Entry and Predation: British Shipping Cartels 1879–1929

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I examine the outcomes of cases of entry by merchant shipping lines into established markets around the turn of the century. These established markets are completely dominated by an incumbent cartel composed of several member shipping lines. The cartel makes the decision whether or not to begin a price war against the entrant; some entrants are formally admitted to the cartel without any conflict. I use characteristics of the entrant to predict whether or not the entrant will encounter a price war conditional on entering. I find that weaker entrants are fought, where "weaker" means having fewer financial resources, less experience, smaller size, or poor trade conditions. The empirical results provide most support for the long-purse theory of predation. Due to the small number of observations available, 47, I discuss qualitative evidence (such as predatory intent expressed in correspondence between cartel members) that supports the empirical results. The results are also found to be robust to misclassification of the dependent variable, which is a particular concern when dealing with historical data.

1. Introduction

The phenomenon of predatory pricing has interested economists for many years. The concept of a firm "fighting" a rival and causing its exit from the market is dramatic. Additionally, analysis shows that conditions necessary for predatory pricing violate some standards of perfect competition, making the possibility of predation controversial. Though the contradiction inherent in predatory pricing has motivated considerable debate, the empirical evidence has not kept up with the

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spate of theoretical contributions. This paper looks at a small sample of price wars initiated by shipping cartels around the turn of the century and uses characteristics of the entrants that are fought to evaluate several theories of predation.

The Chicago school is known for the argument that predatory pricing is unlikely to be profitable for a firm, much less for a group of firms, and will therefore not occur. A firm expecting to gain from predatory pricing must be able to earn excess profits (after the victim's exit) to pay for the price war, but excess profits are inconsistent with perfect competition. More recent models in the game-theory literature describe situations under which predatory pricing is rational. The long-purse story, signaling (asymmetric information), and creation and defense of a reputation are three motivations for predatory pricing. Theoretical work on reputation has mostly focused on the characteristics of the incumbent (cartel) rather than the entrant. However, this paper will concentrate on the type of the entrant and how it affects the probability of predation.

At the turn of the century, British shipping firms operated in cartels that held and defended monopoly positions in various international shipping routes. I construct a dataset for this paper that allows possible instances of predation by shipping cartels to be examined quantitatively. The dataset consists of 47 cases where an entrant attempted to break into a cartel and records which entrants precipitated a price war. This paper seeks to understand why some entrants are ''fought'' and others are not. Because the historical nature of the data limits the number of observations, I also include substantial qualitative evidence such as descriptions of the practices of the shipping cartels and of industry characteristics that made predation a likely response to entry. I also examine entrants' choice of market share to see if it is related to entrant and market characteristics. This unusual opportunity to examine predation results both from the lack of contemporaneous antitrust laws and from the propensity of the shipping industry for collusion. Although much of the behavior I describe is now illegal, the analysis sheds light on what firms will do if unconstrained, and thus contributes to our positive understanding of firm behavior.

The empirical results confirm that entrant shipping line characteristics help predict the probability of a price war: a very young firm is a weaker entrant and is more likely to be preyed upon. The young firms in the dataset are ''weak'' in the sense that they lack financial resources, have little multimarket contact with rivals, lack experience, and lack an established customer base. An additional point is that the age of an entrant is unrelated to the state of competition, demand, or supply shocks. This finding provides support for the idea that the price

wars were not simply the outcome of vigorous competition in the context of demand and supply shocks. I find no evidence that long-term contracts for cargo or government subsidies are important in determining the strength of an entrant. Nor do I find that the amount of time since the last war occurred is relevant to the probability of predation; this might be the case if the incumbents were trying to maintain a reputation for preying. I do find that contracts and government subsidies affect the market share at which the entrant enters, however. The significance of entrant-specific characteristics in determining the incidence of war lends support to theoretical models with the same feature. Overall, my results provide the most support for the long-purse theory of predation.

The organization of the paper is as follows. In Section 2 I discuss the predation literature and the way these models could fit the behavior of shipping cartels. Section 3 sets out the qualitative evidence for predatory pricing, industry characteristics, practices, and intent.[1] Section 4 outlines the model, and Section 5 explains the variables used in the estimation and discusses the results. Section 6 concludes.

2. Predation Literature

The amount of theoretical literature in the predation area is vast. The position of the Chicago school provides a valuable null hypothesis and starting point.[2] The Chicago school holds that a firm will not engage in predatory pricing because it would have to be able to recoup its short-run losses by earning excess profits in the long run. Those future profits depend on its successfully driving out the entrant or rival and then maintaining monopoly power long enough to earn back its lost profit, which is difficult in a competitive market. For example, after successful predation, significant entry barriers are required to prevent new entrants from creating competitive market conditions. Execution becomes even more difficult should a cartel, rather than a single firm, consider predation. The distribution of losses and gains must be arranged, and free-rider cheating must be controlled. The proponents of this view conclude that price wars are not evidence of predation, but evidence of competition. If we see price fluctuations, the appropriate interpretation is that entry caused prices to drop because supply increased, and exit caused prices to rise for an analogous reason. Cost changes or

1. The historical details of the three cartels I use in my dataset and a rough picture of shipping-firm finances are covered in the Appendix, Sections A.1 and A.2.
2. For example, Bork (1978) and McGee (1980).

demand shocks could also trigger the periods of low prices, but they are not caused by incumbents intending to prey on entrants.[3]

In a summary of the recent information economics literature, Ordover and Saloner (1989) list three reasons a firm might undertake predatory pricing. The first is the well-known *long-purse* theory: an incumbent with more financial resources than an entrant can force the entrant into bankruptcy and exit by waging a price war. Knowing this, the entrant may be reluctant to enter and initiate a war. However, the entry may still occur if the entrant is uncertain about the relative financial strengths of the players or the probability of a price war. An expensive war of attrition may ensue if each side finds it optimal to fight because each has private information indicating it will win. Many versions of the theory depend on imperfect capital markets to generate an entrant with fewer resources. For example, in Fudenberg and Tirole (1985), predation causes the entrant to have sufficiently little cash after entry that it cannot stay in the market; no bank will lend to it at an acceptable interest rate. An entrant with more cash to begin with, or a better relationship with its bank, will attract less predation. In an extension of the Fudenberg-Tirole model, Snyder (1996) shows that long-term contracts between an entrant and its bank can succeed as a predation defense in some cases. The long-term nature of the financing strengthens the entrant. Bolton and Scharfstein (1990) examine another version of the long-purse story. Suppose a firm is financially constrained in order to provide managers with incentives; then its rivals have a motive for attempting to make the firm earn losses in a price war and exit. In these models, the price war will only be successful if the entrant is sufficiently weak that the incumbents can force exit.

Signaling or renegotiation is a second explanation of predatory price wars. Ordover and Saloner compare signaling price wars to standard limit pricing, except that the entrant has already entered. Predation occurs because the incumbent wishes to credibly signal information about demand or costs that the entrant lacks. For example, in Fudenberg and Tirole (1986), predation is used when the entrant is less informed or weaker and can be persuaded to exit. A price war might lower the acquisition price if the incumbent wishes to buy the entering

3. A phenomenon that may be related to the cartels' existence and pricing patterns is that of the "empty core." Considerable scholarship has applied the theory of the core to the problem of ocean shipping, e.g. Sjostrom (1992) and Pirrong (1992). Although the empty core may well have contributed to cartel formation, the question still remains whether the cartel fought entrants or whether periods of low prices represented spells where equilibrium did not exist. The question of why cartels fought price wars can be addressed regardless of the motivation for cartel formation.

firm (Saloner, 1987). Similarly, a price war might be used by an incumbent shipping cartel to renegotiate an entrant's initial sailing schedule down to a more acceptable market share. Saloner notes that the incumbent is trying both to induce exit and to improve its own position in case the entrant actually stays.

Creation and defense of a reputation is the third story behind predatory pricing. Selten's chain-store paradox (1978) shows that predatory pricing in the face of entry is irrational in a finite game. Milgrom and Roberts (1982) look at reputation and its importance in the case of uncertainty. They show that when potential entrants can enter every period, the incumbent's reputation for preying will have a deterrent effect on entry and therefore some initial predation may be rational. Their result depends on a finite horizon for the game; however, Fudenberg and Levine (1989) show that in the case of an infinite horizon, a monopolist committed to a strategy can get at least his Stackelberg equilibrium payoff if he is sufficiently patient. Preying to convince entrants of its strategy can be profitable for a monopolist in a game that does not end with certainty in any period.[4]

Another way to categorize predation models is by the behavioral prediction each generates, rather than by the motivation for the predation. On the one hand, Milgrom and Roberts (1982) and Selten (1978) derive strict results: predation is rational but not very often necessary, or useless and never used. In contrast, many of the long-purse and signaling models that predict predatory behavior will be used more often when the entrant is *weaker*, but will be less common when the entrant has better survivability characteristics, or is tougher. The models allow for an entrant's characteristics to affect the chance of a price war. Whether the characteristic of interest is financial resources, information, or an investment of some kind, the general conclusion we can draw from these types of models is that predation is less likely to be undertaken against firms that are stronger. The idea that outcomes will differ depending on entrant and market characteristics motivates the empirical work that follows. I test if variables measuring entrant characteristics help predict the probability of a price war.

Unfortunately, empirical studies of predatory pricing are rare due to a lack of suitable data; predatory pricing is often illegal in modern economies. The primary purpose of the empirical studies cited below is to show a particular price is predatory, rather than to explain when prices are predatory and when they are not. Burns (1986) finds Ameri-

4. Indeed, the incumbent can do better than Stackelberg, if it is faced with forward-looking entrants, by committing to a strategy over time.

can Tobacco was preying to reduce the costs of acquiring rivals. Weiman and Levin (1994) show that Southern Bell Telephone priced below cost and earned drastically less per phone in areas where it competed with rival networks; the company succeeded in driving out or merging with most of its rivals by 1913. Genesove and Mullin (1996) show that the Sugar Trust priced below cost in the late 1800s and argue that the Trust was trying to drive out recent entrants. These analyses provide evidence that predation is a viable strategy for a firm. Lerner's (1994) work is most closely related to this paper; he looks at the effect of entrant characteristics on pricing and finds evidence for long-purse predation in the disk-drive industry. He shows that healthy firms choose a lower price for products located in product space next to products of financially constrained firms in order to drive out those weak firms.

The legal standard for identifying predatory pricing involves examining the relationship of the low (possibly predatory) price to different measures of costs.[5] Since I do not have detailed costs over time, much less marginal-cost data, it will be impossible for me to prove predatory pricing existed according to common legal standards. The focus of the paper is not on determining what price can be described as predatory, but rather on whether the observed low prices were used in a manner consistent with one or more theories of predatory intent. The definition of a "predatory" price that I will use throughout the paper is a price that is lower than it otherwise would be due to an intent to force exit of a rival.

3. The Merchant Shipping Industry

3.1 Motivation and Data Sources

I examine shipping cartels at the turn of the century because ever since their inception these cartels have generated enormous controversy over their alleged anticompetitive behavior, particularly predatory pricing. Numerous dramatic accounts of price wars to drive out entrants are described in publications of the period. For example, in the business archives of a cartel member is a letter that runs, "there is no room for the Strick Lines [in the market] . . . . We must repel his attack, and if

5. Various standards for predatory prices have been advanced: price is less than marginal cost, short-run marginal cost, long-run marginal cost, average cost, or average variable cost; cost does not have any particular relationship to price, due to more complex factors; and output increases. See Areeda and Turner (1978) for full details.

continued we should retaliate . . . .''[6] With ample material of this nature available for critics to use against the cartels, a mini-industry has arisen in critiquing and defending shipping conferences. One of the earliest British antitrust suits was filed against a shipping cartel for excluding a rival[7]; the UK Government held an inquiry in 1906 to determine if shipping conferences were harming trade; arguments over shipping conferences appear regularly in the modern US popular press (e.g. the *Wall Street Journal*, December 3, 1996); Milgrom and Roberts mention shipping cartels as a motivating example in the introduction of their seminal article ''Predation, Reputation, and Entry Deterrence'' (1982).[8] If economists' models of predation apply anywhere, they should apply in the international shipping industry before the advent of antitrust laws.

It is possible to gather information about this interesting industry because there is a plethora of secondary sources on the early shipping industry (listed after the references under ''Data Sources''). Shipping was very important to the political economy of Britain in the late nineteenth century; it helped the nation retain control of its colonies and fed the industrial revolution with raw materials and export markets. The popular press, the business press, and the government wrote about the activities of British shipping lines and the cartels to which they belonged. The three cartels used in this analysis cover politically important trade routes (South Africa, India, Far East), and remained intact and stable for the whole period, which improves the amount of available evidence. Both the qualitative and quantitative data I use in this study were collected from histories of shipping companies, general histories of shipping, or histories of a specific port that were generated due to this popular interest.[9] Most of these books are not specifically about the operations of a particular cartel and the entry it faced, and therefore tabulating and cross-checking the data was a difficult and time-consuming process. I also had access to some primary sources: correspondence, ledgers of accounts, and contracts written by the members of some cartels, as well as the minutes of a government investigation into (allegedly destructive to colonial development) cartel practices. All the descriptions of market practices and the characteristics of cartels that affect the success of predation are culled from these sources.

6. See Appendix, Section A.1, for the full quotation.
7. Mogul Steamship Co. v McGregor, Gow, and Co. 23 Q.B.D. 598 (1889).
8. They cite Yamey (1972), an early academic source.
9. These sources are listed at the end of the paper.

Because the quantitative information I have is limited, it is important to have the support of qualitative evidence, and therefore it is presented in some detail below. First I describe what shipping cartels consisted in and discuss features of their environment that are important to the predation argument. Then I focus on the particular practices the cartels used to help preserve their monopoly and deter entry. The last subsection describes price movements before and after instances of predatory pricing and relates price movements to the evidence of predatory intent on the part of managers and owners.

3.2 Definitions and Basic Facts

Shipping conferences are associations of deep-sea merchant or passenger shipping lines. British shipping lines invented the concept and the name ''conference,'' which I will use interchangeably with ''cartel.'' British lines were the largest and most technologically advanced, and were dominant in most trade routes during the period.[10] The first conferences were composed entirely of British lines and nevertheless held monopoly positions on their routes.[11] It is important to establish that the existence of formal cartels in the economic sense is not an assumption. In the 1889 antitrust case mentioned above, the British courts and the House of Lords decided the law did not prohibit cartel agreements. I have examined some of the contracts signed by the member firms setting schedules, freight rates, and dues. The members of the conferences explicitly and formally agreed to common prices, a set schedule, and renegotiation and dispute procedures. A voluminous correspondence among members of many conferences exists, which allows the reader to track disagreements and the renegotiations that accompanied the changing environment.[12]

A shipping conference was composed of a number of lines, all

10. Additionally, British lines were privately held and did not receive large government subsidies, providing a better experiment for the economist. UK mail payments did exist, but on the routes in this dataset those payments were not designed to sustain a line when there was not enough private business to keep it going. In contrast, the German government subsidized several lines to Africa, explicitly noting that there was not enough business on the route for a line to run without government help.

11. The first conferences were formed in the 1870s; the practice quickly spread and has lasted to the present day. By the turn of the century most shipping routes had been cartelized, although many of the cartels were not stable.

12. The Shipping Records Archive of Glasgow University, Scotland, is a repository for these documents.

traveling the same route.[13] A shipping line (or firm) might have been quite small, three ships for example, or might have been large enough to cover many routes all over the world, as many of the well-known shipping firms did. The purpose of a shipping conference was to set rates and sailing schedules to which each line would adhere. The cartel also allocated market shares of specific types of goods and decided the exact ports to be served by each member line (which had a similar effect to allocating trade by products, since manufacture of a good was often concentrated in one area).

Cargo rates were rather like modern-day airline fares. Each type of good had a different rate, often nonlinear in quantity, as did each port pair. Some large shippers had long-term contracts that offered savings off the standard rates. On top of that, some shippers were able to claim an additional rebate (discussed below). As a result, it is nearly impossible for a researcher to construct an average per-ton rate for even one month on one route; I do not attempt it in this paper. Additionally, there are no price series that hold these factors constant over a significant time period, so the paper does not contain an analysis of price movements over time such as in Porter (1983).

A conference agreement included all shipping lines providing scheduled service on the route. Part of the definition of a conference is that it had a complete monopoly of scheduled service—hence the conflict when another firm wished to offer service on the route. Conference size in my dataset ranges from five to fifteen or so members. Two of three conferences studied here covered routes from the UK to British colonies (UK to South Africa, UK to India); the third ran from the UK to the Far East (China, Japan, Hong Kong); all were mostly composed of British firms. See Figures 1 and 2 for conference routes and Section A.2 of the Appendix for more detailed conference histories.

3.3 The Environment and Practices of Shipping Cartels

Imperfect capital markets motivate some of the theoretical predation literature. The capital markets of nineteenth-century Britain were certainly not primitive, as the quotation below indicates, but it would be difficult to argue there were no imperfections:

13. Technically, each conference agreement would apply to only one direction of one route (UK to Calcutta, for example) because the opposite direction might be served by a different set of firms. Boats often traveled circular routes, *A* to *B* to *C* to *A*, for example. A line running a ship only from *A* to *B* belonged to the *A*-to-*B* conference, but not to the conference on the *B*-to-*A* route. I include both directions of the route in my discussion and empirical analysis because my three conferences had a high proportion of overlapping members in the two directions.

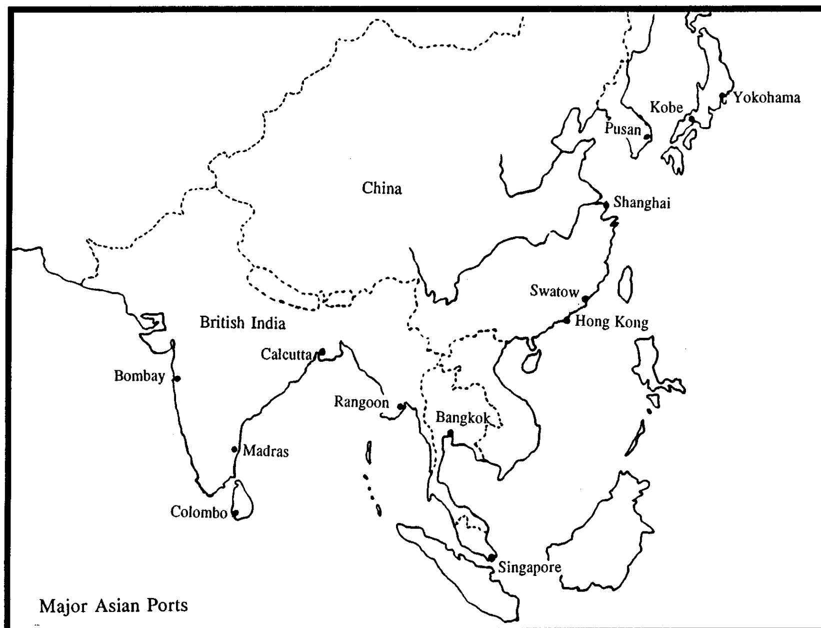


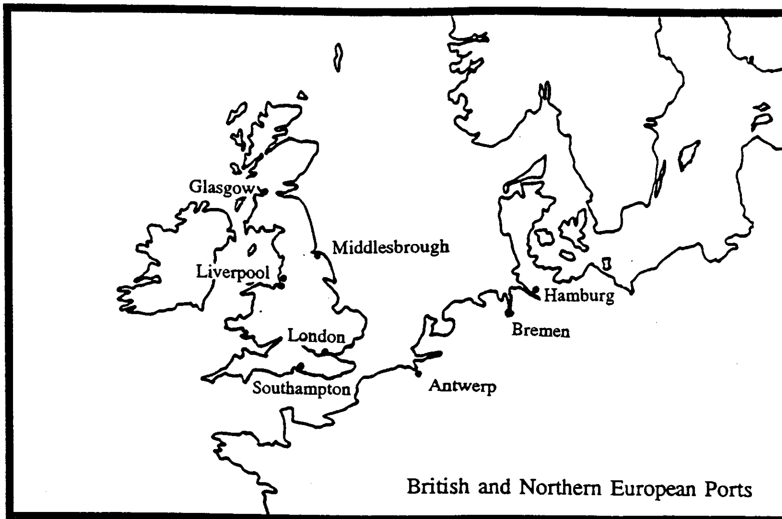
FIGURE 1.

> The boom in the market for stocks and shares of all kinds after the repeal of the Bubble Act in 1825 included massive joint-stock promotions in the shipping industry .... The new capital was sorely needed ... to cover the much higher costs of iron-hulled steam-powered fleets ... and no less than 413 shipping companies were registered under the new limited-liability legislation between 1856 and 1881.[14]

Limited liability allowed the owners to use external financing more easily. However, Green finds that shipowners had not been eager to borrow from banks in the early part of my period.[15] A reliance on private financing meant there were substantial informational asymme-

14. Green (1985, p. 229).

15. "For most of the nineteenth century the industry had been reluctant to ask banks and other institutions for support .... 'It was never company policy to attempt to secure outside finance.' For their part banks had been unenthusiastic about closer involvement." Green (1985, p. 230).



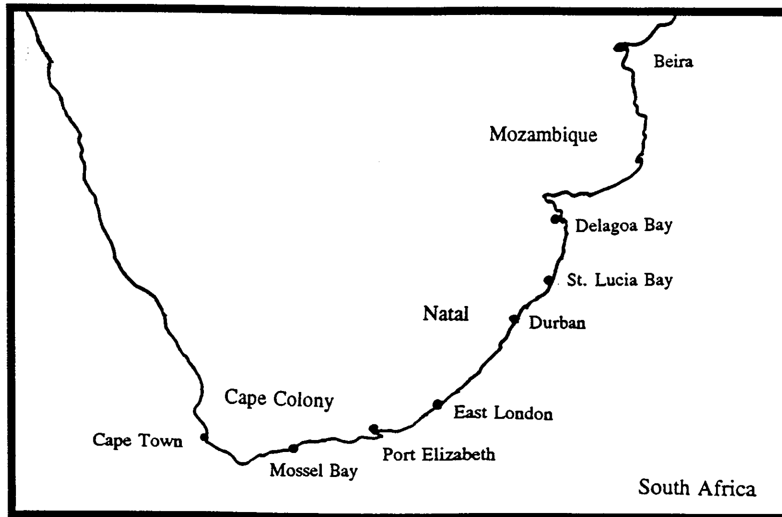


FIGURE 2.

tries among shipping firms in this time period. Most shipping firms were privately owned. Their capital would typically be owned by one or two extended families and neighbors. Each firm would have a different mixture of loans and equity, and partners with different wealth and liquidity. Thus a cartel would not know the exact financial strength of an entrant, nor would an entrant know the precise financial strength or cohesion of a cartel.

The strength of a conference's market power is critical in deciding whether predation could be a profitable strategy. The only substitutes available to the merchant were sailing ships (speed depended on the weather), tramp ships, and specially chartered vessels. The difference between liners and tramps was not physical; it lay in how the ship was scheduled. A tramp picked up a full shipload of cargo X at port A and carried it to port B, whereupon the ship looked for another contract. Tramps operated on a spot market where rates could fluctuate according to supply and demand. Liners, in contrast, committed to a fixed schedule and set of rates. Tramps were a viable option in a port such as Singapore where many ships passed through on their return journey to Europe with empty space.[16] In South Africa tramps were rarer and did not reliably have space at any given time.

In all the conferences, speed was probably the most crucial distinguishing characteristic of the conference ships. Relatively valuable manufactures and tea had high opportunity costs of time. Therefore, slower means of transportation were not very good substitutes. Additionally, chartering a slower tramp required paying for the whole ship. The chartering solution would not be feasible for a merchant who wanted to send regular, less-than-shipload lots; too much space, capital, and risk was involved. The data sources I read never describe a single merchant resorting to tramp shipping in response to the high prices charged by conference ships. Additionally, the conference defended itself vigorously against those merchants who joined together to form a charter company to transport their goods. The merchants would be discriminated against by the conference during their rebellion and perhaps afterwards also.

There is some evidence that prices in all three conferences generated positive profits for cartel members. During price wars, the entrant line was occasionally able to operate without loss at the fighting rates. For example, Solomon (1982) reports that during the price war caused by the entry of the shipowner Houston in the South African trade,

16. In fact, the Straits Conference from Singapore was very unstable and much less successful than others due to tramp competition.

Houston's half-price rates were enough to cover his costs and the costs of the slower Conference lines.[17] Letters from the owner-manager of the Blue Funnel line report that Far East Conference rates increased Blue Funnel earnings by 20% over free-market rates.[18] The Calcutta Conference members claimed to be earning profits after cutting their prices in response to entry by India Mutual.

If excess profits were being earned, then the conference had to be concerned with protecting its monopoly position from firms that wanted to share in those profits. Besides fixing rates of freight and volumes carried, the conferences invented the *deferred rebate*, which may have accomplished this. To promote shipper loyalty, the lines arranged to pay back a certain percentage (usually 10%) of a shipper's total freight bill over six months, *if* the shipper had patronized the conference exclusively during that six months and for a further six- or nine-month waiting period. Therefore the shipper faced the loss of 10% of a year's freight if he decided to switch his business to an entrant. The deferred rebate created a strong barrier to entry, which, in turn, increased the likelihood that predation could be profitable.[19]

If the cartel could protect itself from external challenges, it still faced the common problem of cartel members themselves cheating on the agreement. A convenient feature of shipping from a collusive point of view is that it is impossible to expand capacity (number of ships) without being detected. Giving secret price discounts to major customers was the only feasible way to cheat, but keeping discounts secret was difficult because brokers were involved in each transaction. Brokers were the equivalent of modern-day travel agents. They made reservations for freight and collected charges from the customer. Brokers often worked for more than one shipping firm and had their own reputations to maintain. The histories I have read suggest that cheating on the part of cartel members was not a significant problem.[20]

17. Slower ships were older and less expensive to purchase.

18. Hyde (1967, p. 96).

19. Shipping conferences have been accused of creating the deferred rebate to protect their monopoly for many years. Traditionally, they have defended themselves with various reasons why the deferred rebate is necessary, but not anticompetitive. For example, the penalty could have been designed to promote stability in the amount of cargo shipped, which would lower average costs by allowing the shipowner to match demand and capacity exactly.

20. Bargaining over prices was common and provided more information about cheating. A large customer would typically claim that the goods were not selling at their destination due to high transportation costs. The cartel would consider whether or not to lower the freight rate on that product. The customer would end up paying the cartel rate or not sending the goods. If the customer changed lines within the cartel (rather than using the geographically closer line or previous provider), the cartel would have a strong hint that the new carrier had cheated on price.

Revenue pooling also cut down on the incentive to attract cargo away from other lines and promoted stability by giving the aggressive line only a fraction of marginal freight revenues. A revenue pool might require every line to contribute 50% of its freight revenues, for example, to a common fund.[21] Distributions from the fund were made in accordance with previously agreed-upon market shares. Cartel members also might agree to share cargo from certain manufacturers in fixed proportions. Again, this reduced the ability to steal market share from a fellow cartel member.

One of the cartels' problems was the difficulty of coordinating the competitive response to an entrant. The burden of fighting an entrant would likely fall unequally on members, as would the cost of admitting the entrant. Cartel members reduced conflict by using direct transfer payments among themselves; these are described frequently in the secondary sources and must have been very common. In this way the cost of pursuing the collective best interest could be spread fairly. Revenue pools, direct payments, and cargo-sharing agreements developed in all three conferences. Additionally, the British Government made shipping lines bid for long-term contracts to carry its cargo; government cargo was usually exempted from a cartel agreement. A cartel therefore did not enforce any collusive agreement for the segment of the market where collusion might have been hardest to sustain.

3.4 Qualitative Evidence of Predation

The available qualitative evidence on price movements challenges the explanation of the Chicago school. When price movements during an entry incident are known, they seem not to move consistently with supply and demand. In some of the observed cases of entry, market prices rose a few weeks after they plummeted due to entry, but no exit had occurred. Prices are described as changing dramatically from one week to the next, more rapidly than demand could have changed, without corresponding changes in capacity. Also, price levels were correlated with membership in the formal conference organization; prices rose from price-war levels to exactly the prewar level at the time the entrant was admitted to the formal conference organization. At the same time, the secondary sources quoted a letter or newspaper report saying that the entrant had agreed to abide by the conference prices and had been assigned a market share. This combination of events is more consistent with a deliberate price war than with the interaction

21. 50% was a typical level.

TABLE I.
PRICE MOVEMENTS AROUND PRICE WARS

Description	Price before	Price during	Price after	Exit?
FEFC forms 1893: textiles to China	30 pence	—	120 pence	—
Indian Mutual war to Calcutta, 1891	258 pence	90 pence	NA	Yes
Austrian Lloyd war to Bombay, 1881	20 rupees	5 rupees	20 rupees	No
Houston war to South Africa, 1902	510 pence	≥192 pence	NA	Yes
NYK war to Yokohama, 1896	480 pence	300 pence	384 pence	No

of supply and demand. To determine sound cases of predatory pricing, Easterbrook (1981) suggests finding evidence of firms being driven out of the market by low prices and *then* of prices rising. Table I lists several cases of entry where prices fell and then rose when the entrant was driven out or when the entrant joined the cartel.

Establishing predatory intent is an important part of the qualitative argument. Section A.1 in the Appendix quotes from a series of letters between members of a conference facing a determined entrant. The members discuss ''punishing Strick by making him take unremunerative rates'' and ''repel[ling] his attack'' because there is ''no room for the Strick Lines'' in the trade. The lower prices they agree to charge in these letters are a deliberate and conscious attempt to force Strick to leave the market. I saw several letters of this type in shipping archives, and secondary sources describe more correspondence and interviews showing predatory intent. There are also letters discussing the formal terms under which an entrant could be admitted to the cartel and a price war started or stopped. The strong evidence of predatory intent on the part of owners and managers, the timing of formal entry into the cartel, and the price movements described above are all consistent with the predation story.

Price wars were exciting events for the media of the day, uncommon enough to be news, but common enough to be analyzed for motives and patterns. The dataset I have constructed (Table II) has 47 cases of entry, of which 14 are price wars. Based on my reading from the industry and time period, this proportion of wars does not seem unusual. Overall, liner shipping in this period was uniquely placed to try coordinated acts of predatory pricing. Predation was not illegal, ships

TABLE II.
LOCATIONS OF PRICE WARS

Region	Entries	Price Wars
South Africa	24	7
India	12	4
Far East	11	3
Total	47	14

were fungible, marginal costs were low, information was imperfect, transfer payments within the cartel were easy, the cartel had some market power, and the deferred rebate created a barrier to entry. All of these factors contributed to creating a favorable environment for predation activity.

4. Model

I interpret the favorable environment for predation to mean that predation as a strategy could plausibly have been profitable for a shipping cartel. The question remains, how did firms carry out predatory pricing? When did they find it to be the best strategy? In what kind of situations, and against which entrants? Below I describe the timing and information of an entry-and-predation game that has the features of the shipping industry just described. I do not focus on the role of differing private information in causing price wars, since the empirical data I have were common knowledge at the time of entry. Instead, the model below shows that the commonly known characteristics of the entrant help predict the likelihood of predation and allow the different theories of predation to be tested.

Suppose the entrant line has a type, t, which represents its strength in terms of cash and other resources:

$$t = X\beta + \epsilon.$$

Here ϵ, and therefore t, are unknown to any party, while the entrant's characteristics X and the coefficients β are common knowledge. The entrant knows its own financial state, but, for example, does not know exactly how much its bank would be willing to lend in case of a price war, or how much it can expect to lose per week in a price war with the prevailing trade conditions on the route. These uncertainties can

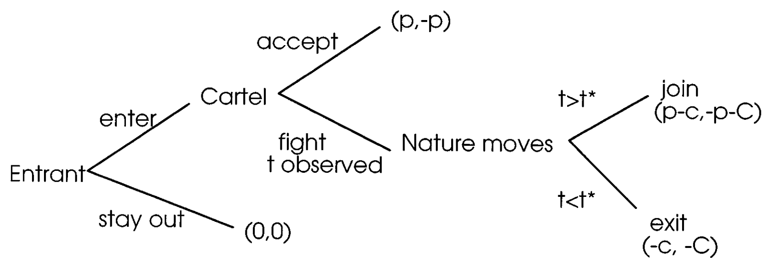


FIGURE 3.

only be resolved if the price war actually takes place. If there were no uncertainty about an entrant's type, strong entrants would enter and weak ones would not. We would never observe price wars. ϵ is therefore crucial; its distribution is described by the cdf $F(\cdot)$ and the pdf $f(\cdot)$. The cost to the entrant of fighting a price war is $c > 0$. The cost to the incumbent cartel of fighting the war depends positively on the strength of the entrant and is $C(t) > 0$. For convenience, the entrant's outside opportunity will be set equal to zero. If the entrant is accepted into the incumbent cartel, its payoff is π and the cartel's payoff is $-\pi$. One way to think about the magnitude of π is that it represents a share of cartel profits forever. Define $\pi = \Pi/(rn)$, where Π is cartel profits, r is the discount rate, and $1/n$ is the market share allotted to the new entrant. The extensive form game is as shown in Figure 3, where t^* is defined to be the (known) entrant strength at which the cartel is indifferent between forcing exit and admitting the entrant. Define $\underline{X\beta}$ by

$$\text{pr}(\underline{X\beta} + \epsilon > t^*)\cdot\pi - c = 0,$$

and define $\overline{X\beta}$ by

$$[1 - \text{pr}(\overline{X\beta} + \epsilon > t^*)]\ \pi - \text{E}[C(t \mid \overline{X\beta})] = 0.$$

The entrant prefers to enter if

$$\underline{X\beta} \leq X\beta \leq \overline{X\beta} \quad \text{and} \quad \text{pr}(t > t^* \mid X\beta)\cdot\pi - c \geq 0.$$

The cartel wants to fight the entrant when

$$X\beta \leq \overline{X\beta} \quad \text{and} \quad \text{pr}(t < t^* \mid X\beta)\cdot\pi - \text{E}[C(t \mid X\beta)] \geq 0.$$

Should a price war actually occur, the cartel's decision rule is to admit the entrant if its type turns out to be greater than t^*, but to drive it out otherwise. The strategies can be expressed more succinctly in the

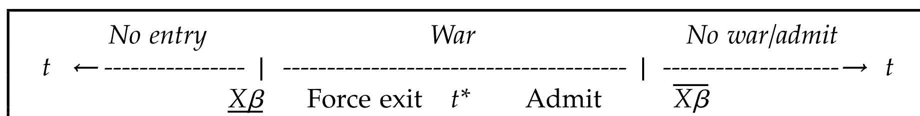


FIGURE 4.

diagram in Figure 4. The interesting region here is the middle one, where the entrant knows it will be preyed upon and yet enters anyway. Assume in this region that $\pi - c - C(t) > 0$; this is equivalent to saying that the profits at stake are large compared to the cost of predation for some part of the distribution of potential entrants. I believe this is a realistic assumption for my data. The assumption is necessary to show that the intermediate region exists.[22]

The intuition for the game is straightforward. An entrant with cash and other resources is more expensive to fight. The cartel would prefer not to share the market with any entrants; it calculates the cost of forcing an entrant to exit and compares that with the gain (recovering profits) from exit. In some cases the common knowledge characteristics of the entrant make this calculation come out strongly one way or the other. In other cases, it is not clear how many resources the entrant has (its type). In this case, it is worth fighting the entrant to learn its type, because the probability of winning times the profit recovered is greater than the expected cost of the war. The value of ϵ and the entrant's true strength are revealed to everyone in the event of a price war due to the strain of the war on the entrant's resources.

I have a set of measurable entrant characteristics, X, that can be used to estimate the entrant's true type. Regressing these characteristics on whether or not a price war occurred will generate two interesting results. First, if any of the characteristics are statistically significant, then we can conclude that using only private information to explain predation omits potentially important information—at least in the case of shipping cartels. Secondly, the coefficients on the variables will provide estimates of which characteristics give the entrant significant strength. From the above equilibrium strategies and an assumption of normally distributed errors, the appropriate equation to estimate is

$$\text{pr}(\text{War} \mid \text{Entry}) = \Phi(X\beta + \epsilon).$$

22. If $\overline{X\beta} \le \underline{X\beta}$, then $\text{pr}(\overline{X\beta} + \epsilon > t^*) \cdot \pi - c \le 0$ and $[1 - \text{pr}(\overline{X\beta} + \epsilon > t^*)] \cdot \pi - E[C(t \mid \overline{X\beta})] = 0$. Adding, we have $\pi - c - C(t) \le 0$, a contradiction.

TABLE III.
Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
War	47	0.298	0.462	0	1
Weighted Route Tons	47	29,069	29,052	1686	146,587
Route Tons	47	27,854	24,284	1449	126,000
Firm Tons	47	78,615	111,181	1449	598,203
Trade Growth	47	3.95	13.86	−13.94	52.68
Outside Opportunities	47	−2.90	12.34	−37.44	13.97
New	47	0.298	0.462	0	1
Subsidy Dummy	47	0.340	0.479	0	1
Contract	47	0.213	0.414	0	1
Publicly Owned	47	0.213	0.414	0	1
Age of Line	47	29.62	32.96	0	135
Length of War (days)	46	79.24	200.09	0	960
Past War Percentage	47	0.207	0.154	0	0.417
Time since Last War	36	4.78	5.13	1	25
Time since Last Entry	43	2.36	2.06	1	8

5. Variables and Estimation

5.1 Variables

I include in the dataset (Table III) when, where, and for how long price wars occurred; these facts were consistently reported in the texts mentioned above. Most of the entry incidents are mentioned in more than one source, so I am quite confident that events occurred as reported. I record a war, rather than entry without war, when the historical sources describe a sharp commercial conflict between the parties including price cuts. Sometimes the texts use the term ''price war'' when describing vigorous price decreases in the history of the firm or market, but not always. Other common descriptions are ''sharp price decrease,'' or ''rates dropped by 40%,'' for example. If entry involves only negotiation and no price cuts, or minor price changes (five or ten percent), then it is not classified as a war. The distinction was made easy because there is a natural break in the data; all reported percentages were either small or more than 30%.

A typical price war might last three months and feature a price drop of 50% to the ports the entrant has chosen to serve. Price decreases greater than 50% are also observed, as well as wars that lasted as little as two days or as long as one year. Four potential observations were dropped due to insufficient information on the tonnage of the entrant or whether or not it was receiving a government subsidy. There were

an additional five or so references to price wars in secondary sources that did not identify either the participants, the time period, or the market, so I was unable to use them as observations. I have no reason to believe that the omitted observations vary in a systematic way from the included observations, but there is no way to know for sure.

Clearly, shipping conferences felt that keeping their monopoly positions was worth periodic price wars. However, they did not fight every entrant that threatened to erode the conference's monopoly position. A price war is an expensive way to protect a monopoly. The first concern of any type of entrant or cartel would be the cost of fighting a price war weighed against the benefits. It is impossible to determine the expected cost of a war without detailed information on marginal cost for each ship in each line, composition of cargoes, exact structure of rate cuts, etc.[23] However, it is possible to find some proxies for the cost of a price war. Below I describe each explanatory variable and its possible effect on the cost of a war as well as the predation theory it supports.

The ideal information for testing the long-purse hypothesis would be data on the financial backing of an entrant: personal resources of the main owner and his[24] family, resources of other equity holders, relationship with bank, and outstanding loans. Much of this information is unobservable to me, so I must use related variables.[25] *Firm Tons* is the total number of ten thousands of gross tons of shipping that the entrant owns; all of them may not be on the route in question. The tonnage data come from the annual publication *Lloyd's Register of Shipping*. During this time period, Lloyd's reported the tonnage, type, and owner of every ship in the world, allowing a researcher to construct a very accurate tonnage series for each shipping line for each year. The data sources make clear that the size of the entrant firm is correlated with financial and other resources. The very biggest lines had large

23. If the entrant were serving a selected port or carrying a particular commodity, the price cuts could be specifically targeted and the cost to the conference members much reduced. The war against DADG's entry to a single South African port in 1894 is a perfect example; the conference lowered rates on fertilizer and machinery to that port. Often I can't find this information for an observation, and other times a general price cut was required.

24. All shipowners during this period were men.

25. However, I do know whether the company was publicly traded on the London Stock Exchange or not and can use that as an explanatory variable. *Stock Exchange Intelligence* lists publicly traded shipping companies' financial structure in its yearly report. The long-purse hypothesis is less likely to be a motivation when the entrant's financial situation is publicly known: a public firm can conceal less information than a privately owned firm. However, most of my entrants were not publicly traded, and I found the dummy variable *Publicly Owned* empirically ineffective, so it is not discussed further.

cash reserves and networks of ships all over the world.[26] The larger the firm, the more likely that the price war was occurring on only some of its routes and the more cash the firm would have had. Also, the more routes an entrant firm covered, the greater the likelihood of multimarket contact with a firm in the cartel. Cooperation in the overlapping markets might be jeopardized by a price war, so a price war became less likely. For example, in four cases of entry in the dataset, despite there being no price war, the entrant exited. In these cases, the lines reached agreements where each party would exit from the other party's ''territory'' to resolve the conflict created by the entry. The long-purse theory says that a price war is less likely to be initiated by the incumbent as the entrant's financial resources increase, because it becomes more difficult to drive the entrant into bankruptcy. Thus we expect *Firm Tons* to negatively affect the probability of a price war. Additionally, a war will be more costly to cartel members as a result of their (likely) multimarket contact, which will discourage predation.

I also know the number of gross tons the entrant places on the route (*Route Tons*).[27] The amount of tonnage the entrant places on the route determines the maximum volume of trade the cartel loses. As the size of the successful entrant rises, either *ex post* Cournot prices (including the new entrant's capacity) will fall or else current members' share of perfect-monopoly profits will fall. As the entrant's market share increases, the cartel's opportunity cost of starting a price war declines; the cartel is more likely to start a price war if *Route Tons* is higher. Additionally, as the entrant's tonnage on the route (*Route Tons*) increases, it is likely to provoke price wars for renegotiation reasons; the cartel would like to renegotiate (down) the entrant's route tonnage even if it does not expect to drive it to zero. Thus Table IV shows a positive expected sign of *Route Tons* on the probability of a price war according to the renegotiation/signaling hypothesis.

The dummy variable *New* is assigned a one if the firm had existed for less than five years at the time of entry. A young firm was unlikely to have the cash and insurance reserves common to established shipping firms at the time.[28] To found a firm, an entrepreneur raised funds

26. Large firms tended to self-insure; they had large pools of cash sitting in banks or invested in government securities, so they could easily replace any ship that sank or was damaged.

27. I realize that net tons would be a better measure of capacity than gross tons (net tons measures only cargo space, whereas gross tons includes the space taken up by the engine and fuel). However, gross tonnage data were available for all observations, while net tonnage data were available for only about half the observations.

28. This statement likely holds more weakly for the *owners* of the firm, as opposed to the firm itself.

TABLE IV.
EXPECTED SIGNS OF VARIABLES UNDER DIFFERENT THEORIES OF THE CAUSES OF PRICE WARS[a]

Variable	Theory:	Long Purse	Renegotiation or Signaling	Reputation
Route Tons			+	?
Firm Tons		−		
New		+	+	
Government Subsidy		+/−	+	
Contract		−	−	
Trade Growth			−	
Outside Opportunities				−
Time since Last War		+		+

[a] A blank cell indicates the variable should not have an effect under that theory.

for purchasing ships and beginning operations; typically there were not significant cash reserves early on. After a firm had been in existence for a while, it would have built up cash reserves to help it through cyclical downturns (during which it might need to purchase ships, for example); the firm might also be self-insuring, in which case it would have additional cash reserves. Since most shipping firms were privately held, the data do not reveal what the cash positions of each firm in the sample were at each entry date. I assume that the conference was more likely to think it could drive the entrant into bankruptcy or exit if the entrant was a *New* firm. If so, then the long-purse model of predation suggests that *New* firms will be exposed to a greater likelihood of predatory pricing.

One might think that a *New* firm had inferior information about demand on the route and might have entered with an overly aggressive level of tonnage or target customers. If so, *New* will also predict a greater probability of a price war due to signaling and renegotiation on the part of the cartel. However, most *New* entrants in the dataset were run by managers with a great deal of experience in the shipping business. Typically, a manager with ten years of management experience at a shipping firm borrowed money from his relatives and started out on his own. These managers had a lot of experience with the trade and good information about the market. For example, I find the difference in the growth of trade in years when new entrants entered compared to years when older entrants entered is not significant. The value of *Firm Tons* differs significantly between *New* and older entrants (100

compared to 28 thousand tons, *t*-test 2.09), as one might expect; however, the value of *Route Tons* does not differ significantly between the two groups. Unfortunately, both long-purse and renegotiation hypotheses predict a positive coefficient for *New*, so we will not be able to distinguish the two in the empirical results.

Contracts secured by an entrant before entry will make a long-purse price war less effective in reducing an entrant's financial resources, and therefore longer, less likely to succeed, and less likely to be undertaken. *Contract* is a dummy variable taking a one if the entrant has a long-term contract for cargo on the route. The long-purse theory says that entrants with contracts should not be preyed upon. Additionally, renegotiation is not an option, since a contract provides the entrant excellent information about its own demand. *Contract* will reduce price wars according to the long-purse theory [as in Snyder (1996)] and discourage renegotiation price wars also.

Trying to make a government-subsidized line (*Government Subsidy*) run out of funds and exit does not make much sense, since such a firm has a softer budget constraint. Therefore, the long-purse model says such an entrant should be less likely to attract predation. However, a war against a subsidized line could be effective in creating political difficulties for the line in its home country and, through that channel, produce a reduction in its services on the route. Both German and Japanese subsidized lines experienced problems gathering and keeping political support for their subsidies, especially when they made losses and had to ask for more money. Price wars might be undertaken to renegotiate (down) the market share of government-subsidized lines. Government-owned firms are not run by owners, in contrast to most of the firms in the sample, but by professional managers.[29] The Bolton-Scharfstein long-purse hypothesis predicts that a price war will be more effective when managers are cash-constrained. The coefficient on the dummy variable *Government Subsidy* will indicate whether a subsidized firm is more or less likely to be preyed upon for Bolton-Scharfstein long-purse reasons and will reflect any increased likelihood of renegotiation price wars also.

Trade Growth is a two-year moving average of the percentage change in the value of trade on the route. The value of *Trade Growth*

29. Nonmonetary as well as monetary penalties existed for managers of publicly subsidized firms that earned persistent operating deficits: the line could be closed down, or the management altered. NYK had an unstable political constituency in the Japanese Diet in the 1880s; its subsidies were approved with difficulty, and the debate affected its status in the conference. NDL lost 5.25 million marks on mail steamer lines to East Asia and Australia despite a subsidy of 44 million marks (Scholl, 1985, p. 200).

fluctuates widely from year to year because of extremely procyclical trade flows during the late 1800s. If trade on a route was increasing, the conference may have been less likely to fight a price war; a price war would have meant more forgone profits than a war during a recession. Cost considerations make the likely sign on *Trade Growth* negative. Additionally, a trade boom (*Trade Growth*) reduces the need to bargain down the entrant's quantity in absolute terms. Although the cartel should have valued additional boom trade as much as current trade, the difficulty of coordination within the conferences caused heavy reliance on the status quo. It was much easier for a conference to allocate six sailings a year to an entrant if the original members could keep their current schedules. Arguing over which lines would make room for an entrant in a case where the market was not expanding was a time-consuming, tension-filled, and costly process. Hence, increasing trade on a route made negotiating entry easier. The renegotiation theory says there is less chance of a price war if growth is strong.

The reputation theory has played a small part so far in the discussion. Reputation models are not based on entrant characteristics as much as on the cartel's concern for maintaining entrants' belief that it is tough, in order to discourage entry. The reputation theory enters the empirical analysis through variables that reflect the state of the cartel and equilibrium entry patterns. For example, the entrant's opportunity cost, which here is relative trade growth on other routes, will affect incentives to enter and exit, which in turn will affect the incidence of price wars. *Outside Opportunities* is defined to be a two-year moving average of the growth rate of all British trade excluding the entrant's route, less the growth rate of the entrant's route.[30] A change in alternative trade conditions affects the entry choices of potential entrants.[31] In particular, if outside opportunities get worse, weaker entrants will find it worthwhile to attempt entry into the cartel. In that case, a higher equilibrium level of predation on the part of the cartel may be optimal. Under the reputation hypothesis a decline in *Outside Opportunities* could increase the probability of a price war.

The reputation hypothesis also affects the specification choice for firm tonnage and route tonnage in the regressions. Forcing out a very small entrant may not enhance a cartel's reputation for toughness. If

30. I use British Government trade statistics from the appropriate years to calculate all the trade variables.

31. This variable is used for foreign entrants because they are sharing traffic on the trade route with the British incumbents, although they might not overlap 100% with business already handled by the incumbents. Also, industrial products originating in Germany (shipped by German lines) are direct substitutes for British products.

the cartel will not fight once the entrant is above a certain size, increasing size will have little effect on the probability of war. The dummy variables for the first two quartiles of firm size are included to pick up any nonlinear effects if they exist. Similar effects may occur with tonnage placed on the route. The cartel may respond differently to market-share increases from different starting points. *Route Tons* is therefore divided up into quartiles to allow the cartel flexibility in response to different market shares by the entrant.

Time since Last War is a dynamic variable measuring the number of years since the last war occurred in the cartel. (This variable is not defined for the first case of entry in each cartel.) If there has not been a war in the conference for many years, the members will have more cash reserves than if they have been fighting price wars recently, all else equal.[32] The long-purse theory predicts a positive effect on the likelihood of a price war. The variable *Time since Last War* also helps explore reputation-motivated wars. If the cartel is signaling that it is a tough type with each price war and its reputation erodes, there will be less need for a reputation-building war if one has just occurred. Therefore, the probability of war conditional on entry will increase as the last war recedes in time. In contrast, if the cartel's reputation does not erode and is well known before the sample period starts, this dynamic effect will not show up in the results. However, as mentioned above, *Time since Last War* has cash-flow implications that work in the same direction.

Throughout the study I consider the continental ports of Hamburg and Antwerp to be good substitutes for London, Liverpool, Glasgow, and Middlesbrough. A map of the area (Fig. 2) shows how geographically close these ports are to each other, particularly in comparison with the long trade routes considered here. Additionally, Germany produced many of the same manufactured goods in demand in the Far East and South Africa, so transshipment of cargo was not necessarily required. German lines did enter all three cartels during the period and provided robust competition for the British lines.[33]

The information I have regarding entrants is sufficiently crude that one variable can feature in several hypotheses. Table IV summa-

32. Since trade is very cyclical, lines build up their cash reserves to outlast downturns and disburse more money to shareholders when reserves are high enough (in the opinion of management). These cash reserves can be used to help a firm survive a price war also.

33. There is a large literature on the growth of German shipping, its competition with British shipping, and its success, and on whether or not direct subsidies to German shipping lines during the period gave them an advantage over British firms. For example, see Aldcroft (1974).

rizes the expected effect on the probability of war for each of these variables under each type of model. In cases where a variable has implications under two models, the expected sign of the variable happens to be the same. This means I will not be able to distinguish between long-purse and reputation theories, for example, if *Time since Last War* has a positive coefficient.

5.2 Estimation

I begin the empirical analysis with simple tabulations showing the instances of predation by result and age of firm. The basic conclusion of the empirical work is clear from these contingency tables. Table V reports the outcomes of the price wars and focuses on differences between the *New* and non-*New* groups. Of the war events, close to half resulted in exit by the recently-arrived entrant. It is clear from the raw event counts in Table V(B) that *New* entrants face a much greater likelihood of both predation and exit. The fact that the predation is often successful supports the hypothesis that cartels are more likely to prey on *New* entrants.

The main empirical specification I estimate is

$$\Pr(\text{War} \mid \text{Entry}) = \Phi(X\beta),$$

where the dependent variable is zero in case of an uncontested entry, one in case of a price war. The X's are the characteristics of the entrant and the market, which have been discussed previously.

The estimation of the probability of a price war is conditional on entry. An immediate reaction might be that there is a selection problem, and I should estimate an equation that explains if the line enters in the

TABLE V.
Outcomes of the Price Wars

(A) Experience of All Entrants

	Accepted	Unclear Result	Driven Out
War	8	0	6
No War	28	1	4

(B) Experience of New vs. Not New Entrants

	No War	War	Accepted
New	5	8	4 (1 unclear result)
Not New	27	6	32

first place and then estimate an equation that determines the probability of war. However, the simplicity of the model removes this concern. The model assumes that an entrant can be characterized by one variable, strength. If the entrant is strong enough, it enters, and if it is strong enough again, it is not fought. So entry is already explicitly conditioned on strength in the model. For example, since strength is the only characteristic of interest, there does not exist an identifying variable (to use in a Heckman correction procedure) that affects entry and not the probability of war. The strength of an entrant determines both whether it will enter, and how successful it will be upon entry. An analysis of the entry decision would be a very interesting study, but very difficult to undertake in this context, since one cannot observe the set of potential entrants that do not enter.

5.3 Results

Results from the probit estimation are contained in Table VI. The first specification in column (1) of Table VI(A) shows that firm and market characteristics are crucial in estimating the probability of war. *New* has a large positive coefficient; young firms are more likely to be fought by a cartel. This result provides support for the long-purse, and perhaps renegotiation, motivations for price wars.

Firm Tons has a negative coefficient that is significant at the 10% level (one-tail test). It is of the expected sign; larger firms are stronger entrants and provoke wars less often. The effect is not constant across all firm sizes; the coefficient on very small firms is insignificant, but wars are less likely for firms in the second quartile. Combining the quartile dummies and the coefficient on *Firm Tons* shows that the smallest firms face a higher probability of predation, while the entry of big lines is less often met with an aggressive response. The long-purse theory is supported by the *Firm Tons* finding as well as the notion that the cartel finds it less attractive to undertake a war with possible multimarket repercussions, all else equal.[34]

34. On the surface this finding is inconsistent with Burns's (1986) result that American Tobacco preyed upon larger rivals, not smaller. However, there are several significant differences in the industries. First, capacity is fungible in shipping, so merging is not necessary to reduce competition. American Tobacco was much larger and stronger than all its rivals—unlike these shipping conferences—and we therefore never observe its response to a relatively strong rival. Burns claims American Tobacco picked fights with larger rivals because there was a larger merger premium available for reduction. The analogous statement for shipping conferences is that wars should have occurred against entrants that expanded capacity a lot; that could be the case here also if one believed the positive (but insignificant) coefficient on *Route Tons*.

TABLE VI.
Determinants of a Price War Conditional upon Entry

(A) Probit Specification[a]

Variable	(1)	(2)	(3)
New	1.57**	1.07	2.09**
	(0.762)	(0.883)	(1.23)
Outside Opportunities	−0.88**	−0.080*	−0.128**
	(0.049)	(0.053)	(0.065)
Trade Growth	−0.091**	−0.093**	−0.110**
	(0.044)	(0.044)	(0.056)
Firm Tons	−0.180*	−0.210	−0.226**
	(0.117)	(0.153)	(0.133)
Firm Tons 1q—dummy	−1.18	−1.30	−1.51
	(1.20)	(1.36)	(1.52)
Firm Tons 2q—dummy	−2.74**	−3.31**	−3.52**
	(1.19)	(1.41)	(1.63)
Route Tons if lowest quartile	0.987	0.698	0.868
	(1.11)	(1.19)	(1.51)
Route Tons if second quartile	0.778	0.909*	0.321
	(0.608)	(0.634)	(0.807)
Route Tons if third quartile	0.480	0.395	0.305
	(0.445)	(0.453)	(0.528)
Route Tons if highest quartile	0.089	0.072	−0.017
	(0.133)	(0.148)	(0.163)
Time	0.047*	0.068**	0.006
	(0.032)	(0.039)	(0.056)
Contract		0.925	
	—	(0.843)	—
Subsidy		−0.514	
	—	(0.734)	—
Time since Last War			0.038
	—	—	(0.092)
Constant	−0.711	−0.551	1.03
	(1.53)	(1.72)	(2.04)
$\Phi(X\beta)$	0.230	0.197	0.190
Observations	47	47	36
Log likelihood	−16.42	−15.52	−11.63

(B) Predicted vs. Actual Outcomes[b]

	War	No War
Correct Prediction	10	31
Incorrect Prediction	4	2

[a] Standard errors in parentheses; *, significant at 10% level (one-tail test); **, significant at 5% level (one-tail test).
[b] Correlation: war and estimated probability, 0.701.

A larger number of *Route Tons* creates opportunities for renegotiation and therefore, perhaps, for a price war.[35] That story is neither supported nor disproved by the pattern in the *Route Tons* coefficients here. Each quartile of *Route Tons* was given its own coefficient so that the effect of entrant size could differ across sizes. Although the coefficients on *Route Tons* are nearly always positive—for all four quartiles and across specifications—they are never significant. The renegotiation hypothesis is not supported by the data in this case. This result does not change across different specifications of *Route Tons.*

The extent of *Trade Growth* on the route negatively affects the probability of a price war. If trade is growing quickly, more profits are forgone in the event of war and the cartel is less likely to initiate one. The cartel may be avoiding costly wars and also finding it less necessary to renegotiate entrant shares.[36] *Outside Opportunities* negatively affect the probability of a price war. Booming trade on other routes reduces the incentive to enter and therefore the need for price wars to discourage entry. This result is the only piece of evidence supporting price wars for reputation reasons. *Time* is significant if included; there is a small, positive trend in the probability of a price war over time. I expected the conference dummies to be significant; this could reflect different reputations or equilibrium levels of predation. However, the conference dummies are insignificant if included, and the results for the other variables are unchanged; conference dummies are therefore omitted. The normal pdf evaluated at the estimated index is reported at the bottom of each column to allow calculation of marginal effects. The effect of *New*, for example, is quite large; the probability of incurring a price war upon entry is about 36% higher for a young firm than for an older one.

35. See Gelman and Salop (1983) for a model where small entrant capacity reduces the likelihood of retaliation.

36. It is interesting to note that *Real Outside Opportunities* and *Real Trade Growth* are insignificant if they are included in the regression rather than the nominal values. The two series are quite different because a relatively small change in the general price level creates a large wedge between nominal and real rates of change. Only the nominal values have predictive power. Inflation and deflation were known phenomena by this period, but it seems unlikely that shipowners would deflate trade flows when thinking about how well a route was doing compared to last year. For example, Temin (1987) reports that managers at AT&T analyzed nominal profits up until the 1970s. Alternatively, when managers deflated they may have used a price index specific to goods traded on that route and items that were part of costs; a specific price index of this nature might not have been very well correlated with the overall consumer price index, which is what I have. Trade routes were often dominated by a few products, e.g. tea or manufactured cotton products, for which I do not have price indices. In that case, the deflated trade measures are not reflecting anything economically significant, and we should expect the variables to be unimportant in the regression.

In column (2) I include two more variables that represent the strength of an entrant. Having a contract to carry cargo on the route (*Contract*) does not affect the probability of a price war; it was predicted to decrease the likelihood of a price war because the war would not affect entrant finances. Likewise, having a *Government Subsidy* does not affect the probability of a price war. However, the two opposing long-purse effects of *Government Subsidy* (additional pressure on managers and the soft budget constraint) may be canceling each other out. Of course, both *Contract* and *Government Subsidy* may just be too crude to pick up an effect; I do not have a great deal of historical information about these firms, such as contract details and incentives or rules attached to subsidies.

Column (3) adds a dynamic variable to the specification: *Time since Last War*. The information about a cartel's behavior in the past should tell us about the state of the cartel's cash reserves and reputation, both key for predicting the current probability of war. There is no evidence here that elapsed time since the last war in the cartel increases the probability of the current entry triggering a war. This result gives no support to any dynamic story of learning or erosion of cartel reputation.

If the model previously discussed is correct, firms with lower types should not only be preyed upon, but on average they should exit more often. My estimation of the index for each observation is also the estimation of the firm's signal. I divide the "war" observations into those that resulted in exit and those that did not; the first group has six observations, and the second, eight. If the model is correct, we would see a higher index for the exit group than the accepted group. The two means from specification (1) are 0.622 and 0.349 respectively. However, because the sample sizes are so small, the two means are insignificantly different (*t*-statistic 0.46). If the sample were larger, we would expect the exit group to have a significantly higher mean estimated index value.

Despite the small number of observations, many of the coefficients from Table VI(A) are significant at the 10% level. The results are not sensitive to the choice of error distribution; estimating the same three specifications using a logit or linear probability regression produces virtually identical results in terms of coefficient signs, significance levels and marginal effects. Table VI(B) shows that the empirical estimation [based on column (1) of Table VI(A)] does quite a good job of predicting the outcome of entry. Ten out of fourteen wars are correctly predicted. The explanatory variables—characteristics of entrants and the market—are empirically important in determining whether or not a cartel will begin a price war. Additionally, the effect of entrant age

provides some evidence for a predatory explanation of price wars, rather than a demand- or cost-shock approach.

5.4 Correction for Misclassification of a Price War

It is possible that my sources may mistake a negative demand shock for a predatory price war. The reason this is of some concern is that if the dependent variable in a probit regression is misclassified, the resulting coefficients are biased (Hausman and Scott Morton, 1994).[37] Misclassification could occur in the other direction also: an entry that resulted in a price war, but was never described as such in my sources. If a price war is misclassified, then the estimates presented in Table VI will be inconsistent. Hausman and Scott Morton (1994) discuss two methods for correcting such bias. One is simply to use a likelihood function that explicitly includes the possibility of misclassification, which we call α.[38] Maximizing such a likelihood function results in an estimate of the percentage of observations that are misclassified as well as estimates of the β's.

However, this method relies on knowledge of the error distribution. The ability to identify the misclassification percentage comes from the shape of the tails of the distribution. For example, as the latent variable becomes very negative, the observed outcome still has an α% chance of being a one due to misclassification. Therefore, the results I report involve a semiparametric method that does not depend on any error distribution. The semiparametric method has two parts. First, Han's (1987) maximum rank correlation (MRC) procedure estimates the coefficients of the explanatory variables.[39] Secondly, I estimate the extent of misclassification with an isotonic regression (IR).[40] These techniques provide a basic check for misclassification problems. However, because these methods estimate more parameters and/or do not im-

37. Porter (1983) uses econometric techniques to identify railroad price wars and discovers a high correlation between his results and accounts of price wars cited by newspapers. His evidence suggests historical reports of price wars are quite accurate.

38. The idea behind this equation is that the probability of observing a one will be the probability that the latent variable is greater than zero times the probability that the outcome is not misclassified, plus the probability that the latent variable is less than zero but the outcome is misclassified. Writing down that expression and simplifying yields the likelihood function $\text{pr}(y = 1) = \text{pr}(\text{War} \mid \text{Entry}) = \alpha + (1 - 2\alpha)\cdot\Phi(X\beta)$.

39. The observations are ordered by the index $X\beta$, and then a sum is constructed by giving an indicator variable a one in cases where the dependent variables are also in the correct order.

40. Isotonic regression nonparametrically estimates a cdf using ranked index values. The final estimate is in the form of a step function; the lowest and highest "steps" are the tails and provide consistent estimates of the misclassification percentages.

pose a functional form, the results are not nearly so precise as those a simple probit would generate from a small sample. I go through the exercise of estimating the additional specifications to establish that the point estimates for the amount of misclassification in the data are zero. The point estimates for the coefficients will be insignificantly different from zero due to large standard errors.

Column 1 of Table VII lists the earlier probit results, now scaled to make them comparable to the other column. Column 2 gives the MRC/IR coefficients, which are robust to both misclassification and nonnormal error distribution. (This method estimates the ratio of the coefficients rather than their absolute size.[41])

The semiparametric coefficients lie for the most part near the original probit estimates, although the coefficients on *Firm Tons* and the trade variables increase in magnitude. Unfortunately, as described more fully in the footnote to the table, there is no generally accepted procedure for calculating the standard errors in this regression, so no conclusions can be drawn from the coefficient point estimates. However, the whole reason to use the IR method is to get an estimate of the amount of misclassification in the data. The IR/MRC method estimates the first step at height zero and the last at height one; the estimates of both α_0 and α_1 are zero. The important conclusion to take away from these estimates is that as far as we can tell, neither category of dependent variable appears to suffer from misclassification.

5.5 Estimating Entrants' Tonnage

The analysis thus far has focused on the entry decision as a zero-one choice. However, an entrant also had the choice of how much tonnage to place on a route when it entered. This choice should also have depended on firm and market characteristics. The previous section estimated the effects of entrant characteristics on the probability of predation; now it is possible to examine how the explanatory variables are related to one another, and determine if these relationships are consistent with theories of predation. The analysis will focus more specifically on whether shipping firms' actions can be explained by the renegotiation and reputation theories of price wars. The results show that entrant tonnage choices are consistent with the predation results already obtained: the renegotiation theory is supported, while no evidence can be found for the reputation theory. I look at a reduced-form model of

41. The MRC procedure estimates a normalized coefficient vector, which must be rescaled by holding one variable fixed. *Route Tons if first quartile* is held fixed in Table V.

TABLE VII.
COMPARISON OF PROBIT, MLE, AND SEMIPARAMETRIC ESTIMATES OF THE DETERMINANTS OF PRICE WARS

Variable	Probit	MRC/IR
α_0, probability that a true "no war" is misclassified	—	0
		(undefined)
α_1, probability that a true "war" is misclassified	—	0
		(undefined)
New	.680	0.404
	(.330)	(.671)
Outside Opportunities	−.038	−.020
	(.021)	(.849)
Trade Growth	−.039	−.041
	(.019)	(.058)
Firm Tons	−.078	−.078
	(.051)	(.042)
Firm Tons 1q—dummy	−.511	−.277
	(.520)	(.073)
Firm Tons 2q—dummy	−1.19	−.821
	(.515)	(.910)
Route Tons if lowest quartile	.427	−.158
	(.481)	(.632)
Route Tons if second quartile	.337	.181
	(.263)	(undefined)
Route Tons if third quartile	.208	.056
	(.193)	(.956)
Route Tons if highest quartile	.039	.118
	(.058)	(.391)
Time	.020	.036
	(.014)	(.191)
Observations	47	47

1. Column 1 contains the results from Table VI, column (1), rescaled by 0.433.
2. Because the estimates of α_0 and α_1 are zero, their standard errors cannot be calculated using the MRC/IR method; an adjacent step is necessary for standard error estimation.
3. One variable must be held fixed to calculate the standard errors for the Han coefficients. In Table VII it is *Route Tons if second quartile*.
4. The Probit results must be scaled in order to be able to compare them with MRC. The MRC IR method only estimates the ratios of the coefficients, not their absolute magnitude. I chose a scaling factor that creates equal *Firm Tons* coefficients across the two methods. That scaling factor was then used on the other probit coefficients.
5. The size of the window width used to construct the kernel for computation of the standard errors of the MRC estimates strongly affects the resulting standard errors. As the window width rises, so do the standard errors. The corresponding standard errors in Hausman and Scott Morton (1994) are not sensitive to the window width; the dataset in that paper has 5200 observations. I report results using a window width of 0.3, which gives reasonable standard errors; however, there is no general theory that gives an optimal window width for this method.

tonnage choice conditional on entry, thereby restricting the dependent variable to the strictly positive range. Potential entrants that placed zero tons on the route, i.e. did not enter, are not included. The equation I estimate is

$$\mathrm{E}(\textit{Route Tons} \mid \mathrm{Entry}) = X\gamma + \epsilon,$$

where the *X*'s are the characteristics of the entrants and the market discussed above with two additional variables. *Past War Percentage* is defined to be the cartel-specific percentage of entries that have resulted in wars up to the current entry. If a cartel's equilibrium strategy is to prey on a certain proportion of entrants to maintain a reputation and keep others out, then *Past War Percentage* will be positively correlated with the probability of the current entrant attracting a war. A higher *Past War Percentage* may also encourage entrants to place more tonnage on the route, since they are more likely to be bargained down in a price war. The second new variable, *Time since Last Entry*, is the number of years between the current entry incident and the most recent case of entry into the same cartel.

The results of an OLS regression explaining an entrant's route-tonnage choice conditional on entry are reported in Table VIII. Relatively poor trade elsewhere (*Outside Opportunities*) causes an entrant to place more tons on the route. *New* has a large negative coefficient; young lines on average enter with a smaller amount of tonnage. Having a *Contract* causes a line to place more tonnage on the route, all else equal. *Contract* was not significant in the probit specification, but here displays a significant and positive effect on an entrant's tonnage. *Government Subsidy* is only marginally significant; firms receiving a subsidy may enter with more tonnage than otherwise.

The coefficient on *Firm Tons* supports rational behavior on the part of shipowners. The total amount of tonnage the firm owns (*Firm Tons*) has a very weak influence on how much tonnage it will place on the new route. Only if the upper bound is binding do we expect an effect. The coefficient on *New* perhaps represents the effect of imperfect capital markets. The coefficients of the conference dummies are determined by sailing conditions and magnitude of trade flows on the route and are not economically significant.

In column (2) I include *Time since Last War* to see if it affects entrant tonnage. The coefficient is insignificant. If a cartel's reputation is well known, then the amount of time since the last war should not affect the entrant's choice of *Route Tons*. This result is therefore not inconsistent with reputation theories, but is not evidence for them either. I also try including *Time since Last Entry* rather than the time since the last war, in case information is conveyed without a war taking place, but

TABLE VIII.
DETERMINANTS OF ENTRY TONNAGE: OLS REGRESSION[a]

Variable	(1)	(2)	(3)	(4)
New	−1.70	−1.71	−1.78	−1.71
	(0.807)	(1.04)	(0.839)	(0.802)
	0.042	0.112	0.041	0.039
Outside Opportunities	−0.055	−0.063	−0.056	−0.060
	(0.027)	(0.033)	(0.030)	(0.028)
	0.053	0.068	0.068	0.036
Contract	1.89	1.79	1.69	1.86
	(0.858)	(1.07)	(0.903)	(0.853)
	0.034	0.106	0.070	0.036
Subsidy dummy	1.00	0.472	0.821	1.06
	(0.754)	(0.939)	(0.798)	(0.751)
	0.191	0.619	0.311	0.167
Firm Tons	0.029	0.027	0.029	0.032
	(0.032)	(0.037)	(0.033)	(0.032)
	0.371	0.473	0.399	0.331
Time	0.039	0.011	0.055	0.016
	(0.033)	(0.059)	(0.040)	(0.038)
	0.238	0.849	0.185	0.675
India Conference dummy	−0.716	−1.56	−0.968	−0.566
	(0.814)	(1.13)	(0.906)	(0.818)
	0.384	0.180	0.293	0.493
Far East Conference dummy	−1.43	−1.92	−1.64	−0.762
	(0.770)	(1.01)	(0.810)	(0.940)
	0.072	0.070	0.052	0.423
Time since Last War	—	−0.008	—	—
		(0.109)		
		0.939		
Time since Last Entry	—	—	−0.205	—
			(0.180)	
			0.264	
Past War Percentage	—	—	—	3.55
				(2.92)
				0.231
No. of Obs.	47	36	43	47
Adjusted R^2	.317	.260	.327	.326

[a] Standard errors are in parentheses. *p*-Values are in the third row.

its coefficient is not significant in column (3). However, the proportion of entrants fought in the past is important. Column (4) shows that *Past War Percentage* has a large positive coefficient but is only marginally significant. Given that an entrant has decided to enter the route, it may want to enter with more tons if there is a history of price wars on the route. However, the coefficient drops in half if early entrants (*Past War Percentage* = 0) are excluded from the regression. The result is being driven by early entrants who entered with fewer tons (perhaps because there was no history of organized opposition on the route or because technological change in ship sizes is not captured with the *Time* variable). Overall, the tonnage results support renegotiation motivations for price wars but do not support reputation theories, although it is difficult to draw conclusions from the dynamic variables because of the small sample and the complex setting.

6. Conclusions

The evidence on price wars in the early liner shipping industry suggests they were predatory in nature. I cannot compare costs with prices and establish whether a legal standard was violated, but I can use information about entrants to determine if the pattern of reported price wars is consistent with predation. The evidence in this paper—although it is from a small sample of only 47 observations—suggests that these price wars were not caused by competition (demand or cost shocks). Whether an entrant is a *New* firm or not should be irrelevant to the opportunity cost of entering or exiting the route and the size of any supply or demand shock, and yet it helps predict the probability of a price war. The nature of shipping services, the structure of the cartels, and the contracts the cartels entered into created an environment favorable to successful predation. The intent expressed in the correspondence between members of the cartels as well as other anticompetitive behavior exhibited by the cartels provides important supporting evidence for the predation story.

The results of my analysis show that the incidence of such shipping price wars depended in part on the characteristics of the entrant and the market. Opportunities for outside trade, growth of trade on the route, the age of the entrant, and the size of the entrant's firm all contributed to the cartel's decision to prey. The results provide support for the general type of theoretical work that argues predation will be a more profitable strategy against weaker entrants. The characteristics that I find make an entrant weak are lack of age, or lack of the experience and financial resources correlated with age, as well as weak market conditions. Larger absolute size of the firm, regardless of its entry size,

also makes the entrant stronger. This result is most consistent with the long-purse theory of predation. I do not find that government subsidies or contracts significantly affect the probability of predation. I also find little evidence to support any kind of reputation motivation for price wars. For example, the amount of time since the last war occurred is not relevant to the probability of predation, which it might be if the cartel were trying to maintain a reputation for being tough. The importance of some entrant-specific characteristics in determining the incidence of war lends support to theoretical models with the same feature. The significance of the size and age variables in predicting predation suggests that the long-purse theory of predation, rather than signaling or reputation, was the dominant motive on the part of the shipping cartels.

Appendix

A.1 Quotations

Below are quotations from shipping managers' letters at the time of the entry of the Strick Line into the Bombay Trade. The correspondence reported here was saved by the Ellerman Line, a member of the conference, and is now archived in the Business Records Library of Glasgow University.

A.1.1 Minutes of Meeting of the Bombay Steam Trade Conference, May 6, 1903

> Mr. Gill having returned from London reported that before proceeding further with the points already under review, there was a new and serious feature to take into account, namely the reported amalgamation between Messrs. Strick, Messrs. Bucknall and the West Hartlepool S.S.Co. in the Persian Gulf trade, who were stated to be endeavouring to get shippers in Manchester to sign contracts. Mr. Gill explained that he had discussed the whole matter very fully with the B.I.Co. [British India], and they were willing, in order to assist in defeating this opposition, to carry the goods on from Bombay to Persian Gulf Ports at cut rates, say one-third of whatever rate the West Coast Lines accepted through from Manchester, with a minimum of five shillings, ...

A.1.2 Minutes of Meeting of the Bombay Steam Trade Conference, July 3, 1903

> 3) *Persian Gulf Trade:* Again discussed, and until Strick's next boat from Manchester was out of the way, it was agreed

that the Conference Steamers should quote very low rates, down to 17/6 [17 shillings and 6 pence] if necessary, with the idea of specially punishing Strick by making him take unremunerative rates. After the departure of Strick's boat the matter to be reconsidered, ...

A.1.3 Letter

31st August, 1903
Dear Mr. Ellerman, [Ellerman Lines]

I have today been shewn the Letters between Sir George Mackenzie and Mr. Lloyd of the 14th and 17th July, by which it appears the proposal is to admit the Strick Line to the Bombay Trade from Newport by a monthly sailing, in consideration of the Line withdrawing from the Persian Gulf Trade and not taking cargo via Bombay to the Indian Coast, i.e., if you give up the Persian Gulf Trade we would negotiate for your admittance to the Bombay Trade from Newport.

It is further proposed that the Strick Line should stop competition from Bombay and Karachi cargo from Manchester and Liverpool, whilst the Bombay Lines are to discontinue carrying cargo to the Persian Gulf Ports via Bombay, and although this may be a good arrangement for the Strick and Persian Gulf Lines I fail to see how it can be of advantage to the Bombay/Liverpool Lines, and the reason for their advocating it.

You have always urged the necessity for the Bombay Lines loading from Newport, and I have agreed with you that it is to our interest to do so. There is no room for the Strick Lines and I am opposed to any negotiations for an arrangement with him. We must repel his attack, and if continued we should retaliate on the Persian Gulf Trade.

Yours faithfully,
C.W. Cayzer [Clan Line]

A.2 Conference Histories

A.2.1 South Africa: The South African conference served the ports of the Cape Colony and Natal from both the East and West coasts of Britain (see Fig. 3). The two founding lines were the Union Line and Castle Line. In the 1870s the South African Government gave each a half share in the mail contract to spur technological competition; the

Union and Castle lines split the contract until 1900, when they merged. Meanwhile steamships were becoming more efficient and profitable, and a spate of entry began. The Union and Castle lines felt sufficiently threatened to organize a formal conference in 1882 with two other firms. The conference established freight rates to be charged by all members and tightly regulated the number of sailings and ports of call allotted to each member line. The two mail lines worked closely in the conference, essentially deciding the rules for the other member lines; they kept the lion's share of sailing for themselves and negotiated favorable rate differentials for their faster (mail) ships. Additionally, South Africa did not export very much during the period—gold and diamonds were the major commodity exports—yet the colony demanded every sort of British manufactured good from railway ties to jam. Needless to say, the shipping lines did not have much volume in the way of ''homeward,'' or UK-bound, freight. The two mail lines expressly forbade the others from loading what little homeward freight there was, instead paying each line an annual subsidy in compensation.[42] The mail lines made substantial side payments on several occasions to settle disputes, and most lines belonged to at least one revenue-pooling arrangement. Though the cartel was disrupted by entry, price wars never arose because of internal disagreements alone.

Competition on the basis of price, though submerged, is occasionally visible in shipper actions. For example, a line could compete on the basis of price by absorbing wharfage dues, usually paid by the shipper, or by including some inland transportation, or by misclassifying freight. The rate differential between the faster mail ships and the slower cargo lines was also an area of continual disagreement, as each member line tried to implement a pricing policy favorable to itself. A particular characteristic of South African trade was the strength of local merchant feeling against the monopoly power of the Conference.[43] On several occasions South African merchants who wanted an alternative to the conference encouraged entry without success. Local merchant associations occasionally formed their own line with charter ships, or threatened to, on all three routes. If the merchants were homogeneous and united, as in the case of Calcutta, they could gain. Most often

42. In fact, a cargo line that ''loaded homewards'' was fined £2,000 by the conference (Solomon, 1982, p. 39).

43. See Solomon (1982) for a thorough description.

merchants' movements were too fractured to extract concessions from the conference, as in South Africa.[44]

A.2.2 Calcutta and Bombay Conferences: The Indian conferences were naturally more disparate than the South African conference, due to the geography of the route (see Fig. 1). Some members continued to the Far East, some to the Persian Gulf, some to the East coast of Africa, etc. The first Calcutta conference was formed in 1875, consisting of the British India, P&O, Hall, and City lines. All Indian tea was shipped from Calcutta or Ceylon; the Calcutta Conference agreed on the tea rate each year. Each line paid a percentage of its freight revenues into a common pool, which was then allotted to lines in a certain proportion. No restrictions were placed on volume carried or number of sailings. Again, many side payments and other pooling arrangements also existed. For example, after Clan entered the tea trade in 1882, it was paid £2,000 per year by the P&O and £1,000 by British India not to carry passengers.[45]

On occasion a member would quit the conference and start a price war over some disagreement—usually market share. I do not include these cases of war in the above analysis. A representative example of this type of behavior occurred in 1886, when Clan decided it would like a bigger share of the tea coming from the port of Calcutta (one of the stops in the India Conference). The other lines were not receptive, so Clan withdrew from the Conference and started carrying tea in special arrangements with plantations. The conference capitulated in the summer of 1887, giving Clan a larger percentage of trade. Motivations for such behavior were different from standard entry, so the two types of observations are not combined.

The Bombay Conference was initially formed in 1879. It set standard cargo and passenger rates, most importantly rates on Lancashire cotton piece goods from Liverpool. By 1885, its members consisted of the P&O, British India, Anchor, Harrison, Hall, Clan, City, and Rathbone. I can find 16 cases of entry occurring in the following years. Many entrants were resented and fought vigorously; others were given complex shared rights to certain ports and cargo.

44. According to Hyde (1967, p. 97), conference pricing gave merchants one advantage, ". . . a uniform, continuous rate to make forward contracts with a certainty that no competitor by getting cheaper conveyance, can undercut him or depreciate his stock." He thought merchants were worried about windfall profits and losses if freight rates, a large proportion of the cost of goods, were set by a free market.

45. Muir and Davies (1978, p. 133).

A.2.3 Far Eastern Freight Conference: The original Far Eastern Freight Conference (hereafter FEFC) agreement included the P&O, OSS, Glen, Shire, Mogul, Skinner, and Messageries Maritimes (French) in 1879. The most valuable cargo of all heading to China was Lancashire and Yorkshire (L&Y) goods: yarn, wool, cotton, and silk manufactures. OSS, being based in Liverpool where the products were manufactured, had a virtual monopoly of L&Y goods. However, it paid shares of the L&Y revenue to other lines in the conference, which were forbidden to load at Liverpool.

Although primarily British firms tried to enter in the early period of the FEFC, in the 1890s a new group of non-British lines began sending ships to China. A few nations that had interests or possessions in the region now had ocean-going steamships. Sweden and Italian lines are the main examples. Austrian Lloyd (Italian) entered Far Eastern routes in 1892; it was heavily subsidized by the Italian Government, but seemingly without a clear strategy for the business of the line. In contrast, the government of Japan gave the FEFC's main competitor, the newly formed Nippon Yusen Kaisha (NYK) line, explicit goals. One was to keep export freight rates low. The Japanese government frequently denied rate increases to NYK on silk and cheap manufactures. The NYK bargained and muscled its way into the conference in several stages from 1893 to 1901. Government subsidies, special route subsidies, and specific rate requests on the part of the government considerably enhanced NYK's bargaining power vis-à-vis the FEFC.[46]

A.3 Accounting Data

To give the reader some idea of the basic costs and profits of steamship operation, a selection of data in nominal pounds sterling follow below. These data include profits, rates of return, average cost, and shipbuilding costs.[47]

In the 1870s steamships for international voyages were only 1000–2000 gross tons. By the 1880s, the common new-ship size was in the 3000–4000-ton range. In the nineties, big technical advances in engines and twin screw propellers led to much bigger ships of about 6000 tons. A large steamship of 7000 gross tons cost about £70,000 in 1893. Such a ship would have a life of approximately 20 years and would earn a net annual income of £7,000 (excluding depreciation). Size con-

46. Irwin (1991) applies modern strategic trade theories to this period. He does not claim the agents knew what they were doing strategically, whereas in this case the Japanese Government may well have been aware of the effects of its actions.

47. The principal collector was Professor Francis Hyde of Liverpool University.

TABLE IX.
AVERAGE COST PER TON[a]

Year	Cost (£/ton)		
	3500 tons	5500 tons	8500 tons
1885	.0616	—	—
1890	.0570	—	—
1895	.0510	.0501	—
1900	.0486	.0486	.0372
1905	.0440	.0420	.0360
1910	.0450	.0407	.0290
1914	.0412	.0392	.0260

[a] Hyde (1967). These costs were calculated by the managers of Charente based on the actual costs to the firm, i.e. expenses of feeding the crew, insurance, dock fees. The costs exclude depreciation. There is no reason to believe that these costs reflect optimal conditions.

tinued to increase up to W.W. I, although different trades had different needs. For example, North Atlantic passenger ships were much bigger than cargo ships intended to travel to South Africa.

Technological advances vastly changed nearly every aspect of steamship management over the period. For example, the time needed for the voyages decreased substantially. In the early 1870s a steamer could reach South Africa in about 25 days. By the early 20th century South Africa was only 10 days away. As a result, a firm wanting to run a weekly service to South Africa could own fewer ships than would have been necessary 25 years before—although those ships would be more expensive and bigger.

Average costs fell over time (Table IX) with technological improvements to engines and propellers and as ship size grew. Increasing returns to scale certainly existed at the single-ship level; hence the continuous growth in the size of ships. Cargo handling costs were the main element of marginal costs. Burley (1968) estimates that marginal costs for Australian shipping in 1923 were about 18–19% of total costs. Taking this figure to be roughly correct implies a ''fighting rate'' for freight could be 80% lower than average cost and still cover marginal costs.

The rate of return earned by Harrison ships in the period 1895–1914 was over 6%.[48] Hyde writes that OSS (Holt family firm) earnings were somewhat lower for trips to China in the 1870s and 1880s; average net profit was £2000 per voyage.[49] Average net voyage

48. Again excluding depreciation (Hyde 1967, p. 119).
49. Hyde (1957, p. 69).

TABLE X.
AVERAGE NET VOYAGE PROFIT[a]

Year	Profit (£1000s)	
	Far East and Australia	Indian and South African
1871	5.1	3.2
1881	4.7	3.9
1885	1.57	0.44
1890	0.73	1.2
1895	1.9	0.76
1900	4.03	1.84
1905	4.29	1.21
1910	3.94	1.74
1913	7.06	3.55

[a] Excluding depreciation. Taken from Hyde (1967).

profits (Table X) for the Far East route mentioned above ranged from £620 in bad years to £4000 in boom periods.

Of course, revenue pooling arrangements smoothed out differences among companies and commodities, but still the industry tended to be very cyclical. From 1897 to 1899 the value of exports to South Africa fell at an average rate of 6%; the next four years it grew at 15%, 35%, 40%, and 2%, respectively. Steamship companies had to expect and plan for such fluctuations. Price wars also disrupted profit flows; Harrison's earnings fell from £143,000 in 1891 to £72,000 in 1892 because of price wars with Brocklebank, Anchor Lines, and Indian Mutual.[50]

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50. Hyde (1967, p. 96).

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