ARE LINER SHIPPING CONFERENCES NECESSARY?

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ABSTRACT

The issue of whether liner conferences are necessary arose in Australia in 1993 when the Federal Government appointed a panel to review Part X of the Trade Practices Act. This part exempts liner conferences from the anti-collusion provisions of the Act. In thin trades, liner shipping is a natural oligopoly. This, combined with certain characteristics of liner shipping, gives rise to a high likelihood of breakdowns in pricing discipline and 'cutthroat' competition. Collusion becomes likely under these circumstances. Recently, some American economists, drawing on a concept from game theory, 'the theory of the core', have argued that the peculiar characteristics of liner shipping give rise to chronic instability even where the market is not oligopolistic. Some criticisms of this contention are examined. A model is developed which shows that under certain assumptions, inefficient entry is possible in thin trades and a conference can be a means of preventing this. The regular, frequent services provided by conferences require co-ordination between ship operators and conferences provide a framework for this. Shipping conferences may also give rise to savings in transactions and marketing costs and reductions in risk. It is concluded that shipping conferences are necessary but shippers may still need protection from the exercise of market power by shipping conferences

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INTRODUCTION

The question of whether liner conferences are necessary arose in Australia in 1993 when the Federal Government appointed a panel to review Part X of the Trade Practices Act. This part exempts liner conferences from the anti-collusion provisions of the Act. The panel was faced with the question of why liner shipping is a special case which should be treated differently from other industries. This paper is based on work of a theoretical nature undertaken to assist the panel (Harvey 1993). The issue addressed is whether uncoordinated shipping services competing against one another can reach a stable market equilibrium while at the same time providing a service with optimal welfare characteristics.

While there are always concerns about the ability of liner shipping conferences to exercise market power, it is widely accepted that due to certain unique characteristics of liner shipping, conferences create benefits that would not otherwise be available. Hence national governments generally create exemptions to their anti-collusion legislation to enable conferences to function. The main reasons discussed in this paper as to why shipping conferences are necessary are based on arguments that in the absence of collusion, liner shipping will be subject to chronic instability to the detriment of both shippers and ship operators.

This paper is in four parts. The first part takes the oligopolistic nature of liner shipping in thin trades as its starting point and argues that this, combined with certain characteristics of liner shipping, make collusion highly likely. The second part reviews recent work by some American economists that arrives at the same conclusion but without the need to assume an oligopolistic market. The third part examines a model in which a shipping service with optimal service characteristics and competitive pricing can be undermined by inefficient hit-and-run entry. The final part deals with some of the other potential benefits arising from conferences

CUTTHROAT COMPETITION IN OLIGOPOLISTIC MARKETS

It is commonly claimed that in the absence of regulation, either from within or without, liner shipping would be subject to bouts of 'cutthroat' (also called 'destructive', 'wasteful' or 'ruinous') competition (for example, Marx 1953). One interpretation of the term 'cutthroat competition' is a breakdown of oligopolistic pricing discipline leading to prices charged being well below average total costs.[1] The motivation of the firm initiating the price cuts is short-term loss minimisation through increasing its market share. This distinguishes cutthroat competition from predatory pricing where the motivation of the firm initiating the price cuts is to damage competitors in order to improve the price cutter's long-term market position.

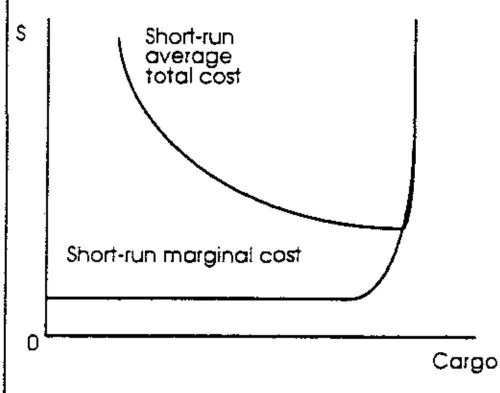
[1] The term cutthroat competition is unfortunate as it has strong negative connotations. From a social viewpoint, it may be desirable when it is the efficient elimination of surplus capacity by market forces.

The first prerequisite for cutthroat competition according to the above interpretation is an oligopolistic market. In a competitive market all firms are price takers so there is no pricing discipline which could break down. The next section examines a theory which purports to show how cutthroat competition can occur in a market with a large number of sellers and no pre-existing pricing discipline.

In between extremely thin trades where only one ship is required, and very thick trades where the number of ships is large enough to approach pure competition, there is a wide range of volumes over which liner shipping in a trade is a natural oligopoly. A given volume of trade can be carried by either a smaller number of larger ships or a larger number of smaller ships. Larger ships give rise to economies of scale, and larger numbers of ships reduce the costs of cargo waiting time by increasing service frequency. These two factors have to be weighed up in determining the optimal ship size–service frequency combination. The service frequency benefits from increasing ship numbers are subject to rapid diminishing returns. For example, the time between sailings for a single ship service on a 20 day voyage cycle would be cut by 10 days if an additional ship was introduced. If there were four ships in the trade implying an interval between departures of five days, an additional ship would reduce the interval by only one day. The benefits from economies of scale in ship size continue on as volume increases until draught restrictions in ports or canals take effect. Because increased ship sizes yield greater benefits than increased frequency, the long-run equilibrium expansion path for a shipping fleet as volume increases is biased in favour of increasing the size rather than the number of ships. Only when the trade is quite 'thick' will there be sufficient ships for a trade to meet the conditions required for pure competition.

The nature of ships' costs enhances the tendency towards instability in an oligopolistic trade. All the costs of the ship itself—capital, crew, fuel, and so on—remain virtually unchanged whether the ship sails full or empty. Given that the ship is going to sail, these costs are fixed giving rise to the familiar rectangular hyperbola shaped average fixed cost curve. At load factors around or below the normal level, the variable costs are comprised of stevedoring costs, wharfage dues and commissions to cargo and booking agents. Once the normal load factor is exceeded, it may become necessary to pay overtime stevedoring charges and increase the ship's speed to compensate for extra time spent in port. Increasing ships' speeds is very expensive because in the short run, fuel consumption rises approximately with the cube of speed. The shapes of these cost curves are shown in figure 1.[2] Fixed costs constitute a very high proportion of total costs. Figure 2 shows the orders of

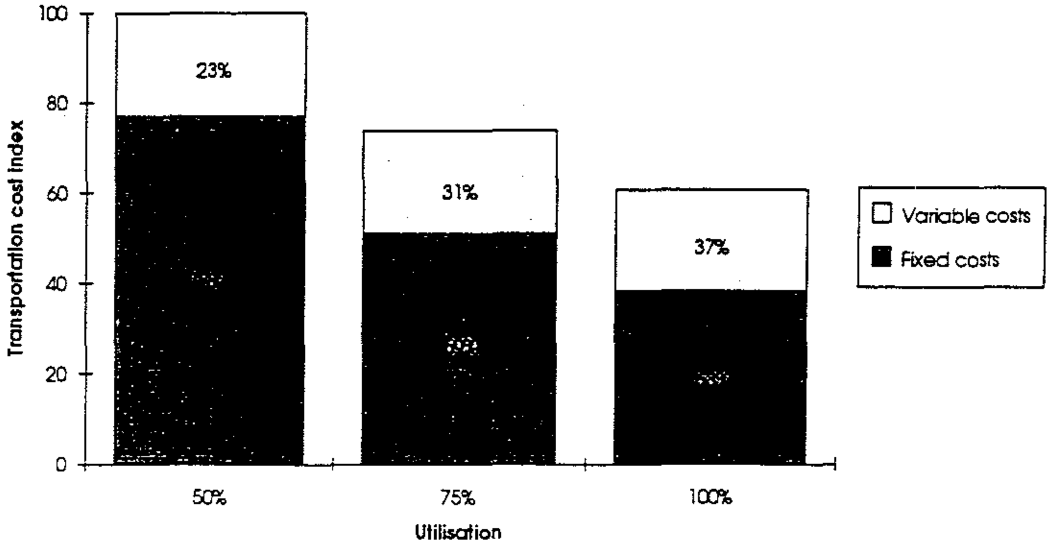
Figure 1 Short-run average and marginal cost curves given that a vessel will sail



[2] Since it is given that the ship will sail, fixed costs are defined here as including fuel at the rate of consumption that obtains at the ship's normal speed.

magnitude for container ships at different levels of utilisation. The significance of the rapidly falling average costs is that heavy penalties are imposed for underutilisation of vessels. This is also demonstrated in figure 2.

Figure 2 Relationship between fixed, variable and total costs per slot as vessel utilisation changes



Source: Davies 1983 p421.

In an oligopolistic industry, some kind of collusive behaviour is likely to occur. This may be tacit collusion as suggested by Chamberlin (1933) where the firms recognise their interdependence and act so as to maximise industry profit, that is, they act as though they were a monopoly, or it may take the form of price leadership or a formal agreement on rates and schedules.

Scherer (1980) sums up the position taken by a number of writers thus:

> 'There is evidence that industries characterised by high overhead costs are particularly susceptible to pricing discipline breakdowns when a cyclical or secular decline in demand forces member firms to operate well below designed plant capacity.' (p206)

With the short-run marginal cost curve being very steep in the region of the intersection with the demand curve for each ship, and assuming marginal revenue is equated with marginal cost, the falls in price and profits are greater than occurs in the textbook models having higher proportions of variable costs and gradually rising short-run marginal cost curves. The situation is worsened for the oligopolists if demand is inelastic.[3] Since

[3] Robinson (1961) stated that 'The primary ingredients for cutthroat competition are inelastic demand and a high fixed-variable cost ratio. The prospects for this unhappy outcome are improved if the minimum level of AC occurs close to a definable 'capacity' level of output, thus pushing MC below AC for all save near-capacity outputs, in other words, if the total cost curve has the linear shape commonly used in break-even charts' (pp222-3).

shipping costs comprise a fairly small proportion of the selling price of freight, the demand for liner shipping tends to be quite inelastic. If price is held rigid because the oligopolists fear that any reduction to the profit maximising level could be misinterpreted and trigger off a price war, the level of excess capacity in times of declining demand will be much greater and, as already noted, this is expensive.

With fixed costs not being covered, interest payments and dividends unable to be met out of current earnings, the firm's decision-making horizon shortens. Attention is turned '.... to immediate remedies ignoring the risks of diminished profits from weakened industry discipline in the uncertain future' (Scherer 1980 p208). A substantial increase in sales can be gained by one firm if it cuts its price while the others hold theirs constant. Once the firm has cut its price, the others, faced with a loss in market share, must follow.

For the conclusion, we again quote from Scherer.

> 'Here again we find an important difference between industries with high and those with low fixed costs. Price cutting will be checked at higher price levels when marginal costs are high and fixed costs low than when marginal costs are low and fixed costs high. The industry suffers more when demand is depressed both because of stronger inducements toward price cutting and a lower floor to price declines.
>
> From this analytic conclusion, we are tempted to generalise: The higher fixed costs are relative to total costs, the more prone an industry is to serious pricing discipline breakdowns during recessions. Unfortunately, the problem is more complicated. Recognising the temptations confronting them, firms in high fixed cost industries seem to exercise extraordinary restraint in their pricing actions; and when tacit restraint fails, they have an unusually high propensity to scurry in to formal collusive agreements. .....
> We conclude then that the probability of pricing discipline breakdowns increases with the burden of fixed costs borne by sellers, *ceteris paribus*, but that recognition of this danger may stimulate institutional adaptations nullifying the tendency.'

At first sight, the situation described here appears to match liner shipping perfectly, having both inelastic demand and high fixed costs. The only reservation is that Scherer uses the term 'fixed costs' in the conventional sense referring to capital and land costs. In the liner shipping literature, a very large part of fixed costs is comprised of vessel operating costs. Fuel costs can be avoided in the short run by reducing the number of sailings and other operating costs by laying up the ship. Even so, continuing to operate a ship or ships that fail to cover operating costs could be a rational strategy in an oligopolistic trade. If the fall in demand is permanent and the required number of ships has fallen, when pricing discipline has been re-established, the loss of market share to a firm that has withdrawn capacity could be permanent. The thinner the trade, the greater this loss of market share from withdrawing a ship becomes. Thus even though the greater part of so-called fixed costs are not really fixed in the usual sense, it is still possible for rates to fall well below operating costs. Also, the capital intensive nature of liner shipping means that the proportion of costs that are truly fixed in the short run is substantial. The force of the argument is therefore not substantially diminished.

An empirical objection could be raised against this model, that conferences and independent lines are able to coexist without price wars. Even though conferences do not bring all the shipping lines in a trade together, by bringing some together, stability in the market is enhanced. Coordination between oligopolists becomes easier with smaller numbers of sellers in the market. The number of two way information flows required is given by the expression $N(N-1)/2$ where N is the number of firms (Scherer 1980). Another factor may be that the independent lines are offering differentiated services from the conferences, for example, catering for particular types of cargo or offering multi-modal services.

CUTTHROAT COMPETITION AND THE THEORY OF THE CORE

A different version of the cutthroat competition argument applies to competitive as well as oligopolistic liner shipping markets and does not presuppose the existence of any previously established pricing discipline. Marx (1953) put the argument thus:

> '.... once a vessel has been scheduled by a liner operator or actually placed on a berth by a tramp operator, a large proportion of the total expenses of the voyage become fixed and until the vessel is loaded 'full and down' it will be remunerative for that vessel to carry any additional cargo that can be procured so long as it pays anything in excess of the actual out of pocket expense involved. In trades where the flow of commerce is not balanced—and this is the case more often than not—both liners and tramps will be tempted to engage in cutthroat competition at least on the leg of the voyage on which cargo is light.' (p21)

Quoting from Cassidy (1982):

> 'Therefore in a competitive millieu, *if unemployed shipping space is available*, "cutthroat" competition would force shipowners to cut their rates to a market price below the level necessary to cover costs. In the limit, rates could be driven considerably below what was necessary to cover vessel expenses (since these are seen as fixed in this time period) and might conceivably settle as low as direct handling costs (i.e. cargo handling costs) ' (p35 emphasis in original).

Many authors in the field of shipping economics have rejected this argument (Bennathan and Walters (1969); Devanney *et al* (1975); Cassidy (1982)). The difficulty they have with it is that it only applies if there is excess capacity. In a competitive market, this is a case of disequilibrium. The resulting non-compensatory rates will eventually force the unused tonnage off the route. As Devanney *et al.* state:

> '... a long-run quasi-equilibrium will be established in which the long-run average of the fluctuating market price will return to the marginal investor who stays in the business his opportunity cost of capital.' (p156)

Devanney *et al* go on to point out that the dry cargo and tanker tramp shipping industries have the same problematical cost characteristics as liner shipping but are able to function successfully Bennathan and Walters (1969) and Cassidy (1982) use as an example the road haulage industry which is sometimes said to be subject to the same problem. The road haulage industry shows that in a competitive industry, joint costs that arise because every trip in one direction creates capacity in the opposite direction, can be covered on routes having unequal demands in the two directions, with rates well above handling costs able to be sustained on backhauls.

In the last few years, Sjostrom (1989) and Pirrong (1992) have revived the idea that liner shipping trades are inherently unstable under competitive conditions. Their hypotheses are based on the 'theory of the core'. The theory of the core dates back to last century but it has only been applied to questions of industrial economics in the last twenty years. In game theory, the theory of the core shows the conditions under which a game in which people have to agree to divide up some quantity among themselves has a stable equilibrium. In the jargon of core theory, a seller and the buyers he or she contracts with, are said to form a 'coalition'. By forming a coalition, that is, by contracting among themselves to produce, buy and sell a commodity, these individuals can generate gains from trade (surplus) which they can divide among themselves. The division of these gains depends on the prices paid and quantities sold. A buyer may patronise several sellers and so be a member of several coalitions. Coalitions must compete for membership by offering larger shares of the gains from trade (Pirrong 1992).

> 'A particular division of the gains from trade (surplus) among the various buyers and sellers is an equilibrium one if two conditions hold. First, no group of individuals can do better by forming a coalition and contracting among themselves. .... Second, ... the aggregate of the surplus allocated to all the various buyers and sellers must be feasible: this aggregate cannot exceed the maximum gains from trade that these buyers and sellers can generate given their endowments of resources.' (Pirrong 1992 pp91-2)

The core is defined as the set of equilibrium allocations. If no stable equilibrium exists, that is, it is impossible to simultaneously satisfy the two conditions, the core is said to be 'empty'.[4]

> 'When the core is empty, no competitive equilibrium exists. .... unrestricted competition cannot sustain any allocation of resources, including the efficient allocation. Participants in a market plagued by empty core problems have incentives to devise restrictions on the

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[4] The following example from Friedman (1989) is a game with an empty core. Three players are told they can divide $100 between them any way they wish. The umpire will accept any agreement between them provided the agreement is signed by the majority of players. No matter how the money is divided up there is always a new coalition that can be formed in which the members of the new coalition do better than they did under the previous arrangement. For example, if (50, 50, 0) is proposed, players 1 and 3 can do better by proposing (75. 0, 25). Players 2 and 3 can improve on this by proposing (0, 37.5, 62 5) and so the game would, in theory, continue forever. The first condition for an equilibrium cannot be satisfied. It would be satisfied if each of the three possible coalitions of two players could receive $100 but this would require $150 to divide up ($50 for each player) which violates the second condition. Suppose the rules of the game were changed so that provided all three players sign the agreement they will receive $150 to divide among themselves. They still receive $100 if only two players agree. Now the core is no longer empty but contains a single equilibrium (50, 50, 50). To determine if the core is empty, one solves a linear programming problem. For this example the problem is minimise $y = x_1 + x_2 + x_3$, subject to $x_1, x_2, x_3 \geq 0$ and $x_1 + x_2, x_1 + x_3, x_2 + x_3 \geq 100$ where the x's are the amounts received by each player. The $100 amount is the best result each coalition of two players can possibly obtain under the rules of the game. The solution is y = $150. If the total surplus available for distribution is less than the minimum value of y so obtained, the core will be empty. Hence the core is empty when only $100 is available for distribution. An equilibrium is created by increasing the surplus available from $100 to $150 or greater while still ensuring that $100 is the best outcome any two player coalition can achieve.

freedom to form coalitions, that is, to restrict the freedom to compete and contract. Indeed, they have incentives to devise an efficient set of restrictions.' (Pirrong 1992 p92)

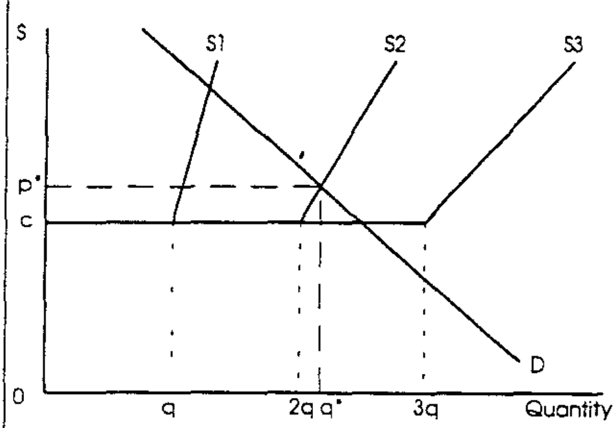
Restrictions may include the formation of cartels and contracts tying buyers to the cartel.

What makes liner shipping susceptible to an empty core is the combination of:

- the cost characteristics of shipping, namely low avoidable costs (cargo related costs) and sharply rising short-run marginal costs in the region of capacity (making partly full ships expensive and capacity effectively lumpy); and
- finely divisible demand for liner shipping (in contrast to bulk shipping where a single shipper will usually purchase the whole capacity of a ship for a voyage).

It was stated previously that supporters of the stable competitive equilibrium hypotheses argue that prices below costs are evidence of excess capacity and that once this excess capacity had been forced to leave the market, equilibrium will be restored. Core theorists would counter by saying that due to the lumpy nature of capacity, removal of enough ships to eliminate the excess capacity will probably lead to a shortage of capacity and prices would then rise above costs. This would not be stable because there would be an incentive for existing shipowners or new entrants to reintroduce tonnage, throwing the market back into a state of excess capacity. The market would cycle back and forth between the two disequilibriums. Only in the improbable case of demand exactly equalling supply with an integer number of ships will a stable equilibrium be possible. Given the variability of demands for liner shipping, even if such an equilibrium occurred, it would only be temporary.

Figure 3 Unstable liner shipping market



Source: Sjostrom (1989 p1164)

Figure 3 presents this diagrammatically. It is assumed that the ships are identical with a cost per unit of cargo of c up to the point where variable costs rise steeply. S_1 is the supply curve for one ship. S_2 and S_3, the supply curves for two and three ships are horizontal multiples of S_1. Entry and exit are assumed to be free and costless. With three ships in the market, competitive pressures push price below average costs. When one ship leaves, the market price rises to p^*. But at this price, excess profits are earned by the two remaining ships. This attracts firms back into the market and so the process recommences. Sjostrom's explanation relies on inefficient entry as a condition for the empty core. Pirrong states that this is a sufficient but not a necessary condition. If a ship was laid up, once price had risen to p^* the owner of the idle ship would have an incentive bring his ship back into action at a price between p^* and c. This would occur even when the optimal production plan, taking into account the combined interests of shipowners and shippers, required only two ships.[5]

Core theorists would argue that the comparisons made between liner shipping and bulk shipping and road haulage, are invalid. In the case of bulk shipping:

> 'The correlation between competition and the size of demanders corresponds to the predictions of core theory; since demanders can fill an entire vessel, ship owners have no incentive to cut prices to the marginal cost of a ton of cargo to add marginal customers. There is no indivisibility problem simply because the capacity of a bulk carrier—unlike that of the liner—need not be divided among many shippers (at a given point in time) in order to satisfy demand efficiently at that point in time.' (Pirrong 1992 p127)

In the case of road haulage, the size of the vehicle is very small in relation to market demand. Usually a single consigner fills up the entire vehicle capacity. Small consignments are consolidated into vehicle size lots by freight forwarders.

Sjostrom shows that the probability of an empty core and hence the likelihood of agreements is higher:

- the more homogeneous are the firms in the industry (so they have similar costs);
- the larger the capacity of firms relative to market demand;
- the more inelastic the demand;
- the greater the variability in demand over time;
- the easier it is to enter and leave the industry (lower sunk costs, absence of legal restrictions); and
- in times when the industry is in a slump.

The inelasticity of demand for liner shipping has already been noted. Sjostrom used some of these factors to test the hypothesis that core theory was a better explanation of the existence of conferences than cartel theory, that is, collusion for the purpose of increasing profits. Cartel theory would predict that collusion was less likely where demand was variable because of the difficulties of coordinating price changes and would be more likely where there were legal restrictions on entry. For 25 conference routes to and from the west coast of the United States, Sjostrom undertook an econometric analysis of the relationship between the market shares of the conferences and a number of variables including measures of the variability of demand and the existence of legal restrictions on entry. The positive coefficient for the former, significant at the 95 per cent level, and the negative coefficient for the latter, significant at the 99 per cent level supported the theory of the core. The positive relationship between conference share and tonnage, significant at the 99 per cent level, also supported core theory. It implies that more successful agreements increase output. A successful cartel agreement, on the other hand, would raise price and lower output. A successful agreement to establish equilibrium would lower contracting costs and therefore raise output.

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5 Whether it would be optimal to operate with two or three ships could be found by comparing the sums of producers' and consumers' surpluses.

Although admitting that the severity of empty core problems will abate somewhat as market size increases, Pirrong maintains that very large markets could face empty core problems where short-run marginal costs rise very steeply once a certain output has been reached. He used regression analyses of voyage costs of liner ships against container loadings to show that fixed costs are very high in relation to avoidable costs of cargo giving rise to steep marginal cost curves. Hence the core theory analysis is not confined to thin trades.

Pirrong argues that liner shipping is highly contestable and that conferences have been dogged by entrants, both 'hit-and-run' and permanent, throughout their history. Despite this, they have survived.

> '..... the ability of cartels to survive the constant pressure of entry is clearly at odds with the view of cartels as inefficient monopolisers. ..... As long as the conference attempts to raise prices above the level that generates normal profits for the efficient set of vessels, new firms will enter profitably. Unrestricted entry implies that colluders will earn only normal profits: So why collude in the first place? Core theory answers that riddle: collusion is an efficient response to competitive chaos.' (Pirrong 1992 p124)

The recent work of Sjostrom and Pirrong restates the arguments of earlier authors that conferences are a response to instability of competition in liner shipping trades, but does so in a much more intellectually rigorous and sophisticated way making use of relatively new developments in economic theory. It therefore cannot be rejected so easily.

Some objections may arise from the fact that when applying core theory to liner shipping, it is implicitly assumed that the ships are simply providing services between two ports and that these services are all identical. Opportunities for multiple port calls at both ends of the trade, for loading and unloading part cargoes at intermediate ports and for triangular and more complex route patterns would permit small adjustments to be made to both capacities and demands. For example, calling at an additional port will reduce the annual carrying capacity of a ship and may generate some additional demand. In a competitive market, following a fall in demand forcing prices below costs, instead of a shipowner withdrawing from the trade followed by a rise in price above costs, a shipowner might seek to improve his load factor by calling at additional ports. Of course opportunities for this will not always exist and may not be able to be acted upon in a short enough time frame to eliminate instability.

Shipowners varying their route patterns is a form of product differentiation. Other forms of product differentiation available to shipowners include, reliability, customer relations, electronic systems for monitoring cargo movements, multimodal services and catering for particular cargoes (eg. equipment that cannot be fitted into containers, refrigerated cargoes). A shipowner occupying a niche market or having built up a loyal group of customers, is to a degree insulated against hit-and-run entry and, as the only supplier in a sub-market, can limit price reductions in the face of falling demand.

SHIP SIZE AND SERVICE FREQUENCY

In this section another way in which an empty core can arise in liner shipping is considered. It is shown that under certain assumptions, even when the incumbent shipowners are operating ships of optimal size, providing the optimal service frequency and charging at costs, inefficient entry may be possible. To demonstrate this, a very simple model is developed. It is assumed that ship size is a continuous variable. S represents the quantity of cargo carried in a ship at the normal load factor and ship size is directly related to this. The total cost of operating a ship of the required size for one round trip is $B(S)$. $B(S)/S$ is the cost per unit of cargo. For simplicity it is assumed that the route only involves two port calls, one at each end of the voyage and that there is no cargo to carry on the backhaul. Costs of handling cargo at both ends of the voyage are ignored because they are the same regardless of ship size and service frequency. Time spent in port is assumed to be so small that it can be disregarded.

Cargo becomes available for shipment at a constant rate of X units per year and the cost of waiting time for one unit of cargo for one year is t. The cargo is assumed to be homogeneous. The time taken as a fraction of a year for sufficient cargo to accumulate to fill one ship is S/X. A unit of cargo arriving just after a ship's departure would have to wait the full S/X of a year for the departure of the next ship. A unit of cargo arriving just before the departure does not have to wait at all. The constant arrival rate of cargo means that the average unit waits for $S/2X$ of a year. In this first version of the model it is assumed that cargo can be sold on arrival so there are no waiting time costs at the end of the voyage. The cost per unit of cargo for shipping and time is therefore:

$c = \frac{B(S)}{S} + \frac{tS}{2X}$. The optimal ship size is found where $\frac{dc}{dS} = \frac{1}{S}\frac{dB}{dS} - \frac{B(S)}{S^2} + \frac{t}{2X} = 0$. This can be simplified to $\frac{B(S)}{S} - \frac{dB}{dS} - \frac{tS}{2X} = 0$. The difference between average and marginal ship cost must equal the cost of time for the average unit of cargo.

Say the incumbent shipowners are employing ships of size S_i. A hit-and-run entrant having a ship of size S_e appears on the scene to take a one-off load of cargo. It is assumed there is no customer loyalty to the incumbent. The best time for the entrant's ship to depart is as soon as possible after departure of the incumbent's ship *when sufficient cargo has accumulated to fill the entrant's ship*. The larger the entrant's ship, the later it must sail to allow sufficient cargo to fill the ship to accumulate. The entrant will therefore depart S_e/X of a year after the departure of one of the incumbent's ships. The maximum price the entrant can charge would be the incumbent's price plus the value of time saved by the cargo carried. Each unit of cargo carried by the entrant saves $(S_i - S_e)/X$ of a year in time. The maximum price chargeable is $p_e = p_i + t(S_i - S_e)/X$ where p_i is the incumbent's price. If the entrant's ship is the same size as that of the incumbent, the entrant would have to depart at the same time as incumbent and charge the same or less. The smaller the entrant's ship, the earlier it can depart and the more the entrant can charge. The entrant has to weigh up the benefits from an earlier departure against the loss of the cargo and loss of economies of scale in ship size. Since the entrant carries S_e units of cargo, his profit would be:

$$\pi_e = p_e S_e - B(S_e) = p_i S_e + t\left(S_i S_e - S_e^2\right)/X - B(S_e)$$

For a maximum: $\dfrac{d\pi_e}{dS_e} = p_i + \dfrac{t(S_i - 2S_e)}{X} - \dfrac{dB}{dS_e} = 0$

Whether the entrant is able earn a positive profit will depend the various parameters including the size of the incumbent's ships and the price charged by the incumbent. To show that the inefficient entry can be profitable, the incumbent is assumed to maintain the ship size–price combination which excludes entry and it is shown that this means a non-optimal ship size. To make entry unprofitable, the incumbent must first set her price so she earns zero economic profit, otherwise, the entrant could enter with a ship of identical size and undercut her price. Hence $p_i = B(S_i)/S_i$. Second the incumbent must set her ship size so that the entrant earns zero profit at the entrant's profit maximising ship size. This will occur where the incumbent's ship size is identical to the entrant's profit maximising size. Substituting $p_i = B(S_i)/S_i$ and $S_e = S_i$ into the entrant's profit maximising condition, the result is obtained that:

$$\frac{B(S_i)}{S_i} - \frac{dB}{dS} - \frac{tS_i}{X} = 0$$

which differs from the optimum size condition derived above in respect of the last term. In order to deter entry, the incumbent must adopt a ship size which is smaller than the optimum. If hit-and-run entrants could be excluded, optimum size ships could be employed creating a welfare gain.

To illustrate what is happening here, imagine that 20 passengers arrive at a bus stop each hour, one every three minutes. A bus with capacity for 20 passengers departs every hour full at a cost of \$10 per passenger. Each passenger values time at \$8 per hour. On average a passenger waits half an hour so the average time cost per passenger is \$4. The social cost per passenger is therefore \$10 + \$4 = \$14. An alternative is for a smaller bus with capacity for 10 passengers to depart every half hour at a cost per passenger of \$13. The average passenger would wait 15 minutes giving a time cost for the average passenger of \$2. The average total cost would be \$15 so the service provided by large buses is preferable from a social point of view. Assume that the large bus service is charging at ticket price of \$10 so it exactly covers its costs. If a small bus showed up half an hour after a large bus had left, it would find 10 passengers waiting. These passengers would have to wait another half hour for the next large bus service so each would be willing to pay up to \$4 on top of the \$10 charged by the large bus for an early departure. With each passenger willing to pay up to \$14 but the small bus costing \$13 per passenger to operate, the coalition of the small bus and the ten passengers arriving in the first half hour gains \$1 per passenger of additional surplus. The underlying problem is that the burden of waiting time costs is shared unevenly among passengers arriving at different times.

This is a different type of empty core problem from that discussed in the previous section though it still comes about because of lumpiness in capacity (which occurs due to economies of scale) and finely divisible demand. Telser (1994) gives an example of a taxi to an airport picking up passengers waiting for a regular limousine service and likens it to the situation where a tramp ship departs just before a conference ship charging freight rates below the conference's rates. This differs from our model in that the entrant's ship charges a higher freight rate (which shippers are willing to pay for an earlier departure), and in our model the entrant's departure need not be just before that of the incumbent. However, the model assumes a constant arrival rate which may not be realistic and does not allow for any differences in service quality other than departure time. The entrant may have to charge less if the service is inferior in some respects. Telser goes on to mention deferred rebates for loyalty as one way in which conferences deal with the problem. This is not to say that deferred rebates are necessarily desirable. They can exclude entry by lower cost vessels thereby preventing a welfare improvement (Sjostrom 1988). Dual rate contracts are another way to make it more costly for shippers to defect to non-conference vessels (Sjostrom 1993).

The empty core in the above model depends critically on the assumption that there are no waiting time costs at the end of the voyage. If cargo is sold or consumed at the end of the voyage at a constant rate just as at the beginning, the average unit of cargo incurs a cost of $tS/2X$ at the end. Adding the waiting time costs at the beginning and end of the voyage together, total waiting time is tS/X. The optimum size condition then becomes:

$$\frac{B(S)}{S}-\frac{dB}{dS}-\frac{tS}{X}=0$$

which results in the same ship size as that required to deter entry. In any case, if cargo is being consumed at the end of the voyage at a constant rate, shippers would have little use for a one-off early shipment since any time savings at the start of the voyage would be offset by a longer wait at the end. Entry would have to be by a fleet of ships offering a regular service. The threat of such entry in a perfectly contestable market would provide an incentive to an incumbent not only to charge a price where zero economic profits are earned but also to maintain a fleet of optimal size ships.

Since both types of cargoes, those with and without waiting time at the end of the voyage, are likely to be present, it is difficult to say to what extent the empty core due to hit-and-run entry by smaller vessels is an explanation for the existence of a conference, as compared with explanations offered in the previous sections. Final goods are more likely to have zero waiting time costs at the voyage end and so would benefit more from a one-off early departure than intermediate goods. Final goods are often a substantial proportion of liner cargoes. The problem becomes less significant as the thickness of the trade increases. In a thick trade, the intervals between departures are less so there are less gains to be made from a hit-and-run entry.

The analysis so far implicitly assumes that the number of ships is perfectly divisible. If ships in a trade are to be fully utilised, the ship size must equal the total annual cargo divided by the number of trips per year. The number of trips equals the number of ships times the number of round voyages per annum. Thus $S \equiv X/nR$ were n is the number of ships and R the number of round voyages made per year by a ship. Because n can only take on integer values, S can only take on certain values. If the optimum number of ships was a non-integer, say 3.6, the practical optimum would be found by taking the integer on either side with the lower total of ship and shore-based costs, that is, the cheaper of 3 and 4 ships. This is only a problem in thin trades because at small values of n, the gaps between adjacent feasible values of S are large. The problem disappears as the number of ships rises. This is another way in which an empty core can arise. It is an example of the general case identified in the literature where firms have identical U-shaped average cost curves and demand is such that when all firms produce at minimum cost there is too little or too much produced (Telser 1994). If the firms produce to meet demand, they will not be at minimum cost and could be undercut by a firm producing at minimum cost.

OTHER REASONS FOR COLLUSION

Leaving aside very thin and thick trades, provision of a regular service requires a *fleet* of ships. A single shipowner cannot do it alone unless that owner accounts for a very large share of the market. Provided the inefficient entry problem discussed above does not arise, it would be possible in theory for uncoordinated shipping lines to provide regular services with the economically optimal number and size of ships. It is, however, difficult to imagine in practice except in trades which are thick. If one ship experiences an unforeseen delay in its schedule it could find itself encroaching on another shipowner's market. If the ships do not follow identical routes, it could take some time for the shipowners to sort out schedules without communication between them. It seems that, at least in thin trades, coordination between shipowners is necessary to arrange schedules with ships departing at uniform intervals of time. In very thick trades, this would not be a problem as the intervals between sailing would be so small that variations in sailing intervals become relatively unimportant. Australian liner trades tend to be relatively thin.

A further reason for collusion is potential savings in transactions and marketing costs. If each shipping company in a group providing regular services owned no more than a few ships, a shipper wishing to take advantage of the service frequency offered, that is, consigning cargo on several ships departing at different times, would have to deal with a several shipping companies. In consortiums within shipping conferences, shipowners charter slots on one another's vessels, so a shipper can deal with just one shipping company while at the same time having access to a frequent service. This would save on transactions costs and also marketing costs since a single shipping company could meet most of the needs of a single customer and could concentrate its marketing efforts on a much smaller number of customers.

Shipping companies with fleets of ships tend to spread them over a number of trades rather than keep them all in the same trade. If each fleet owner confined himself to a single trade, a frequent service could be provided in each trade without the need for collusion. The present arrangement could be seen as reducing risks because if one trade experiences difficulties, the effect on any one shipowner will be less.

CONCLUSION

In considering why liner shipping conferences are necessary, this paper has reviewed the literature arguing that the peculiar cost and demand characteristics of liner shipping make it prone to bouts of 'cutthroat competition' and this induces collusion. In a thin trade, this could be a breakdown in oligopolistic pricing discipline, however, recent work by economists applying core theory has shown that the problem may be more fundamental and may apply equally to thick trades. The basic problem is matching finely divisible demand to capacity which can only be changed in discrete lumps. This paper has shown that under certain assumptions, inefficient hit-and-run entry is possible in thin liner shipping trades and a conference could be an efficient way of preventing this.

Several other reasons why conferences can be advantageous were also put forward. Service frequency is unlike other dimensions of service quality in that it requires a number of ships to provide it. Except where a single shipowner operates a sizeable fleet, coordination between ship operators is necessary to provide a regular frequent service. This requires information to pass between ship operators which the price mechanism alone will not ensure. Conferences may also give rise to savings in transactions and marketing costs and reduced risk levels.

In view of the arguments put forward for the necessity of collusion in liner shipping, the question may arise as to why independent shipping lines are so prevalent and able to coexist with shipping conferences. Two reasons have been advanced, namely that conferences reduce the number of players making coordination easier, and service differentiation. The conferences provide regular, reliable services while the independent lines, offering less frequent services, may offer other attractions to shippers. A third is the existence of non-vessel operating common carriers (NVOCCs).

Sjostrom (1993) makes the interesting suggestion that NVOCCs offer an alternative to conferences as a way of dealing with the empty core. NVOCCs do not own ships but charter capacity from ship operators and put together shipments to fill this capacity. This reduces the fine divisibility on the demand side. It also makes it easier for shippers to take advantage of alternatives to conferences so deferred rebates and dual rate contracts become less effective. The shipper bodies set up to negotiate on behalf of Australian exporters under Part X of Trade Practices Act would have the same effect. Davies (1986) and Harvey (1993) both report that deferred rebates and dual rate contracts are almost non-existent in Australian liner trades, and Sjostrom (1993) reports that their importance has declined world-wide. Even if shipping markets develop alternatives to conferences to solve the empty core problem, conferences may still be needed to coordinate regular shipping services in thin trades.

Finally, although this paper has argued that conferences are necessary and may be beneficial, collusion can give rise to market power which can be used to the detriment of shippers. Issues concerning the extent of conferences' market power and how it might be limited should not be ignored.

REFERENCES

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

Cassidy, P. (1982). *Australian Overseas Cargo Liner Shipping: An Economic Policy Analysis.* Unpublished PhD Thesis, University of Queensland.

Chamberlin, E.H. (1933). *The Theory of Monopolistic Competition.* (Harvard University Press: Cambridge, Massachusetts).

Davies, J.E. (1983). "An Analysis of Cost and Supply Conditions in the Liner Shipping Industry." *Journal of Industrial Economics*, 31(4), June, pp. 417-435.

Davies, J.E. (1986). *Contestability and the Australian Liner Trades.* Bureau of Transport and Communications Economics, Occasional Paper 78 (AGPS: Canberra).

Devanney, J.W., Livanos, V.M. and Stewart, R.J. (1975). "Conference Ratemaking and the West Coast of South America." *Journal of Transport Economics and Policy*, 9(2), May, pp. 154-177.

Friedman, J.W. (1989). *Game Theory with Applications to Economics.* (Oxford University Press: New York).

Harvey, M.O. (1993) "Review of Part X of the Trade Practices Act 1974: An Assessment of the Economic Issues." *In* REVIEW OF PART X OF THE TRADE PRACTICES ACT 1993, *Liner Shipping: Cargoes and Conferences.* (AGPS: Canberra).

Marx Jr., D. (1953). *International Shipping Cartels.* (Princeton University Press: Princeton, New Jersey).

Pirrong, S.C. (1992). "An Application of Core Theory to the Analysis of Ocean Shipping Markets." *Journal of Law and Economics*, 35, April, pp. 89-131.

Robinson, R. (1961). "The Economics of Disequilibrium Price." *Quarterly Journal of Economics*, 75(2), May, pp. 199-233

Scherer, F.M. (1980). *Industrial Market Structure and Economic Performance.* 2nd edition, (Rand McNally: Chicago).

Sjostrom, W. (1988) "Monopoly Exclusion of Lower Cost Entry: Loyalty Contracts in Ocean Shipping Conferences." *Journal of Transport Economics and Policy*, 22(2), September, pp. 339-344.

Sjostrom, W. (1989). "Collusion in Ocean Shipping: A Test of Monopoly and Empty Core Models." *Journal of Political Economy*, 97(5), October, pp. 1160-1179.

Sjostrom, W. (1993). "Antitrust Immunity for Shipping Conferences: An Empty Core Approach." *Antitrust Bulletin*, 38(2), Summer, pp. 419-423.

Telser, L.G. (1994). "The Usefulness of Core Theory in Economics." *Journal of Economic Perspectives*, 8(2), Spring, pp. 151-164.