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Competition and Cooperation in Liner Shipping

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1. Introduction

Liner shipping is the business of offering common carrier ocean shipping services in international trade. Since it became an important industry in the 1870s, it has been characterized by various agreements between firms. Historically, since the formation in 1875 of the Calcutta Conference, the conference system was the primary form of agreement in liner shipping. Variously called liner conferences, shipping conferences, and ocean shipping conferences, they are formal agreements between liner shipping lines on a route, always setting (possibly discriminatory) prices, and sometimes pooling profits or revenues, managing capacity, allocating routes, and offering loyalty discounts. Conferences agreements were quite successful and in many cases have lasted for years. In the last two decades, conferences have begun to be supplanted by alliances (particularly in the American and European trades, where legislative changes have been unfavourable to them), which are less complete (they do not, for example, set prices) but encompass more broadly defined trade routes.

Section 1 will review cooperative agreements in the liner industry, including conferences and alliances (1.1), as well as the historical origins of that cooperation (1.2). Section 2 reviews the primary models that have been used to explain the conference system, including models of monopolizing cartels (2.1), contestability (2.2), destructive competition (2.3), and the empty core (2.4). Section 3 reviews a variety of practices and alleged practices in liner shipping, including predatory pricing (3.1), loyalty contracts (3.2), price discrimination (3.3), and price and output fixing (3.4). Finally, section 4 offers a brief conclusion.

1.2 Cooperation

International liner shipping has long been dominated by collusive agreements, originally conferences and more recently alliances. Conferences have been used since at least the 1870s, when the industry was being established. In recent years, these agreements have been supplemented and replaced by other kinds of agreements such as consortia and alliances. The focus of this chapter is on explaining the economic models of competition used to analyse cooperation in liner shipping for purposes of competition policy.

Conferences are organizations of shipping lines operating on a particular route. At different times, subject to various regulations, they have set tariffs, employing policing agencies to check on adherence to the tariff. Members have been fined out of the membership bonds they post.[2] They may also allocate output among their members, by either cargo quotas or more commonly sailing quotas. If ships always sailed at the same capacity, which they do not, cargo and sailing quotas would be identical. Sailing quotas are, however, probably easier to enforce. They may also

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[2] Jansson, J.O. and Shneerson, D. 1987, *Liner Shipping Economics* (London: Chapman and Hall). For historical evidence on this point, see also Greenhill, R. 1977, Shipping, 1850-1914. In: *Business Imperialism, 1840-1930: An Inquiry Based on British Experience in Latin America*, edited by D.C.M. Platt. (Oxford: Oxford University Press), pp. 119-155.

pool revenues and allocate particular ports on a given route.[3] All of these practices have been used by conferences throughout their history. For example, in the late nineteenth century and into the beginning of the twentieth century, as part of the Calcutta Conference, the P&O, the B.I., and the Hansa line had an agreement about the number of sailings each would make out of Hamburg.[4]

In the 1970s, liner consortia and alliances were formed by conference members as a supplementary means of conference enforcement.[5] They are essentially a system of common agency. More significant has been the rise of the strategic alliance. They were first used in the 1990s,[6] and there is some evidence that conferences are being displaced by alliances, perhaps because of the declining antitrust immunity of conferences. Alliances engage in cross route rationalization, and there is some evidence that the rationalization reduces costs by taking advantage of economies of density.[7] Unlike conferences, they do not issue a common tariff, but they cover much broader trade routes. Only recently have economists begun to examine them. Unfortunately, the state of research is limited to a lot of speculation about their functions and effects, and a few facts, without substantial testing of models of alliances.

Speculation on the reasons for alliances has focused on risk reduction and scale economies. The claims about risk reduction focus on two issues. First, alliances give liners companies access to other routes without investing in ships, thereby reducing the risk of new investment.[8] Second, by reserving slots on ships from other members of the alliance working other routes, liner companies reduce risk by diversifying into multiple routes.[9]

Although no evidence has been produced in support of the expansion explanation of risk, there is cross industry evidence that firms use strategic alliances for this reason.[10] Explanations that focus on diversifying through multiple routes face the problem that investors can already diversify their portfolios by investing in multiple lines on different routes. If there is evidence for this explanation, it will likely have to

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[3] Bennathan, E. and Walters, A.A. 1969, *The Economics of Ocean Freight Rates* (New York: Praeger); Jansson, J.O. and Shneerson, D. 1987, *Liner Shipping Economics* (London: Chapman and Hall).

[4] Smith, J.R. 1906, Ocean freight rates and their control by line carriers. *Journal of Political Economy*, **14**, 525-541. The range of detail in conference agreements is described in Deltas, G., Serfes, K., and Sicotte, R. 1999, American shipping cartels in the pre-World War I era. *Research in Economic History*, **16**, 1-38.

[5] Farthing, B. 1993, *International Shipping*, Second Edition. (London: Lloyd's of London Press); Clarke, R.L. 1997, An analysis of the international ocean shipping conferences system. *Transportation Journal*, **36**, 17-29.

[6] OECD. 2001, Regulatory Issues in International Maritime Transport, Paris: Organisation for Economic Co-operation and Development http://www.oecd.org/dataoecd/0/63/2065436.pdf

[7] Bergantino, A.S. and Veenstra, A.W. 2000, Interconnection and Co-ordination: An Application of Network Theory to Liner Shipping *International Journal of Maritime Economics*, **4**, 231-248.

[8] Ryoo, D-K. and Thanopoulou, H.A. 1999, Liner alliances in the globalization era: a strategic tool for Asian container carriers. *Maritime Policy and Management*, **26**, 349-367; Midoro, R. and Pitto, A. 2000, A critical evaluation of strategic alliances in liner shipping. *Maritime Policy and Management*, **27**, 31-40.

[9] Sheppard, E. and Seidman, D. 2001, Ocean shipping alliances: the wave of the future? *International Journal of Maritime Economics*, **3**, 351 – 367.

[10] Robinson, D.T. 2008. Strategic alliances and the boundaries of the firm. *Review of Financial Studies*, **21**, 649-681.

come from focusing on managerial risk. There is cross industry evidence that managers with specialised skills diversify to protect themselves against bankruptcy and job loss[11]

The claims about scale economies[12] focus on economies in marketing and allocating ships to ports to reduce shipping time. The evidence available supports these explanations, with evidence that alliances reduce costs[13] and raise capacity utilisation[14]. How well these explanations work will, however, have to address the evidence that alliances are in decline over the last decade.[15]

1.1 Historical Origins

Because sailing ships are subject to the vagaries of the wind, liner shipping offering regular scheduled service had to wait for the arrival of the steam vessel,[16] although the thirteenth century Venetians operated what can be interpreted as a liner service to the eastern Mediterranean using a combination of oar and sail.[17] Steam did not begin to be a competitor to the sailing ship until the development of the compound engine in the late 1860s and the triple expansion engine in the early 1880s.[18] These developments substantially improved fuel economy and increased speed to about 10-12 knots. The compound engine cut fuel consumption by over half compared to a single cylinder steam engine. Essentially, it involved adding additional cylinders to the steam engine, each additional cylinder reusing steam before it cooled. The increase in fuel economy also expanded the space available for cargo. Steam vessels began to offer regular, scheduled service, i.e., liner service. It is in liner shipping that conferences have thrived.

Curiously, sailing vessels belonged to conferences operating on the UK-Australia route and the Germany-South America route,[19] and there were early British coastal conferences involving sailing vessels as well.[20] By and large, however, these were exceptions.

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[11] May, D. 1995, Do managerial motives influence firm risk reduction strategies? *Journal of Finance*, **50**, 1291 – 1308.

[12] Ryoo, D-K. and Thanopoulou, H.A. 1999, Liner alliances in the globalization era: a strategic tool for Asian container carriers. *Maritime Policy and Management*, **26**, 349-367; Midoro, R. and Pitto, A. 2000, A critical evaluation of strategic alliances in liner shipping. *Maritime Policy and Management*, **27**, 31-40; Sheppard, E. and Seidman, D. 2001, Ocean shipping alliances: the wave of the future? *International Journal of Maritime Economics*, **3**, 351 – 367.

[13] Bergantino, A. and Veenstra, A. 2002, Interconnection and co-ordination: an application of network theory to liner shipping, *International Journal of Maritime Economics*, **4**, 231 – 248.

[14] Fusillo, M. 2006, Some notes on structure and stability in liner shipping, *Maritime Policy and Management*, **33**, 463 – 475.

[15] Parola, F. and Musso, E. 2007, Market structures and competitive strategies: the carrier – stevedore arm – wrestling in northern European ports, *Maritime Policy and Management*, **34**, 259 – 278.

[16] Boyce, G.H. 1995, *Information, Mediation and Institutional Development: The Rise of Large-Scale Enterprise in British Shipping, 1870-1919* (Manchester: Manchester University Press).

[17] Fleming, D.K. 2002, Reflections on the History of US Cargo Liner Service (Part I), *International Journal of Maritime Economics*, **4**, 369-389.

[18] Harley, C.K. 1971, The shift from sailing ships to steamships, 1850-1890: a study in technological change and its diffusion. In: *Essays on a Mature Economy: Britain after 1840*, edited by D.N. McCloskey (Princeton: Princeton University Press), pp. 215-234.

[19] Burley, K. 1968, *British Shipping and Australia, 1920-1939* (Cambridge: Cambridge University Press)

[20] Armstrong, J. 1991, Conferences in British nineteenth-century coastal shipping. *Marriner's Mirror*, **77**, 55-65.

The U.K.-Calcutta conference is usually described as the first conference, and it is certainly the first modern conference. It started in 1875, consisting of five carriers: the P&O (Peninsular and Oriental Steam Navigation Co.), the B.I. (British India), and the City, Clan, and Anchor Lines. Within a decade or so, the conference extended its coverage of ports of origin from only the UK to the rest of northern Europe.

It was followed quickly by the development of other conferences. In the thirty years following the formation of the U.K.-Calcutta conference, conferences were formed on most of the major trade routes out of the UK and northern Europe. The Australia conference was started in 1884, the South African conference in 1886, the West African and northern Brazil conferences in 1895, the River Plate conference in 1896, the west coast of South America conference in 1904, and a conference covering the North Atlantic trade around 1900.[21] Most of these conferences covered the outbound trade from Europe, leaving the inbound trades of mostly bulk commodities to tramp vessels.[22]

There were precursors, however. A conference from 1850 to 1856 on the North Atlantic involved the British and North American Steam Packet Company (the Cunard Line) and the New York and Liverpool United States Mail Steamship Company (the Collins Line).[23] Glasgow ship owners may have fixed rates with a conference system in the 1860s.[24] In addition, the Transatlantic Shipping Conference was formed in 1868. It was concerned, however, with issues such as uniform bills of lading and improving methods for inspecting cargo, and did not become involved in rate setting until 1902.[25] Although conferences are generally associated with international shipping, there were precursors in British coastal shipping as early as the 1830s.[26]

Conferences were limited to the liner trades, without any success in the bulk trades.[27] There were also conferences in the passenger shipping trade.[28]

It is commonly assumed by historians of shipping conferences that they were formed in response to excess capacity, typically based on documents produced by

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[21] Kirkaldy, A. 1914, *British Shipping* (London: Kegan Paul, Trench, Trubner); Dyos, H.J. and Aldcroft, D.H. 1969, *British Transport: An Economic Survey from the Seventeenth Century to Twentieth* (Leicester: Leicester University Press)

[22] Marx, D. 1953, *International Shipping Cartels* (Princeton: Princeton University Press); Dyos, H.J. and Aldcroft, D.H. 1969, *British Transport: An Economic Survey from the Seventeenth Century to Twentieth* (Leicester: Leicester University Press)

[23] Sloan, E.W. 1998, The first (and very secret) international steamship cartel, 1850-1856. *Research in Maritime History*, **14**, 29-52.

[24] Dyos, H.J. and Aldcroft, D.H. 1969, *British Transport: An Economic Survey from the Seventeenth Century to Twentieth* (Leicester: Leicester University Press)

[25] Smith, J.R. 1906, Ocean freight rates and their control through combinations. *Political Science Quarterly*, **21**, 237-263.

[26] Armstrong, J. 1991, Conferences in British nineteenth-century coastal shipping. *Marriner's Mirror*, **77**, 55-65.

[27] McGee, J.S. 1960, Ocean freight conferences and American merchant marine. *University of Chicago Law Review*, **27**, 191-314; Abrahamsson, B.J. 1980, *International Ocean Shipping: Current Concepts and Principles* (Boulder, Colorado: Westview)

[28] Deltas, G., Sicotte, R., and Tomczak, P. 2008, Passenger shipping cartels and their effect on trans-Atlantic migration, *Review of Economics and Statistics*, **90**, 119-133.

participants in the trade.[29] A common version of this argument is that the opening of the Suez Canal, by shortening the distance between Europe and Asia, created excess capacity, but this version is not supported by the evidence.[30] Sailing vessels could not use the Canal. Existing steamships had been built for short routes through the Mediterranean Sea or the Red Sea, and most of them were scrapped after the opening of the Canal. Moreover, after the opening of the Canal, there were increases in net steamship production, which increased later in the 1870s with the introduction of the double expansion engine. The continued steamship production is inconsistent with excess capacity.

One alternative to cooperation would be merger. Merger is generally a substitute for collusion, but not a perfect substitute because merger increases agency costs.[31] The only known attempt to explicitly replace a conference with a merger was the largely unsuccessful International Mercantile Marine Company.[32]

The Ocean Shipping Reform Act of 1998 changed the treatment of conferences under American antitrust law, effectively eliminating the ability of conferences to control their members by mandating secret and independent action. EC regulation 4056/86, which gave conferences an exemption from EC competition law, was repealed effective October 2008. Given that agreements and mergers are substitutes, we should expect an increase in industry concentration. Sys[33] shows that mergers have increased worldwide industry concentration, using a wide variety of measures, including the Gini coefficient and the Herfindahl index.

2. Alternative Models of Agreements

Most work on shipping conferences has involved four kinds of models: monopolistic cartels, contestable markets, destructive competitive, and empty cores.[34] The argument that conferences are monopolistic cartels is at least as old as Alfred Marshall,[35] who argued that conferences could act as monopolists because there were substantial scale economies in the industry that led to a small number of firms. Lenin and the Marxist historian J.A. Hobson described shipping conferences as vivid examples of the tendency toward the concentration of capital.[36] The other

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[29] Greenhill, R. 1998, Competition or co-operation in the global shipping industry: the origins and impact of the conference system for British ship owners before 1914. *Research in Maritime History*, **14**, 53-80.

[30] Sjostrom, W. 1989, On the origin of shipping conferences: excess capacity and the opening of the Suez Canal. *International Journal of Transport Economics*, **16**, 329-335.

[31] Bittlingmay, G. 1985, Did antitrust policy cause the great merger wave? *Journal of Law and Economics*, **28**, 77-118.

[32] Livermore, S. 1935, The success of industrial mergers. *Quarterly Journal of Economics*, **50**, 68-96; Navin, T. and Sears. M. 1954, A study in merger: formation of the International Mercantile Marine Company. *Business History Review*, **28**, 291-328; Boyce, G.H. 1995, *Information, Mediation and Institutional Development: The Rise of Large-Scale Enterprise in British Shipping, 1870-1919* (Manchester: Manchester University Press)

[33] Sys, C. 2009, Is the container liner shipping industry an oligopoly? *Transport Policy* (forthcoming).

[34] An innovative attempt was made to apply monopolistic competition models to conferences, but was not followed up. See Officer, L. 1971, Monopoly and monopolistic competition in the international transportation industry. *Western Economic Journal*, **9**, 134-156.

[35] Marshall, A. 1921, *Industry and Trade* (London: Macmillan)

[36] Cafruny, A.W. 1987, *Ruling the Waves: The Political Economy of International Shipping* (Berkeley: University of California Press)

explanations arose largely as responses to the cartel model. Destructive competition and its modern variant, the empty core, are alternative explanations of why conferences exist. Contestable markets have been used to criticise the proposition that conferences can usefully be described as monopolistic cartels. This matters for competition policy, because if conferences are not monopolizing cartels, then competition policy need not address them.

Models of competition are important for making sense of the role agreements play in liner shipping, and seeing whether those insights can be generalized to other industries. They are also important for competition policy. Assuming that competition authorities are attempting to increase competition,[37] it is important to establish whether a particular practice reduces competition rather than having an alternative purpose. If it can be established that a practice does not reduce competition, it needs no further analysis for purposes of competition policy.

The term "competition" is routinely used vaguely, with differing and sometimes inconsistent meanings. Sometimes it used simply to mean the number of sellers (both as a measure of concentration and as a measure of how far to the right the supply curve lies). Sometimes it is used to mean low measured profitability,[38] which is taken to mean the absence of monopoly and monopoly profit. Sometimes it is used to mean that buyers have good substitutes; sometimes it is used simply to mean that the seller faces a downward sloping, rather than perfectly inelastic demand curve.

Rather than getting absorbed in a semantic debate, it is simpler and more useful to think about competition by the outcome: the mark-up of price over marginal cost.

2.1 Non-cooperative game-theoretic models of collusion: cartel enforcement

It is easy to get involved in pointless and unproductive discussions about what it "really" means to be a cartel. It is simpler to simply define a cartel, following the conventional practice of economists, as an agreement that attempts to get its members to act jointly as a monopolist. Agreements that serve other purposes, such as preventing destructive competition, reducing risk, or trade promotion, should simply be referred to as such.

In perfect competition, output allocation is simple and automatic. Each seller produces an output such that its marginal cost is equal to the market price. In a cartel, prices are increased, but output must be reduced. Therefore, each firm's output must be centrally directed. Each firm produces an output such that marginal cost is less than the price, giving each firm an incentive to raise output and upset the cartel arrangement. The primary problem for any monopolising cartel is therefore enforcement. Enforcement means that output increases must be punished,[39] but first they must be detected.[40]

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[37] A point disputed with respect to both the US and Europe in McChesney, F.S. and Shughart, W.F. 1995, *The Causes and Consequences of Antitrust: the Public-Choice Perspective* (Chicago: University of Chicago Press) and Sjostrom, W. 1998, Competition law in the European Union and the United States. In: *The New Palgrave Dictionary of Economics and the Law*, volume 1, edited by P. Newman (London: Macmillan), pp. 370-377.

[38] Productivity Commission. 1999, International liner cargo shipping: a review of Part X of the Trade Practices Act 1974. Report No. 9 (Canberra, Australia: AusInfo)

[39] The basic models of punishment are Green, E.J. and Porter, R.H. 1984, Noncooperative collusion under imperfect price information. *Econometrica*, **52**, 87-100, and Rotemberg, J.J. and Saloner, G.

Footnote continued next page

One argument disputing the cartel explanation should be dispensed with quickly. A seller with market power will raise price until its rivals' products are good substitutes. (It will raise price until marginal cost equals marginal revenue. Positive marginal cost implies positive marginal revenue, and positive marginal revenue implies an elastic demand.) The frequent assertion that conferences cannot be monopolies or monopolistic cartels because they face too many good substitutes[41] may be the opposite: they face good substitutes because they act monopolistically.

A number of attempts have been made to test whether shipping conferences can be explained by cartel models. Fox measured the effect of the number of firms in a conference and a conference's market share on freight rates.[42] She finds that freight rates fall when the conference market share falls. She also finds that as the number of conference members rises, freight rates also fall, which is consistent with Stigler's theory of oligopoly,[43] specifically that increased numbers in a cartel increase the cost of coordination and therefore lower price.

In a separate paper, Fox looked at the provision in the U.S. Shipping Act of 1984 that allows conference members to deviate from conference rates on ten days notice.[44] A cartel model would predict that allowing independent action, even though it is public rather than secret price cutting, should undercut conferences because it makes enforcing the conference tariff more difficult. She fails, however, to find evidence that the Act made any difference at all to conferences.

Paul Clyde and James Reitzes, in an ingenious study, distinguished between increased freight rates because of increased conference market share and because of increased market concentration.[45] They find statistically significant but economically insignificant effects of increased market concentration on freight rates, but, contrary to the results in Fox, no effect of increased conference market shares on freight rates.

It is worth emphasis that focusing on price can be misleading. Conferences can raise price because they restrict output (making shippers worse off) or because they add value, thereby raising demand and raising output. A better test would be to focus on the effect of conferences on output. Some insight can be gained from a study of trans-Atlantic passenger shipping cartels in the first decade of the twentieth century.[46] The authors estimated that westward migration fell by 20% – 25% because of the passenger cartels operating that decade.

1986, A supergame-theoretic model of price wars during booms. *American Economic Review*, **76**, 390-407.

[40] Stigler, G.J. 1964, A Theory of oligopoly. *Journal of Political Economy*, **72**, 41-61.

[41] Sletmo, G. and Williams, E. 1981, *Liner Conferences in the Container Age: US Policy at Sea* (New York: Macmillan)

[42] Fox, N.R. 1992, An empirical analysis of ocean liner shipping. *International Journal of Transportation Economics*, **19**, 205-225.

[43] Stigler, G.J. 1964, A Theory of oligopoly. *Journal of Political Economy*, **72**, 44-61.

[44] Fox, N.R. 1995, Some effects of the U.S. Shipping Act of 1984 on ocean liner shipping conferences. *Journal of Maritime Law and Commerce*, **26**, 531-544.

[45] Clyde, P.S. and Reitzes, J.D. 1998, Market power and collusion in the ocean shipping industry: is a bigger cartel a better cartel? *Economic Inquiry*, **36**, 292-304.

[46] Deltas, G., Sicotte, R., and Tomczak, P. 2008, Passenger shipping cartels and their effect on trans-Atlantic migration, *Review of Economics and Statistics*, **90**, 119-133.

Deltas, Serfes, and Sicotte took a historical approach, using a sample of 47 pre-World War I conferences.[47] They looked for reasons why a cartel might be easier to negotiate and enforce, arguing that a cartel can then successfully impose stricter, less flexible terms on its members. Enforcement is easier if there is multi-market contact. The basic intuition is that punishment for deviations from a cartel agreement in one market can be carried out in several markets. It also argues that enforcement is also easier if one or more of the firms has a large global market share. In that case, it is easier for the large firm to transfer ships to a market to carry out punishment. Agreements are easier to negotiate if there are a small number of firms and if there is heterogeneity in size, allowing a large firm to dominate the agreement. A strict, inflexible agreement is also more sustainable if entry is less likely.

This argument should not be confused with the idea that a firm operating in multiple markets can cross-subsidize predatory pricing to prevent destabilizing entry. Gordon Boyce[48] argues that because the International Mercantile Marine (a combination of five transatlantic lines sponsored by J.P. Morgan formed in the period 1900-1902) ran diversified lines from the UK to Canada, the US, and Australasia, it could use cross-subsidization to harm smaller, single route firms. Boyce's argument requires highly inefficient capital markets, because both the predator and its victim are borrowing for a price war. The predator is merely borrowing from its own income stream.[49]

A different approach is to use developments in what has been called the New Empirical Industrial Organization. The approach can be seen in Figures 1 and 2. In models of monopoly and of perfect competition, an increase in demand raises price and output, and a decrease in demand lowers both, as shown in Figure 1. Therefore, the consequences of a rise or fall in demand cannot separate the two models. Suppose instead that the demand rotates (becoming steeper or flatter). In a model of perfect competition, this does not raise or lower price or output. In a model of monopoly, however, flattening the demand curve raises marginal revenue relative to demand, thereby lowering price and raising output. Making demand steeper lowers marginal revenue relative to demand, thereby raising price and lowering output. This can be seen in Figure 2.

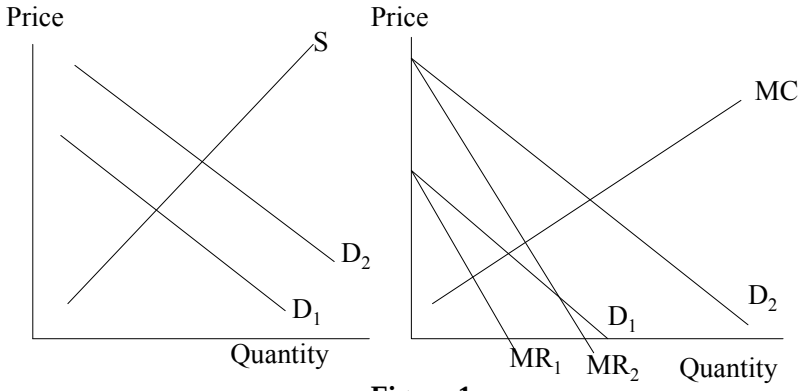

Figure 1

[47] Deltas, G., Serfes, K., and Sicotte, R. 1999, American shipping cartels in the pre-World War I era. *Research in Economic History*, **16**, 1-38.
[48] Boyce, G.H. 1995, *Information, Mediation and Institutional Development: The Rise of Large-Scale Enterprise in British Shipping, 1870-1919* (Manchester: Manchester University Press).
[49] McGee, J.S. 1980, Predatory pricing revisited. *Journal of Law and Economics*, **23**, 289-330.

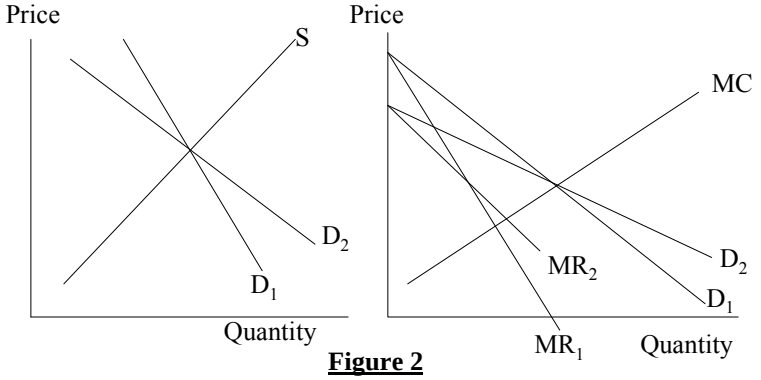

Figure 2

Start by writing the market demand curve as P(Q), so that price depends on quantity sold. The slope of the demand curve is $\Delta P/\Delta Q$. Marginal revenue is $P + (\Delta P/\Delta Q)Q$. The second term is the difference between marginal revenue and price. Static oligopoly models predict how much of that difference is *perceived* by sellers. Let λ be the fraction of that difference that is perceived by sellers. The marginal revenue as perceived by sellers is $P + \lambda(\Delta P/\Delta Q)Q$.

Different oligopoly models imply different values of λ. In monopoly, the whole marginal revenue is perceived, so $\lambda = 1$. In perfect competition (or Bertrand Nash equilibrium), none of the marginal revenue is perceived (marginal revenue is simply market price), so $\lambda = 0$. In Cournot Nash, the economist's standard model of non-cooperative equilibrium, λ is the Hirshman-Herfindahl index (the sum of the squared market shares).[50]

The value of λ is found by equating perceived marginal revenue to marginal cost. As a simple example, suppose the demand curve is

(1) $P = \beta_0 + \beta_1 Q + \beta_2 ZQ + \beta_3 Z,$

where P is price, Q is output, and Z is a demand shifter. Note that the slope of the demand curve is $\beta_1 + \beta_2 Z$, so that Z can also rotate the demand curve, as in figure 2 above.

Given the demand equation, marginal revenue can be written as $P + (\beta_1 + \beta_2 Z)Q$, and therefore perceived marginal revenue can be written as $P + \lambda(\beta_1 + \beta_2 Z)Q$. Write industry marginal cost as

$MC = \delta_0 + \delta_1 Q + \delta_2 W,$

where W measures some input price.[51] (If $\delta_1 = 0$, then marginal cost is constant.) Profit is maximised when perceived marginal revenue equals marginal cost, that is, when

$P + \lambda(\beta_1 + \beta_2 Z)Q = \delta_0 + \delta_1 Q + \delta_2 W$, or equivalently, when

(2) $P = \delta_0 + (\delta_1 - \lambda\beta_1)Q - \lambda\beta_2 ZQ + \delta_2 W$

[50] Perloff, J., Karp, L., and Golan, A. 2007, *Estimating Market Power and Strategies* (Cambridge: Cambridge University Press), pp. 43 - 47

[51] The extremely parsimonious descriptions of demand and marginal cost are for illustration, not a guide to actual empirical work.

Equation 1, (the demand function) and equation 2 (the profit maximisation condition), can be estimated jointly, and λ can be estimated from the ratio of the coefficient of ZQ in equation 2 ($-\lambda\beta_2$) to its coefficient in equation 1 (β_2).[52]

One important drawback to this approach is that the value of λ is not clearly specified in a cartel model, and that poses a problem for measuring whether agreements in liner shipping are cartel arrangements. A costlessly enforced cartel would have $\lambda = 1$, that is, it would behave like a monopolist. It would equate industry marginal revenue to industry marginal cost. Note that equating marginal revenue to marginal cost is the same as setting marginal revenue minus marginal cost (i.e., marginal profit) equal to zero. At the industry profit maximum, a small increase in output costs roughly zero in profits. Cartel enforcement is not costless, however, because setting price above marginal cost gives cartel members an incentive to cheat. At the industry profit maximum, a small increase in output does not lower profits, but preventing it incurs positive enforcement costs. It follows that the cartel equilibrium involves higher output and lower price than the monopoly equilibrium.[53] The economic theory of cartels tells us λ will be less than one and greater than its non-cooperative equilibrium value, but little beyond that. Where it lies in between those two values depends on the costs of cartel enforcement.

These techniques allow both a measure of the extent of competition in the market and a way to test alternative theories of markets. Even though cartel models do not make a specific prediction about the value of λ, the models are good for estimating how, for example, various legislative changes alter the value of λ. Using these techniques, Wilson and Casavant[54] offered evidence that the US Shipping Act of 1984 raised the value of λ (in other words, raised prices), except where the Act explicitly allowed conference members to independently deviate from conference rates, in which case it lowered λ (in other words, lowered prices). Unfortunately, although this approach could tell us a lot about the effect of regulation in the industry, Wilson and Casavant are the only authors I am aware of who apply these techniques to liner shipping.

Now that these techniques are laid out in detail, there is scope for more formal testing of a variety of questions about competition, including the assumption that bulk shipping is best explained by models of perfect competition.[55]

2.3 Non-cooperative game-theoretic models of collusion: contestable markets

The theory of contestable markets focuses heavily on sunk costs. It draws on the insight that potential competitors are a constraint on pricing behaviour as much as actual competitors. Suppose in a market there are no sunk costs and incumbent firms do not respond to entry by lowering prices. Then entry is costless in the sense that all costs of entry can be recovered on exit. Entry is therefore riskless. Moreover, the

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[52] The econometric issues in measuring λ are discussed in detail in Perloff, J., Karp, L., and Golan, A. 2007, *Estimating Market Power and Strategies* (Cambridge: Cambridge University Press), chapter 2.

[53] Johnsen, D. Bruce. 1991, Property rights to cartel rents: The Socony-Vacuum story. *Journal of Law and Economics*. **43**, 177-203.

[54] Wilson, W. and Casavant, K. 1991, Some market power implications of the Shipping Act of 1984. *Western Journal of Agricultural Economics*. **16**, 427-434.

[55] Pirrong, S.C. 1993, Contracting practices in bulk shipping markets: a transactions cost explanation, *Journal of Law and Economics*, **36**, 937-976.

entrant can make its entry decision without regard to strategic decisions by the incumbent.

Suppose a market had only one seller. The seller could not act as a monopolist because an entrant would undercut it. If entry is costless, schemes to exclude entry do not work because the entrant cannot be threatened with losses on entry. Should the entrant face the prospect of losses, it can always costlessly depart until the problem goes away.

John Davies has emphasized focused attention on the degree to which liner firms face sunk costs, and the risks of retaliatory price-cutting.[56] He has provided evidence that sunk costs are low, and that retaliation is slow. That is, he has shown that the assumptions of contestability are *roughly* satisfied by the liner market. If the liner market is contestable, then conferences may have difficulty acting like monopolizing cartels. Whatever service they provide, they must do so at (economic) cost, lest they are uncut by entry.[57]

An important, unresolved difficulty is how sensitive contestable markets to deviations from the assumptions of zero fixed costs and no retaliatory pricing. There are theoretical grounds for believing that very small deviations from these assumptions can have large consequences for contestability,[58] but little effort has been made to empirically quantify the problem.

2.4 Destructive Competition

Destructive competition arguments come in two forms. The usual form among maritime economists focuses on high sunk costs, inelastic demand, and the risks to carriers of "overtonnaging" or excess capacity. (The next section discusses another version, the theory of the core.) Daniel Marx is the primary early exponent,[59] and the argument has been made by industry practitioners.[60] Maritime historians have tended to favour this argument as well.[61] In this argument, because a large proportion of costs is sunk, it follows that price would have to fall substantially before sellers would leave the market. Brooks argues:

> The high barriers to exit give shipowners reasons to delay capacity reduction; unless prices are good for scrap or the second-hand market is buoyant, there is a tendency to hope that a redeployment opportunity will materialize or be created. This results in an industry with an almost perpetual state of capacity oversupply.[62]

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[56] Davies, J.E. 1983, Pricing in the liner shipping industry: a survey of conceptual models. Canadian Transport Commission, Report No. 1983/04E; Davies, J.E. 1989, Impediments to contestability in liner markets. *Logistics and Transportation Review*, **25**, 325-342.

[57] Further evidence is offered by Lam, J., Yap, W., and Cullinane, K., 2007, Structure, conduct, and performance on the major liner shipping routes [1]. *Maritime Policy and Management*, **34**, 359 – 381.

[58] Farrell, J. 1986, How effective is potential competition? *Economics Letters*, **20**, 67-70; Gilbert R. 1989, The role of potential competition in industrial organization, *Journal of Economic Perspectives*, **3**, 107 – 127.

[59] Marx, D. 1953, *International Shipping Cartels* (Princeton: Princeton University Press)

[60] Graham, M.G. 1998, Stability and competition in intermodal container shipping: finding a balance. *Maritime Policy and Management*, **25**, 129-147.

[61] Hyde, F.E. 1967, *Shipping Enterprise and Management 1830-1939* (Liverpool: Liverpool University Press)

[62] Brooks, M. 2000, *Sea Change in Liner Shipping* (Amsterdam: Pergamon), p. 62; see also Sagers, C. 2006, The demise of regulation in ocean shipping: A study in the evolution of competition policy

Footnote continued next page

The assertion of high exit barriers implies inelastic short run market supply. It is frequently asserted that the demand for liner shipping services is highly inelastic. A combination of inelastic supply and demand leads to a highly unstable price. Therefore, carriers are exposed to increased risk of losses, and shippers face substantial uncertainty about freight rates. On this explanation, conferences offer reduced risk to both carriers and shippers.

This explanation suffers from two serious flaws.[63] First, if fluctuating prices lead to periods of losses, then they must also lead to periods of offsetting gains. Carriers will not enter unless the risk-adjusted present value of profits is positive. If long run changes in the market occur such that the present value of profits is negative, firms will (efficiently) leave the market, and the losses are their signal to do so.[64] Second, if shippers valued rate stability, they could write forward contracts.

2.5 Cooperative game-theoretic models of collusion: the empty core

A more recent and theoretically coherent revival of the idea of destructive competition is the theory of the core,[65] which has been applied several times to conferences[66] and alliances.[67]

The theory of the core focuses on avoidable fixed costs and the integer problem (the number of firms in an industry must be an integer). With avoidable fixed costs and rising marginal cost, the relevant average cost curve is U-shaped. No output will be produced at any price below minimum average cost. When price rises to a firm's minimum average cost (p*), that firm will enter at the output q* where average cost is minimized. The firm will produce $q \geq q^*$ if $p \geq p^*$. Under perfect competition, the firm's output will therefore be either 0 or $q \geq q^*$. Suppose firms are identical. Then at p*, industry output must be an integer multiple of q* (the integer problem). It would be only by chance that demand at p* would be an integer multiple of q*. It is therefore possible that demand and supply would not intersect. The problem would go away if a firm were willing to produce a fraction of q*, but avoidable fixed costs mean that no firm could profitably do so.

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and the predictive power of microeconomics. *Vanderbilt Journal of Transnational Law*, **39**, 779-818, at p. 803, n. 110.

[63] McGee, J.S. 1960, Ocean freight conferences and American merchant marine. *University of Chicago Law Review*, **27**, 191-314; Bennathan, E. and Walters, A.A. 1969, *The Economics of Ocean Freight Rates* (New York: Praeger); Officer, L. 1971, Monopoly and monopolistic competition in the international transportation industry. *Western Economic Journal*, **9**, 134-156.

[64] Fusillo finds evidence of low supply elasticities, but finds evidence that conferences *reduced* supply elasticities. See Fusillo, M. 2004, Is liner shipping supply fixed? *Maritime Economics & Logistics*, **6**, 220 – 235.

[65] Surveyed in Telser, L. 1994, The usefulness of core theory in economics. *Journal of Economic Perspectives*, **8**, 151-164.

[66] Sjostrom, W. 1989, Collusion in ocean shipping: a test of monopoly and empty core models. *Journal of Political Economy*, **97**, 1160-1179; Pirrong, S.C. 1992, An application of core theory to the analysis of ocean shipping markets. *Journal of Law and Economics*, **35**, 89-131; Sjostrom, W. 1993, Antitrust immunity for shipping conferences: an empty core approach. *Antitrust Bulletin*, **38**, 419-423; Davies, J., Pirrong, C., Sjostrom, W. and Yarrow, G. 1995, Stability and related problems in liner shipping: an economic overview. *Hearings before the Committee on Commerce, Science, and Transportation*. US Senate, 104th Congress, first session.

[67] Button, K. 1999., Shipping alliances: Are they at the 'core' of solving instability problems in shipping? *Liner Shipping: What's Next, Proceedings of the 1999 Halifax Conference, International Association of Maritime Economists*, Halifax, Canada, September, pp. 58-88.

If inventories were inexpensive, a firm could produce only part of the time and provide a fraction of q* with inventories. In transportation industries especially, however, output is cargo or passenger space. Once the ship or airplane leaves, empty space is gone, so inventories are impossible.[68] The only way to create inventories is to have excess capacity, which can lead to an empty core.

The integer problem does not necessarily lead to an empty core, but is likely to under some circumstances. Consider an example attributable to George Bittlingmayer.[69] Suppose taxis can carry at most two passengers, and that the cost of a taxi trip is independent of whether there are zero, one, or two passengers. Admittedly, these assumptions are likely to be factually inaccurate. Most taxis can squeeze in an extra passenger in a pinch, and extra passengers reduce mileage. These assumptions, however, capture the same points that a more realistic but also more complex model would. First, there are some scale economies: once a taxi carries one passenger, the marginal cost of a second is less than the average cost. Second, there are capacity constraints: marginal cost exceeds average cost beyond some output.

Assume each taxi's cost of a trip to the airport is £5, and that there are no sunk costs, so the competitive supply of taxi trips is constant at £5 per trip. Assume as well, for simplicity, that each possible passenger is willing to pay £10 for a taxi trip, so a taxi trip is efficient (relative to no trip) even if there is only one passenger. Suppose four people want to make a trip to the airport. They will take two cabs, each with two passengers, and each pair of passengers will pay £5. How they divide the £5 cost between them is irrelevant to the problem.

Suppose instead that only three people, imaginatively named A, B, and C, want to make the trip. The efficient solution is for the three to take two taxis, generating a surplus of 3x£10 - 2x£5 = £20. In this case, however, the problem of dividing the £10 cost of the two taxis eliminates the possibility of a competitive equilibrium. One possibility is that A and B travel together, pay £2.50 each, and let C travel alone and pay £5. C, however, could offer to let A travel with him if A pays £1. C is better off, paying only £4 instead of £5, and A is better off, paying only £1 instead of £2.50. B is left, however, paying £5 instead of £2.50, leaving B in the same position as C was originally to upset the allocation.

An equilibrium allocation has to ensure that no coalition (A, B, or C alone, pairs of A and B, A and C, or B and C, or the grand coalition of A, B, and C) can do better by upsetting the existing allocation. If X_i is the surplus to customer i, i=A,B,C, then an equilibrium allocation has to satisfy the following constraints:

$X_A + X_B \geq £15$; $X_A + X_C \geq £15$; $X_B + X_C \geq £15$

$\Sigma X_i = X_A + X_B + X_C \leq £20$

The first constraint states that any two passengers travelling together can get a combined surplus of £15. The second constraint states that the best all three passengers can get is the surplus from the efficient solution of travelling in two taxis. Summing all three terms in the first constraint implies that $\Sigma X_i \geq £22.50$, which is

[68] The accounts in Smith, T.K. 1995, Why air travel doesn't work. *Fortune*, 3 April, of conversations with airline executives are similar to the views routinely expressed by people in the liner shipping business, particularly the problem that inventories are extremely expensive.

[69] Bittlingmayer, G. 1989, The economic problem of fixed costs and what legal research can contribute. *Law and Social Inquiry*, **14**, 739-762.

inconsistent with the second constraint. There is no equilibrium allocation. In this example, q*=2, and if demand is not a multiple of two, there is no equilibrium.

The absence of equilibrium in market exchange poses a problem for the participants in the market, both buyers and sellers, because it necessarily raises the costs of contracting. Sellers will try to protect themselves from the consequences of the integer problem by selecting technology with lower capacity and higher costs.[70] It is therefore in the mutual interests of buyers and sellers to find a way to achieve an allocation through non-market means. It remains true that an individual buyer or seller has an incentive to disrupt the allocation, just as in a cartel model. Unlike a cartel model, however, buyers as a group do not have an incentive to assist the deviating party.

The example suggests two of the more interesting implications of the model of the empty core. First, it is worth noting that there are ways of resolving the problem. For example, if the three passengers were friends, they might simply split the cost three ways because an attempt by two of them to exclude the third would result in the loss of a valuable friendship. Alternatively, there might be a social custom, the violation of which would result in being ostracized, dictating that in such cases there be some fair division of the cost. It is important, however, to recognize that these methods of resolving the problem are not market solutions. This implies that collusion may be a means of resolving the problem of an empty core, although merger and vertical integration may be alternatives. Archibald, et al.[71] provide laboratory evidence that with high avoidable costs, players formed cartels, and that those cartels produced more efficient results than competition.

Second, suppose there were sunk entry costs. Then the necessity of earning a return on the initial sunk investment, aggravated by the prospect of facing the costs of an empty core, would limit entry. In the example, suppose there are only three taxis. Then there is an empty core if demand is three or five, but not otherwise. If demand were seven or greater, because capacity is only six, competition would drive the price up to the reservation price of £10, and only six passengers would travel. The empty core would only occur when demand was low, for example if the industry were in decline or if demand were a low draw from a high variance distribution.

Two systematic tests of the empty core model have been made. Sjostrom[72] focused primarily on demand conditions. Two important results are that increased conference market share raises output and that conferences are more dominant when demand is more variable, both consistent with an empty core and contrary to a monopoly model. Sjostrom does not specify the precise mechanism whereby increased share increases output. Given the results in the study by Clyde and Reitzes[73] that increased market share has trivially positive effect on freight rates, the

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[70] On this point, see Telser, L. 1978, *EconomicTheory and the Core* (Chicago: University of Chicago Press), especially chapter 3, and McWilliams, A. 1990, Rethinking horizontal market restrictions: in defense of cooperation in empty core markets. *Quarterly Review of Economics and Business*, **30**, 3-14.

[71] Archibald, G., van Boening, M., and Wilcox, N. 2002, Avoidable cost: can collusion succeed where competition fails? *Research in Experimental Economics*, **9**, 217 – 242.

[72] Sjostrom, W. 1989, Collusion in ocean shipping: a test of monopoly and empty core models. *Journal of Political Economy*, **97**, 1160-1179.

[73] Clyde, P.S. and Reitzes, J.D. 1998, Market power and collusion in the ocean shipping industry: is a bigger cartel a better cartel? *Economic Inquiry*, **36**, 292-304.

increased output presumably comes from less costly contracting and more efficient production.

Pirrong[74] focuses on measuring the assumptions of the model, providing evidence of rising marginal cost and U-shaped average cost curves (implying fixed costs). With cost data from the routes to Europe from the North and South Atlantic ports of the US, he estimates alternative cost functions. Of particular interest is his successful use of the semi-logarithmic cost function, with the form (simplifying from Pirrong) $\ln C = \beta_0 + \beta_1 Q$, where C is total cost and Q is output. With $\beta_1 > 0$, the marginal cost function is rising ($\partial C/\partial Q = \beta_1 C > 0$) and the average cost function is U-shaped [$\partial(C/Q)/\partial Q = (C/Q)(\beta_1 Q-1)$, which is negative if $Q < 1/\beta_1$ and positive if $Q < 1/\beta_1$]. Pirrong's empirical results imply falling average cost over a substantial range of output, which in turn implies that the integer problem is significant. He also discusses why the model implies the absence of conferences in tramp shipping, which is consistent with only two attempts, both unsuccessful, to form conferences in tramp shipping.[75]

Empty core models have been successfully applied to other industries as well, from airlines[76], to cast iron pipe[77], to the Australian tomato industry[78]. It has also been successfully applied more generally to the problems of merger and trusts[79], although there has been some empirical dissent[80].

3. Liner Shipping Practices

Three liner practices have generated some controversy. Predatory pricing and loyalty contracts are ways in which liners may have attempted to preclude entry. The effect of price discrimination on cartel stability is more problematic. In a cartel model, it is destabilizing because it attracts entry. In an empty core model, it is a way of increasing output when there are falling average costs.

3.1 Predatory Pricing

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[74] Pirrong, S.C. 1992, An application of core theory to the analysis of ocean shipping markets. *Journal of Law and Economics*, **35**, 89-131.

[75] McGee, J.S. 1960, Ocean freight conferences and American merchant marine. *University of Chicago Law Review*, **27**, 191-314; Abrahamsson, B.J. 1980, *International Ocean Shipping: Current Concepts and Principles* (Boulder, Colorado: Westview)

[76] Antoniou, A. 1998, The status of the core in the airline industry: the case of the European market. *Managerial and Decision Economics* **19**, 43-54; Button, K. 2003, Does the theory of the 'core' explain why airlines fail to cover their long-run costs of capital? *Journal of Air Transport Management*, **9**, 5 – 14. For an opposing view, see Domanico, F. 2007, The European airline industry: law and economics of low cost carriers, **23**, 199 – 221.

[77] Bittlingmayer, G. 1982, Decreasing average cost and competition: a new look at the Addyston Pipe case. *Journal of Law and Economics*, **25**, 201-229; Bittlingmayer, G. 1983, Price fixing and the Addyston Pipe case. *Research in Law and Economics*, **5**, 57 – 128.

[78] Hone, P. 1997, Market power and contestability in factor markets: the case of tomato pricing. *Economic Analysis & Policy*, **27**, 59-73.

[79] Bittlingmayer, G. 1985, Did antitrust policy cause the great merger wave? *Journal of Law and Economics*, **28**, 77-118; McWilliams, A. and Keith, K. 1994, The genesis of the trusts: rationalization in empty core markets. *International Journal of Industrial Organization*. **12**, 245-267; Bittlingmayer, G. 1995, Output and stock prices when antitrust is suspended: experience under the NIRA. In *The Causes and Consequences of Antitrust: A Public Choice Perspective*, edited by F.S. McChesney and W. Shughart II. (Chicago: University of Chicago Press), pp. 287-318.

[80] Taylor, J.E. 2002, The output effects of government sponsored cartels during the New Deal. *Journal of Industrial Economics*. **50**, 1-10.

The most common allegations of predatory pricing, especially in the early years of conferences, revolved around the use of "fighting ships". The conference would, in response to an entrant, allegedly lower the rates on one of its vessels to compete with the entrant until the entrant lost money and left the market. John McGee casts doubt on the use of fighting ships,[81] describing them as instances of normal competition, but Basil Yamey[82] cites the opinion in the 1891 decision by the law lords in the House of Lords in the case of *Mogul Steamship Co. v. McGregor, Gow & Co. et al*.[83] for an example of the use of fighting ships.[84] It is not clear, however, from Yamey's discussion whether predatory pricing was successful in this instance. When, in 1885, Mogul sent two ships to Hankow, an inland port on the Yang-tse River (another non-conference firm sent a ship as well), the China conference responded by sending ships to Hankow, inducing a fall in rates, which the Court in *Mogul* described as unprofitable. On the other hand, the two Mogul ships and the third independent ship sailed sufficiently full that they did not have to carry ballast (effectively garbage carried to stabilize the ship when there is too little cargo), whereas some of the conference ships sailed empty. Although Mogul was not admitted to the China conference, it was given some landing rights on the Yang-tse.

Two more recent contributions have improved our understanding of the ways in which conferences may have used predatory pricing to control entry. Fiona Scott Morton, studying pre-World War I conferences, finds evidence supporting the "long purse" theory of predation, whereby firms can profitably engage in predation if their financial resources are large relative to the prey.[85] A long purse theory requires that capital markets are sufficiently costly that the prey cannot gain access to capital to survive the price war, whereas the predator can, most likely because the predator already owns larger liquid assets before the war starts.[86]

In a later study with the sociologist Joel Podolny,[87] Scott Morton extended her earlier results primarily by finding that entrants with high social status were less likely to be preyed upon. The social status of an entrant is used as a measure of the extent to which an entrant could be relied upon to cooperate with the conference. They also show that the effect of social status declined with the age of the entering firm. This is consistent with the idea that information about a firm becomes more public over time and therefore the conference had less need to rely on social status as a proxy.

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[81] McGee, J.S. 1960, Ocean freight conferences and American merchant marine. *University of Chicago Law Review*, **27**, 191-314

[82] Yamey, B.S. 1972, Predatory price cutting: notes and comments. *Journal of Law and Economics*, **15**, 129-142.

[83] [1892] App. Cas. 25

[84] *Mogul Steamship Co.* is the most well known instance of a claim of predatory pricing in liner shipping. Useful discussions can be found in Letwin, W. 1965, *Law and Economic Policy in America: The Evolution of the Sherman Antitrust Act* (Chicago: University of Chicago Press) and Yamey, B.S. 1972, Predatory price cutting: notes and comments. *Journal of Law and Economics*, **15**, 129-142. Its legal fame rests on the Court's decision that under common law, agreements in restraint of trade (which the Court judged the conference to be) are unenforceable but *not* actionable.

[85] Scott Morton, F. 1979, Entry and predation: British shipping cartels, 1879-1929. *Journal of Economics and Management Strategy*, **6**, 679-724.

[86] McGee, J.S. 1960, Ocean freight conferences and American merchant marine. *University of Chicago Law Review*, **27**, 191-314; Bork, R.H. 1980, *The Antitrust Paradox* (New York: Basic Books).

[87] Podolny, J.M. and Scott Morton, F.M. 1999, Social status, entry, and predation: the case of British shipping cartels 1879-1929. *Journal of Industrial Economics*, **47**, 41-67.

These results are consistent with Gordon Boyce's discussion[88] of the International Mercantile Marine (IMM), a combination of five transatlantic lines sponsored by J.P. Morgan and formed in the period 1900-1902. The IMM had alliances with two German lines, Norddeutscher Lloyd (NDL) and the Hamburg Amerika Line (HAPAG), with whom it had a ten year route allocation agreement. Boyce argued that IMM's connection to Morgan gave it access to "abundant capital".

3.2 Loyalty Contracts

Conferences used two kinds of loyalty contracts: the deferred rebate and the dual rate contract (sometimes called contract rates). Under a dual rate system, the shipper signs an agreement to deal exclusively with the conference, and in turn receives a discount on the freight rate. If the shipper uses a non-conference carrier, the conference imposes a fine. Under a deferred rebate system, if the shipper deals exclusively with the conference for, say, six months (the typically length of time), and then deals exclusively with the conference for next six months, the shipper receives a rebate of an agreed proportion of his freight bill from the first six months. The deferred rebate was a novel contract first introduced successfully by the UK-Calcutta Conference in 1877[89] after being proposed in 1873 on the Yang-tse River trade.[90] The deferred rebate system was prohibited in U.S. trades by the 1916 Shipping Act.

There are two important distinctions between the two systems. First, under the deferred rebate system, the shipper loses interest on the price cut. Second, the conference incurs lower enforcement costs with the deferred rebate because it does not have to enforce the fine by going to court.[91] Perhaps because of these differences, discounts under deferred rebates tended to be larger than under dual rate contracts, typically double the size.[92] Under both systems, the conference must incur the costs of determining whether the contract has been broken, giving rise to estimates of violations of the loyalty agreements of 5-15% of shippers.[93] In a recent study, however, Pedro Marín and Richard Sicotte used the event study technique to show that loyalty agreements made significant contributions to profitability.[94]

Whichever system a conference used, deferred rebate and dual rate systems usually applied to only certain commodities. For example, the Far East Conference introduced the deferred rebate when it was formed in 1879, but certain bulk commodities such as rice and silk were excluded from the loyalty arrangement.[95]

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[88] Boyce, G.H. 1995, *Information, Mediation and Institutional Development: The Rise of Large-Scale Enterprise in British Shipping, 1870-1919* (Manchester: Manchester University Press)

[89] Marshall, A. 1921, *Industry and Trade* (London: Macmillan); Marx, D. 1953, *International Shipping Cartels* (Princeton: Princeton University Press).

[90] Marriner, S. and Hyde, F.E. 1967, *The Senior: John Samuel Swire, 1825-1898, Management in the Far Eastern Shipping Trades* (Liverpool: Liverpool University Press)

[91] McGee, J.S. 1960, Ocean freight conferences and American merchant marine. *University of Chicago Law Review*, **27**, 191-314

[92] Marx, D. 1953, *International Shipping Cartels* (Princeton: Princeton University Press)

[93] Grossman, W.L. 1956, *Ocean Freight Rates* (Cambridge: Cornell Maritime Press)

[94] Marín, P.L. and Sicotte, R. 2003, Exclusive contracts and market power: evidence from ocean shipping. *Journal of Industrial Economics*. **51**, 193-213.

[95] Hyde, F.E. 1957, *Blue Funnel: A History of Alfred Holt and Company of Liverpool from 1865 to 1914* (Liverpool: Liverpool University Press)

Moreover, the loyalty requirement was typically waived if the conference were unable to provide sufficient capacity within a reasonable time.[96]

Loyalty contracts are designed to encourage customers to use a particular seller exclusively. The shipper is charged a lower price in exchange for dealing exclusively with the conference. One question is whether they serve to exclude new entry, or whether they serve to reduce costs by gaining economies of regularity, such as easier planning. A second question is, assuming they serve to exclude entry, whether such exclusion is efficient.

Under constant marginal costs, loyalty contracts are an unprofitable method of deterring entry. Moreover, the customers who are most deterred from dealing with the entrant are those the conference least wants to deter, i.e., those owed the largest rebate.[97] Nevertheless, they can exclude an entrant constrained in its ability to offer a service of sufficiently high frequency to satisfy shipper demand.[98] Loyalty contracts reduce uncertainty for conference members by ensuring them a less variable flow of cargo, which is particularly valuable given the cost structure that makes full ships particularly attractive.[99] Because reduced uncertainty lowers costs and prices, these arguments are consistent with evidence that shippers were favourable to dual rate contracts.[100] The pre-WWI West Africa Conference used a deferred rebate system, which small shippers favoured but large shippers, who had better options to charter an entire ship, opposed.[101]

3.3 Price Discrimination

Conference freight tariffs for a long time were detailed and lengthy, with different freight rates for each commodity shipped. An important issue of contention is the extent to which those differing rates are the consequence of cost differences or price discrimination. Differences in cost could arise from, inter alia, differences in density (called the stowage factor), difficulties in handling the cargo, insurance, and the need for refrigeration. Differences in transport demand elasticities could arise from differences in the costs of waiting: more valuable and more readily perishable goods would bear a higher freight rate for quick service. Even after the widespread use of containers, which have made cargoes more homogeneous, these tariffs have remained in effect.

Allegations that conferences price discriminate by charging higher freight rates to higher valued commodities are of long standing. One claim is that they are simply

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[96] Marx, D. 1953, *International Shipping Cartels* (Princeton: Princeton University Press)
[97] Bork, R.H. 1980, *The Antitrust Paradox* (New York: Basic Books)
[98] Sjostrom, W. 1988, Monopoly exclusion of lower cost entry: loyalty contracts in ocean shipping conferences. *Journal of Transport Economics and Policy*, **22**, 339-344; Yong, J-S. 1996, Excluding Capacity-Constrained Entrants Through Exclusive Dealing: Theory and an Application to Ocean Shipping. *Journal of Industrial Economics*, **44**, 115-129.
[99] Lewis, W.A. 1949, *Overhead Costs: Some Essays in Economic Analysis* (New York: Rinehart); Boyce, G.H. 1995, *Information, Mediation and Institutional Development: The Rise of Large-Scale Enterprise in British Shipping, 1870-1919* (Manchester: Manchester University Press)
[100] Gordon, J.S. 1969, Shipping regulation and the Federal Maritime Commission, Part 1. *University of Chicago Law Review*, **37**, 90-158.
[101] Davies, P.N. 1973, *The Trade Makers: Elder Dempster in West Africa* (London: George Allen & Unwin)

attempts to extract additional profits from a monopoly position.[102] The alternative view is that conferences price discriminate because the large element of fixed common costs requires price discrimination to cover costs.[103]

On the monopoly interpretation, price discrimination is destabilizing for the conference. Price discrimination makes entry more attractive because entrants are encouraged to focus on the high priced end of the market. The conference sacrifices stability and durability in exchange for higher profits now.

On the common cost interpretation, price discrimination increases the stability and durability of the conference because it allows the conference to expand output and therefore is in the joint interests of the conference and shippers as a form of Ramsey pricing.[104]

An important difficulty is that Ramsey pricing is necessary only if marginal cost prices do not cover costs, which means that firms are operating under falling average costs. This seems inconsistent with several firms in a conference. Having several firms all operating in the region of falling average costs may be consistent with efficiency, although not with perfect competition. With U-shaped average cost curves, it is usually efficient to bring in an additional producer at a level of demand lower than that level necessary to bring the additional producer into the market under competition.[105] U-shaped average cost curves capture the technology problem, because they imply a range of output over which marginal cost is less than average cost, so that marginal cost prices do not cover total costs.

Figure 3[106] is the easiest way to see this result. Demand is BB'. MC_1 is industry marginal cost with one producer, and MC_2 is industry marginal cost with two identical producers (which assumes a cost minimising division of output between the two producers). Average cost is U-shaped and reaches a minimum at average cost AA' and output L. With one producer, efficient output is K. At that output, total value (the area under the demand curve) is OBCK. The cost of output L is OADL, and the cost of the extra output K-L is LDCK. Therefore, total surplus is ABCD.

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[102] McGee, J.S. 1960, Ocean freight conferences and American merchant marine. *University of Chicago Law Review*, **27**, 191-314; Bennathan, E. and Walters, A.A. 1969, *The Economics of Ocean Freight Rates* (New York: Praeger)

[103] Jansson, J.O. and Shneerson, D. 1987, *Liner Shipping Economics* (London: Chapman and Hall); Sjostrom, W. 1992, Price discrimination by shipping conferences. *Logistics and Transportation Review*, **28**, 207-215.

[104] For a detailed description of Ramsey pricing, see Brown, S.J. and Sibley, D.S. 1986, *The Theory of Public Utility Pricing* (Cambridge: Cambridge University Press)

[105] Telser, L. 1978, *Economic Theory and the Core* (Chicago: University of Chicago Press)

[106] Simplified from Telser, L. 1987, *A Theory of Efficient Cooperation and Competition* (Cambridge: Cambridge University Press), p. 114.

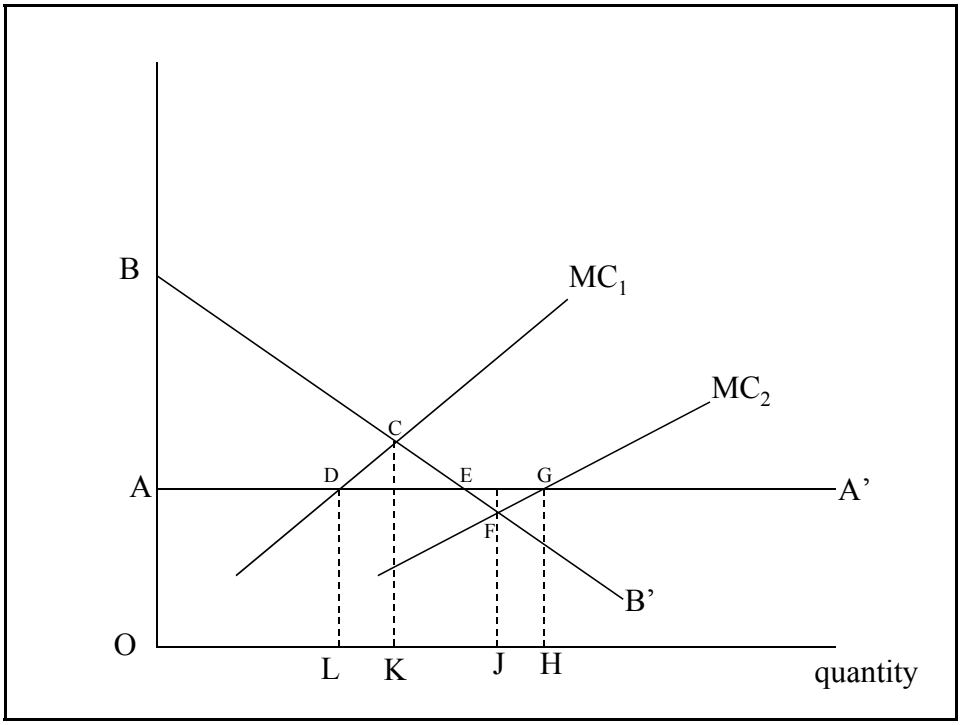

Figure 3

With two producers, efficient output is J, where demand intersects MC_2. Perfect competition cannot sustain that outcome because with two producers, price would be below A, and price would not cover average cost. To see whether it is efficient to have two producers rather than just one, first calculate total cost if output is J. With output H (equal to 2L, because average cost is minimized for one producer at L and for two producers at 2L = H), cost is OAGH (average cost times output). If output is reduced from H to J, costs fall by JFGH (the area under the marginal curve between J and H). Therefore, the cost of output J is OAGFJ. Total value is OBFJ (the area under the demand curve), so net surplus is ABE – EFG. The net gain in surplus from switching from one to two producers is therefore CDE – EFG. It is efficient to add a second producer if CDE > EFG. To sustain a second producer under perfect competition, demand must intersect MC_2 at point G, and the area EFG equals zero. It follows that it is efficient to bring in an additional producer at a lower level of demand than would be supported by perfect competition.

A number of attempts have been made to find out whether conferences practice price discrimination. A number of attempts have been made to measure price discrimination by regressing the freight rate for different commodities against the price of the commodity and a group of variables intended to capture differences in transport costs. The fundamental difficulty is identifying variables that capture differences in demand elasticities without also identifying differences in costs. A statistically significant regression coefficient on commodity price is usually asserted to be evidence of price discrimination. Unfortunately, higher priced goods usually carry higher insurance costs and frequently require more delicate handling. To identify price discrimination, we would have to know the (unknown) coefficient implied by these higher costs and look for evidence of a higher coefficient. The cost variables, moreover, might include price discrimination elements. For example, refrigerated goods usually carry a higher freight rate. The higher rate may the result of the extra costs of refrigeration, or the result of the less elastic demand implied by

the perishability of the goods. To complicate matters, it could easily include both elements, so the model cannot identify the separate effects. A long series of papers[107] have failed to answer this question because they failed to tackle the identification problem. Two papers have made attempts to solve this identification problem.

Clyde and Reitzes[108] have made an innovative attempt to separate the effects of market power from cost differences by using panel data (different commodities on fourteen routes over four years) in a fixed effects model. By using dummy variables for each commodity, they try to control for cost differences. The relevant part of their regression is $r_{ij} = \beta_1 s_j + \beta_2 s_j p_{ij}$, where r_{ij} is the freight rate for commodity i on route j, s_j is the conference market share on route j, and p_{ij} is the price of commodity i on route j. It follows that $\partial r_{ij}/\partial s_j = \beta_1 + \beta_2 p_{ij}$. If conferences are price discriminating, then a drop in competition from independent carriers (an increase in s_j) will not only raise freight rates ($\beta_1 > 0$), but will raise them more for higher valued commodities ($\beta_2 > 0$). Clyde and Reitzes find no evidence for discriminatory pricing.

A recent paper by Hummels, Lugovskyy, and Skiba[109] tries to solve the problem by looking at changes in import duties. As product price rises, a given increase in the freight rate produces a smaller proportional change in product price, so a higher product price implies a less elastic transport demand. Changes in import duties change the elasticity of transport demand without changing transport costs, so they become a way to identify price discrimination. They find substantial price discrimination, with a 1% increase in an import duty raising freight rates 1 – 2%, and consequent substantial effects on developing country trade.

3.4 Price and Output Fixing

Conferences not only fix prices, they set both minimum and maximum outputs. It is much easier to make sense of the role of maximum output rules. In a cartel model, maximum output rules prevent price from falling to competitive levels. In an empty core model, a maximum output rule allows for efficient use of capacity[110]

Why though a minimum output rule? One explanation consistent with both cartel and empty core models is entry deterrence. Entry deterrence is important in both cartel and monopoly models. In cartel models, entry lowers price; in empty core models, entry destroys equilibrium. Fusillo[111] and Wu[112] offer evidence that conference liners create excess capacity for strategic entry deterrence. In an open conference system, if conferences are successful in imposing entry barriers to non-conference lines, the entrant may attempt to by-pass those barriers by joining the conference. If the minimum output is set high enough, the entrant may end up expanding capacity on the route to unprofitable levels. This limit-pricing strategy

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[107] Survey and critiqued in Sjostrom, W. 1992, Price discrimination by shipping conferences. *Logistics and Transportation Review*, **28**, 207-215.

[108] Clyde, P.S. and Reitzes, J.D. 1998, Market power and collusion in the ocean shipping industry: is a bigger cartel a better cartel? *Economic Inquiry*, **36**, 292-304.

[109] Hummels, D., Lugovskyy, V., and Skiba, A. 2009, The trade reducing effects of market power in international shipping, *Journal of Development Economics*, **89**, 84 – 97.

[110] See Telser, L. 1987, *A Theory of Efficient Cooperation and Competition* (Cambridge: Cambridge University Press), chapter 5, for a rigorous proof.

[111] Fusillo, M. 2003, Excess Capacity and Entry Deterrence: The Case of Ocean Liner Shipping Markets, *Maritime Economics & Logistics*, **5**, 100-115.

[112] Wu, W. 2009, An approach for measuring the optimal fleet capacity: evidence from the container shipping lines in Taiwan, *International Journal of Production Economics*, **122**, 118 – 126.

requires the conference to commit to the minimum output rules by guaranteeing its sailing schedules. As with any irreversible commitment, however, this would expose the conference to the risks of a mistake. An entrant might overestimate demand and therefore mistakenly enter, leaving the conference with excess capacity.[113]

Minimum output rules are also consistent with the efficiency argument, raised in Figure 1 in the previous section, that with large fixed costs, it may be efficient to operate where marginal cost is below average cost.

Alternatively, consistent with a cartel model, the minimum output rule may be a way of excluding small, high cost sellers from the conference. The willingness to adhere to a minimum output may be a way of signaling low costs. Every agreement has to ensure it is not eroded by attracting high cost entrants.

Albert Ballin, the managing director of the Hamburg-America Line (Hapag) wrote in 1914:

> Especially a very strong and powerful party must continuously bear in mind the question, whether the advantages of relying on the free interplay of market forces would not be far greater than the benefits from inhibiting influence of a conference, which after all flow more to its weaker than its stronger members.

Hapag was at the time the world's largest shipping line. Although Ballin was implying that Hapag was among the stronger, there is some evidence that it was by no means the most profitable, which is counter-evidence to the idea that minimum output quotas were about excluding high cost entrants.[114]

Revenue pooling can be a method of sustaining price discrimination and preventing internal cheating in a cartel. It can also be a means of ensuring low cost production by separating the decision about efficient output allocation from individual firm profitability.[115]

4. Concluding Remarks

Although our understanding of cooperation in liner shipping has improved in recent years, there is still much that remains a mystery. In particular, research on strategic alliances remains largely descriptive has not expanded to the careful testing applied to other industries. Maritime economists have much to keep them busy.

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[113] McGee, J.S. 1980, Predatory Pricing Revisited, *Journal of Law and Economics*, **23**, 289-330.

[114] Broeze, F. 1993, Shipping Policy and Social-Darwinism: Albert Ballin and the Weltpolitik of the Hamburg-America Line 1886-1914, *The Mariner's Mirror*, **79**, 419-436.

[115] Letwin, W. 1965, *Law and Economic Policy in America: The Evolution of the Sherman Antitrust Act*. (Chicago: University of Chicago Press); Wilson, T. 1962, Restrictive Practices, in J.P. Miller (ed), *Competition, Cartels and their Regulation* (Amsterdam: North Holland)