The Liner Shipping Industry

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Introduction

Shipping is a global service industry that, by general recognition, provides the lifeline of international trade. Suffice it to say that, due to the morphology of our planet, 90% of international trade takes place by sea. Technological developments in ship design and construction, and the ensuing *economies of scale* of larger ships have reduced transport costs, thus promoting trade –particularly that of developing countries- by making the transportation of goods over long distances affordable. As a matter of fact, *geographical distance* plays a much lesser role today, as a determinant of trade between countries, and it is being replaced in trade models by the concept of *economic distance*, as this is represented by ocean freight rates. These developments have expanded markets for raw materials and final products, have reduced unit costs, and have facilitated the industrialization of many countries around the world. Often, international ocean transportation and Information and Communication Technologies (ICT) are referred to as the two basic ingredients of globalization (Stiglitz, 2006).

Traditionally, the shipping industry is thought of as consisting of two major sectors (markets): the *bulk shipping* sector -engaged mainly in the transportation of raw materials such as oil, coal, iron ore and grains- and the *liner shipping* sector (involved in the transportation of final and semi-final products such as electronics, textiles, furniture and a miscellany of other manufacturing output). (Figure 1).

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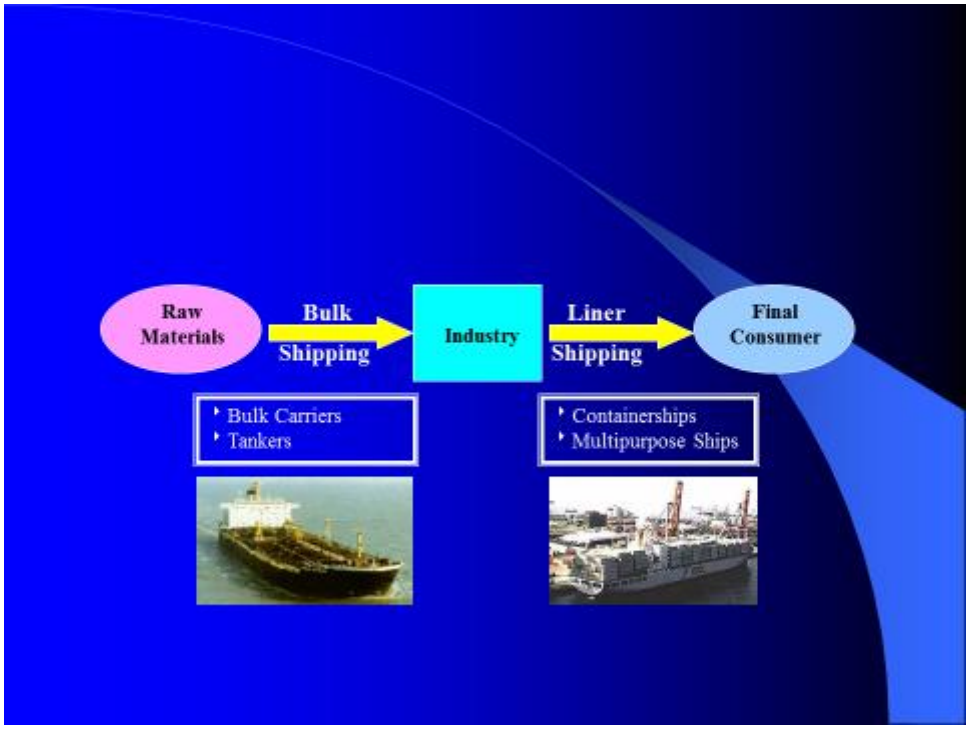

Figure 1: Shipping in the production process

From a *market structure* point of view, the two sectors are as different as they could be (Figure 2): bulk shipping uses large and fairly unsophisticated ships, such as tankers and bulk-carriers, to transport goods in bulk, i.e. in an unpackaged form, on a contract basis (the so-called *charterparty*). Other than the ship itself, the provision of this service requires minimal carrier infrastructure[1], and in this respect it resembles the service of a taxi, whereby the contractual relation between passenger and driver (cargo owner and shipowner in our case) ends upon the completion of the trip and the driver is on the lookout for new custom. The industry is highly competitive, with prices (freight rates) fluctuating wildly even in the course of a single week.

[1] Things nowadays may have changed somewhat, but I remember a shipowner friend of mine, years back, telling me that to run a dry bulk shipping company the only things you need is a telephone, a shared office and a part-time secretary!

Figure 2: Bulk- and liner shipping: comparison and contrast

Research on bulk shipping has therefore been mostly concerned with the estimation of tonnage demand and supply functions, and freight rate forecasting. For a good literature review see Haralambides *et al*. (2005); Veenstra (1999); Stopford (1997); Beenstock and Vergottis (1993); Wergeland (1981); and Norman (1979).

On the contrary, liner shipping is geared to the provision of regular services between specific ports, according to timetables and prices advertised in advance (Haralambides, 2004; Jansson and Shneerson, 1987). The service is in principle open to anyone with some cargo to ship, and in this sense it resembles a public transport service, like that of a bus or tram. The provision of such a service –often of global coverage- requires extensive infrastructure in terms of terminals and/or cargohandling facilities, ships, equipment, warehousing and agencies. For instance, the provision of a weekly service between Europe and Southeast Asia requires investments in excess of one billion US dollars in ships alone. Understandably, investments of this magnitude may, on the one hand, lead to undesirable capital concentration and, on the other, pose considerable barriers to entry for newcomers. These aspects of the industry have constituted important research areas and are briefly discussed below.

Cargo carried by liner shipping has come to be known as *general cargo*. Up to the beginning of 1960s, such cargo was transported, in various forms of *unitization* (packaging), such as pallets, slings, boxes, barrels and crates, by relatively small vessels, known as *general cargo ships, cargo freighters, multipurpose ships, twin-deckers or multi-deckers*. These were ships with *holds* (cargo compartments) in a shelf-like arrangement, where goods were stowed in small pre-packaged consignments (parcels) according to destination (Figure 3). This was a very labor-intensive process[2] and, although seafaring may have been fun (sic) in those days, ships were known to spend most of their productive time in port, waiting to berth, load or discharge. Congestion was thus a chronic problem in many ports, raising the cost of transport and hindering the development of trade. Equally importantly, such delays in ports made

[2] Labor productivity at those times was roughly 1 ton per man-hour; with containerization, this has increased twentyfold.

trade movements erratic and unpredictable, obliging manufacturers, wholesalers and retailers to keep large stock. As a consequence, warehousing and carrying (capital) costs were adding up to the cost of transport, making final goods more expensive and, again, hindering international trade and economic development.

Figure 3: Multipurpose general cargo ships

This situation started to change in the 1960s with the introduction of *containerization* in the trade between the United States and Europe and, subsequently, in the rest of the world. Containerization is often described as a *revolution* in transport. General cargo goods are now increasingly carried in steel boxes (containers) of standardized dimensions (most common is the 8x8x20 feet unit known as TEU –Twenty (feet) Equivalent Unit-, although containers of double this size (40 feet) are increasing in importance). Perhaps one of the most important effects of containerization is that, now, containers can be packed (*stuffed*) and unpacked (*stripped*) away from the busy waterfront, either at the premises of the exporter (consignor) and/or the importer (consignee), or at Inland Container Depots (ICD), warehouses, and distribution centers (dry ports).

Expensive and often strongly unionized port labor is thus by-passed; pressure on port space relieved; and ship time in port minimized. These developments have increased ship and port productivity and system reliability immensely, thus allowing ships to become even bigger, achieving significant economies of scale and, consequently, lower unit transport costs. Actually, as we will discuss below, the economic incentive behind the construction of ever larger ships is higher port efficiency and productivity, rather than technological advances in ship design, or economies of scale at sea (which are lost if the ship has to wait at port). Nowadays, containers are increasingly carried by specialized *cellular* containerships many of which able to carry more than 19,000 TEUs, while designs for 20- or even 25 thousand TEU ships are already on the drawing boards of naval architects.

In parallel, by-passing the waterfront in the stuffing and stripping of containers, and thus having them ready in port to be handled by automated equipment, has increased immensely the punctuality, predictability and reliability of cargo movements and transport systems, enabling manufacturers and traders to reduce high inventory costs through the adoption of flexible Just-in-Time and Make-to-Order production technologies.[3] *Inter alia*, such technologies have helped manufacturers to cope with the vagaries and unpredictability of the business cycle and plan business development in a more cost effective way. Indisputably, containerization has been the kindle wood under global logistics and supply chain management.

At the time of writing, such a mammoth ship could cost anything in the neighborhood of 100+ million US dollars and it could take up to 9 of them to run a weekly service between Europe and Southeast Asia. The capital intensity of these ships –the equivalent of a jumbo jet in aviation- obliges them to limit their ports of call at each end to just a few *hub* ports or *load centers* such as Shanghai, Singapore, Hong Kong and Rotterdam, from where huge surges of containers are consolidated or further forwarded (*feedered*) with smaller vessels, rail or road, to regional and local ports. Complex *hub-and-spoke* networks have thus evolved whose logistical fine-tuning and optimization bears directly on consumer pockets.

Around the world, the port industry has invested a lot, in order to cope with the technological demands of containerization. Modern container terminals and commensurate cargohandling equipment have been built and new, more efficient, organizational forms (including privatization) have been adopted in an effort to speed up port operations. Operational practices have been streamlined; the element of uncertainty in cargo flows largely eliminated; forward planning has been facilitated; port labor regularized; and customs procedures simplified. These developments took place in the firm understanding of governments and local authorities that ports, now, constitute the most important link (node) in the overall door-to-door supply chain and thus inefficiencies (bottlenecks) in the port sector can easily wither all benefits derived from economies of scale and scope in transportation and logistics. Since 2000, the measurement of port efficiency has thus become a key research area in maritime economics and, as already mentioned above, it has been *port efficiency* itself that has led to the construction of larger ships and not the other way around.[4]

Optimisation of Liner Shipping Operations

Under the assumption of a certain market share (demand); the constraints of regularity and frequency; and the incessant drive to cut costs (mainly through the deployment of larger ships), liner shipping companies must incessantly optimise their operations, providing solutions to a number of important problems such as: how many ships to

[3] The concept of logistics does not regard only cargo systems but it permeates every aspect of our everyday lives. In a reliable transport system, I know precisely what time I need to leave home to make it to the airport. But if taxis are on strike; rail under maintenance; or security controls at airport a mess, I need to leave home one hour earlier. And this hour is 'my' inventory cost.

[4] This research has been pioneered by the *Maritime Economics & Logistics* journal (www.palgrave-journals.com/MEL).

deploy on a route? At what speed? Should a carrier serve a specific demand with few larger ships or with more smaller ones? What are the logistical requirements of the customer in this respect? At which ports to call? How should one deploy ships and containers? How to manage a fleet of empty containers and trade imbalances? Should one buy or lease ships and containers?

Operations Research (OR) has been extensively used to give answers to such questions. For a review see Cariou and Haralambides (2000) and Ronen (1983 and 1993).

Ronen (1993) notes that, since the 1980s, the problems addressed in the literature have become more realistic, involving 'actual' optimal solutions rather than approximations (in operations research the latter solutions are known as *heuristics* and are rather common due to the mathematical complexity of real-world problems). He attributes this to advances in mathematical programming, facilitated by the development of inexpensive computing power.

The vessel deployment problem, in particular, concerns the allocation of ships to routes within the service network of a liner operator. Examples of problems of size, mix and deployment of vessels can be found in Lane *et al*. (1987) (fleet size and mix) and Jaramillo & Perakis (1991) (deployment). Lane *et al*. attempt to determine the most cost effective size and mix of a fleet of ships on a specific route. They apply their model to the Australia-North America West Coast route. Jaramillo & Perakis (1991) construct a model that assigns a fixed fleet of ships to a given set of routes, taking into account detailed information on operating costs, sailing speeds and frequency of departure. They present an example of 14 ships and 7 routes.

Rana and Vickson (1988) present a model for the determination of fleet size and routing of vessels. Their problem starts from an operator who contemplates adding an extra ship to his fleet. The authors are able to determine the route this additional ship should ply, and they also solve problems that include schedules of up to 10 or 20 ports. This makes their model suitable for practical purposes, although they limit it to include only one type of container.

Jansson & Shneerson (1985) derive a transport cost function that also includes user costs (mainly inventory costs). In this way, they are able to determine the optimum ship size. Their analysis however does not address the issue of routing.

Scheduling problems deal with the assignment of departure and arrival times of ships operating on a certain route. Rana & Vickson (1991) present such a model. They point out that, although scheduling is a fairly common exercise in transport, liner shipping has certain intrinsic features that make the design of scheduling models particularly difficult. *Inter alia*, these complexities consist of the existence of combined pick-up and delivery activities; the fact that ships in a fleet can ply different routes; and the peculiarity that routes, being a string of ports, are always visited in a fixed sequence. The Rana & Vickson model extends the results of their 1988 work in the sense that the model is now able to address problems involving more than one ship. In essence, this

makes their model a routing one. The scheduling issue is addressed by determining the sequence in which the different ships call at ports in a service network. The authors report an example that includes three ships and five ports, although they mention the possibility of applying the model to networks of 10 to 20 ports. The computational requirements, however, increase very rapidly with the number of ships. This seems to constrain the applicability of the model in liner shipping, where eight to 12 ships are commonly used on a route. Nevertheless, Rana & Vickson believe that their procedure is the surest way forward to more realistic models that can cope with more ships, and they see applications in aviation, bus and railway networks.

One of the largest cost elements in liner shipping has to do with the management of the fleet of containers. The flow of containers across the world does not coincide with the routing of containerships, because containers do not spend all their time aboard ships: they need to be picked up and delivered at inland locations, maintained, repaired or they may not be needed for some time. This makes the management and optimal relocation of empty containers a separate control problem. The main objective here is to ensure that, at every location, enough empty containers are available so that all transport requests from customers can be satisfied. This problem becomes an actual and immediate one whenever, on a certain route, more cargo moves in one direction compared to the other. Such a route is known as an *unbalanced route*, or a route with *cargo imbalance*. This is the case, for instance, of the Europe-Far East route, one of the three trunk east-west routes where most of the containerized trade takes place (the other two being the transatlantic and the transpacific).

All liner companies have management systems in place to optimise the relocation of empty containers, but as a result of commercial sensitivities little is known on the associated models. As an exception, Gao (1994) presents a two-stage container repositioning model that determines first the size of the container fleet, and subsequently the allocation of containers in the liner service network.

Market Structure in liner shipping

Perhaps one of the most pronounced characteristics of liner shipping is its high fixed costs; and this is why. In order to keep to its pre-advertised time-schedule, a ship must leave port regardless if it is full or not. Her costs thus become fixed, i.e. independent of the amount of cargo carried. The only variable costs in this regard are *Terminal Handling Charges* (THC). Next, imagine the admittedly simplified case where, minutes before the ship sets sail, an unexpected customer arrives at the port with one container to ship. If the vessel has spare capacity, which is often the case in liner shipping, being a declining costs industry, or an industry of *increasing returns to scale* (IRS), her operator might be tempted to take on the extra container even at a price as low as merely the extra (marginal) cargo-handling costs involved in taking the container aboard. However, if this were to become common practice among carriers, competition among them could become *destructive competition*, pushing prices down to the level of short-run marginal costs. Consequently, liner services would not be sustainable in the long-

run, as operators would not be able to recover costs in full, most importantly capital costs, such as depreciation allowances, for the eventual replacement of the ship (Figure 4).

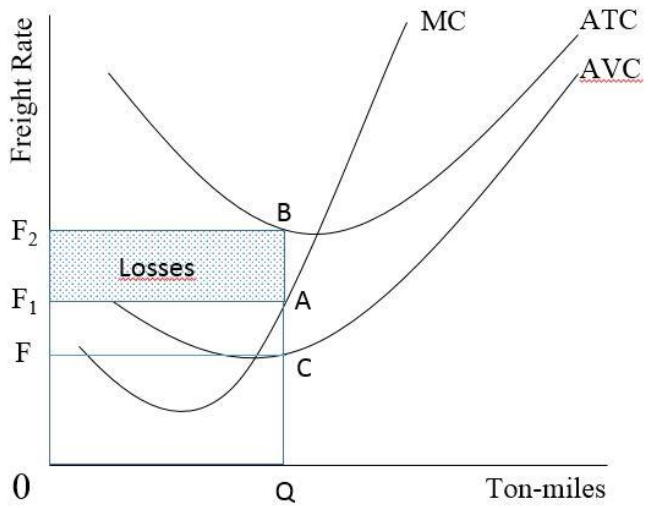

Figure 4: Declining cost industries (increasing returns to scale)

Figure 4 exemplifies the above point. In declining cost industries, marginal costs (MC) are always lower than average total costs (ATC) and, with a production of 0Q, marginal cost pricing at F_1 would generate losses equal to F_1ABF_2. At that level of output, the company covers its variable costs (0QCF) but only part ($FCAF_1$) of its total fixed costs ($FCBF_2$).

Liner shipping conferences

Liner shipping is by no means unique with regard to the possibility of destructive competition. All *national* declining cost industries, i.e. "high fixed - low variable" cost industries, from agriculture and pharmaceuticals to steel, aviation, railroads and shipbuilding, have historically enjoyed some degree of protection from price competition. But shipping is a predominantly *international* industry and, thus, no national laws could possibly apply to regulate competition.[5]

It has thus been considered that price competition should be limited through a *self-regulating mechanism*, allowing carriers to charge on the basis of *long-run average costs*, to the benefit of a sustainable, regular, frequent and reliable service, according to the requirements of demand (i.e. the shippers themselves). Moreover, the freight rate instability that would ensue as a result of unlimited competition – something quite

[5] Europe's agricultural policy; Korea's and China's shipbuilding subsidies; or the decades-long war between Boeing and Airbus are good cases in point.

common in bulk shipping – has always been detested by shippers, who have consistently argued in favour of stable and predictable prices (for them, *transport costs*). On the *rate stability* aspect, Figure 5 compares the fairly stable liner tariffs with volatile bulk shipping freight rates (left part); and the variability of liner tariffs, due to deregulation (i.e. limitation of conferences' powers) in the North Atlantic market (right part).

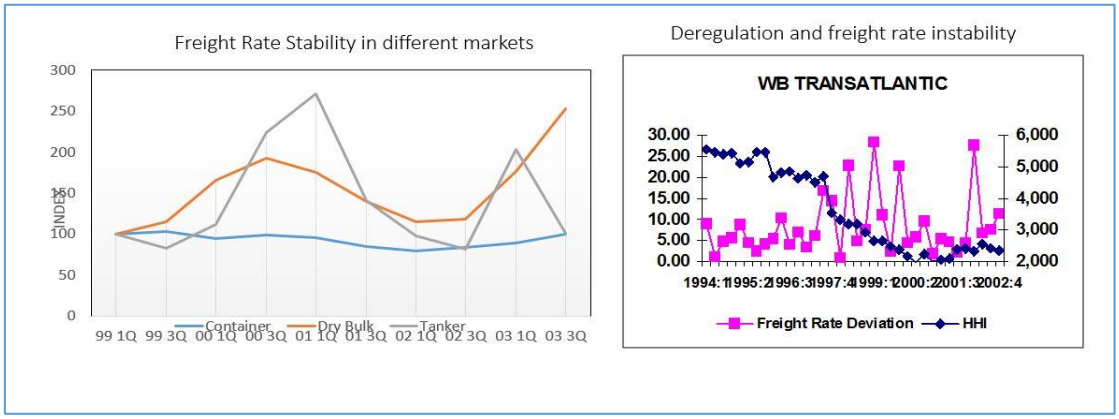

Figure 5: Rate instability

This rate-stabilizing mechanism was found in the face of *conferences*. These are price-setting cooperative schemes among carriers aimed at the limitation of price competition and at the setting of tariffs at 'minimum common denominator'. This allows a sustainable service in the long-run, to the benefit of the shipper who, as said, requires stable and predictable transport costs (Haralambides, 2004).

In the UNCTAD Code of Conduct for Liner Conferences (UNCTAD, 1975), the term *conference* or *liner conference* is defined as '...a group of two or more vessel operating carriers which provides international liner services for the carriage of cargo on a particular route or routes within specified geographical limits and which has an agreement or arrangement, whatever its nature, within the framework of which they operate under uniform or common freight rates and any other agreed conditions with respect to the provision of liner services'.

Daniel Marx Jr. (1953) in his celebrated book defines shipping conferences, or *rings*, -among the earliest cartels in international trade- as '... agreements organised by shipping lines to restrict or eliminate competition, to regulate and rationalise sailing schedules and ports of call, and occasionally to arrange for the pooling of cargo, freight monies or net earnings. They generally control prices, i.e. freight rates and passenger fares. The nature of their organisation varies considerably, depending on the market structure of the trade route. Some have been conferences quite literally -informal oral conferences- but many have employed written agreements establishing a permanent body with a chairman or secretary, and containing carefully described rights and obligations of the conference membership...'

Historically, limitation of price competition has enabled conference members to compete on *quality of service*. A good insight into the role of the *quality* variable in

liner shipping can be found in Devanney *et al.* (1975). These authors observe that conferences, while often considered as monopolists, did not actually earn the corresponding monopoly profits. They explain this by pointing to the strong competition among conference members on the quality of service.[6] When price is fixed, differentiation on quality is the only way a conference member can increase its own revenue at the cost of other members. Devanney *et al.* suggested that the main variable in this competition was speed: some conference members were simply able to offer quicker services or, in case of difficult circumstances such as congestion in ports or bad weather, they were in a better position to maintain sailing schedules. Nowadays, quality variables are considered to be the provision of information and EDI systems; logistical services of all sorts; better coordination and integration with inland transport companies; ownership of terminals and equipment; frequency of service; geographical coverage and, in general, supply chain integration and management.

It all honesty it must be said that conferences pre-existed the *destructive competition* worries of carriers, and in reality they were conceived as mechanisms to protect trade (often combined with *gunpoint diplomacy*) between the metropolis and its colonies. In modern times, conferences have been allowed to exist, so far exempted from anti-trust legislation, on the basis of 'sustainability of service' arguments like the above. Such regulatory leniency however has not come without the sometimes severe criticism and outcry of many *shippers* (cargo owners) who have seen price-setting; price discrimination; port, cargo and market share allocations; secrecy of conference agreements and similar restrictive business practices exercised by conferences as not promoting trade to the detriment of the consumer. Moreover, the *European Court of Justice* has rightly argued that 'rate stability' cannot be an objective in itself and 'stability' *per se* cannot be more important than competition. In 2008, the European Commission, under strong lobbying from the European Shippers' Council (ESC) banned conferences to and from its territory. I was against this decision, and in the "Erasmus Report" (Haralambides *et al*, 2003), prepared for the Competition Directorate General of the European Commission -the directorate responsible for the review/repeal of Regulation 4056/86 (liner conferences)- I claimed that conferences were a low-cost *necessary evil*. In their absence, I had claimed, there would be greater industry concentration (e.g. mergers, consortia, and alliances), lower service reliability and shipper complaints. Developments have proven me right.

In the earlier days, conferences had been known to exercise price discrimination –the ultimate trait of monopoly pricing- according to the principle of *charge what the traffic can bear*. In brief, what this means is that the carrier had the ability to assess the price elasticity of transport demand for a certain cargo and charge the shipper according to his ability or willingness to pay. In economics jargon, price discrimination enables the carrier to extract most of *consumer surplus* for himself, converting it into *producer surplus* (Figure 6).

[6] In both sides of the *Atlantic*, however, many industrial economists have considered 'competition on quality', or the 'cost of monopolisation', or the 'eating up' of supernormal profit by such things as 'advertising', as socially wasteful.

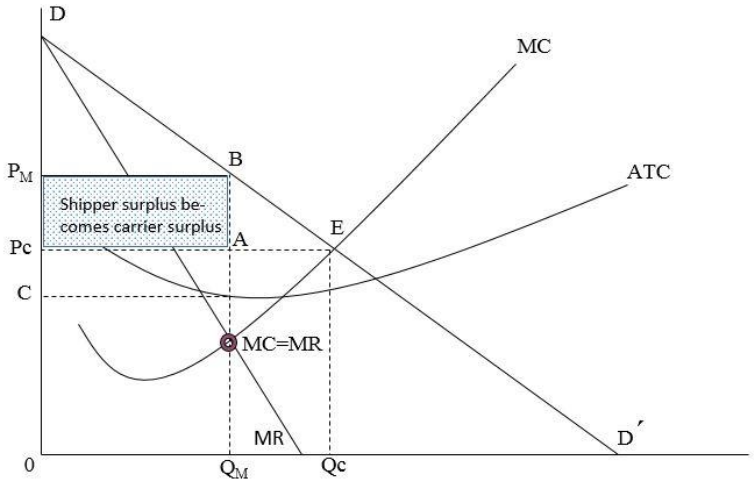

Figure 6: Pricing in imperfectly competitive markets

The liner conference of Figure 6 reduces carrying capacity from Q_C to Q_M, charging a tariff (P_M) considerably higher than the competitive tariff (P_C). Correspondingly, the competitive *shipper surplus* of P_CED reduces to P_MBD, with part of the difference (P_CP_MBA) becoming *carrier surplus*.[7]

Such practices, however, have become less and less common as a result of containerisation and the consequent charging of uniform rates per container. Obviously, containerisation makes it increasingly difficult to justify price discrimination based on an alleged need for different treatment of goods according to their particular characteristics (such as volume, stowage, cargo-handling, etc.). In this way, containerization *commoditized* liner services, thus increasing price competition among carriers. This encouraged them to try and find other means of service differentiation, such as logistics, supply chain management, and a door-to-door transportation service, tailor-made to the particular requirements of the individual shipper/consignee.

Price discrimination in liner shipping has been viewed both negatively and positively. First, regardless of whether price discrimination is effectively exercised or not, only the potential ability of carriers to do so demonstrates a certain degree of monopoly power justifiably detested by consumers and regulators alike. However, price discrimination, or better, in this case, *price differentiation*, has also been seen positively in the sense that it has promoted trade by making possible the exportation of low value, price-sensitive commodities, many originating from developing countries. Furthermore, it has often been argued, price discrimination introduces, paradoxically, an element of competition in the sense that it attracts *hit-and-run operators* who, with minimal infrastructure and other overheads, can 'skim' the market, targeting high-value goods only, by rigorously undercutting conference prices. As a result, conferences have

[7] The area ABE is known as "deadweight loss", having nothing to do, of course, with the deadweight of ships! This is a loss to both carrier and shipper, in other words a loss to society, as a result of monopoly pricing.

traditionally tried to exclude independent outsiders through a number of devices such as fighting ships (price wars), deferred rebates, loyalty agreements and so on.[8]

Notwithstanding the above, the issue of monopoly power and the ensuing pricing strategies of conferences have constituted important research areas of market structure modelling in liner shipping. Whether price discrimination –which has undoubtedly been exercised by conferences in the past- aims at profit maximisation or merely at allowing low-value cargoes to be transported (in order to increase ship capacity utilisation and/or expand geographical coverage to peripheral or otherwise *uninteresting* regions such as Africa and Latin America) still remains to be seen. Research results have not been conclusive given the inherent difficulties in measuring price elasticities of a miscellany of goods loaded at a great number of ports around the world (Sjostrom, 1992).

The issue of monopoly power

The pricing behaviour of a firm gives an indication on the competitiveness of the market in which it operates. How competitive is, therefore, liner shipping as an industry? Have conferences abused their price setting privilege, discriminate, manage capacity, and charge prices well above costs? At first sight the answer should be *no*.

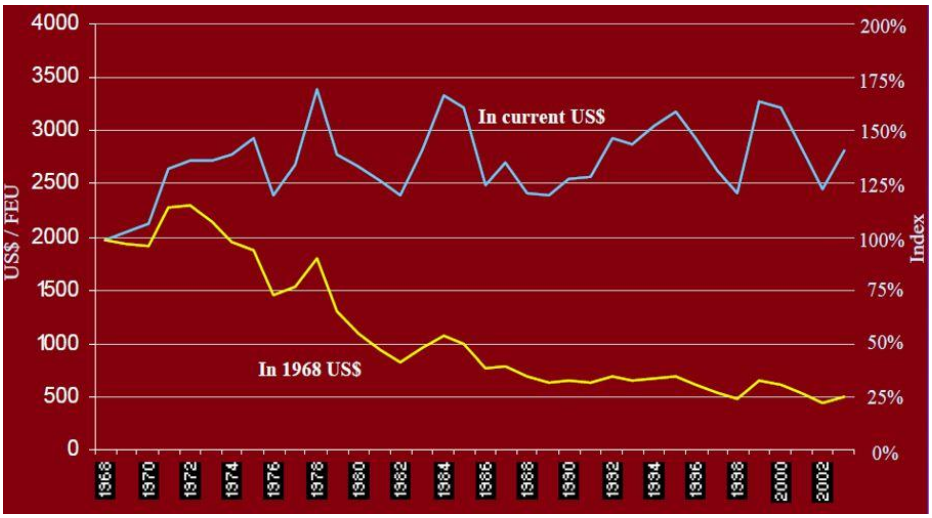

Figure 7: Liner tariffs, trans-pacific east-bound, 1968-2003, $/FEU

Figure 7 shows that, in the 35 years from 1968 to 2003, real tariffs in the Pacific have declined by 75%. One could therefore legitimately claim that even if conferences *did* have some monopoly power over their rates, they have been quite unsuccessful in exercising it. The counter argument is of course that this decline in rates has been the result of the *economies of scale* of the larger ships and that, as a result, in the absence of conference-pricing, rates could have declined even more.

[8] The idea of 'fighting ship' is met even today at certain ports, especially in passenger and Ro-Ro transport. In Brindisi, during my term there as president of the port, the Ro-Ro traffic with Greece was virtually monopolized by Grimaldi Lines. As soon as a second operator appeared, Grimaldi lowered prices and doubled capacity; a textbook example of *limit pricing* (see below). That was enough to dissuade the newcomer from even attempting to enter that market.

Whatever the case, how can *abuse* be defined and measured? Are tariffs cost-based (competition) or do companies charge according to *what the traffic can bear* (monopoly)? Such studies have been done in aviation but not yet in shipping, due to secrecy and unavailability of cost and tariff data.

Abuse can be established by calculating a firm's *degree of market power*: a measure showing by how much a producer, such as a conference, can maintain prices above marginal costs. Let us try to formalize somewhat the discussion here, assuming for the time being that liner shipping is an imperfectly competitive market, such as a monopoly, where the producer is a price-maker, able to discriminate among buyers, selling different quantities (q) at different prices (f). In such a case:

Total Revenue, R, is equal to: $R = f \cdot q$

while *f* is a function of quantity sold, *q*; i.e. $f = g(q)$

Marginal revenue, *MR*, would then be: $MR = \frac{\partial R}{\partial q} = f + q\frac{\partial f}{\partial q} = f(1 + \frac{q}{f}\frac{\partial f}{\partial q})$, or:

$$MR = f\left(1 - \frac{1}{e}\right) = MC$$

Where *e* is the price elasticity of demand and *MC* is marginal cost.

Finally, the above can be written as:

$$\frac{f - MC}{f} = \frac{1}{e}$$

Equation 1

The above expression, the inverse of the price elasticity of demand at equilibrium, *1/e*, is known as *Lerner's Degree of Market Power*. Knowledge of *e* (of different cargoes or different shippers) is of paramount importance for the pricing strategy of a liner company. This strategy is known under the term *market segmentation*: through a large sales force, carriers are in constant contact with shippers, offering them a miscellany of logistics services, *mining* in this way their willingness to pay for them. This information is subsequently collected centrally and analyzed by the carrier's research department to establish *e*.

We should remember that the source of *welfare loss* under monopoly is the restriction of output, which raises the price above MC. It is natural therefore to measure the degree of market power by the extent to which the monopolist can hold the price above MC. (Equation 1 gives the proportional excess of price over marginal cost).

Even for a monopolist, however, there is a limitation on control over price: this is the extent to which customers *leave* when prices increase. If the quantity demanded is sensitive to price, the price elasticity of demand will be large. The right hand side of Equation 1 will thus be small, and so would have to be the numerator of the left hand side. In other words, the profit-maximising price will have to be close to marginal cost. In such a market, the profit-maximising monopolist will restrict output only slightly below the competitive level.

On the other hand, if the price elasticity of demand is small, the monopolist has more leeway to raise prices. When the quantity demanded does not decline much as the price rises, the profit maximising monopolist will be able to raise the price above marginal cost without suffering substantial losses in patronage.

Market segmentation

A digression might be in order at this point on the issue of *segmentation*; i.e. a carrier's ability to split its customer base according to shippers' *willingness to pay* for certain tailor-made services. One can distinguish two carrier strategies which I have coined earlier as *retailer* and *wholesaler* strategies (Figure 8). In the former, the carrier is himself targeting the individual shipper/consignee, through a large global salesforce which could eat up a substantial chunk of his budget (Figure 8, 'marketing and sales'). The salesperson would call up *his account* at least once a week, while I still remember consignees complaining of being overwhelmed by SMSs, four times a day, telling them the whereabouts of their container. This information is subsequently collected centrally so as to decide a) which shipper should be targeted further with a higher sales effort and resources, and who should be instead neglected; b) set sales targets for the following year, to be subsequently disseminated downwards to the whole sales network.

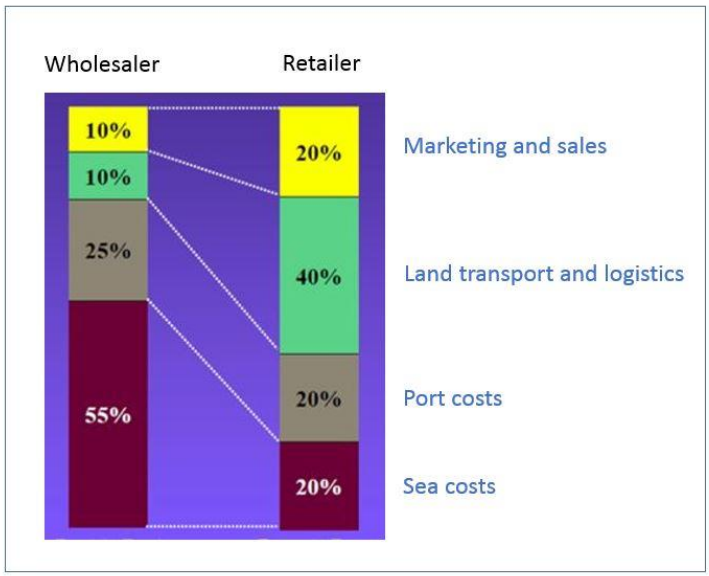

Figure 8: Retailer-Wholesaler strategies of carriers

The *retailer* strategy is of course part of a carrier's wider strategy of vertical integration along the supply chain. As already mentioned above, containerization has gradually led to the commoditization of the ocean liner service and thus to higher competition among

carriers. In an effort to differentiate their service, as well as better control the supply chain, carriers started to invest in the other components of the supply chain, such as container terminals, distribution centers, road, rail and air transport, and in a miscellany of other logistics services, such as bar-coding, assembly, documentation, etc.[9] Investment in logistics services and related infrastructure, rather than in ships, -which, incidentally, can be chartered-in from private equity investors (e.g. KG funds in Germany)- allows the carrier to become more *asset light*, thus more agile in coping with the vagaries of the business cycle.[10] In addition to service differentiation, vertical integration also serves in increasing both the complexity of operations and the *sunk* costs of aspiring new competitors (carriers)[11], particularly if shippers are convinced, through effective marketing, that an integrated service is the only way to better serve their requirements.

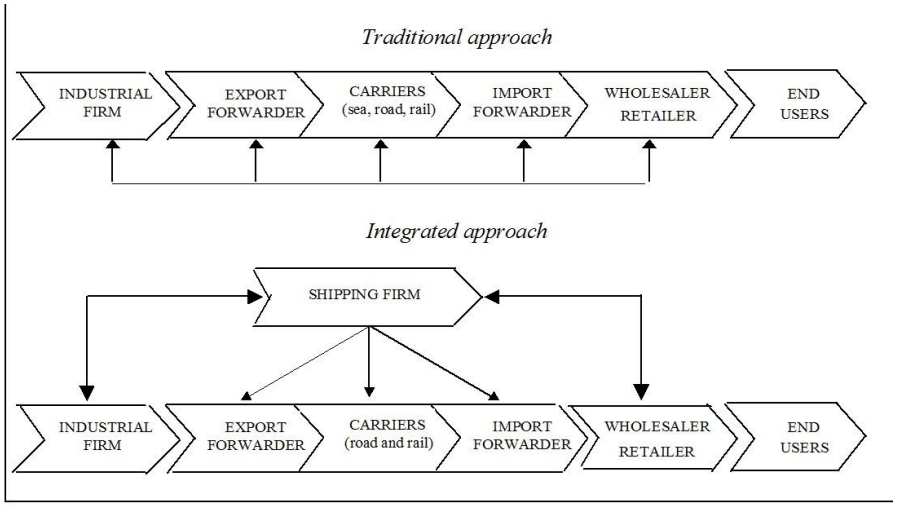

Figure 9: Vertical integration and supply chain control

In order to fill the ship, the *wholesaler* strategy depends instead on the freight forwarder, or the *Non Vessel Owning Common Carrier* (NVOCC), or both. The former assumes no risk, simply matching shipper demand with available shipping capacity. The NVOCC instead -and here one should include all global logistics service providers (LSP)- purchases shipping space in advance, thus becoming a 'virtual' *non vessel owning carrier*, and by doing so he assumes the market risk of filling the capacity he has pre-paid.

Carriers on their part, in their eagerness to fill their ever bigger ships, in their pursuit of the holy grail of economics of scale, have been found quite willing to sell capacity to NVOCCs, who are both their customers and their competitors. Recent estimates raise

[9] During my years of running the NOL/APL management trainee program in Singapore, logistics managers of APL Logistics were telling me that they were involved from the production lines of a shirt made in Vietnam, all the way to the shelve the shirt would be placed in a high street shop in New York.
[10] At the time of writing, about 50% of total slot capacity is *operated capacity*, owned in practice by private investors.
[11] Investing in new tonnage, even when market conditions do not warrant it, may have a similar 'dissuasive' effect on new competition (see *limit pricing* below).

the percentage of NVOCC-managed capacity to 40% of total liner shipping slot capacity. I have always maintained that this carrier strategy is flawed: Building larger and larger ships, while knowing that you will be unable to fill them alone, and then sell the extra capacity to your competitor corresponds to nothing less than offering him the knife to stab you in the back.

In the carrier-NVOCC arm-wrestling for the control of the supply chain, the carrier possesses a distinct comparative advantage his competitor doesn't, albeit desperately needs: the ship. Why should a carrier share this advantage with his competitor? Wouldn't in fact be more reasonable, instead of creating surplus carrying capacity, to coordinate better with his alliance partners? Moreover, ownership of fixed assets like ships limits an operator's agility to adjust to market fluctuations, contrarily to NVOCCs who just buy capacity as and when needed. If one looks at the financial results of both players, he will notice that 3PLs are more stable and robust, with consistently higher EBITs. Simply put, by being asset light, 3PLs *ride the cycle* rather than be ridden by it. By selling wholesale capacity to 3PLs, the carrier helps them become more agile, and thus more profitable, while he himself is stuck with the fixed assets (the ships) which draw him down at every business cycle downturn.

Instead, I have always claimed, better capacity utilization and carrier profitability can be achieved through improved alliance cooperation, as well as through pricing of all-in, door-to-door, services that is leveraged around the component carriers maintain a comparative advantage; i.e. the ocean transportation leg of the supply chain. In economics, this pricing strategy is known as *raising rival's costs*; i.e., the rival is forced to buy an essential input (shipping) at a higher price. Simply put, this means that the carrier charges a higher price for the ocean transportation leg, where the carrier maintains the comparative advantage (i.e. also the component with the lowest price elasticity of demand), and lower prices for the other components of the supply chain (e.g. road transport) where he competes. From a competitiveness perspective, the door-to-door transport price should remain the same as before, but the NVOCC would now have to pay much more for his ocean freight requirements and this would put him at a comparative disadvantage.

At the time of writing, the situation I have described above has started to change. Carriers appear to be returning back to core business, shedding the idea of vertical integration in favor of better horizontal integration (alliances) and dominance in the sector (shipping) where they have the comparative advantage. For one more time I have been proven right and I argue that this return to roots has been the result of the weakening or banning of conferences, and the low freight rates and service reliability that have ensued. In 2016, one could bring a TEU from Hong Kong to Rotterdam with $300; far below breakeven point. Laid up container tonnage was 5% of the total fleet (over one million slots) and, interestingly, it was often the largest and newest ships, such as MSC Oscar, which were laid up. To no avail, consignees were desperately looking for someone to talk to on the phone. In complex ports like Los Angeles, the terminal of arrival was often unknown until the last minute. At the other end, in Asia, to be filled, a mega ship would call at far more ports than what its size would warrant;

something creating a stowage nightmare at the receiving ports. *In short, you had a ghastly mess,*[12] brought about by the shippers themselves.

Market power: Econometric studies

But let us return. The issue of monopoly power has been approached through other avenues as well. A number of econometric models, using cross-section data, have been estimated with varying degrees of success. They all attempt to explain prices (tariffs) through such explanatory variables as the 'unit value of the transported goods' (an indicator of price discrimination); 'stowage factor' (an alleged cost indicator expressed by the volume/weight ratio of the goods); and the 'total trade volume on the route' (indicating the potential for outside competition).

Several authors have presented results on such pricing models, where tariffs were regressed on the above variables. Examples are Deakin & Seward (1973), Bryan (1974), Heaver (1973a), Shneerson (1976), Jansson & Shneerson (1987), Talley & Pope (1985) and Brooks & Button (1994). The models of the first five of these works are rather similar in terms of the selected variables. Their results are also fairly comparable and indicate that both 'unit value' and 'stowage factor' are important explanatory variables of liner tariffs.

The basic idea with these two variables is that if the 'unit value' variable proves to be significant, conferences are able to discriminate on price and there is thus a considerable degree of monopoly power. If, however, the stowage factor is shown to be the most important explanatory variable, this implies that conferences compete on costs and thus considerable competition prevails in the market.

The inclusion of the 'trade volume' variable has given rise to the examination of an interesting phenomenon which has come to be known as the 'inbound-outbound freight rate controversy' (Heaver, 1973b)[13]. A number of authors have observed that inbound routes usually involve different rates, *vis à vis* outbound ones in certain areas, even when small trade imbalances exist. This was first noticed in the transatlantic route, but it appeared to exist in other routes as well. Bennathan & Walters (1969), Heaver (1973b), Devanney *et al*. (1975) and Byington and Olin (1983) have contributed in this discussion. They found that explanations lie in the commodity structure of the inbound and outbound routes, as well as cargo imbalances, which give rise to different levels of

[12] Lyrics from "*The life I Lead*" (Mary Poppins) […] A British bank is run with precision. A British home requires nothing less. Tradition, discipline and rules must be the tools; without them: disorder, catastrophe, anarchy, *in short you have a ghastly mess*.

[13] Although the discussion in this section has only historical value, it can still explain to some extent differences in tariffs for Asian cargoes destined for the Mediterranean *vis à vis* northern European ports, or Asian cargo destined for the East- and West Coast of the United states; differences that cannot be explained merely by differences in transportation costs, as the latter are proxied by navigational distances.

competition on the two legs of the route. In this respect, more competition means lower rates.

In the case of the United States and the transatlantic route, Bennathan and Walters (1969) observed a cargo imbalance favouring the outbound leg (US-Europe). This was of course reasonable due to the reconstruction of Europe after a ruinous WWII and the European import demand this generated; the picture (and the imbalance) is the opposite nowadays. As a result, the authors argued, *tramps* (i.e. unscheduled independent carriers)[14] were sailing from the US full with bulk cargo, leaving all outbound liner cargo to conferences. Competition from tramps was thus minimal and as a consequence tariffs on the outbound leg were higher than the inbound one (Europe-US) where more competition prevailed. This situation could be explained reasonably well by variables such as *trade volume* and number of conference and non-conference operators on the route.

In the 1960s, but particularly in the 1970s, containerisation virtually eliminated competition from tramps. Obviously, large company size, cargohandling technologies and infrastructural requirements could not be met by the often single-ship tramping companies whose advantage was merely 'flexibility'. Interest in the *inbound-outbound controversy* was thus lost together with the importance of the 'stowage factor' as an explanatory variable of liner tariffs.

The demise of the *stowage factor* was illustrated in the work of Talley and Pope (1985) who obtained data similar to this of Deakin and Seward, Heaver, Bryan, and Jansson and Shneerson, but on a containerised route. These authors found that the stowage factor, previously an important explanatory variable, disappeared from the equation and, at the same time, the coefficient of 'unit value' was much smaller than in previous results. Due to the uniform way of treating cargo in a container, these results are not difficult to understand. Brooks and Button (1994) confirmed these results and suggested alternative variables that should nowadays be considered: customer type, direction of trade and type of service.

The year 2008 saw the prohibition of liner shipping conferences in trades to and from Europe. The EU Council of Ministers decided to revoke Regulation 4056/86 that exempted conferences from the competition law stipulations of the Union. This happened while conferences are still allowed throughout Asia and when, simultaneously with the EU abolition, Singapore's newly established Competition Commission legislated in favor of conferences. Haralambides *et al*. (2003) have shown this to be a wrong decision. The authors claimed that the removal of *some* self-regulatory power from an industry as international as liner shipping, where no national

[14] A note of caution is due here; something I have always wanted to clarify and this is the first opportunity. Often in the literature, the word *tramp* has been confused, or used interchangeably, with the word *bulk*. Even worse, a 'tramp ship' has often been used synonymously with a bulk ship, or bulk-carrier. However, 'tramping' means simply operating in the *spot* voyage market and certainly it does not does not indicate a particular type of ship. To put it differently, a bulk carrier on a long-term time-charter is not tramping, nor is one engaged in a contract of affreightment. In conclusion, the mere fact that a bulk ship is not offering regular or scheduled services, like a liner ship, does not make it a tramp.

competition law could apparently apply, would lead –with mathematical certainty- to higher *rate instability* and transport system unreliability, seriously jeopardizing global *Just-in-Time* systems of production and distribution. In addition, such a step was bound to invoke further consolidation in shipping. At the end of the day, the European citizen would again have to foot the bill of ill-conceived and introvert policies that ran against global European competitiveness. At the time of writing (2016 – i.e. 15 years later), these findings have been fully validated.

Industry concentration, market power, and the theory of contestability

It is often argued that liner shipping is a highly concentrated industry. The mere fact that, at the time of writing, four global shipping alliances[15] control 95% of global trade in general cargo would *prima facie* come in support of this assertion. But how can we measure concentration and is concentration necessarily a bad thing? Does concentration always lead to market power and if so how do we measure it?

Concentration in liner shipping

In most industrialised countries, central government bodies like the US Bureau of the Census (something like a *national statistical service*); the UK Ministry of Industry (where the competition authority also belongs); and the Japanese Fair Trade Commission classify firms in industries according to a system known as the *Standard Industrial Classification* (SIC). The SIC divides the economy into a hierarchy of industries, ranging from broadly defined categories to very specialized products.

Obviously, the broader the definition of an industry, i.e. the greater the number of dissimilar firms included in it, the less concentrated the industry would appear to be. Unfortunately, disaggregated data at specific product level are either not collected or are difficult to get by, mainly due to reasons of confidentiality. In 1997, the US replaced SIC by NAICS – North American Industry Classification System- in order to account for new industries and production technologies. NAICS applies to USA, Canada and Mexico (NAFTA) who no longer support SIC. Similar efforts to industry reclassifications are attempted by other countries and competition authorities too, tacitly or formally, in order to account for the fact that companies tend to become, again, more focused on *core business*, i.e. on specific business areas where they can dominate, and, therefore, industries tend to become less fragmented (i.e. more concentrated) (Figure 10).

[15] 2M, G6, Ocean3, CKHYE.

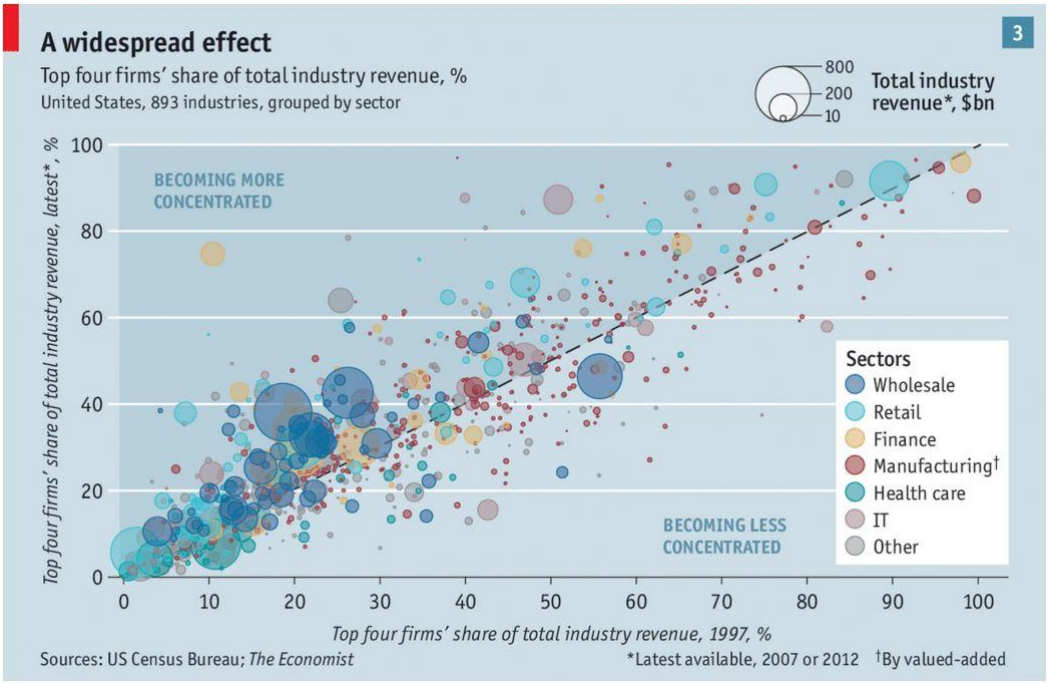

Figure 10: Concentration: back to core business

Figure 10 shows that, in the past 20 years, companies have become more focused, while, at the same time, the market share of the top 4 companies (CR4), in the 900-odd US sectors examined in the example of Figure 10, has increased from 26% in 1997, to 32% today.

Shipping provides a good and fairly representative example in the new course inversion. Contrary to what was the tendency 15 years ago, i.e. un-commoditization of service (ocean transportation) and investment in complimentary sectors (logistics), so as to differentiate and thus command a premium price from the willing shipper, companies are again reverting to core business, shedding 'peripheral activity' and aiming at greater market share (and thus long-term profit) in core business (transportation), through mergers and the strengthening of strategic alliances.

An easy to use measure of concentration is the *concentration ratio*, CRx, showing the cumulative market share of the *x* largest firms in the industry. CR4 = 37.9, for instance, means that the top four liner shipping companies of Figure 11 have a joint market share of 37.9%.

Although the CR makes comparisons between similar industries possible, it suffers from a number of shortcomings. First, the CR returns information only on the largest *x* firms, ignoring information about the relative size of smaller firms and their size distribution in the market. An example could illustrate this point:[16]

A CR4 of 60% could for instance mean that the largest firm in the market has a market share of 54%, sharing the market with 23 firms, each with a 2% share. However, it could also mean that the four largest firms in the market have 15% each, which they

[16] This and the following example are thankfully credited to Stephen Martin of Krannert Business School on whose book (Advanced Industrial Economics; Blackwell Publishers, 2001) this part leans.

share with four smaller firms, each with a 10% market share. From an industrial policy point of view, the two cases are quite different: the first case is a market with a *dominant* firm, while the second is an *oligopoly*. The 4-firm CR provides little guidance here.

Ranking (TEU)	Operator	Country/ territory	Number of vessels	Average vessel size	TEU	Share of world total, TEU (percentage)	Cumulated share, TEU (percentage)	Growth in TEU over 2012 (percentage)
1	Maersk Line	Denmark	453	4 745	2 149 524	13.4%	13.4%	2.1%
2	MSC	Switzerland	398	5 186	2 064 118	12.9%	26.2%	1.9%
3	CMA CGM Group	France	288	4 004	1 153 088	7.2%	33.4%	-0.7%
4	COSCO	China	155	4 614	715 219	4.5%	37.9%	14.6%
5	Evergreen Line	Taiwan Province of China	187	3 795	709 702	4.4%	42.3%	24.3%
6	Hapag-Lloyd Group	Germany	141	4 533	639 148	4.0%	46.3%	-1.5%
7	APL	Singapore	127	4 492	570 497	3.6%	49.8%	-4.9%
8	CSCL	China	124	4 550	564 151	3.5%	53.3%	1.3%
9	Hanjin	Republic of Korea	107	5 190	555 279	3.5%	56.8%	11.6%
10	MOL	Japan	111	4 576	507 894	3.2%	60.0%	13.2%
11	OOCL	Hong Kong (China)	102	4 442	453 044	2.8%	62.8%	14.0%
12	NYK	Japan	93	4 334	403 030	2.5%	65.3%	28.0%
13	Hamburg Sud	Germany	93	4 132	384 293	2.4%	67.7%	4.1%
14	HMM	Republic of Korea	67	5 438	364 373	2.3%	70.0%	15.8%
15	Yang Ming	Taiwan Province of China	86	4 222	363 057	2.3%	72.2%	5.7%
16	K Line	Japan	75	4 558	341 848	2.1%	74.3%	-0.2%
17	Zim	Israel	71	3 978	282 411	1.8%	76.1%	-7.1%
18	UASC	Kuwait	41	6 361	260 818	1.6%	77.7%	36.5%
19	CSAV	Chile	55	4 716	259 391	1.6%	79.3%	-25.5%
20	PIL	Singapore	98	2 426	237 776	1.5%	80.8%	0.3%
Total top 20 liner companies			**2 872**	**4 519**	**12 978 661**	**80.8%**		
Others			2 957	1 041	3 079 572	19.2%		
Total all liner companies			**5 829**	**2 755**	**16 058 233**	**100.0%**		

Source: UNCTAD secretariat, based on data provided by Lloyd's List Intelligence, available at www.lloydslistintelligence.com.
Note: Includes all container-carrying ships known to be operated by liner shipping companies.

Figure 11: Liner shipping concentration (2013)

Another commonly used method for calculating industry concentration is the *Hirschman Herfindahl Index* (HHI) or, as it is also known, the Herfindahl Index, *H*. This measure has the merit of combining information on the market shares of *all* firms in the industry, not just the largest four or eight of them. The H-index is also used for policy purposes; competition authorities employ it in order to decide which proposed mergers or acquisitions they might consider challenging.

Assume there are N firms in the industry, and s_i is the market share of firm i. The H-Index is the sum of the squared market shares of the N firms:

$$H = \sum_{i=1}^{N} s_i^2 = s_1^2 + s_2^2 + \cdots s_N^2$$

$$0 \leq H \leq 1 \ (or\ 0 \leq H \leq 10{,}000)$$

The H-Index ranges between 0 and 1, or 0 and 10,000 depending on how market shares are expressed (i.e. 0.1 or 10(%)). If a market is supplied by a monopolist, his market share is 1 (100%) and the value of the Index is also 1 (or 10,000). If there are two firms, each supplying half of the market, then the value of the index would be one and half. In the case of 3 equal-sized firms, the value of the index would be one third, and so on. in general, if there are *N* equal-sized firms in the industry, the value of the H-Index is *1/N*; i.e.:

$$H = \left(\frac{1}{N}\right)^2 + \left(\frac{1}{N}\right)^2 + \cdots + \left(\frac{1}{N}\right)^2 = N\left(\frac{1}{N}\right)^2 = \frac{1}{N}$$

Thus, as the number of industry firms increase, the value of the Index falls from 1 to 0. The larger the value of the H-Index, the fewer the number of companies competing in the industry. Often, an industry is considered concentrated if the HHI exceeds 1,800, corresponding to 4 to 5 equal-sized firms. What if, however, firms are not of equal size? Let's consider the following example.

$$1.\, H = (1)^2 = 1$$
$$2.\, H = \left(\frac{1}{2}\right)^2 + \left(\frac{1}{2}\right)^2 = 0.500$$
$$3.\, H = \left(\frac{1}{3}\right)^2 + \left(\frac{1}{3}\right)^2 + \left(\frac{1}{3}\right)^2 = 0.333$$
$$4.\, H = \left(\frac{1}{2}\right)^2 + \left(\frac{1}{4}\right)^2 + \left(\frac{1}{4}\right)^2 = 0.375$$

The first case represents a monopolist; the second, a duopolist. In the third case, three firms share equally the market among them, while in the last case, one firm supplies half of the market, and two more firms divide equally between them the remaining 50%. The value of the H-Index in this last case is 0.375. This is less than 0.5 (the value of the index for 2 equal-sized firms), but more than 0.333 (the value of the index for 3 equal-sized firms). In other words, 3 firms, one larger than the other 2, represents a greater industry concentration than 3 equal-sized firms but a smaller concentration than 2 equal-sized firms. As an example, in December 2015, Dow Chemical and DuPont announced their intended merger. Subsequently, and if everything goes well, the two *chemicals* giants plan to split into three specialist companies each of which will have a higher share of its market than either original company had before the deal (The Economist, 2016).

Is therefore liner shipping a concentrated industry? By inputting the market shares of the top 20 carriers of Figure 11 in a spreadsheet and calculating and adding their squared values, the result of 548.41 should be derived. Moreover, the number *N* of equal-sized firms with an H-Index=548.41 should be given by: N=10000/548.41=18 firms. As 548.41 < 1800, liner shipping should not be considered as a concentrated industry; but this is only have the truth, if not even less than that.

From a competition law point of view, the concept of 'market' which is of interest is the *relevant geographic market*. In other words, this is the *physical* place where consumers and suppliers interact for the acquisition/provision of a good or service, and competition among suppliers is prevalent. The consumer is expected to have ample choice, i.e. enough substitute goods should exist for him to choose from. In the form of a witticism, although, say, Maersk covers a global network, the service it offers in South America is not much use to a consumer in Antwerp, and unless the latter decides to move house, he cannot substitute that service for a bad one he may be receiving in Antwerp, neither can he do so if Antwerp tariffs go up. In this sense, the two markets of our example are distinct and geographically irrelevant. *Global* concentration, in this sense, means very little.

A market has thus a geographical attribute which is of relevance in determining concentration and competition. For instance, the market of the city where the port is located is fairly *captive*. But as the port tries to extend its hinterland towards the region, the country or the continent, the market becomes just a *potentially targetable* market, with more players and thus more competition (Figure 12). To give another example: The Shanghai-Rotterdam *port-to-port* market may be highly concentrated, with just a handful of carriers offering services, but if one were to consider that, actually, the market is the *door-to-door* importation of bicycles made in Wuhan, China to Paris, France, then the market is highly competitive with many players offering services, using not only those two ports but many others, at both ends of the trade. Simply put, if the market is *port-to-port* it could indeed be concentrated; if however the market is *door-to-door*, including a miscellany of *add-on* logistics services, it could well be considered as not concentrated at all.

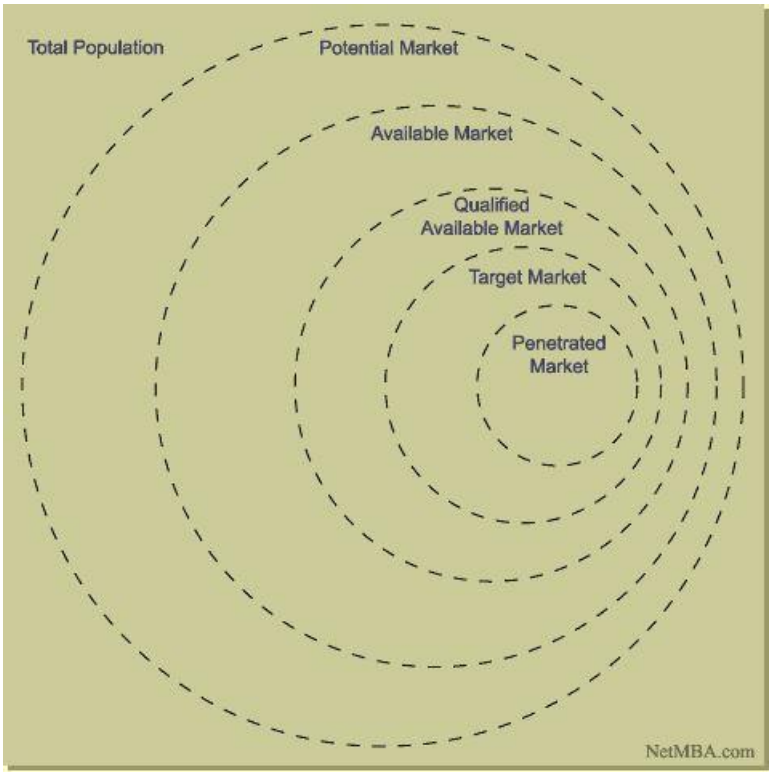

Figure 12: Market definition (source: NetMBA.com)

Therefore, without defining the *geographically relevant market*, one cannot express opinions as to whether liner shipping as an industry is concentrated or not. Finally, one should not forget that the example and calculations of Figure 11 hinge on the assumption that these firms operate independently. However, this is not true and, as we have seen, carriers operate within (price-setting) conferences and (capacity-managing) alliances. In some way, it should be these organisations and not the independent carriers themselves which should enter into the *concentration* calculations.

Contestable markets

The monopoly/cartel approach to liner shipping has not been able to give convincing answers to a number of important questions. For instance: Does the industry realise supernormal profits (i.e. economic rent)? How is it possible that carriers consistently post meagre financial results and at the same time have such an impressive newbuilding programme? Do alliance members coordinate the size and timing of their investments in new ships? As a result of market structure, are there inherent *barriers to entry* in liner trades? Is vertical integration (logistics) a necessity or an anticompetitive contrivance, meant to keep new competition out? William Baumol's *Theory of Contestable Markets* (Baumol *et al*., 1982), although not universally accepted as *conventional wisdom* in industrial economics, has been more successful in providing plausible answers to many such questions.

In mainstream neoclassical economics, competition is seen to progressively diminish as the number of firms in an industry is reduced.[17] The *rationale* behind this is that the techniques of large-scale production which allow the number of firms to be reduced; effective, complex and expensive government lobbying by incumbents; and restrictive trade and *product standards* regulations, can create difficulties to aspiring newcomers in the form of, for example, capital or scale barriers, or very high transaction costs. In the past 25 years, for instance, the number of startups in the US economy has declined precipitously while, in the same period, concentration has increased by at least 6% (Figure 10). With regard to capital requirements, in liner shipping, it should be remembered, the provision of a weekly service between SE Asia and NW Europe could require investments in excess of 1 billion US$ in ships alone.

Contrarily, the theory of contestable markets contends that concentration does not necessarily lead to market power, provided markets are *contestable*; i.e. easily accessible to new entry. In such cases, only the *threat* of entry (potential entry) is enough to discipline incumbents (existing producers) from abusing their market share, thus charging prices not far from marginal costs. In this sense, to quote Baumol, "lack of entry can be a virtue, rather than a vice".

The theory of contestability brings out one major difference between the European and the American regulator. In Europe, equal emphasis is placed on market share as well as on its abuse. It is believed that a large market share would probably lead to market power, which in turn can lead to loss of social welfare and transfer of income from consumers to producers (Figure 6). These are aspects less easily acceptable in Europe than in the US.

[17] We shouldn't forget that one of the assumptions of perfect competition is the large number of sellers, none of which being able to influence market prices through his actions.

In the US instead, where the *Chicago School* has had a marked influence on competition law-making, market share *per se* is not a major issue. Market share is often considered the outcome of normal business processes, or the most efficient way of organising production. It is rather market power, i.e. the abuse of market share (through high prices, collusion or price discrimination) that ought to be prevented or punished.

The *threat* of entry is particularly relevant in network industries, like liner shipping, offering hundreds of services around the world, albeit not all of them equally profitable (e.g. north-south or south-south services). Short-run profitability notwithstanding, such services are important in order to maintain market share (i.e. long-term growth) and all that comes with it. In such cases, a carrier is susceptible to *market niching* or *cherry-picking*: A new entrant, e.g. a regional carrier, with minimum infrastructure and low costs, can target only the profitable, or dense, parts of the network, i.e. the *cherry* which was however cross-subsidizing the cherry tree (network). If sustained for long, this competition *in* the market could easily become competition *for* the market and the incumbent carrier could lose its entire output. A good example of cherry-picking can be found in the demise of the majority of national, *legacy*, air carriers with the liberalization of the air transport market and the appearance of budget companies, targeting only the dense parts of the network.

Capital requirements and other barriers to entry notwithstanding, however, easiness of entry requires also *easiness of exit*. If a potential entrant can recoup the bulk of his initial (entry) costs upon his eventual exit, he will deem himself to be in a relatively safe situation, and this can make his entry decision much simpler. The existence of *sunk costs*, i.e. non-recoverable costs, is thus a major consideration that could inhibit new entry and more competition; in their absence, even price wars or other retaliatory responses of the incumbent need not worry a potential entrant, and his entry decision should be based only on the prospect of short-run profit.

Sunk costs are often confused with *fixed costs*. However, the latter are simply costs that do not vary with output, such as capital costs or depreciation, while sunk costs are those costs that cannot be recovered once the firm decides to leave the market. Advertising and brand-name-building costs are good examples here. It is thus possible fixed costs not to be sunk (you can always sell or charter-out a containership if you decide to exit that market), and a lot of variable costs (such as advertising and brand-name-building) to be sunk. The issue however is: the lower the sunk costs the easier it is to enter, and eventually exit a market; i.e. the more contestable the market is.

If potential new carriers have access to the same technology as incumbents (i.e. ships; infrastructure; capital; knowhow; networks; etc.) and they assess entry to be riskless, in terms of limited sunk costs, then even the prospect of a fairly small profit will convince them to enter the market. Industry structure (concentration and number of firms) becomes thus irrelevant and the only way an incumbent monopolist could maintain his position is to make profitable entry impossible. This will necessitate setting prices equal (if not below) to the average cost incurred in producing the desired output, yielding him thereby only normal profit. Such a pricing strategy is known as *limit pricing* (Figure 13). Yet, such behaviour is normally expected in competitive markets. This is the full explanation lying behind Baumol's statement that *an absence of entry in a highly concentrated industry may be a sign of virtue and not vice*.

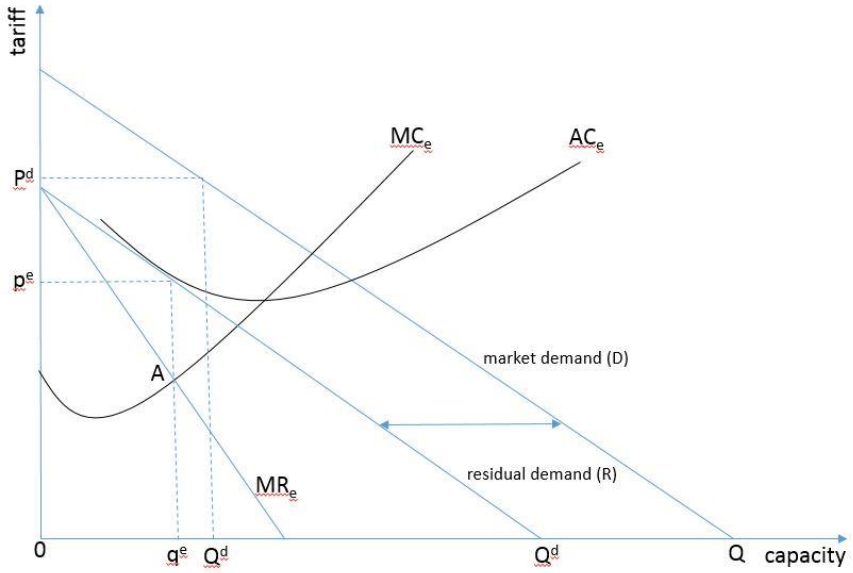

Figure 13*: Limit pricing of a dominant firm*

Assume MC_e, AC_e and MR_e in Figure 13 are respectively the marginal cost, average cost, and marginal revenue of the prospective entrant. If the incumbent commits to a capacity QQ^d (= to $0Q^d$), the *residual* demand, i.e. the demand left to the new prospective entrant, is R. The price p^e that the latter would achieve, however, at point A where his marginal revenue is equal to his marginal cost, is lower than his average cost and entry is not profitable. By committing to $0Q^d$ capacity instead, the incumbent enjoys a prise P^d which is the limit price.[18]

Has there, however, been new entry (and exit) in the liner shipping industry? A simple look at the list of carriers of Figure 11 tells us that the same companies –household names really- have been there for years, and the only thing that changes from year to year is their ranking. But again, the concept of *geographically relevant market* comes into play. The real question is not whether new companies appear and vanish in the *global* liner shipping market, as it regularly happens in bulk shipping, but whether *new services*, of the same *incumbent* companies, appear and vanish in a certain market segment or trade route (e.g. Asia-Europe; Transatlantic; and Transpacific); and here, the picture is very different, with entry and exit taking place incessantly. Entering ships may be new ones, but could also be existing ones previously active in another route; and it is this possibility of shifting ships between routes that makes contestability theory so appealing in liner shipping.

Davies (1986) is the only author who offers an actual empirical analysis to substantiate the validity of contestability theory in liner shipping. He presents counts of actual entries and exits of ships on a number of liner routes and on the basis of these he concludes that entry and exit do occur a lot. His work is heavily criticised by Pearson (1987) and Jankowski (1989a), who argue that it is not the 'actual' entry that is relevant, but the *threat* of entry. Substantial entry and exit, they argue, could also point at

[18] For completeness I should have included the cost curves of the incumbent firm too. In this way, I could have shown you that, for the incumbent, limit pricing means offering more capacity at a lower price. This though would have complicated the graph unnecessarily.

destructive competition, which is an indication of short run marginal cost pricing rather than contestability.

In his critique of contestability, Jankowski (1989b) argues that '(..) *market contestability does not explain why institutions such as conferences have emerged in liner shipping and not in other modes, something that limits the usefulness of the theory for purposes of policy analysis*'. Pirrong (1992) and Sjostrom (1989) claim that such an explanation can be provided by the *theory of the core* (see below).

In conclusion, we are living in an era of consolidation that permeates all aspects of life, from economics to politics and international relations. Decision making power is again centralized rather than delegated. In spite of its alleged and incessantly proclaimed efficiency gains, consolidation is bad news for both employment and price levels. In imperfectly structured markets, such as liner shipping, it is doubtful if efficiency gains are passed on to the consumer through lower prices, or are appropriated by the producer through higher profits. Two thirds of Americans believe that their markets are rigged, and this is a central theme in Hilary Clinton's 2017 electoral campaign.

Moreover, sooner or later, consolidation is bound to lead to market power and *rent seeking*. An old Greek adage tells us that *he who has honey at his fingertips is bound to lick it in the end*. In the United States, consolidation in railway transport has seen freight rates rising by 40% in real terms in the last 10 years, while *return on capital* has doubled since 2014. In the same country, rent seeking, above a 'normal' 10% RoC, corresponds to 1.7% of that country's GDP, or $300 billion (The Economist, 2016). One should of course question whether, with interest rates nearing zero, a 10% return on capital could be considered as 'normal'.

Naturally, consolidation, apart from making new entry more difficult, allows for a better control of supply and the 'coordination' or limitation of new investment. Shipping alliances, for instance, have as an objective the more efficient utilization of capacity through joint network planning, vessel swaps and slot-chartering amongst them. From this, however, it is only just a step further to also plan jointly individual carriers' future investments in new ships and competition authorities have yet something to say on this. Moreover, common shareholders of dominant firms -notably large institutional investors- would have an interest to limit competition among 'their' companies and this is most welcome to CEOs who'd rather have a *quiet life* rather than put their neck on the block by undertaking risky new investments. As R.A. Gordon has so succinctly put it […] *executives of large corporations do not receive the profits which may result from taking a chance, while their position in the firm may be jeopardized in the event of serious loss*.

It is often said that the internet makes markets far more efficient, and firms more competitive, due to higher transparency, price information to consumers, and elimination of *physical distance*; an obstacle to consumer choice.[19] The consumer now

[19] In many cities, to draw a parallel, zoning arrangements is a good case in point. You would rarely find two competitors next to each other and even if you do, in all likelihood they will not be selling an

shops in global markets, through direct business, with little trade impediments, and low transport costs. Being as it may though, one could also argue, price information could lead to more consolidation, so as to limit competition and the customer's ability to shop around.

Issues such as the above should normally fall in the ambit of competition authorities. The problem here however is that competition authorities are *reactive* rather than *proactive* regulators. In other words, their mandate is to ensure that the law is not violated, e.g. that a certain market share threshold is not exceeded by a merger, rather than look into the effects and implications of the merger.

The Theory of the Core[20]

A less disputed, albeit more esoteric, approach to liner shipping market structure is the Theory of the Core. Here, in short, the trading mechanism is not based on price but on *exchange arrangements* between agents (such as carriers and shippers) in a particular market economy. The trading process is called a *market game.* The combined *possessions* (such as vessel fleet and amount of cargo) of agents in a market game is called an *allocation*. If such an allocation is feasible and it cannot be improved by a coalition of agents (such as a conference or alliance), then the allocation is said to lie in the *core* of this market economy. One of the contemporary proponents of the theory is Telser (1978, 1987).

The theory of the core has been applied to liner shipping to show that this could be an example of an industry where the *core* is actually 'empty'. This means that stable liner systems cannot exist for long. Pirrong (1992) finds that '…*a core-based model effectively explains the incidence of collusion and competition in ocean shipping markets*'. Sjostrom too argues that liner shipping might be characterised by an *empty core*, which could imply that conferences exist to 'solve the problem of an empty core'.[21] Jankowski (1989b,) argues similarly that conferences exist to change the structure of market games in such a way that the outcome is more beneficial to both shippers and carriers.

The conditions for an *empty core* are: inefficient entry, demand divisibility, and marginal cost indivisibility. Both Sjostrom and Pirrong argue that these conditions are met in liner shipping and they provide empirical evidence for their assertion.

By relaxing the conditions of an empty core, Sjostrom constructs a test to obtain situations where it is uncertain whether an empty core might arise or not. If the core is empty, Sjostrom assumes that a cooperation agreement will emerge. In this way, he derives a number of testable implications:[22] Thus, agreements are more likely a) the

identical product. Differentiating to avoid price competition is a seller's prime concern, often achieved through tacit competitor agreements.

[20] A first draft of this part on the *theory of the core* is gratefully attributed to A.W. Veenstra.

[21] *op. cit*. 1162; see also Pirrong (1992), 89-90.

[22] *op. cit*., p.1164 ff.

more homogenous firms are; b) in markets with lower price elasticity of demand; c) if firms' capacity is large relative to market demand; d) if the industry is in recession; e) in industries with more variable demand or costs. Oppositely, agreements are less likely if there exist legal restrictions to entry.

Pirrong (1992) emphasises the importance of costs, relative to demand, as a possible source of an empty core. His investigation thus focuses on the nature of demand and the structure of (marginal) costs. First, Pirrong asserts that demand in liner shipping is finely divisible (i.e. existence of very small consignments, such as a single container) and highly variable. He calculates ratios of parcel size to ship size and finds these to be small (.2 to 5 per cent). Furthermore, coefficients of variation of monthly shipments are considerable: demand varies by 10 to 20% of average shipping volume.

With regard to costs, Pirrong estimates cost functions from data on 266 voyages from North Atlantic US and Mexican ports to Europe. He distinguishes between capital costs, voyage costs and cargohandling costs, and presents evidence that voyage costs represent 35-43% of total costs. Since these costs are largely unavoidable, cost indivisibilities exist in liner shipping. Therefore, the author argues, the combination of a highly divisible demand with cost indivisibilities support the view that, even in a larger market, liner shipping may be confronted with an empty core problem. [23]

[23] *op cit.*, p.115.

Concluding remarks

In addition to an effort to provide a general overview of liner shipping, this chapter has focused on two types of models that have mainly occupied the attention of researchers in recent years. The first concerns models aiming at the optimisation of liner shipping operations. The volume of publications here is rather limited, the reason being the confidentiality that often shrouds highly commercial information such as fleet deployment and container repositioning strategies. Still, the available literature offers a comprehensive coverage of the various optimisation problems that can be found in liner shipping.

The second, and more important, type of models in liner shipping concerns market structure. The pertinent questions here –entailing significant policy implications- are the degree of capital concentration, carrier coalitions such as conferences and alliances, monopoly power and related pricing strategies. The amount and extent of work carried out in the last few decades leaves a lot to be desired. This is particularly true in the area of economic modelling of market structures and tariff setting processes. With the imminent demise of the conference system -and the monopoly theory approach- general price theory in liner shipping has come to a virtual standstill. In addition, the theory of contestable markets does not offer clear modelling opportunities, while Core Theory provides useful albeit difficult to interpret insights.

Modelling efforts have also been seriously hampered by the unavailability of time-series data of reasonable length and consistency. Most of the works cited in this chapter have employed cross-section data. Time-series modelling could, however, offer interesting insights into the market structure of liner shipping –something that cross-section modelling cannot reveal- and could also allow the construction of forecasting models (for an overview of time-series modelling in bulk shipping, see Haralambides *et al*., 2005). A time-series data set would at least have to contain data on fleet, tariffs, secondhand ship prices and volumes of container flows. Of these, limited information exists on the fleet of containerships and on liner tariffs. The latter are mostly published tariffs, having little or nothing to do with the 'actual' prices paid for the transportation of containers nowadays. Building suitable and comprehensive data sets on liner shipping markets is one of the most important research tasks in the coming years.

A final word is due on the recent phenomenon of *global shipping alliances*. These are also coalitions of carriers but, contrarily to the route-based character and price-setting objectives of conferences, alliances are not involved in price-setting and one of their main objectives is to offer shippers global geographical coverage through cooperation, harmonisation, and dovetailing of their members' operations.

Regularity and frequency of service, the two imperatives of liner shipping, combined with today's need for very large containerships, can easily lead to low capacity utilisation for operators that would decide to go it alone. Alliances have thus emerged in order to exploit *economies of scope* among otherwise competing operators, through strategies such as the dovetailing of individual service networks; vessel sharing; slot-

chartering; joint ownership and/or utilisation of equipment and terminals and similar endeavours on better harmonisation of operations.

With a few notable exceptions (Evangelista, P. and A. Morvillo, 2000), research on the institution of shipping alliances is still in its infancy and questions on their stability, market power, degree of integration and similar concerns that permeated the discussion on conferences in the past have yet to be addressed.

References

Baumol, W.J., J.C. Panzar and R.D. Willig (1982) *Contestable Markets and Theory of Industry Structure*. Harcourt Brace Jovanovich, New York.

Beenstock, M. and A. Vergottis (1993) *An Econometric Model of World Shipping*. Chapman & Hall, London.

Bennathan, E. and A.A. Walters (1969) *The Economics of Ocean Freight Rates*. Frederick A. Praeger, New York.

Brooks. M.R. and K.J. Button (1994) The Determinants of Shipping Rates: A North Atlantic Case Study. Dalhousie University Nova Scotia, Centre of International Business Studies, Report No. 139.

Bryan, I. (1974) Regression Analysis of Ocean Liner Freight Rates on Some Canadian Export Routes. *Journal of Transport Economics and Policy* 161-173.

Byington, R. and G. Olin (1983) An econometric analysis of freight rate disparities in US liner trades. In: *Applied Economics*, **15**, 403-407.

Cariou, P. and H.E. Haralambides (2000) Capacity Pools in Liner Shipping; An Allocation Model for the East-West Trades (Forthcoming: *International Journal of Maritime Economics*).

Davies, J.E. (1986) Competition, Contestability and the Liner Shipping Industry. In: *Journal of Transport Economics and Policy*, **13**, 299-312.

Davies, J.E. (1990) Destructive Competition and Market Sustainability in the Liner Shipping Industry. In: *International Journal of Transport Economics*, **27**, 227-245.

Deakin, B.M. in collaboration with T. Seward (1973) *Shipping Conferences - A study of their origins, development and economic practises*. Cambridge University Press, Cambridge.

Devanney III. J.W., V.M. Livanos and R.J. Stewart (1975) Conference Ratemaking and the West Coast of South America. *Journal of Transport Economics and Policy*, **9**, 154-177.

Evangelista P. and A. Morvillo (2000) Cooperative Strategies in International and Italian Liner Shipping. *International Journal of Maritime Economics (IJME)*, **2**, 1-17.

Fox, N.R. (1992) An Empirical Analysis of Ocean Liner Shipping. *International Journal of Transport Economics*, **19**, 205-225.

Franck, B. and J.-C. Bunel (1991) Contestability, competition and regulation, The case of liner shipping. In: *International Journal of Industrial Organisation*, **9**, 141-159.

Gao, Q. (1994) An Operational Approach For Container Control in Liner Shipping. *Review of Logistics and Transportation*, **30**, 267-282.

Haralambides, H.E., M. Fusilo, U. Hautau, W. Sjostrom and A.W. Veenstra (2003) *The Erasmus Report* (*Consultation Paper on the Review of Council Regulation 4056/86 (Liner Conferences)*. European Commission Competition Directorate General, Contract No COMP/2002/16/SI2.346635).

Haralambides, H.E. (2004) Determinants of Price and Price Stability in Liner Shipping. Workshop on *The Industrial Organization of Shipping and Ports*, National University of Singapore, 5-6 March 2004, Singapore (Workshop Proceedings).

Haralambides, H.E., S.D. Tsolakis and C. Cridland (2005) Econometric Modelling of Newbuilding and Secondhand Ship Prices. In: Cullinane, K.P.B. (ed.) *Shipping Economics*, Research in Transportation Economics, Vol. XII, Elsevier, Amsterdam.

Heaver, T.D. (1973a) The Structure of Liner Freight Rates. In: *Journal of Transport Economics and Policy*, **4**, 257-265.

Heaver, T.D. (1973b) The Inbound/outbound freight rate controversy. University of British Columbia, report.

Jankowski, W.B. (1989a) Competition, Contestability and the Liner Shipping Industry; a Comment. In: *Journal of Transport Economics and Policy*, 199-203.

Jankowski, W.B. (1989b) The Development of Liner Shipping Conferences: A Game Theoretical Explanation. *International Journal of Transport Economics* 16: 313-328.

Jansson, J.O. and D.O. Shneerson (1985) A Model of Scheduled Liner Freight Services: Balancing Inventory Costs Against Shipowners' Costs. In: *Review of Logistics and Transportation*, **21**, 195-215.

Jansson, J.O. and D.O. Shneerson (1987) *Liner Shipping Economics*. Chapman & Hall, London.

Jaramillo, D.I. and A.N. Perakis (1991) Fleet deployment optimisation for liner shipping Part 2: implementation and results. In: *Maritime Policy and Management*, **18**, 235-262.

Lane, D.E., T.D. Heaver and D. Uyeno (1987) Planning and scheduling for efficiency in liner shipping. In: *Maritime Policy and Management*, **14**, 109-125.

Norman, V.D. (1979) *The Economics of Bulk Shipping*. Report, Institute for Shipping Research, Bergen.

Pearson, R. (1987) Some doubts on the contestability of liner shipping markets. M*aritime Policy and Management* 14: 71-78.

Pirrong, S.G. (1992) An Application of Core Theory to the Analysis of Ocean Shipping Markets. *The Journal of Law and Economics* 35: 89-131.

Rana, K. and R.G. Vickson (1988) A model and solution algorithm for optimal routing of a time-chartered containership. In: *Transportation Science*, **22**, 83-95.

Rana, K. and R.G. Vickson (1991) Routing container ships using Lagrangean relaxation and decomposition. In: *Transportation Science*, **25**, 201-214.

Ronen, D. (1983) Cargo ships routing and scheduling: Survey of Models and Problems. In*: European Journal of Operational Research*, **12**, 119-126.

Ronen, D. (1993) Ship Scheduling: The last decade. In: *European Journal of Operational Research*, **71**, 325-333.

Shashikumar, N. (1995) Competition and models of market structure in liner shipping. In: *Transport Reviews*, **15**, 3-26.

Shneerson, D. (1976) The structure of Liner Freight Rates. In *Journal of Transport Economics and Policy*, 52-67.

Sjostrom, W. (1989) Collusion in Ocean Shipping, A Test of Monopoly and Empty Core Models. In: *Journal of Political Economy* 97: 1160-1179.

Sjostrom, W. (1992) Price Discrimination by Shipping Conferences. In: *Logistics and Transportation Review*, **28**, 207-216.

Stiglitz, J.E. (2006) *Making Globalization Work*. W.W. Norton and Company, Inc. New York.

Stopford, M. (1997) *Maritime Economics* (2nd ed.). Routledge, London.

Talley, W.K. and J.A. Pope (1985) Determinants of Liner Conference Rates under Containerization. In: *International Journal of Transport Economics*, **12**, 145-155.

Telser, L.G. (1978) *Economic Theory and the Core*. University of Chicago Press, Chicago.

Telser, L.G. (1982) *A Theory of Efficient Cooperation and Competition*. Cambridge University Press, Cambridge.

The Economist (2016) *Too much of a good thing*. March 26, 2016.

Veenstra, A.W. (1999) *Quantitative Analysis of Shipping Markets*. PhD Thesis, Delft University Press, Delft.

Wergeland, T. (1981) *Norbulk, a simulation model for bulk market freight rates*. Report, Institute of Shipping Research, Bergen.

Zerby, J.A. (1988) Clarifying some issues relating to contestability in liner shipping. and perhaps eliminating some doubts. In: *Maritime Policy and Management*, **15**, 5-14.