 9 percent drop per year. Container costs have risen slightly in ad valorem terms to the United States – by two percent on average; and have risen more strongly to Hong Kong and Malaysia. The latter can be explained by sharp drops in prices in the early 2000s, and a subsequent rectification (see Appendix Table III.A.1).

62. In 2006, the cost of shipping goods by container as a percent of their total import value was between 0.5 and 7 percent for all the countries for which data is available. Not surprisingly, it is most expensive to import manufactures and processed agricultural products to Australia and New Zealand: transport costs of all goods hauled by container are between 6 and 7 percent of the total value of imports

(Figure 6). For these countries, maritime transport is a significantly larger trade cost than their tariffs which are 3.78 on average for Australia and 3.18 for New Zealand.[20]

63. Countries in the medium range – where container-shipped imports account for 3-5 percent ad valorem – include Brazil, Hong Kong, the Philippines and the United States. These levels are not insignificant and can represent barriers to trade, albeit small ones.[21] For both the United States and Hong Kong, maritime transport costs are higher than tariffs on industrial goods which are 3.33 percent for the United States; industrial goods enter Hong Kong relatively duty free. Similar figures for Brazil are 12.6 percent industrial tariffs as opposed to 3.3 percent for maritime transport; for the Philippines they are 5.8 percent industrial tariffs as compared with 3.6 percent for maritime transport. Finally, the cost of shipping by container is between 0.5 and 3 percent for imports to the following countries: China, the European Union, Indonesia, India, Japan, Korea, Malaysia, Saudi Arabia, Singapore and Thailand. For these countries, it can be assumed that the price of importing by container overall does not represent a major cost to the economy.[22]

Figure 6. Transport costs of goods shipped in containers, 2006, ad valorem equivalent by importer



Note: Estimates for total maritime freight costs have been calculated and divided by the total CIF value of imports. These data are therefore equivalent to weighted average transport costs.

Source: OECD Maritime Transport Cost Database. See Appendix Table II.1 for data availability.

64. However, these overall figures hide large differences in transport costs between different product groups and countries of origin. Although for example all imports from China to the United States averaged 6.5 percent ad valorem, in fact these figures ranged from 3.5 percent to 17 percent ad valorem for the most traded product groups (Figure 7). The highest transport costs were for heavy goods such as wood, furniture and ceramics. The lowest transport costs ad valorem were for light goods – clothing and

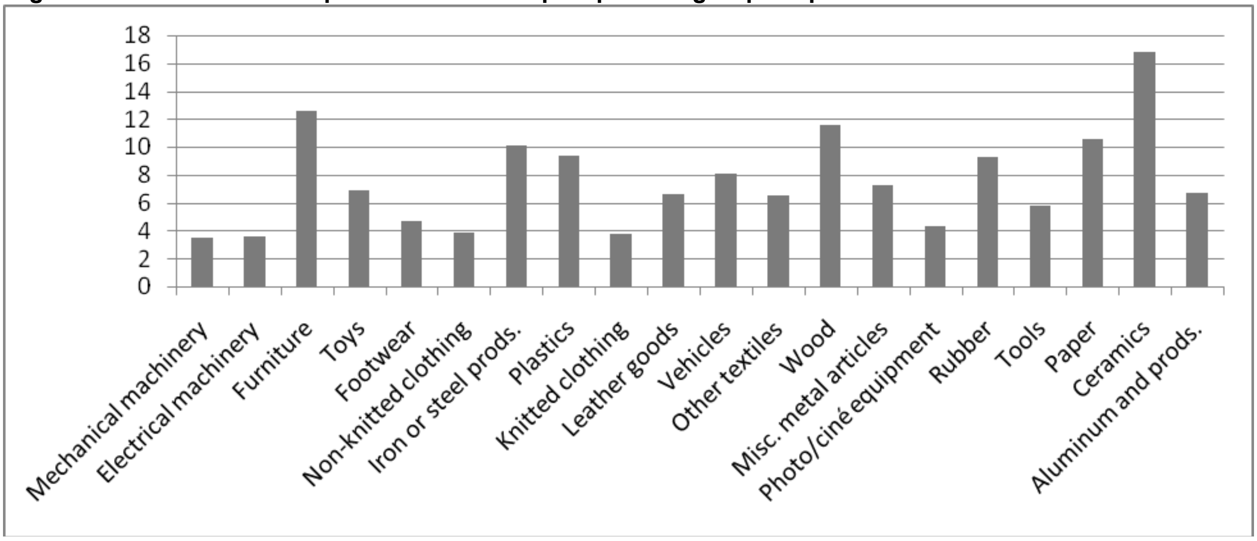
[20] Refers to 2006 MFN applied rates for all industrial products emanating from all countries of the world, simple average.

[21] These averages are over all products and countries of origin in the dataset and some of the differences can be attributed to location of countries concerned, the mix of products imported, port efficiency, etc. These issues will be partially covered later in this section, and will be the object of further scrutiny in a future paper.

[22] One can recall the notion of a "nuisance tariff" which is applied to tariff levels under 3 percent ad valorem which is assumed to have little distortionary power even in terms of effective rates of protection.

footwear – and for higher value added goods such as machinery and equipment. The overall figures therefore hide large differences and can represent much higher rates on some goods, even those that are exported in large volumes.

Figure 7. Ad valorem transport costs of the top 20 product groups imported to the United States from China



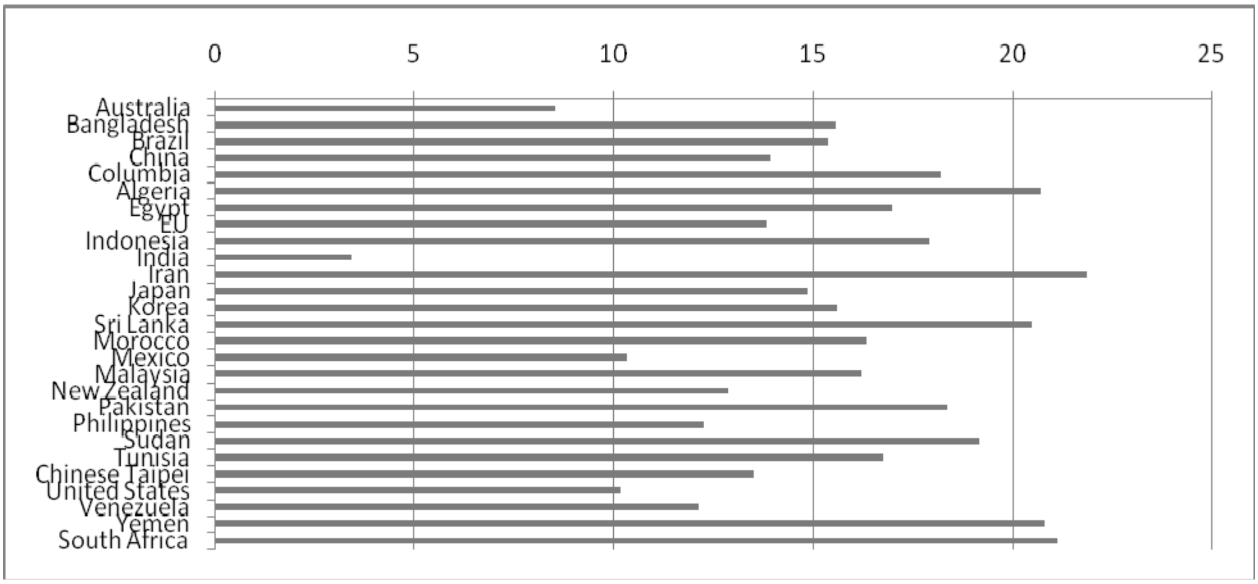
Note : These are the top 10 imported product groups at HS2 level to the United States from China in 2006.

Source: OECD Maritime Transport Cost Database.

65. In contrast to container-shipped goods, grains and oilseeds are generally shipped on small bulk carriers and the cost of shipping these goods is very high as a percent of their value. There are a number of reasons for this: smaller ships used do not offer the same economies of scale, for example, and there is less automation for bulk carriers in some ports. For most countries in the study, the cost of shipping grain is between 10 and 20 percent of the total import cost. For some countries – Algeria, Iran, Sri Lanka, Yemen and South Africa – the transport cost is greater than 20 percent ad valorem (Figure 8). These countries, almost without exception, are not large importers generally, although they are large grain importers. Their ports thereby do not generally represent regional hubs of any size. The one exception is South Africa which has major ports (Richard’s Bay, Durban) but which is far from grain exporting countries.

66. For most countries in this survey, transport of grains represents a significant cost. Transport costs of grains and oilseeds are over 10 percent of the total import value for: Bangladesh, Brazil, China, Columbia, Egypt, the European Union, Indonesia, Japan, Korea, Morocco, Mexico, Malaysia, New Zealand, Pakistan, Philippines, Sudan, Tunisia, Chinese Taipei, the United States and Venezuela (Figure 8).

Figure 8. Transport costs of grains, 2006, ad valorem equivalent by importer



Note: Estimates for total maritime freight costs have been calculated and divided by the total CIF value of imports. These data are therefore equivalent to weighted average transport costs.

Source: OECD Maritime Transport Cost Database. See Appendix Table II.1 for data availability.

67. The transport rates of small bulk carriers have increased sharply over the last 15 years in most cases. In the European Union and China, the cost of importing grain has risen on average by 12-13 percent per year, and has been particularly high since 2003. Increased costs have been on the order of 5-7 percent for many other countries: Algeria, Egypt, Korea and Morocco. Costs have remained unchanged or have fallen for Australia, New Zealand and the United States (see Appendix Table III.A.2 for evolutions over time).

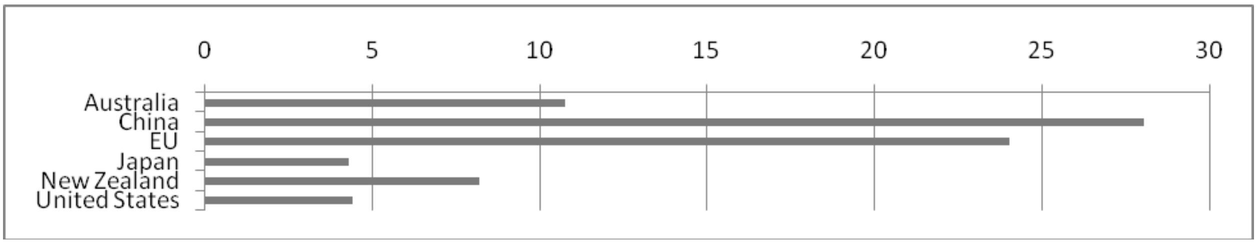
68. These particularly large increases in the cost of shipping in small bulk carriers, particularly over the last 4-5 years, are at least in part attributable to the soaring imports of industrial raw materials by China and other countries of South East Asia. The demand for large bulk carriers has soared due to high demand for raw materials in China and South East Asia, and supply of such carriers is relatively inelastic in the short to medium term (it takes at least three years to build such a ship, and there are limited shipbuilding facilities that can accommodate building such large vessels worldwide). Raw material exporters have therefore turned to smaller bulk carriers to move their shipments of iron ore, coal, bauxite, etc. This has put strong pressure on the cost of hiring small bulk carriers traditionally used for grains. Given the orders tendered in the shipbuilding industry and expected demand for industrial raw materials, this situation is not expected to improve over the short- to medium-term.

69. The countries for which data are available for transport costs of industrial raw materials, transported in “dirty bulk” carriers, echo the evolution of the cost of transport of “clean bulk” grains and oilseeds. China and the EU have shown strong increases in the ad valorem transport cost of iron ore, coal, bauxite, alumina, etc. of 12-13 percent per annum. Australia, New Zealand and the United States have shown slight decreases of 1 to 3 percent per annum (see Appendix Table III.A.3 for evolutions over time).

70. These changes have led to a varied picture of the transport costs of raw materials among the countries studied in 2006. Transport costs of industrial raw materials to China or the EU represent 28 percent and 24 percent ad valorem on average in 2006 respectively (Figure 9). These figures are extremely

high, and put these countries at a severe disadvantage if one considers the cost of transport as a form of tax on inputs – the cost of producing semi-processed manufactures or finished goods for which the raw materials are imported will be correspondingly higher. The effective cost on finished goods is therefore very high. Similar figures for the imports of raw materials to Australia, New Zealand, Japan and the United States are smaller but not insignificant: 11, 8, 4.3 and 4.4 percent ad valorem respectively (Figure 9).

Figure 9. Transport costs of industrial raw materials, 2006, ad valorem equivalent by importer



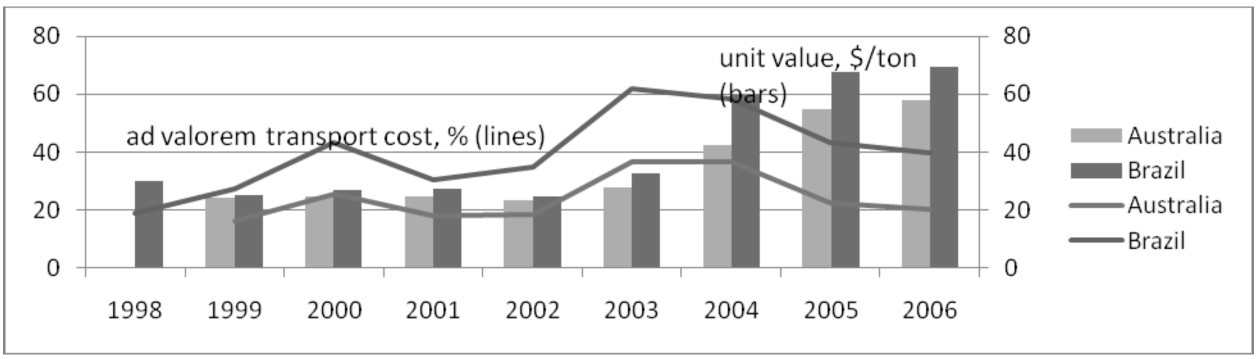
Note: Estimates for total maritime freight costs have been calculated and divided by the total CIF value of imports. These data are therefore equivalent to weighted average transport costs.

Source: OECD Maritime Transport Cost Database. See Appendix Table II.1 for data availability.

71. An example of the transport costs of a single commodity may illustrate their importance. One of China's most important imports is iron ore. Two-thirds of China's imports of iron ore comes from its two major suppliers, Australia and Brazil. Iron ore imports from China's two major suppliers rose five to six <u>times</u> in the last eight years. Ad valorem transport costs of iron ore originating in Brazil have risen over the eight year period from 20 percent ad valorem to reach a high of 60 percent in 2003, dropping to 40 percent in 2006 (Figure 10). Ad valorem transport costs for Australia rose less – 20 percent ad valorem with a high of 40 percent in 2003-4, returning to 20 percent in 2006. In addition, iron ore shipments will arrive more quickly from Australia as Australia is less than half the distance from China as compared with Brazil. The unit value of iron ore originating in Australia is slightly lower than that for Brazil, particularly in recent years (Figure 9). Imports of iron ore from Australia (126 billion tonnes) are concomitantly roughly twice those for Brazil (68 billion tonnes). The lower transport cost and quicker delivery time coupled with a slightly lower unit value contributes to make Australia's iron ore more competitive in China than Brazil's.

Figure 10. Chinese imports of iron ore from Australia and Brazil, unit values and ad valorem transport costs

US$/tonne and percent of import value



Source: OECD Maritime Transport Cost Database.

72. The analysis in this section suggests large differences in the ad valorem maritime transport cost of different goods in a given country. In Australia, for example, manufactures and processed agricultural products face transport costs of about 6 percent, grain imports are at 8.5 percent and industrial raw materials face 11 percent ad valorem costs. Nowhere are these differences more evident than in China where the transport costs of imported manufactures are 1.3 percent ad valorem, grains are 14 percent and industrial raw materials are 28 percent (Appendix Tables III.A.1, III.A.2 and III.A.3).

Do maritime transport costs represent insurmountable barriers to trade in some cases ?

73. The answer to this question is "yes" for a small number of countries.[23] Given the available data in this study, eight countries, mostly remote nations with very small markets, face such high transport costs that they represent a significant drag on most exports (Appendix Table III.B). These countries are: Christmas Islands (maritime transport costs of exports to all countries in this study equal 43 percent ad valorem on average in 2006), Andorra (38 percent), Montserrat (37 percent), Togo (36 percent), Guinea (23 percent), American Samoa (21 percent), Sierra Leone (21 percent) and Tonga (17 percent). The average for developing countries overall is 8 percent. Given these extremely high transport costs, these countries would need to specialize in export goods with very high value to weight ratios where transport costs play a smaller role.

74. A significant group of other exporters face high but potentially not insurmountable barriers to trade in the form of transport costs. These include some large exporters. Brazil and Argentina, for example, show export costs of 11 percent ad valorem on average, Australia 12 percent and Morocco 15 percent. These overall figures hide large differences in costs at the product level: some products are facing very high ad valorem transport costs. These countries are hampered by the cost necessary to get their goods to market, but nonetheless export significant volumes.

75. Some of the high costs facing exporters are rather hard to explain. Morocco for example, shows 15 percent ad valorem transport costs whereas Tunisia, which is nearby and has access only to the Mediterranean Sea (whereas Moroccan goods can be shipped from its Mediterranean or Atlantic ports), shows transport costs of 5.7 percent. Similarly, exports from Paraguay face 15 percent maritime transport costs whereas those from Uruguay represent only 6.5 percent.

76. Some products are subject to particularly high transport costs on a cost per weight basis. In 2006, these included jewellery and precious stones (to and from many destinations), artificial teeth (imports to China from the United States and imports from China into India), crushing or grinding machines (imports to the Philippines from the United States), ball bearings (from Canada to the United States), aircraft parts (imported from the United States into China), and blankets and travelling rugs (from the United States to China).[24] The high costs faced by some of these products can be explained by the high cost of insurance coverage.

What is the role of distance in maritime transport costs?[25]

77. Although distance plays a role in maritime transport costs overall, there is little direct correlation on a destination by destination basis. In fact, it is not distance that is most important but rather time spent

[23] The data used in the analysis of this section are in fact mirror data and refer to imports to all destination countries included in the dataset. See Appendix II for a full list of data availability.

[24] These commodities have a unit transport costs per kilogram of weight greater than 100 US dollars and a total transport cost in 2006 greater than 50,000 US dollars.

[25] This is a preliminary analysis and will be continued in more depth in a future paper.

at sea, which can vary due to different factors on the route (passage through Canals, etc.) as well as the size and speed of vessels. For example, although Sri Lanka is about twice as far from Europe as Sudan, the cost of exporting a tonne of grain there was only two dollars more in 2007 (59$ as opposed to 57$) and was slightly cheaper in 2006 (37$ to ship a tonne of grain to Sri Lanka and 38$ to ship a tonne to Sudan).

78. It seems that the relationship of transport cost to distance is not linear on a destination by destination basis.[26] This is indeed the implication of the information on the relationship between distance and the size of ship as expressed in Figure 1. The prices of transporting a tonne of goods to closer destinations (e.g., Western Europe to North America) are similar; once ships travel a certain distance, however, they are at a higher level. In this way, the transport prices per tonne of merchandise are clustered on two distinct plateaux. A case in point can be found in the grains market. There seem to be two types of major freight markets for grains – Europe and North America where grains are exported for about 35-40 US$ per tonne, and the Indian subcontinent, sub-Saharan Africa and the Persian Gulf, where rates are significantly higher (55-60 US$ per ton). This seems to be a common feature of most grain exporters – neighbouring markets are at one level, those farther afield at a significantly higher level.

79. Major grain exporters face transport costs (in US$/ton) to their main markets as follows:

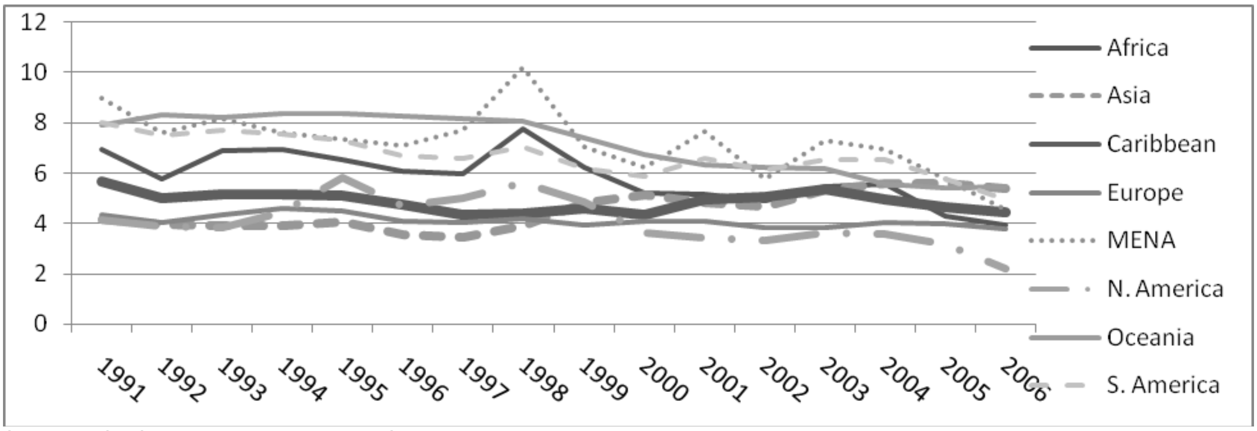
- United States/Canada: 18-30 for closer destinations; 30-49 farther afield
- European Union: 18-24 for closer destinations; 34-41 farther afield
- Baltic Sea: 17-32 (there are fewer export markets)
- Australia: 26-30 for closer destinations; 37-42 farther afield
- Argentina: 28 for closer destinations; 37-53 farther afield.

80. If one compares North American and European rates with those for Argentina, for example, it is obvious that Argentina is at a disadvantage in terms of freight cost. This may be because of the relatively lower level of exports. It does not seem to be due to Argentina's greater distance from major export markets. Argentina is on the most direct route to South Africa, for example, which is a major grain importer. Grains cost 35 US$ per tonne to ship into South Africa from Argentina and 34$ from the European Union, where the route is longer and more circuitous. Instead, the higher transport cost is probably due to the smaller vessels used to export from South America. Generally, South American grains and sugar exports are done on vessels that carry 25,000 tons. They therefore take longer at sea, and do not realize the relative economies of scale of Panamax (50,000 tons) or larger vessels.

81. One way of measuring the impact of distance on transport costs is to compare the evolution of transport costs from different destinations. Imports to the United States were compared from all regions of the world for all products. There is an observed convergence in the values – regions far from the United States or those that face higher maritime transport costs are falling faster than those that are near (Figure 11). This indicates that distance is playing a smaller role over time in the determination of transport costs.

[26] When comparing average maritime transport costs to a given market from many different markets, the correlation with distance is very slight – the graphed relationship resembles a "cloud of points". At a much greater level of aggregation, where transport costs are averaged by continent, the relationship is closer to a linear one, implying that distance is indeed one of the determinants of transport costs, although perhaps not the most important or straightforward one.

Figure 11. Ad valorem transport cost by region, imports into the United States



Source: OECD Maritime Transport Cost Database.

82. Another way to ascertain the role of distance on maritime transport costs is by comparing the cost of shipping each way (eastbound vs. westbound) on a single shipping route. The asymmetry in the freight costs of shipping containers is enormous: in 2006, if one compares the cost of shipping a container on eastbound vs. westbound legs of scheduled routes, they differed on average by 100 percent! That means that on average of the approximately fifty routes covered in the data set it is twice as costly to ship containers from e.g. Singapore to the United States as from the United States to Singapore. The percentage was even higher in the first ten months of 2007 – on average one way was 120 percent more than the return trip.

83. The averages above mask even large differences in eastbound vs. westbound rates on some routes. Some routes show as much as a 300 percent difference, i.e., freight rates going one way are 4 times those returning. The routes showing the highest asymmetry are: EU-Singapore, EU-Hong Kong, US-China, EU-China, Brazil-US, Dubai-Singapore, Singapore-India. The routes showing the least asymmetry are : Brazil-India, EU-India and EU-Dubai.

84. Part of the asymmetry in transport costs can be attributed to differences in the amount of goods transported in containers. Transporters that load large ships going, e.g. from China to the United States return almost empty and therefore charge very little on the United States to China route.[27] However, this cannot fully explain the differences in transport costs between eastbound and westbound routes. Indeed, the routes where there is the greatest imbalance in the freight rates are not necessarily those where there is the greatest trade imbalance of container-transported goods. Two examples are the EU-Singapore and EU-Hong Kong which, while an imbalance exists (18 vs 24 bln$ for EU-Singapore and 17 vs. 24 bln$ for EU-Hong Kong), it is not at all like that facing some other routes (US-China 52 vs 295 bln$ or EU-China 85 vs 247 bln$).

85. This phenomenon is not likely to disappear any time soon as the freight rate imbalances between eastbound and westbound legs of shipping routes have increased in 2007 over 2006 on almost all routes, sometimes very significantly. It is hard to ascertain why this is – it could be due to the large fuel surcharge in 2007 that is pushed more onto paying customers (e.g. Chinese exporters on the China – United States route) as opposed to containers returning empty or returning at low rates due to lack of demand. Similarly,

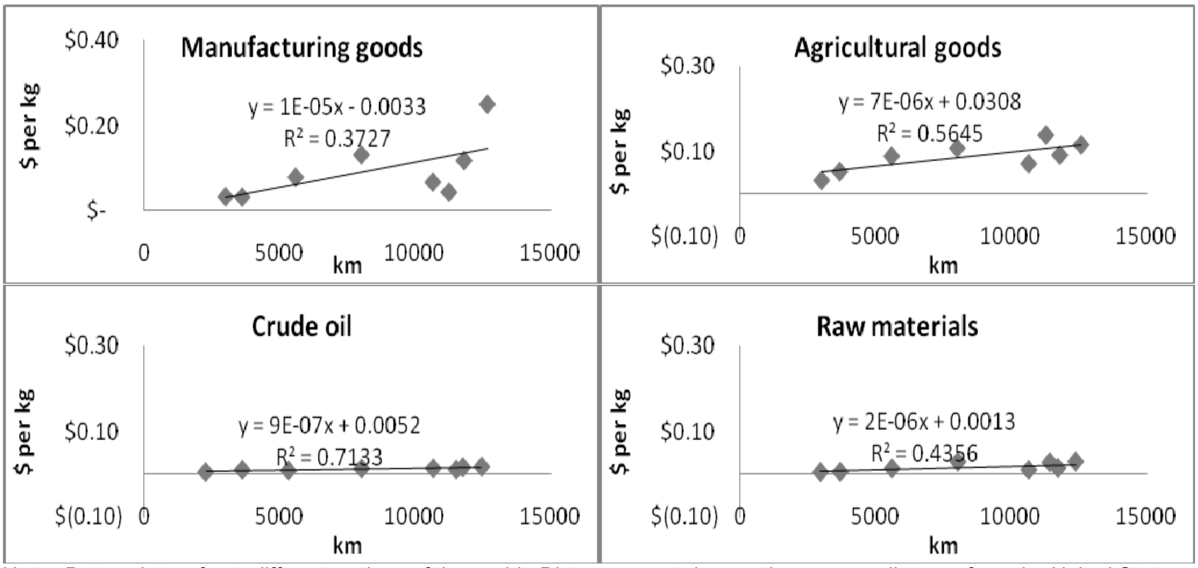
[27] This is not, strictly speaking, the same as the trade (im)balance, as it applies only to goods subject to container transport and does not include agricultural grains and oilseeds, bulk raw materials or petroleum products.

it could reflect the greater fuel costs of bringing full containers on the competitive route as opposed to the smaller amount of fuel used on the "half-empty" return trip.

86. Although the above analysis of freight rate imbalances suggests that distance is of limited importance as a component of transport costs, it may become more important in future. With the rise in the price of oil, one of the important variable components of the cost of transport has increased (see Figure 2 above). Since the fuel cost component of transport is directly correlated with distance, and the price of oil has risen to 110 dollars per barrel at the time of the writing of this paper, maritime transport costs may show a greater correlation with distance in future.

87. The effect of distance on trade costs varies across different product groups. As regards raw materials and crude oil, the effect of distance on trade costs measured in cost per tonne of merchandise is smaller than for manufacturing goods or agriculture. For both manufacturing and agricultural goods, the cost of shipping one tonne of merchandise is much higher, and increases more per extra kilometre transported, than that for raw materials or oil. The cost of importing manufactures and agricultural goods are therefore more affected by higher barriers to trade caused by distance than are raw materials or crude oil (Figure 12).

Figure 12. Transport costs as compared to distance travelled by commodity group, imports to the United States from different regions



Note: Data points refer to different regions of the world. Distances are taken as the average distance from the United States. Average of 1991-2006. See Appendix IV for definitions of commodity groups.

Source: OECD Maritime Transport Cost Database for transport costs, CEPII for distance.

V. Insights

88. This paper outlines developments in the maritime transport sector and interprets the new dataset compiled on maritime transport costs. It also describes the methodology and data sources used to compile the dataset. This dataset includes the most comprehensive information on maritime transport costs at the product level known in the public domain. The dataset will be used in a subsequent paper to ascertain the effects of transport costs on trade flows more precisely than has been possible in the past. A number of the insights in this paper will be used to inform the forthcoming modelling exercise. The potential importance of some of the components of maritime transport costs, information concerning questions of endogeneity between transport costs and trade, and information describing and explaining differences in maritime transport costs between different product groups and different countries of origin and destination will be used to shape the model underway.

89. The analysis of the dataset undertaken in this paper has shed light on some of the main trends in the maritime transport industry. It has revealed the following salient points regarding maritime transport costs:

- ***Despite many technological advances in the shipping industry that have produced economies of scale and greater efficiency, ad valorem maritime transport costs have not fallen much in the last quarter of a century.*** Overall, maritime transport accounted for eight percent of the cost of traded goods in 1980 compared with six percent today. In terms of shipping a tonne of merchandise, there is no evidence either that rates have fallen significantly over the last 15 years. In some countries such as the United States, the cost of importing a tonne of merchandise has risen.

Transport costs by origin and destination

- ***It costs more to ship to developing countries than to developed countries*** – eight percent of the price of final goods in developing countries as opposed to five percent overall for developed countries. These overall rates mask large differences in ad valorem transport costs at the product level, some of which can be very high.
- ***For a few remote nations, transport costs represent a potentially insurmountable barrier to trade.*** The highest cost is from the Christmas Islands, where exporters pay 43 percent of the price of goods overall to ship their goods to major markets. This can be compared to the world average of six percent overall.

Costs by product and segment of the maritime transport market

- The volume of trade in manufactures and processed agricultural products has risen quickly compared with agricultural and industrial raw materials, and ***the price of transporting goods in containers has dropped for most countries in the dataset. The cost of transporting a container to China has dropped most significantly*** – by nine percent per year since 1993.
- ***Transport of bulk commodities – agricultural or industrial raw materials – represents a significantly higher portion of their final cost than transport of manufactures and processed agricultural products.*** Transport costs of importing grains to most of the countries in the dataset represent between 10 and 20 percent ad valorem.
- ***The cost of transporting grains has risen sharply to most destinations in the dataset, particularly in the past five years.*** This is due mainly to increased demand for bulk carriers to transport industrial raw materials to China. Some smaller bulk carriers that have traditionally been used to transport grains are being used to transport industrial raw materials, putting pressure on the supply of ships to carry agricultural raw materials.

- ***For some countries that are major world grain importers but small traders overall, transport costs of grain imports can be greater than 20 percent*** – these include Algeria, Iran, South Africa, Sri Lanka and Yemen.
- ***The cost of transporting industrial raw materials has risen sharply to most destinations*** in the dataset. Transport costs of importing raw materials into China and the European Union are 28 and 24 percent ad valorem respectively. Although one would expect transport rates of industrial raw materials to be high because they are heavy and are generally low value added goods, transport costs over 20 percent represent significant barriers to imports.
- ***Some products are subject to particularly high transport costs***: jewellery, artificial teeth, aircraft parts and rugs are expensive to ship on a cost per weight basis perhaps due to high insurance costs.

Selected determinants of transport costs

- ***Transport costs differ vastly between a shipping route and its return trip***. Eastbound routes vs. westbound or northbound vs. southbound routes differ in cost on average by 100 percent. In some cases, cost of transporting a container one way is four times the cost of transporting a container on the return trip. The large cost imbalances mirror, although not perfectly, imbalances in trade in containerized goods in bilateral country pairs. Routes showing the highest asymmetry are the European Union and the United States with South East Asia; Brazil with the United States; and Singapore with India and Dubai. ***The importance of directional imbalances is one of the specificities of the shipping industry.***
- ***The rise in the price of oil in the last years has undoubtedly had a strong effect on transport costs*** and increased the relative cost of long haul trips compared to short-haul ones.

Bibliography

Anderson, J. and E. van Wincoop, *Trade Costs*, Journal of Economic Literature, 42(3), 2004, p. 691-751.

Baier, Scott, and Jeffrey H. Bergstrand, *The growth of world trade: tariffs, transport costs and income similarity*, Journal of International Economics no. 53, pp. 1027, 2001.

Baltic Exchange, *A History of the Baltic Indices*
http://www.balticexchange.com/default.asp?action=article&ID=47

Bradford, Scott, *The Extent and Impact of Food Non-tariff Barriers in Rich Countries*, Brigham Young University, January 2006, mimeo.

Clark, Don P., *Distance, production and trade*, Journal of International Trade and Economic Development, vol. 16, no. 3, September 2007.

Clark, Ximena, David Dollar, Alejandro Micco, *Port efficiency, maritime transport costs, and bilateral trade*, Journal of Development Economics no. 75, 2004.

Clarkson Research Studies, *The Tramp Shipping Market*, April 2004.

Corbett, J., Winebrake, J, Green, E. Kasibhatla, P., Eyring, V. and Lauer, A. *Mortality from Ship Emissions: A Global Assessment*, Environmental Science and Technology, forthcoming.

De, Prabir, *Impact of Trade Costs on Trade: Empirical Evidence from Asian Countries*, Asia-Pacific Research and Training Network on Trade, Working Paper no. 27, January 2007.

Devlin, Julia and Peter Yee, *Trade Logistics in Developing Countries: The Case of the Middle East and North Africa,* World Economy 28(3), pp. 435-56, 2005.

Djankov, Simeon, C. Freund, and C.S. Pham, *Trading on Time*, World Bank Policy Research Working Paper no. 3909, Washington, April 2006.

Feenstra, Robert C., *US Imports 1972-1994: Data and Concordances*, NBER working paper 5515, Cambridge, Massachusetts, March 1996.

Fink, C., Mattoo, A., and I.C. Neagu, *Trade in International Maritime Services: How Much Does Policy Matter?* The World Bank Economic Review, vol. 16, 2002.

Fuchsluger, J., *An analysis of maritime transport and its costs for the Caribbean*, UN-ECLAC, 2000.

Heaver, Trevor, *The Shipping Conferences Exemption Act: Review and Suggestions of Positions Appropriate for the Panel,* Canada Transportation Act Review Panel, April 2001.

Hoffman, Jan and G.G. Wilmsmeier, *Liner shipping connectivity and port infrastructure as determinants of freight rates in the Caribbean*, presented to the International Association of Maritime Economists conference, Athens, 2007.

Hummels, David (2001), *Toward a Geography of Trade Costs*, Purdue University, September 2001.

Hummels, David (2006), *Global Trends in Trade and Transportation*, 17th International Symposium on Theory and Practice in Transport Economics and Policy, Berlin, 25-27 October 2006.

Hummels, David (2007), *Transportation Costs and International Trade in the Second Era of Globalization,* Journal of Economic Perspectives, vol. 21, no. 3, summer 2007.

Hummels, David and Volodymyr Lugovskyy, *Are Matched Partner Trade Statistics a Usable Measure of Transportation Costs?,* Review of International Economics, 14(1) pp. 69-86, 2006.

IMF, *A Guide to the Direction of Trade Statistics*, http://www.ingentaconnect.com/content/imf/gdtsea.

International Herald Tribune, *China trade unbalances shipping*, January 30, 2006.

International Maritime Organisation (IMO), *International Shipping: Carrier of World Trade*, www.imo.com, 2006.

Levinson, Marc, The Box: How the Shipping Container make the World Smaller and the World Economy Bigger, Princeton University Press, Princeton and Oxford.

Limao, Nuno and Anthony J. Venables, *Infrastructure, Geographical Disadvantage, Transport Costs and Trade*, the World Bank Economic Review, vol. 15 no. 3, pp. 451-479, 2001.

Martinez-Zarzoso, Inmaculada and Felicitas Nowak-Lehmann, *Is Distance a Good Proxy for Transport Costs? The Case of Competing Transport Modes*, Journal of International Trade and Economic Development, vol. 16, no. 3, Sept. 2007.

McKinsey, Freight Expectations, The McKinsey Quarterly, http://www.tliap.nus.edu.sg/tliap/Project_SCG/docs/Reports/frex02.pdf, May 2002.

Micco, Alejandro and Natalia Pérez, *Determinants of Maritime Transport Costs*, IADB Working Paper 441, April 2002.

Nordas, Hildegunn Kyvik, Enrico Pinali and Massimo Geloso Grosso, *Logistics and Time as a Trade Barrier*, OECD Trade Policy Working Paper No. 35, OECD, Paris, 30 May 2006.

Obstfeld, M. and K.S. Rogoff, *The six major puzzles in macroeconomics: Is there a common cause?*, NBER Macroeconomics Annual 2000, http://www.nber.org/papers/w7777.pdf?new_window=1, p. 339-390.

OECD (2005), *The Role of Changing Transport Costs and Technology in Industrial Relocation,* DSTI/DOT/MTC(2005)5/REV1.

OECD(2008), *Vertical Trade, Trade Costs and FDI: Preliminary results*, TAD/TC/WP/RD(2008)7, 3 April 2008.

Radelet, S. and J. Sachs, *Shipping Costs, Manufactured Exports, and Economic Growth*, http://www.earth.columbia.edu/sitefiles/File/about/director/pubs/shipcost.pdf , 1998.

Redding, S. and Venables, A.J., *Economic Geography and International Inequality*, Journal of International Economics, vol. 62, no. 1, 2004.

Rodrigue, J-P., Slack, B. and Notteboom, T., *Maritime Transportation,* http://people.hofstra.edu/geotrans/eng/ch3en/conc3en/ch3c3en.html, Hofstra University, 1998.

Sydney Ports Corporation, *Current: An Update,* http://www.sydneyports.com.au/__data/assets/pdf_file/0014/3371/Current_May_07.pdf, May 2007.

UNCTAD (2006), *Transport Newsletter No. 34*, fourth quarter 2006, Geneva.

UNCTAD (2007), *Review of Maritime Transport*, New York and Geneva, 2007 (and earlier years).

Von Hinten-Reed, N., Chipty, T. and Morton, F.S., *Shipping Conferences: A Study of the Impact of FEFC Activity on Prices in the North Europe-Asia Trade*, Charles River Associates, 4 June 2004.

Wilmsmeier, Gordon, Jan Hoffmann and Ricardo Sanchez, *The impact of port characteristics on international maritive transport costs*, published in "Port Economics", Research in Transportation Economics, vol. 16, K. Cullinane and W. Talley, eds., Elsevier, 2006.

World Bank, Doing Business: comparing business regulations, http://www.doingbusiness.org/.

WTO, *Maritime Transport Services: Background Note by the Secretariat*, S/CSS/W/106, 4 October 2001.

APPENDIX I. THE SHIPPING INDUSTRY[28]

Strong growth in the shipping industry has been fuelled by strong growth in exports, particularly in manufacturing; conversely, technological advances in the industry have permitted world exports to expand rapidly. Ships have become bigger and faster. The growth of containers, permitting automated loading and unloading of ships and more seamless interface with other modes of transport, have revolutionized the way goods travel. There has been much consolidation among shipping companies in their transport activities, and some have combined their reach with acquisitions in the areas of logistics services, port services and port infrastructure.

Market segmentation

A variety of different types of vessels exists, each used to transport a specific range of goods: bulk carriers, tankers, container ships and other ships such as "roll-on, roll-off" car carriers.

Bulk carriers and tankers account for 70 percent of shipped exports measured by weight.[29] Most bulk carriers transport "dirty bulk" goods: iron ore, coal, bauxite and other industrial raw materials. "Clean bulk" carriers transport grains, oilseeds, and some sugar. The bulk market is also referred to as tramp shipping as long as a single product is carried for a single shipper. The tramp market does not maintain regular routes or regular service. The vessel is typically chartered (rented) for a given route or, increasingly, a given amount of time. In the case of a time charter, the shipper rents the ship and crew, but assumes all costs in connection with the voyage, including fuel and port fees, and costs related to loading and unloading.

Goods transported in bulk are generally of lower value per weight than goods transported in containers. More manipulation is generally needed to load and unload the goods and transfer to another mode of transport (road, rail, fluvial) is generally less seamless than for containers.

The leading tramp-owning and tramp-operating nations are, by order of importance: Norway, United Kingdom, Netherlands and Greece. Competition has traditionally been high in the bulk shipping market which explains why this sector has relied earlier and more heavily on open registries and low-cost seafarers.[30]

Tankers typically transport petroleum and petroleum products and some liquid chemicals. The tanker shipping market is somewhat less competitive than that for dry bulk transport.

Most manufactured goods and an increasing amount of agricultural products are transported in *containers*. Containers have revolutionized the shipping industry by bringing greater automation thereby allowing just in time production processes to evolve, permitting the increase in vertical integration that has

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[28] This section refers to the trends and structure of the international shipping industry. Cabotage, or the transport of goods between two terminals in the same country, is outside the scope of this study.

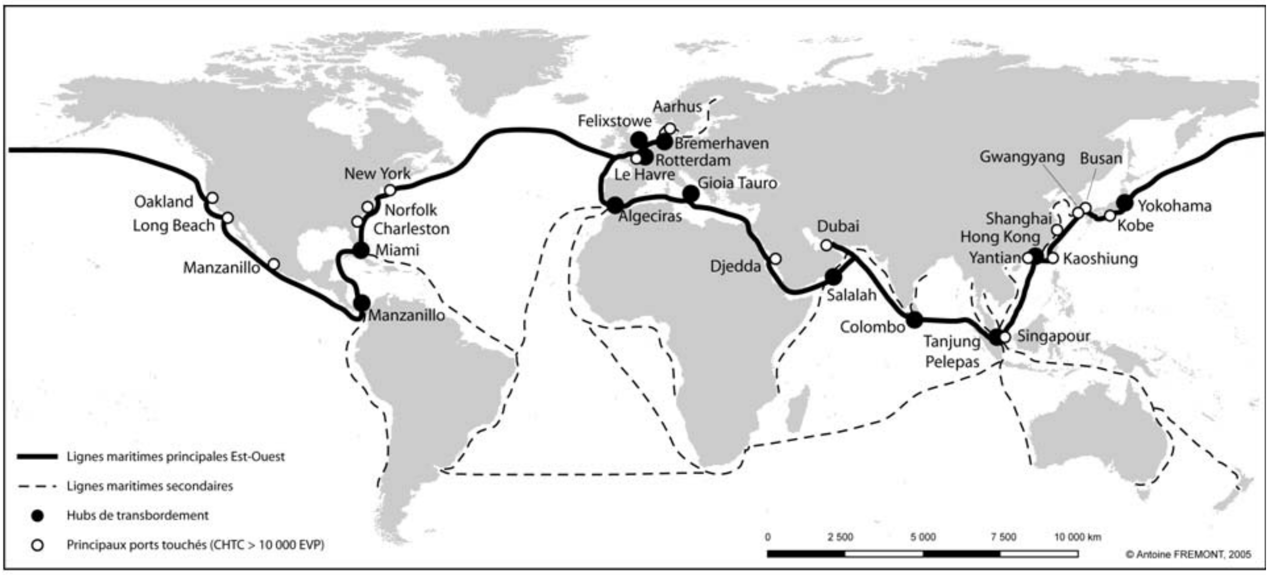
[29] www.shippingfacts.com

[30] Open registries refer to the possibility for ship owners to register their ships under "flags of convenience", i.e., in countries where regulations fit their commercial model. Many ships are registered in Panama, Liberia and the Bahamas largely for commercial reasons.

in turn driven demand for container transport.[31] The revolution in the shipping industry brought on by containerization has often been accompanied by complementary investments in port facilities that have further improved efficiency.

Containerized cargo refers to cargo transported in standard containers that are loaded onto specialized container ships, and contain a wide variety of goods – most manufactures, processed food products and an increasing amount of other merchandise. Containers come in two standard sizes: 20-foot boxes and 40-foot boxes. Container rates are generally expressed as the cost to transport a twenty-foot equivalent unit (TEU), although some references are for forty-foot equivalent units. Containers are generally transported on regularly-scheduled liner services with pre-set schedules and routes. (See map below of the major ports serviced by Maersk, the largest container shipping firm worldwide).

Figure I.A.1. Major ports serviced by Maersk, largest global container shipping firm



Source: Frémont, 2007, Conteneurisation et mondialisation, Les collections de l'INRETS, Lavoisier

Container traffic is generally organized according to the "hub and spoke" model.[32] Given the cost of loading and unloading, time spent in ports, etc., there is a very significant advantage to being close to a "hub". Some countries have made significant port improvements in order to establish themselves as

[31] A history of the growth of containers and the structural changes it has brought with it is in Marc Levinson's The Box: How the Shipping Container Made the World Smaller and the World Economy Bigger.

[32] The "hub and spoke" model of transport and logistics, first devised by Federal Express, organizes transport by bringing goods from "spokes", i.e., lesser-used ports, to "hubs", major transhipment ports, in order to export to another "hub".

regional maritime transport hubs. Port Said in Egypt, for example, has undergone recent investment to consolidate its position as a major Mediterranean hub. Its capacity will have doubled by 2009 to accommodate 5.1 million containers yearly.[33] Tangiers (Morocco) will have increased its capacity to 3.5 million TEU by 2015.[34] Not only are there gains to be had in transhipment services, providing links to "spokes" but establishing such a hub implies that the economy in question is highly integrated into the world economy.

Container traffic has been the fastest growing segment in maritime transport; this trend will undoubtedly accentuate. One billion tonnes of containers were transported in the early 1990s compared with between 3 and 4 billion tonnes today. The forecast for container traffic is 10 billion tonnes in 2020. Similar forecasts for bulk cargo and tankers are just over 2 billion tonnes each.[35]

An increasing palette of goods is being shipped in containers. Some agricultural produce that has traditionally been shipped in bulk is now being moved in containers. Twenty five percent of traded fruits and vegetables, for example, is now shipped in containers. Fruits increasingly shipped in containers include bananas, pineapple, pears and apples. There are a number of reasons for this, not least of all cost. In the past, bulk trade was cheaper than containers for most agricultural produce. Due to a number of reasons, this is no longer the case. Today, it is cheaper to ship sugar, a commodity traditionally shipped in bulk, in containers. The cost of shipping a tonne of sugar from Europe to the Middle East by container is 40 dollars. The comparable cost of shipping by bulk is 50 dollars per tonne.[36] This is due in part to the smaller vessels used to ship bulk agricultural goods that do not benefit from the economies of scale as do some of the large liner vessels. Container trade also implies more automated handling thereby lowering the cost of stevedoring. Additionally, shipping some non-traditional commodities in containers is brought on in some cases due to the trade imbalances on liner routes.

Technological evolutions in size of ships and infrastructure

The capacity of liner ships (i.e., transporting containers) and bulk carriers has increased dramatically over the last half decade. In 1968, liners typically shipped 2000 containers (TEU); by 1988, a typical liner could transport 4000 TEU. Today, the largest container ships transport 11,000 to 16,000 TEU, which equals 67 kilometres of containers aligned from end to end. The latest generation of container ships can carry the equivalent of 10,000 heavy trucks (IMO, 2006).

There are many different sizes of bulk carriers. The most common are Handysize, Panamax and Capesize. Ships of different sizes are used for different purposes. The smallest ships are Handysize which carry between 10 and 40 thousand tonnes of cargo. These ships are very flexible: they are appropriate for use in smaller ports, and in most cases they are "geared" – i.e., fitted with cranes permitting loading and discharging of cargo at ports which lack cranes or other cargo handling systems. Compared to larger bulk carriers, handysizes carry a wide variety of cargo types. These include steel products, grain, soybeans, sugar, metal ores, phosphate, cement, logs and woodchips.

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[33] http://www.animaweb.org/actu-detail.php?actu=2042

[34] http://www.algerie-dz.com/article10515.html

[35] *Sans transport, pas de mondialisation*, presentation by Antoine Frémont, INRETS, "Mondialisation, Transports, Logistique", conference organised by the French Prime Minister's office, Centre d'analyse stratégique, Paris, 20 September 2007.

[36] This example was related by a senior manager of CMA-CGM, 9 March 2007.

The middle-sized bulk carriers are of Panamax size. These refer to ships that are up to the dimensions that can fit through the locks of the Panama Canal. Goods destined to pass through the Canal must be shipped on small- to medium-sized ships and it is therefore not possible to realize economies of scale that are found on very large ships. An increasing number of ships are being built precisely to the Panamax limit, in order to transport the maximum amount of cargo through the Canal in a single vessel. The increasing prevalence of vessels of the maximum size is a problem for the canal. They typically transport a maximum of 5000 TEUs. However, a Panamax ship is a tight fit when passing through the Canal requiring precise control of the vessel in the locks, possibly resulting in a longer lock time, and requiring that these ships be transited in daylight. The largest ships cannot pass safely in opposite directions, so the canal effectively operates an alternating one-way system for these ships.

Post-Panamax is the term for ships larger than Panamax, which do not fit in the original canal. One example is the Capesize ships, which typically carry 175,000 tonnes of goods. These large bulk carriers can transport enough grain to feed nearly four million people for a month (IMO, 2006). Capesize ships are too large to cross either the Panama or Suez Canals. To travel between oceans, such vessels must traverse either the Cape of Good Hope or the Cape Horn. Capesize ships typically transport mineral raw materials. The increasing Chinese demand for raw materials and augmented congestion in the Suez and Panama Canals have led to an increase in the number of Capesize vessel orders.

Increase in demand has also led to infrastructure projects to increase the size and capacity of the canals. In 2006, it was decided that the Panama Canal would be augmented, at a cost of 5.3 billion US dollars. A third set of locks will supplement the two existing sets of locks, increasing capacity to accomodate almost all ship sizes. Expansion is expected to be completed by 2014 and costs are expected to be recovered within 11 years. After expansion, the Panama Canal is expected to be able to handle vessels up to 12 thousand TEU in size; currently, it can only handle vessels up to 5000 TEUs.[37] (By comparison, the Suez Canal can support 8000 TEU containerships.) The present proposal to expand the Panama Canal will be particularly useful for the Asia – US East Coast route. On that route, 61% of the container market uses the US intermodal system (i.e., discharging in US West Coast ports and transporting to final destination cities by road or rail), and 38% through the Panama Canal (1% through the Suez Canal).[38]

Pending Canal expansion, there exists a tradeoff over long hauls between loading large ships, thereby gaining speed in open seas and taking advantage of economies of scale, and using smaller ships that can take more direct routes through existing canals.

The evolution in the size of ships, and their increasing number, has also created port congestion, which may call into question some decisions to outsource. This is considered by shippers to be one of the major problems facing the industry today (see section on future challenges below). One example of a company that has moved its production facilities closer to home in part due to port and transport delays is the French car manufacturer Renault. Renault recently moved some of its parts production facilities to North Africa from China, reportedly due in part to delays in Chinese ports which hindered just-in-time production processes.[39]

[37] Proposal for the Expansion of the Panama Canal: Third set of lochs project, http://www.pancanal.com/eng/plan/documentos/propuesta/acp-expansion-proposal.pdf , p. 6.

[38] Source: Proposal for Expansion of the Panama Canal : Third set of locks project, Panama Canal Authority, April 24, 2006, http://www.pancanal.com/eng/plan/documentos/propuesta/acp-expansion-proposal.pdf

[39] "Mondialisation, Transports, Logistique", conference organised by the French Prime Minister's office, Centre d'analyse stratégique, Paris, 20 September 2007.

In order to secure access to ports, some large shipping lines are buying the rights to port operations. Presently, operation of major ports is performed by 5-6 main port operators. Large liner shippers such as the French conglomerate CMA-CGM are attempting to buy up port facilities.[40] In order to improve congestion problems between ship and rail transport, they are also investing in rail systems in some countries. These improvements require large investments which will lead to even greater consolidation in the shipping and related industries.

Changes in the competitive environment

An important historic feature of oceanic liner transport is the operation of *conferences*.[41] These are formal agreements between companies engaged in particular trading routes. Members of a given shipping conference meet to fix the rates charged by the individual lines. Over the years, in excess of 100 such conference arrangements have been established. Although they may be seen as anti-competitive, conferences have generally escaped prosecution from national anti-trust agencies. This is largely because they are seen as a mechanism to stabilize rates in an industry that is inherently unstable, with significant variations in supply of ship capacity and market demand. By fixing rates, exporters are protected from swings in prices and are guaranteed a regular level of service provision. Firms compete on the basis of service provision rather than price (Rodrigue et al., 1998).

The share of conferences in liner trade has declined (WTO, 2001). Shipping practices have changed dramatically so that conferences that were important up to the early 1990s have greatly diminished in significance. They have often been replaced by wider reaching agreements. These agreements generally involve a larger percentage of carriers than was true for the old conferences but have lesser constraints on rates actually charged as they issue rate "guidelines" (Heaver, 2001). Conferences today do not generally determine or enforce their members' compliance with suggested rates.

Over the last several years, containerized cargo has been transported at individually negotiated rates, whether they are spot rates or rate agreements with longer-term commitments. Carriers typically charge an "all-in rate" which includes sea transport charges, ancillary charges, and surcharges, including for fuel. Some carriers are vertically integrated, owning certain equipment and facilities at ports that can facilitate the loading or unloading of cargo. Certain carriers offer better or more integrated forms of inland transportation. To the extent that conference members may offer better services, in terms of loading/unloading cargo or inland transportation relative to non-conference members, they may be able to charge higher prices (von Hinten-Reed et al., 2004).

The shipping industry, particularly container shipping, has undergone extensive consolidation. Mergers and acquisitions have resulted in large container shipping conglomerates. The top four service operators provide close to one-third of all container shipping services, and the top 10 firms account for close to half of container shipping (Table I.A.1). The top 20 liner operators, 11 of whom are based in Asia, accounted for close to 70 per cent of capacity in 2000, up from less than 50 per cent in 1997 (Sydney Ports, May 2007). This trend is likely to continue, given the orders filed and the larger capacity of newer ships (WTO, 2001). This is of course an overall view, and competition may vary substantially between routes.

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[40] "There is a battle raging" regarding control of ports, indicated one senior manager of CMA-CGM, 9 March 2007.

[41] An historical review of competition in the maritime transport industry can be found in WTO (2001) or in DSTI/DOT/MTC(99)8, *Discussion Document on Regulatory Reform in International Maritime Transport*, OECD.

Table I.A.1. Leading operators of containerships, 2006

Rank	Operator	Country/territory	No. of ships in 2006	TEU capacity in 2006
1	Maersk Line	Denmark	484	1,573,551
2	MSC	Switzerland	320	1,019,725
3	CMA-CGM	France	167	517,213
4	Hapag-Lloyd	Germany	136	454,526
5	COSCO	China	134	390,354
6	CSCL	China	122	387,168
7	Evergreen	Chinese Taipei	127	377,334
8	APL	Singapore	105	342,461
9	Hanjin	Korea	78	337,378
10	NYK	Japan	85	283,109
	Top 10		**1,758**	**5,682,819**
	World container fleet at 1 January 2007		**8,331**	**11,720,000**

Source: UNCTAD Review of Maritime Transport, 2007.

McKinsey (2002) underlines the high risk in the freight transportation industry. This is attributed to a number of causes, not least of all anomalies in contract practices. According to industry practices, exporters or freight forwarders can reserve space on terms that in effect give them a free call option: if the spot price (i.e., the price to ship immediately) falls below the forward price agreed upon between shipper and client, the client can simply rebook space on the spot market, without paying any penalty to the original provider. Although the contract has a minimum-volume clause, such provisions are rarely enforced (Ibid).

Additionally, shippers tend to give volume-based discounts on all routes, regardless of capacity constraints. An exporter seeking a large amount of space on ships sailing, e.g., from Hong Kong to Antwerp, a route in high demand, will always pay less per TEU than clients booking smaller volumes. Conversely, clients prepared to pay higher rates cannot be sure of obtaining space on a ship. A company with an urgent shipment but no space reserved on a full ship that is about to sail cannot buy space on it at any price. Although clients often breach their contracts with carriers, carriers cannot do the same, in part because the freight industry has no system for compensating customers with non-urgent cargoes that could sail on the next available ship (McKinsey, 2002).

Maritime transport in the GATS

The principles of the trade in maritime transport services are contained, like for all services, in the General Agreement on Trade in Services (GATS). The Annex (to the GATS) on Negotiations on Maritime Services provides for resumed negotiations on maritime transport to improve on the commitments included in the Uruguay Round schedules. Existing commitments cover three main areas in the sector: access to and use of port facilities, auxiliary services such as loading and unloading, pushing and towing services and navigational aids and pilotage, and ocean transport.

Thirty two countries made commitments on maritime services during the Uruguay Round negotiations. Five countries did so later. Additionally, ten new acceding countries have included maritime services in their list of commitments.

Environmental aspects of maritime transport

Of the different modes of transport, maritime transport is the least polluting. All modes of transport taken together account for 24 percent of the total emissions of CO_2 linked to petrol combustion. Of these, road transport emissions account for 18 percent of the total, air transport accounts for 3 percent of the total and maritime and fluvial transport together account for 2 percent of total CO_2 emissions (OECD International Transport Forum, 2007). A large cargo vessel emits about 10 grams of CO_2 per tonne/kilometre of freight compared to 50 grams emitted by a large truck with trailer and 550 grams emitted by an airplane (for a 747-400, average calculated over a medium-haul 1200 km flight) (IMO, 2006).

Despite these positive figures, the large volume of maritime transport means that it contributes to pollution levels. A recent epidemiological study finds that 60,000 cardiopulmonary and lung cancer deaths can be attributed annually to pollution from oceangoing ships. Most deaths occur near coastlines in Europe, East Asia and South Asia (Corbett et al, forthcoming). Given current regulations and the expected growth in shipping activity, annual mortalities could increase by 40 percent by 2012 (Ibid).

California, home to Los Angeles, the eighth largest port in the world, recently imposed an environmental tax on containers transiting, loaded, or unloaded in its port. The tax policy is an attempt to integrate the costs of the negative externalities of environmental damage caused by the maritime transport industry. Although the tax will not be large enough to affect demand for goods and for shipping services, since transport costs remain a small share in the total cost of goods, the policy underlines a growing public awareness of the environmental costs of transport.

Future challenges to the maritime transport industry[42]

Despite the phenomenal growth that the maritime transport industry has undergone, it faces a number of challenges to its development. Some of the main ones are listed below.

- Port, canal and inland transport interface congestion
- Increased security that drives up the cost of shipping and poses infrastructure challenges
- The increased cost of fuel
- Environmental issues and consumer responses to them.

It has been seen above that congestion at ports, canals and in interfaces with land and river transport is a significant and increasing problem. The infrastructure necessary to load and unload the largest ships is immense, and infrastructure investments necessary to keep up with expansion have been lagging. It is estimated that congestion in the (total) transport sector represents 1.6 percent of GNP, or 200 billion dollars to the United States alone. Similar figures in the EU are 1.1 percent of GNP or 140 billion euros. Although these figures include congestion on roads, in airports and ports, and most of the total cost of congestion is due to road congestion, the general weight on infrastructure is significant.

Some shippers are putting into place strategies in the face of increased port congestion. One strategy is to use small feeder vessels to call at congested ports such as India’s Jawaharlal Nehru Port, picking up

[42] The information in this section is taken from conversations with senior managers and analysts in the shipping industry.

the goods from a trans-shipment hub such as Colombo, Sri Lanka or Salalah in Oman. These strategies are put into place to try to improve reliability of service but add cost in terms of extra handling.

Since 2001, there have been new security measures put into place regarding control of merchandise. Regulation which is imposed by a major importer (in this case, often the United States) often becomes the norm for shippers and freight forwarders, in order not to have duplicate processes and documentation. The extra cost of scanning and documenting container contents is estimated by one transporter to equal 50 to 100 dollars per TEU.[43] Delays due to new or upgraded security procedures may hold up cargo by 1 to 2 additional days on a loading site. According to estimates of time delays and their effect on trade, each additional day that a product is delayed in the shipping process reduces trade by more than 1 percent by (Djankov et al., 2006).

The increase in the cost of oil, at 110 dollars per baril, has increased costs in all transport industries. Although the maritime industry uses relatively less energy per tonne kilometre than the air transport industry, for example, prices for transport by sea have increased sharply in past months.

It has been seen above that there are significant environmental issues related to the maritime transport industry. Although the air transport industry may suffer more from any consumer response to environmental concerns, some maritime transporters are concerned about movements to “buy local”. Although these movements remain small, some large supermarkets and distribution retailers are including carbon footprint labels on their packages or simply stamping goods with an airplane logo when produce has been flown to its market.[44] Tesco, one of the largest retail distributors in the UK, has assigned a “carbon rating” to everything it sells.[45] Although these movements are not targeting the maritime industry per se, such consumer concerns in OECD markets are closely watched by maritime transporters.

It has been shown that differences in pollution levels result from air, maritime, road and rail transport. If in the long term a tax is placed on polluters, this could affect the future share of different types of transportation, and also potentially affect the total value of traded goods.

[43] Private conversations with senior manager of shipping conglomerate CMA-CGM.

[44] The “carbon footprint” of a product includes the energy required for its manufacture, its packaging and transportation of the product to the supermarket shelves.

[45] Financial Time, 18 January 2007, http://www.ft.com/cms/s/0/133d5be4-a718-11db-83e4-0000779e2340.html.

APPENDIX II. TRANSPORT COSTS DATA

A. Transport cost data obtained from customs declarations.

Transport cost data is obtained from customs declarations for three OECD Member countries: Australia, New Zealand and the United States. These data have been graciously made available to the Secretariat for the purposes of this project. Details on the coverage and scope of these data can be found below.

Australia

Source: Australian Bureau of Statistics

Import data is supplied at HS 6-digit level for all goods transported via sea freight. Data is available by commodity and by country of origin and is valued FOB, customs value (a market price FOB) and CIF. Import quantities are also available. Total insurance and freight costs can be derived by deducting Customs value from CIF.

The Australian Customs Service obtains the import data using Import Declaration N10. Data is also available by other modes of transport (air, post, etc.) Import data are generally collected at the HS 10-digit level and are aggregated to produce estimates at the 6-digit level.

The transaction value of goods is the price actually paid (or payable) for the imported goods.

New Zealand

Source: Statistics New Zealand.

Data is supplied at HS 6-digit level for all goods transported via sea freight. Data is available by commodity and country of origin and are valued CIF (i.e., including insurance and freight to New Zealand) and VFD (value for duty, i.e., the value of imports before insurance and freight costs are added). The difference in values CIF and VFD is therefore the cost of freight and insurance. Weight imported is also available for the vast majority of commodities. The data is measured in current New Zealand dollars. Values are then converted to US dollars for the purposes of this project.

The data is obtained from import entry documents lodged with the New Zealand Customs Service (NZCS). Import values are converted from foreign currencies when import documentation is processed by NZCS.

United States

US import statistics include shipments of merchandise into the US Customs Territory (50 states, District of Columbia and Puerto Rico), US Foreign Trade Zones and the US Virgin Islands from foreign countries. Import data includes net quantity, value data, value and shipping weight data for vessel and air shipments by commodity, by country of origin, by customs district of entry, by customs district of unlading and by rate provision. Import data is valued both FOB (customs value) and CIF (including cost, insurance and freight).

The import charges represent the aggregate cost of all freight, insurance and other charges (excluding import duties) incurred in bringing the merchandise from alongside the carrier at the port of exportation and placing it alongside the carrier at the first port of entry in the United States.

Import data is available by port of entry and, for goods that have entered by ship, whether the merchandise was containerized.

For more information see US Exports and Imports of Merchandise, Technical Documentation CDEX/IM, US Department of Commerce, Washington, DC, April 1995.

B. Container freight rates data sources

Drewry consulting

Drewry, a consulting firm for maritime transporters[46], collects container freight rates for multiple trade routes and port pairs based on averages of spot rates paid by shippers to freight forwarders. Drewry collects bi-monthly freight rates for over 100 routes to and from the US, Europe, Asia, the Middle East and Brazil. These rates have been used to produce annual data by taking simple averages of bi-monthly data. See Appendix Table II.1 for data used in this study with regard to goods shipped in containers.

The freight rates compiled by Drewry are sourced from freight forwarders and non-vessel-operating common carriers (NVOCC) located in Asia, Europe and the United States. The all-in freight rates are gathered from active freight forwarders, checked against other sources, and averaged to obtain the monthly representative freight rates. The rates are actual prices, based on millions of dollars of transactions, and are not mere “price list” tariff rates. The representative freight rates are averages of the rates for the carriers used by the forwarders involved and make no quality differentiation. These freight rates include all surcharges, including bunkers surcharges, as well as Terminal Handling Charges both at origin and at destination.

All Drewry freight rates are sourced from forwarders or NVOCCs: they are the sale rates to shippers, not the (lower) rates at which the intermediaries buy space from ocean carriers. Therefore, these freight rates include some remuneration for the service provided by the intermediary to the shipper, although they exclude inland transport. Shippers requiring a very high level of customized service, inland transport or value-added services pay more than the rates collected by Drewry, but they may still pay the same port-to-port freight rate. Very large shippers will generally obtain volume discounts resulting in lower port-to-port rates than the Drewry freight rates, which reflect the prices charged to small to medium-size shippers.

All the rates are forwarder rates to shippers. They are expressed in US dollars per container and differentiate between 20 foot and 40 foot container rates. The 20-ft. container price was used for this study. Data are calculated bi-monthly and are averages for specific months: January, March, May, July, September and November.

Drewry data are only available starting in 2006. Data for 2006 refer to simple averages of the six bi-monthly figures as available or, for some series that were added later on, four bi-monthly figures. Data for 2007 refer to averages of the five bi-monthly data points available (January, March, May, July, and September). Data for 2007 were not able to be compared with trade flow data as the annual flow data were not available at the time of the completion of the database.

[46] http://www.drewry.co.uk

Analysis of the freight rates was done using the raw data from Drewry. In order to calculate ad valorem equivalents of traded products, ratios of US transport costs to total values were used, and multiplied by the differences in transport costs along the different routes according to the methodology outlined in Box 1. This was done only for products that are generally shipped in containers, i.e., grains and raw materials that are generally transported in bulk carriers and petroleum products that are transported in tankers are not included. See Appendix IV for definitions of products that are transported in different carriers.

Containerization International

Containerization International, a UK-based consulting firm, calculates spot and contract shipping rates for containers originating and destined for the United States, Europe and Asia (i.e., six series).[47] Data are collected from approximately 10 carriers on each route. Asian data are averaged for major ports in East Asia from Busan to Singapore. European ports are averages for North Europe and Mediterranean ports. United States ports are assumed to be West Coast on the US-Asia route and East Coast on the US-Europe route. Data include vessel charges (total sea freight costs: including fuel surcharges, currency surcharges, etc.) but <u>not</u> costs on land side (e.g., Hong Kong's port charge per container; Long Beach port charge).

For the purposes of this study, the data for Asia are used for the following origin/destination countries: Korea, Japan, China, Philippines, Indonesia, Malaysia, Singapore, Hong Kong, Vietnam, and Thailand. The European data are used for the EU container freight costs, and the North American data are used for the exports from the United States. See Appendix Table II.1 for data availability of goods shipped in containers.

C. Data for bulk shipping rates

International Grains Council

The International Grains Council (IGC) collects freight quotes and estimates shipping rates per tonne of heavy grains for major grain exporters and destinations. Shipping rates are indeed estimates as more and more grains are shipped on time charters, i.e., on boats and barges rented on a daily rate over a number of months, or for a set route. In this case, IGC experts estimate the price per tonne of grain.

Heavy grains are assumed to be wheat and spelt, maize, oats, rye and sorghum. In principle, these rates could be used as approximates for soybeans and other oilseeds, but were not used in that way in this study. Barley is not included as it is a lighter, more voluminous grain. Different rates are required for estimating freight costs of barley.

IGC follows freight charges on a number of different routes from six major grains exporters: US/Canada, Australia, Black Sea, EU (Rotterdam/Antwerp), and Argentina. For both the US and Canada, rates are calculated for grains exported from the Northwest (Portland area), and from the East Coast. For this study, rates from the Northwest were used for exports to Asia (China, Indonesia, Japan, Malaysia and Korea). For all other destinations, rates from the East Coast were used. There are a number of reasons for this.

Higher quality, high protein red winter wheat is generally exported from the West Coast. Both soft and hard wheat are exported from the US Gulf. These rates were used for destinations for which the East Coast is closer (e.g., EU, Brazil) as well as those where high quality wheat is not necessary as the tradition is to eat non-rising bread (e.g., North Africa and the Persian Gulf countries).

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[47] These data are widely used and also published by UNCTAD.

Rates from the Black Sea ports were assumed to be shipments of grain from Russia and Ukraine. In practice, in the last few years (data are available for exports from the Black Sea starting in 2005), grains have been shipped either from Ukraine or from Russia due to uncertain weather and resulting difficult harvests.

As the IGC ocean freight rates are expressed in US dollars per tonne of merchandise, the percentage ad valorem of freight cost is a straightforward calculation. (See Appendix Table II.1 for data availability of transport costs of grains).

The Baltic Dry Index

The Baltic Dry Index (BDI) is a daily index of bulk freight rates issued by the London-based Baltic Exchange which traces its roots to the Virginia and Baltick coffeehouse in London's financial district in 1744. Since then, the Baltic Exchange has been published as a leading indicator of real freight rates. The Baltic combines information from freight brokers on the cost of booking different sizes of ships on different routes carrying specific types of cargo. These are blended into the general Baltic Dry Index which gives an overall idea of the changes in bulk shipping rates.

For the purposes of this study, specific routes and sizes of ship were used (i.e., the data underlying the BDI). In particular, 13 routes carrying coal and/or iron ore were extracted for this study. Exporting countries include Australia, Brazil, China, Ecuador, European Union, Japan, South Africa and United States. Importing nations include China, European Union, Japan and United States. (See Appendix Table II.1 for data availability.) Data series are available on a daily basis in terms of the cost of renting a given size ship in US$ per day. All data series refer to Capesize vessels (typically 150,000 DWT). Estimates are then made for the amount of raw materials that are carried on each vessel, and for the number of days each takes to complete a one-way voyage. Data were thus compiled for transporting a tonne of a given raw material on a given route. Daily data were averaged to obtain annual data.

It was assumed that vessels travel at close to full capacity, i.e., that they carry 90 percent of their total weight (dwt) in cargo. For some timecharter routes, brokers are obliged to pay the round trip journey – in this case, this was taken into account.

Appendix Table II.1 Information included in the dataset

	Importers	Exporters
Full information for all products (customs data)	Australia, New Zealand, United States	All destinations.
of which:		
Data covering manufactures and non-bulk agricultural products shipped in containers (estimates)	Brazil	EU, India, United States
	China	Brazil, EU, India, Singapore, United Arab Emirates, United States
	EU	Brazil, China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Philippines, Saudi Arabia, Singapore, Thailand, United Arab Emirates, United States, Vietnam.
	Hong Kong	EU, India, United States
	Japan	EU, United States
	Korea	EU, United States
	India	Brazil, China, EU, Hong Kong, Saudi Arabia, Singapore, United Arab Emirates, United States
	Indonesia	EU, United States
	Malaysia	EU, United States
	Philippines	EU, United States
	Saudi Arabia	EU, India
	Singapore	EU, India, United Arab Emirates, United States
	Thailand	EU, United States
	United Arab Emirates	EU, India, Singapore, United States
	Vietnam	EU, United States
Grains shipped in bulk		
	Algeria	Argentina, Australia, Canada, United States
	Bangladesh	Australia, EU
	Brazil	Argentina, United States
	China	Australia, Canada
	Columbia	Argentina, United States
	Egypt	Argentina, Australia, Canada, EU, Russia, United States
	EU	Argentina, Canada, Russia, United States
	India	United States
	Indonesia	Australia, Canada
	Iran	Australia, Canada
	Japan	Canada
	Korea	Australia, Canada
	Malaysia	Canada
	Mexico	Argentina, Canada, United States
	Morocco	Argentina, Canada, EU, Russia, United States
	Pakistan	Australia, Canada, Russia, United States
	Russia	Australia, Canada, United States
	South Africa	Argentina, Australia, Canada, United States

	Sri Lanka	Australia, Canada, United States
	Sudan	EU
	Tunisia	Argentina, Canada, EU, Russia, United States
	Chinese Taipei	Australia, Canada
	Venezuela	Argentina, Canada, United States
	Yemen	EU
Industrial raw materials (bulk)		
	China	Australia, Brazil, EU
	EU	Australia, Brazil, China, Ecuador, Japan, South Africa, United States
	Japan	EU

APPENDIX III.

Containers (manufactures, processed food products, etc.)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Importer																
AUS	9.22	9.12	9.04	8.49	7.9	7.97	7.87	7.69	6.86	6.83	6.89	6.25	6.22	6.69	6.86	6.42
BGD																
BRA																3.28
CHN			13.75	6.13	7.73	6.76	5.23	5.06	3.21	2.17	1.68	3.53	1.75	1.49	2.18	1.26
COL																
DZA																
EGY																
EU15			1.98	1.98	2.1	2.28	1.91	2.17	1.61	1.65	1.8	1.5	1.71	1.57	1.2	1.13
HKG			4.99	5.32	7.49	6.82	7.26	6.14	5.64	5.97	4.04	1.66	2.43	1.85	1.72	3.79
IDN			1.12	1.41	1.73	4.1	2.96	2.77	7.67	4.24	4.58	10.17	1.63	2.05	2.38	1.81
IND																1.62
IRN																
JPN			4.14	4.13	4.19	3.92	3.8	1.57	1.26	1.33	2.31	3.11	1.39	2.49	1.52	0.8
KOR			1.26	1.21	1.03	1.11	1.26	1.75	2.03	0.89	0.81	0.9	0.78	1.1	0.75	0.61
LKA																
MAR																
MEX																
MYS			5.78	5.62	7.63	5.29	1.31	0.71	1.66	1.05	0.9	0.64	0.62	0.4	4.43	2.38
NZL	8.67	7.91	7.9	7.63	7.33	7.24	6.86	7.21	6.18	6.22	6.22	6.02	5.8	5.81	6.3	6.15
PAK																
PHL						1.23	1.97	0.79	1.06	0.63	0.48	0.37	0.36	0.29	4.32	3.55
RUS																
SAU																2.12

SDN																
SGP			3.89	5.64	6.02	9.26	3.99	3.37	2.5	4.56	2.89	0.78	0.94	0.79	1.33	0.53
THA			2.39	2.81	2.69	1.6	1.54	2.33	1.52	1.19	0.77	1.3	0.98	0.86	1.04	1.01
TUN																
USA	4.29	4.05	4.04	4.01	4.15	3.71	3.55	3.83	4.44	4.69	4.47	4.42	4.84	4.98	5.03	4.83
VNM											0.58	0.58	0.73	0.64	0.71	

Appendix Table III.A1. **Ad valorem transport costs by type of shipment : Containers**

Note: data refer to weighted averages across all products and countries of origin for which data are available in the OECD Maritime Transport Cost Database. See Appendix II for data availability.

Appendix Table III.A.2. **Ad valorem transport costs by type of shipment: grains**

Grains ("clean bulk")

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Importer																	
AUS		12.77	12.23	11.85	13.49	14.55	9.02	8.98	9.1	9.21	9.17	8.09	7.07	12.06	9.6	11.92	8.52
BGD																28.23	15.53
BRA							6.08	3.52	1.56	10.27				12.31	15.4	17.02	15.36
CHN	9.46	11.81	10.16	14.97	15.28	11.56	6.17	8.24	8.85	7.86	8.81	5.54		5.12	14.93	13.16	13.91
COL																19.51	18.18
DZA	14.75	12.8	9.96	14.05	10.8	11.84	8.96	9.8	8.04	9.28				10.61	18.94	26.88	20.68
EGY	13.74	17.63	11.87	11.33	13.02	13.67	7.07	9.66	9.82	11.91	13.75	13.29	12.44	15.96	22.25	22.12	16.95
EU15		8.54	7.06	8.79	6.16	9.03	6.89	7.37	5.89	4.29	8.92	8.59	5.31	8.64	18.74	19.16	13.79
HKG																	
IDN																9.17	17.9
IND		19.08	24.93	22.14	21.34	14.53	11.31	13.08	3.42								
IRN	14.84	25.93		17.57	17.96	12.84	8.62	10.66			13.5			15.31	20.96		21.84
JPN							5.68		7.06	7.06		8.29	6.18	12.02	17.79	14.43	14.82
KOR	10.38	13.04		9.31	10.79	10.51	5.85	6.75	6.52	8.23	10.5	8		10.24	18.66	14.98	15.58
LKA																24.07	20.46
MAR	3.59	18.41	13.53	14.48	11.42	13.45	8.5	10.41	7.72	13.72	14	17.76		12.62	20.44	18.41	16.3
MEX		8.91	9.54	9.13		9.38	5.74	6.51	6.76	8.43		8.91		11.56	16.68	13.67	10.31
MYS																16.32	16.19
NZL		18.29	17.03	17.71	18.34	16.14	12.77	13.25	12.5	13.51	13.42	13.6	10.94	10.19	12.91	12.48	12.83
PAK																21.25	18.35
PHL			12.55	17.48	10.47			10.76	16.74	21.43				7.89	19.57	7.39	12.23
SDN																25.82	19.16
TUN																26.02	16.73
TWN																11.35	13.48
USA		11.71	10.14	9.82	9.72	9.37	8.02	7.88	8.81	9.3	9.75	10.62	10.37	9.95	11.7	11.32	10.12
VEN		12.8	13.52	12.44	12.42	12.57	8.09	7.93	8.56	12.34	11.75	11.79	10.54	9.22	13.42	13.09	12.11
VNM																	
YEM																25.51	20.77
ZAF			19.7		18.51	17.23	9.7	10.65	13.33					12.05	22.53	23.58	21.12

Note: data refer to weighted averages across all products and countries of origin for which data are available in the OECD Maritime Transport Cost Database. See Appendix II for data availability.

Appendix Table III.A.3. **Ad valorem transport costs by type of shipment: industrial raw materials**

Industrial raw materials ("dirty bulk")

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Importer																
AUS	12.84	13.31	13.19	13.18	12.28	12.47	12.49	12.1	10.77	11.75	12.2	11.69	11.32	12.02	11.28	10.76
BGD																
BRA																
CHN								18.21	19.6	30.5	22.16	24.62	45.96	45.37	29.67	28.02
COL																
DZA																
EGY																
EU15	17.75	10.79	13.86	16.8	18.47	13.24	15.45	11.25	14.56	26.16	16.96	14.91	37.8	39.87	26.16	24.02
HKG																
IDN																
IND																
IRN																
JPN									0.5	1.57	1.24	1.08	8.23	10.16	5.23	4.3
KOR																
LKA																
MAR																
MEX																
MYS																
NZL	11.84	11.54	12.32	11.8	11.58	10.64	10.59	11.96	9.34	8.29	9.77	8.63	9.6	9.85	9.2	8.21
PAK																
PHL																
RUS																
SAU																
SDN																
SGP																
THA																
TUN																
TWN																
USA	7.41	6.56	7.26	7.49	7.28	6.53	6.94	8.49	6.73	5.8	6.63	5.46	6.18	6.22	5.18	4.42

Note: data refer to weighted averages across all products and countries of origin for which data are available in the OECD Maritime Transport Cost Database. See Appendix II for data availability.

Appendix Table III.B. Transport costs by exporting country, ad valorem equivalents

		1993	2000	2006
CXR	Christmas Isl.	21.13	26.43	43.1
AND	Andorra	0.58	2.73	37.5
MSR	Montserrat	22.96	3.93	36.97
TGO	Togo	14.27	8.56	35.53
GIN	Guinea	21.02	20.56	22.47
ASM	American Samoa	47.1	54.04	21.09
SLE	Sierra Leone	14.37	15.51	20.66
TON	Tonga	24.24	19.8	17.21
MAR	Morocco	11.87	11.72	15.32
PRY	Paraguay	7.87	11.29	15.24
ZAF	South Africa	8.39	14.82	14.23
SLB	Solomon Islands	9.86	16.23	13.33
BEN	Benin	6.75	9.03	13.3
NIU	Niue	12.87	10.14	13.29
PLW	Palau	5.59	4.23	13.03
MOZ	Mozambique	6.11	6.31	12.36
FJI	Fiji	6.73	5.5	12.32
AUS	Australia	8.01	10.88	12.11
GUY	Guyana	18.74	15.59	12
MDV	Maldives Islands	4.9	3.5	11.59
NFK	Norfolk	8.24	4.41	11.53
AFG	Afghanistan	5.91	22.98	10.99
NCL	New Caledonia	18.09	18.83	10.99
GEO	Georgia	5.68	6.25	10.9
KIR	Kiribati	8.01	6	10.71
BRA	Brazil	8.24	10.42	10.68
ARG	Argentina	8.46	7.45	10.59
BFA	Burkina Faso	7.78	25.46	10.06
GRL	Greenland	4.1	3.46	9.87
VCT	St. Vincent and the Grenadines	4.27	7.49	9.7
WSM	Western Samoa	13.12	8.39	9.62
LCA	St. Lucia	5.12	4.41	9.56
FSM	Federated States of Micronesia	5.81	6.02	9.2
QAT	Qatar	9.6	18.14	8.77
SYC	Seychelles	9.57	3.97	8.75
GHA	Ghana	10.86	8.13	8.22
JAM	Jamaica	6.32	5	8.12
BGR	Bulgaria	7.87	8.21	8.09
BLR	Belarus	13.29	7.69	7.96
TUR	Turkey	6.33	6.29	7.8
CYM	Cayman Isl.	7.25	3.22	7.68
BMU	Bermuda	5.27	5.66	7.48
GIB	Gibraltar	1.96	0.8	7.41
KGZ	Kyrgyz Rep.	6.32	5.91	7.41
LBN	Lebanon	5.83	4.92	7.39

UKR	Ukraine	15.32	10.85	7.38
CRI	Costa Rica	9.21	8.71	7.37
CIV	Cote d'Ivoire	11.01	9.03	7.32
ROM	Romania	8.36	6.67	7.09
DMA	Dominica	5.88	8.04	6.99
WLF	Wallis and Futuna	11.45	7.76	6.93
SYR	Syria	10.34	7.23	6.92
CYP	Cyprus	12.15	6.83	6.91
LTU	Lithuania	12.8	10.03	6.87
CAF	Central African Rep.	3.07	2.15	6.79
EGY	Egypt	7.63	5.48	6.79
ARM	Armenia	5.31	6.73	6.77
GTM	Guatemala	8.46	5.78	6.75
YEM	Yemen	11.59	6.99	6.73
ATG	Antigua	10.24	10.04	6.66
PAN	Panama	10.65	6.71	6.65
FRO	Faroe Isl.	4.64	3.55	6.62
EST	Estonia	7.69	7.79	6.59
MKD	Macedonia	4.84	4.94	6.5
PYF	French Polynesia	4.11	8.89	6.49
BDI	Burundi	4.58	5.53	6.46
URY	Uruguay	5.91	5.64	6.46
CHL	Chile	15.6	11.56	6.43
MWI	Malawi	10.37	5.24	6.43
NRU	Nauru	18.4	19.32	6.39
PAK	Pakistan	5.78	6.19	6.38
CMR	Cameroon	8.83	6.49	6.36
NZL	New Zealand	9.41	7.44	6.29
IDN	Indonesia	6.54	6.75	6.23
ETH	Ethiopia	6.73	7.25	6.2
BTN	Bhutan	8.45	7.7	6.14
OMN	Oman	8.76	7.86	6.06
REU	Reunion	5.4	2.55	6.04
IRN	Iran	10.86	3.91	6.03
STP	Sao Tome and Principe	0.86	4.39	6.03
MCO	Monaco	21.17	3.87	6.02
TKM	Turkmenistan	12.85	5.78	6.02
LVA	Latvia	14.35	6.74	6
MDA	Moldova	8.39	8.36	5.99
MHL	Marshall Isl.	11.69	4.19	5.9
LIE	Liechtenstein	33.98	9.27	5.86
BLZ	Belize	7.73	5.06	5.85
ECU	Ecuador	10.47	9.8	5.82
POL	Poland	7.08	6.6	5.82
MYS	Malaysia	3.82	4.93	5.79
TKL	Tokelu	2.8	6.17	5.72
TUN	Tunisia	6.4	7.52	5.72
PNG	Papua New Guinea	7.85	6.93	5.68
VUT	Vanuatu	7.41	12.38	5.6
BIH	Bosnia	11	9.28	5.57
HRV	Croatia	6.45	6.82	5.5

BRB	Barbados	8.58	5.32	5.36
COL	Columbia	7.6	4.83	5.36
NAM	Namibia	5.03	5.1	5.34
TWN	Chinese Taipei	6.83	5.89	5.28
CCK	Cocoas Isl.	4.09	9	5.21
BGD	Bangladesh	5.66	5.74	5.18
COK	Cook Isl.	4.82	9.43	5.14
TTO	Trinidad and Tobago	8.08	7.34	5.13
RUS	Russia	7.03	4.3	5.08
GNQ	Equatorial Guinea	7.09	5.4	5.07
KWT	Kuwait	8.84	8.07	5.02
RWA	Rwanda	2.1	4.27	4.96
VGB	British Virgin Isl.	3.25	3.66	4.96
TCD	Chad	5.77	8.9	4.95
BHS	Bahamas	5.11	5.57	4.93
MUS	Mauritius	5.68	4.41	4.93
MNG	Mongolia	6.2	5.36	4.87
ISR	Israel	5.38	5.54	4.84
MRT	Mauritania	11.1	4.65	4.81
CAN	Canada	4.21	5.63	4.77
SVN	Slovenia	5.82	5.12	4.77
GMB	Gambia	10.25	19.04	4.76
CZE	Czech Rep.	5.74	5.16	4.74
COM	Comoros	1.49	3.18	4.7
LKA	Sri Lanka	5.5	5.51	4.7
TUV	Tuvalu	0.92	7.81	4.67
ALB	Albania	3.47	4.66	4.6
BHR	Bahrain	12.15	6.71	4.59
GRD	Grenada	5.85	3.09	4.58
ANT	Netherlands Antilles	6.81	4.99	4.57
BOL	Bolivia	4.86	4.79	4.52
SDN	Sudan	5.6	6.19	4.52
PER	Peru	7.3	4.22	4.5
BWA	Botswana	6.19	4.12	4.49
MDG	Madagascar	4.49	3.95	4.46
NOR	Norway	5.36	4.35	4.44
UGA	Uganda	10.5	6.2	4.44
HND	Honduras	7.53	3.45	4.42
MLT	Malta	4.46	4.11	4.35
SAU	Saudi Arabia	8.73	5.89	4.32
KEN	Kenya	7.98	5.12	4.2
VNM	Vietnam	1.9	4.38	4.19
CHN	China	4.56	5.54	4.13
KHM	Cambodia	9.54	4.66	4.13
MMR	Myanmar	5.9	6.46	4.1
SOM	Somalia	6.57	4.48	4.1
BRN	Brunei	5.04	5.03	4.05
THA	Thailand	4.24	5.87	4
LSO	Lesotho	4.03	3.4	3.98
GAB	Gabon	6.74	5.31	3.92
JOR	Jordan	18.59	5.4	3.89

TZA	Tanzania	13.26	8.5	3.86
KAZ	Kazakhstan	6.65	4.17	3.83
IND	India	7.65	7.1	3.82
LAO	Laos	5.95	4.99	3.82
ARE	United Arab Emirates	6.48	6.47	3.76
AGO	Angola	6.73	5.39	3.75
SWZ	Swaziland	8.61	6.61	3.75
NPL	Nepal	11.86	6.1	3.73
DZA	Algeria	7.48	5.39	3.71
SUR	Surinam	4.82	2.92	3.61
ZWE	Zimbabwe	9.64	6.06	3.61
NGA	Nigeria	5.85	4.57	3.6
HUN	Hungary	6.56	3.91	3.57
CUB	Cuba	2.29	5.61	3.52
NIC	Nicaragua	7.95	3.56	3.51
AZE	Azerbaijan	8.87	6.36	3.43
PHL	Philippines	5.48	4.88	3.38
MLI	Mali	6.98	5	3.31
SLV	El Salvador	5.39	2.59	3.2
LBR	Liberia	10.31	3.85	3.19
VEN	Venezuela	6.5	4.86	3.18
MAC	Macao	3.44	3.38	3.16
ISL	Iceland	3.58	4.1	3.15
GUM	Guam	12.14	9.05	2.86
AIA	Anguilla	1.06	2.89	2.78
COG	Congo Brazzaville	7.73	6.56	2.71
CHE	Switzerland	2.16	2.49	2.64
KOR	Korea	2.84	3.79	2.55
DOM	Dominican Republic	3.29	2.28	2.53
SVK	Slovak Rep.	6.17	5.86	2.49
TJK	Tajikistan	5.03	4.58	2.31
HTI	Haiti	4.22	2.71	2.21
PRI	Puerto Rico	1.36	1.88	2.13
EU15	European Union	3.33	2.92	2.06
KNA	St. Kitts and Nevis	10.79	5.32	2.03
USA	United States	4.86	2.07	1.89
SHN	St. Helena	2.36	1.34	1.87
MEX	Mexico	5.35	3.23	1.86
JPN	Japan	1.99	2.1	1.84
HKG	Hong Kong	1.84	2.45	1.49
FLK	Falkland Isl.	10.13	3.4	1.48
SGP	Singapore	1.47	2	1.47
NER	Niger	10.15	1.69	1.3
TCA	Turks and Caicos	17.61	3.11	1.27
SEN	Senegal	9.23	7.03	1.01
UZB	Uzbekistan	19.29	5.99	0.73
ZMB	Zambia	1.36	2.93	0.71
ATA	Antarctica	14.29		
ATF	French Southern Territories	4.17		
COD	Dem. Rep. of Congo,	5.18		

CPV	Cape Verdi	5.36	
DJI	Djibouti	4	5.52
ERI	Eritrea	3.92	6.91
GLP	Guadeloupe	18.61	
GNB	Guinea Bissau	4.49	5.59
GUF	French Guyana	12.52	
IRQ	Iraq	6.25	5.58
LBY	Libya	4.78	
MNP	Northern Mariana Isl.	15.55	10.95
MTQ	Martinique	16.44	
MYT	Mayotte	22.23	
PCN	Pitcairn Isl.	18.93	12.2
PRK	Korea, Dem. Rep.	1.65	
SPM	St. Pierre and Miquelon	2.35	3.77
TMP	East Timor	6.52	3.03
VAT	Vatican City State	1.24	
VIR	Virgin Isl.	3.48	8.97
ZAR	Zaire	12.54	

Note: these calculations are made using mirror statistics, i.e., imports to all markets included in the dataset.

Source: OECD Maritime Transport Dataset.

APPENDIX IV. DEFINITIONS OF GOODS SHIPPED BY DIFFERENT MEANS

Harmonized System (HS) codes used for bulk shipping
Dry or "clean" bulk
Generally:
10 Cereals (light)
1201-1207 Oilseeds (heavy)
IGC data are for wheat, rye, oats, maize and sorghum (barley is separate)

"Dirty" bulk
26 Ores
28 Inorganic chemicals
29 Organic chemicals
31 Fertilisers
72 Iron and steel

Harmonized System (HS) codes used for tankers
27 Petroleum products

All goods not shipped in bulk or in tankers are assumed to be transported in containers.

Definitions of product groups used in this study

HS codes referring to agriculture
01-24

Raw materials
25-27, 72

Manufacturing
28-97 except 72