American Shipping Cartels in the Pre-World War I Era

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ABSTRACT

This paper surveys the formation of the U.S. shipping cartels (conferences) and their state of development before the onset of World War I. These cartels ranged from simple price agreements to very complex and tight revenue pooling agreements. The focus of the paper is to identify the factors that influence the choice of the cartel organizational form. The authors find that the degree of collusion is higher in routes in which entry of competing firms is less likely, in routes with fewer firms of relative unequal size, and in routes in which member firms have large global capacity. The authors also find that multi-market contact facilitates collusion, that is, a cartel is more likely to be “tight” if its members are also interacting in many other routes. These results indicate that complex cartels, as opposed to simple rate agreements, are formed when organizational costs are lower and enforcement easier and more credible.
I. INTRODUCTION

The shipping industry is of vital importance in the international economy because it carries a large portion of world trade. In 1990, more than one-half of the value of U.S. foreign trade was transported by ocean. This fraction was even larger before the widespread employment of air freight. For example, in the year 1910, nearly ninety percent of the value of American trade was with countries other than Canada and Mexico. All of this overseas trade, and a non-negligible portion of North American commerce, was carried by sea. The shipping industry has been characterized by the existence of cooperative agreements between firms, ranging from simple price agreements to agreements on schedules and revenue pooling. Given the special place of maritime transport in the world economy, the continuing importance of cooperative arrangements in determining firm conduct, and the recurring policy interest in the regulation of these arrangements, it is important to study their development and the factors that influenced their type.

Cartels in the ocean shipping industry are remarkable for their longevity and their astonishing ability to regenerate in the aftermath of the occasional rate wars that have characterized the industry. These rate wars are the exception, not the rule, and shipping cartels by and large have been able to maintain price stability. The primary function of these cartels is to meet on a regular basis to fix freight rates—for this reason the cartels are commonly known as shipping conferences.

Although all conferences engage in price-fixing, not all conferences extend inter-firm cooperation beyond that point. This is true even though there are clear advantages from greater cooperation. Some cartels, for instance, coordinate sailing schedules, enabling a greater rationalization of capacity and permitting the cartel to achieve lower average cost. Other cartels have created exclusive territories for their members. In some exceptional circumstances, firms have even agreed to restrict investment in larger or faster ships in order to prevent quality competition. Each of these non-price restrictions has the potential to augment considerably the profitability of the cartel. Nonetheless, agreements that include such restrictions are more costly to negotiate and implement and may also leave firms more vulnerable to opportunistic behavior on the part of their co-conspirators. Thus, it is not surprising that only some cartels have attempted to cement their relationships through revenue pooling accords and agreements on sailing schedules.

In this paper we investigate which factors best explain the choice of the cartel agreement. We have constructed from primary sources a unique data set consisting of forty-seven shipping conferences in the American foreign trade immediately prior to World War I. Twenty-four of these cartels engaged in price-fixing only, whereas the remainder not only fixed freight rates but also colluded in some other aspect, for example, by agreeing to exclusive territories, sailing schedules, or revenue pooling. We first examine the main features of collusion in ocean shipping in this period. We then proceed to a formal investigation of the determinants of the cartel agreement.
This work is important for several reasons. First, it constitutes the most comprehensive statistical examination to date of the organization of shipping conferences. Previous work on conferences has primarily consisted of case studies of individual trade routes or companies. In this paper we examine a cross-section of cartels, and thus benefit from a greater number of observations than is typically available. Second, the pre-World War I era is an especially interesting period in which to study shipping conferences. Despite numerous studies of the changing market structures of manufacturing and railroad industries during this era, comparatively little has been written about the organization of the ocean shipping industry. Also, the late nineteenth and early twentieth century witnessed declines in freight rates, as North (1958) and Harley (1971, 1980) have documented. Harley in particular has attributed much of the reduction in rates to technological advance, and if these cartels were successful in their aim, it must be the case that freight rates would have fallen even further in their absence (Harley 1971, pp. 228–229). Although a detailed examination of the effectiveness of the cartels is beyond the scope of this paper, we believe that studies of market structure and organization are necessary preliminaries and complements to those that specifically address the issue of market power. Finally, and perhaps most importantly, public policy towards shipping conferences is of continuing importance. The U.S. Congress periodically examines the implications of the conference system for the performance of the shipping industry and limits the types of agreements the conferences can negotiate. The conference system operated without any government interference until the outbreak of World War I. Therefore, by studying shipping cartels as they existed shortly after the turn of the century, we are able to look at the type of agreements that emerged when the industry operated unencumbered by any government regulation.

We find that cartel agreements that include revenue pooling and sailing restrictions are more likely relative to simple price agreements when: (1) the member firms interact in routes other than the particular route in which they have a restrictive agreement,7 (2) the global tonnage of member firms is high, (3) there are relatively few members, (4) there is high variability in the relative size of member firms, as measured by their global capacity, and (5) entry into the particular route is relatively difficult.8

Many of these results are consistent with theoretical models of cartel formation: multi-market contact, large global capacities, and high entry barriers all facilitate the formation of tight cartels by making the enforcement of the agreement easier. Some of the findings, however, indicate that tight cartel agreements emerge in certain routes because the organizational costs of maintaining them are lower. In particular, a smaller number of members makes coordination easier while variability in the relative (global) size of member firms implies that there are some firms (or firm) that can act as natural leaders. Finally, some of the findings are consistent with both theoretical models of cartel enforcement and with models of organizational costs. For instance, multi-market contact can facilitate collusion by providing
the opportunity for firms to punish a cheating member through retaliation in many markets. However, multi-market contact can also facilitate collusion by improving the knowledge that member firms have about each other’s operations. We argue, on the basis of our results, that multi-market contact is at least as important in reducing the organizational costs of cartel formation by increasing the familiarity of member firms with each other as it is in providing for stronger punishments.

This paper is organized as follows. The second section provides a brief overview of the origins and spread of the shipping cartels. The third section describes at some length the operation of two particular cartels that are representative of the two main types of agreements. One of these cartels is a tight pooling agreement while the other is a rate agreement. The fourth section describes the primary data sources and the data obtained from them. It also discusses a theoretical framework that relates the underlying factors captured by the variables in the data to the choice of cartel agreement. The fifth section includes a graphical and informal analysis of the relationships between the factors that are thought to influence cartel formation and the type of cartel agreement. The results of formal econometric modeling are presented in the sixth section. The paper ends with a few concluding remarks. A number of appendices provide background information from original sources and a summary of the key features of all cartels included in this study.

II. THE ORIGINS AND SPREAD OF SHIPPING CONFERENCES

Prior to the advent of steam, most ocean transport was undertaken by “tramps.” The vessels were referred to as tramps because they did not adhere to a rigid schedule and were often chartered for individual voyages. With the application of the steam engine to ocean carriage, transit times became much more predictable and schedules more feasible. Steam shipping led to the establishment of a number of liner companies that maintained regular schedules (Royal Commission on Shipping Rings 1909, pp. 10–11).

The steamship implied significant increases in fixed costs, not only because of the physical investment in the vessels but also due to the port-side investments necessary for the maintenance of regular liner operations, especially the renting of berths. The increased costs of operating a steamship line meant that firms typically had to charge higher prices than tramps if they wished to break even (Royal Commission on Shipping Rings 1909, pp. 75–76). As a result, the market for ocean shipping was segmented into two sub-markets: (1) the liner market that served high unit-value commodities for which speed and regular service were essential and whose shippers were thus willing to pay the higher price of liners, and (2) the tramp market that served low unit-value goods for which those characteristics mattered less (Royal Commission on Shipping Rings 1909, pp. 10–11, 75–76). Examples of the former include mail, gold, and manufactured items. Examples of the goods
well-suited to tramp vessels are the vast majority of bulky commodities such as
most foodstuffs, minerals, and chemicals. It was common for a single shipment of
these goods to fill an entire vessel so that the exporter or importer might arrange to
charter a tramp for their transport. Nonetheless, particularly in economic downturns
when freight was more scarce, tramps would call ports where their owners felt there
was the best chance of acquiring freight (Boyd 1914, pp. 200–201).

In addition to the risk of increased competition from tramps in downturns, the
liners themselves had incentives to cut prices when they were not running at full
capacity, because the marginal cost of carriage was very low for most items.9 The
cartel system was an outgrowth of liner firms’ efforts to avoid rate wars among each
other and with tramps (House Committee on Merchant Marine and Fisheries, Vol.
4, p. 416; see also Marx, p. 46; Deakin and Seward 1973, p. 22).

We can best illustrate how the conference system developed by describing a
typical case, the New York-Far East Conference. This shipping conference was
established in the trade between New York and the Far East just six years after the
first regular liner service was founded on that route. In 1898 these companies—the
Hamburg-American Line, Rob M. Sloman and Company, and T.B. Royden—es-

tablished a joint service between New York and ports in China and Japan under the
name of United States and China-Japan Steamship Line, becoming the first regular
line in the trade. Two competing services entered the trade in 1902—the American
Asiatic Steamship Company and the American and Oriental Line. The next two
years witnessed a “serious rate war,” and in 1904 the five companies established a
conference agreement.10 The only subsequent entry to the trade was by the Ameri-
can-Manchurian Line, whose decision to enter was strongly influenced by U.S.
Steel when that firm became dissatisfied with the conference freight rates.11 This
conference operated until World War I, despite being the subject of an antitrust suit
beginning in 1912.

It is worthwhile noting that joint ventures, such as the United States and
China-Japan Steamship Company were rarely good substitutes for cartel agree-
ments.12 Also, despite the occurrence of many significant mergers in the industry
during the years prior to World War I, this sort of unification did not replace the
conference system.13 Mergers were simply not a feasible or desirable option in
many cases. For example, the gains from merger depend to a great extent on the
potential for the rationalization of service along the routes that the merging
companies participate and the additional market power that might be acquired.
However, if these firms did not “overlap” significantly, and/or there were many
other firms also serving the same route, these gains might be relatively small
compared to the firms’ total operations. Most often, firms did not merge but
preferred to cooperate with their rivals on individual routes through the creation of
conferences.14

By 1914 the conference system extended throughout American commerce. A
congressional investigation of the industry that year found that “as regards nearly
every foreign trade route practically all the established lines operating to and from
American ports work in harmonious cooperation" (House Committee on Merchant Marine and Fisheries, Vol. 4, p. 281).

III. EXAMPLES OF CARTEL AGREEMENTS

In this section we take a closer look at the types of shipping conference agreements. We do so by examining two representative cases: the aforementioned New York-Far East Conference and the Trans-Pacific Tariff Agreement covering the trade from Japan to Canadian and American ports on the Pacific coast. Osborne (1976), in his classic article, listed several hurdles that any cartel need overcome—the design of a price-production plan for each firm, the detection and punishment of any deviations from these plans, and the ability to deter entry from outsiders. The two conferences we examine in detail below confronted these problems very differently. The New York-Far East Conference is an example of an extremely restrictive cartel that coordinated schedules and operated a complicated revenue pooling mechanism. In contrast, the Trans-Pacific Tariff Agreement involves little more than rate-fixing.

The New York-Far East Conference came under the scrutiny of the U.S. Justice Department, which began to prosecute it under the Sherman Act in 1912. Many legal documents introduced in the case offer an inside view of the conference operations. In particular, the Justice Department obtained a copy of the written conference agreement.  

The agreement illustrates several methods of restricting competition between its signatories. The second clause describes the procedure by which all freight rates were fixed via meetings between steamship company representatives in New York. The first and eleventh clauses pertain to quantity controls—both in the number of sailings each carrier is permitted and the maximum size of the vessels allowed in the trade. In this regard the agreement was in a select class of agreements that attempted to account for the incentives that firms would have to increase the size of vessels if only the number of sailings was restricted. The second clause also calls for the prompt and regular exchange of "freight lists" in order to facilitate monitoring of the rate and quantity agreements. The twelfth clause explains that arbitration will be the method by which to resolve disputes between the parties. Although the agreement does not explicitly state the penalties for non-compliance, the signatories had financial penalties in mind. The Westward Agreement between the same firms called for penalties in the event of breach equal to one thousand pounds sterling or all profit made by the breach, whichever was higher (Petition in Equity, Exhibit 2, p. 37). The ultimate enforcement tool was not specified in the agreement: it was, in fact, the threat of a complete breakdown of the agreement and "ruinous" rate war.

The agreement thus constitutes a price-production plan for the carriers and includes provisions for the monitoring and enforcement of the accord. As stated in
the text of the accord, "the whole purpose of this Agreement is an equitable and fair division of traffic" (see Appendix A, clause 10). To that end, the firms not only arranged for sharing the "contract" freight of long-term customers (clause 3) but they also formed a complex pooling agreement. The pooling accounts were centralized in Liverpool under the direction of T.B. Royden, a shipping magnate and a conference participant through his interest in the United States and China-Japan Steamship Line. The method by which conference member firms' revenues were pooled was not in the least transparent. First, the following subtractions were made from each firm's gross revenues: port charges, loading and unloading, and any commissions per clause 2. The resulting number was referred to as "net freights" (net revenues). Each firm contributed their net freights to the pool. From the pooled net freights of all firms, three disbursements were made: First, the firms were credited a so-called "coaling allowance" proportional to cargo capacity and distance traveled. Each firm was also credited an amount of money proportional to the time its ships were active, the distance traveled and the cargo capacity of the active ships per clause 3 of the pooling agreement. This amount was called the "Initial Hire." Any remaining money left in the pool after the two disbursements just mentioned was distributed based upon the "Initial Hire" of each firm as described in the fourth clause. As with the conference contract, the pooling agreement contained a provision that called for arbitration if a dispute should arise.

In the case of the Trans-Pacific Tariff Bureau, evidence is available through the records of the U.S. House Merchant Marine and Fisheries Committee, which conducted an investigation of shipping conferences in 1912–1914 and was particularly successful in its collection of "Schedules of Inquiry" (surveys) from the carrier participants in the Trans-Pacific Bureau. Ten lines participated in this cartel during these years, and there was no important outside competition, either tramp or liner. The eastbound rates from Japan to Canadian and American Pacific coast ports were made in Yokohama by mutual agreement of the lines' representatives there. The Pacific Mail Steamship Company, in its response the House Committee's inquiry, stated that:

The Agents of the various Lines meet and discuss the conditions which are changing from time to time, and which are affected by the competition of Tramp Vessels and decide on the policy to be pursued by all the Lines named with reference to the maintenance of stable rates of freight and to prevent demoralization.

The essential feature of the Bureau is a plan adopted by these Lines, whereby shippers who send their freight only be the regular Lines named will be accorded the reduced rates of freight... The plan referred to above was a deferred rebate contract offered by the lines to customers. The cartel credited firms that shipped cargo only with conference vessels with a rebate on the regular freight rate, with the proviso that this rebate would be payable in two equal portions contingent upon continued loyalty to the conference lines in the next two six-month periods. The amount of the rebate varied
according to the commodity and the destination. For example, the highest-value commodities in the trade (raw silk and silk goods) received no rebate because the lines knew that no exporter would ship these items via tramp vessels for the reasons explained above. Rice and peanuts were also exempt because this cargo was only attractive to liners in times of absolute depression—it was cargo naturally suited to tramp shipping. The rebate on freight to the west coast was lower than the "overland" rebate to the interior United States and Canada because the conference faced competition from the New York-Far East conference on the carriage of freight to these destinations. Thus the conference carriers on the Japan-U.S./Canada West Coast route limited their collusion to rate-fixing and entry deterrence. No pooling occurred, nor did the ten firms jointly restrict sailing schedules or otherwise restrict capacity. In addition, monitoring and enforcement procedures were ill-defined (see U.S. House Committee on Merchant Marine and Fisheries, Vol. 4, pp. 134–138).

A discussion of the degree of market power achieved by the cartels and of whether the “tight” conferences, like the New York-Far East Conference, were more profitable than the simpler, price-setting, conferences, like the Japan-U.S./Canada conference, is beyond the scope of this paper. What we wish to emphasize, however, is that the conference system prior to World War I was far from homogeneous and that the extent of collusion varied significantly. The two conferences described above are representative examples of the two basic forms: inflexible cartels that restricted quantity and/or pooled revenues and flexible cartels that focused primarily on price-fixing. It is the goal of the remaining sections to investigate the factors that influenced which of these two types of collusive agreement was adopted in any given route.

IV. DATA SOURCES, VARIABLES, AND THEIR IMPACT ON CARTEL AGREEMENTS

A. Data Sources and the Definition of the Dependent Variable

Given the absence of a comprehensive data-base on early shipping cartels, we had to construct one from primary sources. In particular, we developed a cross-sectional database on shipping conferences in American trades immediately before the outbreak of World War I. We assembled these data from four principal sources. Our first source is the material collected by the U.S. House Committee on Merchant Marine and Fisheries over the course of its investigation into the steamship agreements from 1912 to 1914. The results of this investigation contain detailed discussions of shipping conferences in various geographical areas. Our data on the geographical scope, firm membership, and extent of collusion come principally from this source. We were able to identify this information for forty-seven conferences. Our second source is Lloyd's Register of Shipping, which lists the ships owned by each firm and also gives the tonnage capacity and age of each vessel.
This is the principal source of firm-level data. Our third source was the 1909 report of the British Royal Commission on Shipping Rings. This source includes a comprehensive list of cartels originating from Europe and their member firms. It allows us to measure the extent to which the members of American conferences interacted in routes that did not involve U.S. ports. Finally, we obtained information on the distances between the ports served by the conferences from the U.S. Navy Hydrographic Office’s *Table of Distances between Ports*.

We measure the extent of collusion by assigning each of the forty-seven American cartels to one of two categories—inflexible or flexible. We call a cartel inflexible if the firms collude on variables other than price. For example, if there was any coordination of quantity or quality, such as the joint determination of schedules, or if there was any revenue pooling, we classified the cartel as inflexible. Otherwise, we classified a cartel as flexible. According to these conventions, twenty-three cartels were inflexible and twenty-four flexible. The dependent variable, *Inflex*, takes the value of 0 if a cartel constitutes only a rate agreement (i.e., is flexible) and takes the value of 1 otherwise (i.e., is inflexible).

Figure 1 illustrates the geographic distribution of the types of cartels. Of the seventeen conferences in the busy U.S.-European trade, eight were inflexible. All eight cartels serving the routes from the U.S. Atlantic coast to Africa, Asia, and

*Figure 1.* Conference Routes to and from the United States. First Number Indicates the Number of Conferences Followed, in Parentheses, with the Number of Tight Cartels.
Australia were involved some sort of quantity restriction or pooling. In contrast to these highly structured routes, only two of five trans-Pacific conferences and five of seventeen conferences from the United States to the Caribbean and Latin America were inflexible.

B. Multi-market Contact Variables

We consider several factors that could affect the propensity to form an inflexible cartel. These factors can increase the propensity to form such a cartel either by increasing the ability of firms to enforce the agreement through punishment strategies or by reducing the organizational costs of forming and operating the agreement. Because a firm can “cheat” on more margins in an inflexible cartel—for instance, it can cheat not only on price, but also on the amount of the freight it reports to the pool—the incentives to cheat in an inflexible cartel are stronger than those from cheating in a price agreement. Therefore, the ability to inflict more powerful punishments allows firms to sustain a higher degree of collusion and a tighter cartel. On the other hand, even if an agreement on multiple aspects of shipping operations (schedules, volume) could be sustained, the cost of reaching such an agreement and periodically monitoring it may dissipate any gains from increased co-ordination. Therefore, any factors that lower the cost of reaching and monitoring complicated agreements should increase the likelihood that such agreements will be adopted.

The degree of multi-market contact between cartel member firms is potentially one of the most important factors that affects the complexity of the cartel agreement. In fact, as we discuss below, it can do so both by increasing the enforceability of the agreement and by reducing the organizational costs of forming and maintaining it. Multi-market contact occurs when all, or a subset, of the firms operating one route also operate together on other routes. Bernheim and Whinston (1990) have shown that in such cases firms’ ability to enforce collusion is augmented because they can punish deviations (cheating on the cartel agreement) on one route with retaliation on a number of routes. Ceteris paribus, they predict that collusion will, on average, be more likely to occur in the presence of multi-market contact. According to the theory, the highest responsiveness of collusion to multi-market contact will be in markets where collusion would not be otherwise attainable. In contrast, in some of the markets where collusion would have been easily sustained without threats of punishment in other markets, collusion might be weakened by multi-market contact.

There is some empirical evidence that corroborates the theoretical results. Evans and Kessides (1994) show that in the airline industry route fares increase with the level of multi-market contact. Recently, Fernández and Marín (1998) have shown that hotel prices in Spain tend to be higher when the hotel chains that serve a city have a high degree of interaction in other cities. This is particularly true for cities with a relatively low concentration of market shares, while for cities with the highest
concentration prices tend to respond negatively to multi-market contact. This is the pattern of price responses to multi-market contact predicted by Bernheim and Whinston (1990). There is also anecdotal evidence that price wars in ocean shipping can occasionally spread to other routes. Smith (1906) noted one such instance that occurred in 1905:

A quarrel among London owners in the United Kingdom—Australia trade [was] carried to [the] New York—Australian trade where these same owners ran steamers (Smith 1906, p. 528).

One of our aims is to formally test the existence of a link between multi-market contact and collusion. Our focus differs from that of the previous approaches because we are interested in the influence of multi-market contact on the choice of the form of co-operation in formal cartel agreements, that is, the probability that a cartel is inflexible rather than flexible. Furthermore, we define multi-market contact in two different ways, each one of which is designed to capture a different aspect of firm interaction. The first index is a continuous index—loosely speaking, we count every time any two firms involved in a conference $X$ also interact in another conference as one instance of multi-market contact for conference $X$. The second index, which we call the “Reciprocal Index,” registers an instance of multi-market contact for conferences $X$ and $Y$ only when at least fifty percent of the firms in conference $X$ are members of conference $Y$ and vice versa.

More formally, we define the continuous measure of contact of member firms of cartel $i$ in cartel $j$ by:

$$ CONTACT_{ij} = \begin{cases} \frac{N_{ij}}{N_i} & \text{if } N_{i,j} > 1 \\ 0 & \text{Otherwise} \end{cases} $$

where $N_i$ is the number of firms in cartel $i$ and $N_{ij}$ is the number of members of cartel $i$ that are also members of cartel $j$. The subscript $i$ ranges over the forty-seven American cartels, while the subscript $j$ ranges over all cartels, including those that do not involve American ports.

The continuous interaction index for cartel $i$ is then defined as

$$ INTER_i = 100 \frac{\sum_{j \neq i} CONTACT_{i,j}}{N - 1} $$

where $N$ is the total number of American and non-American cartels in the data-set. In other words, our measure of interaction captures interaction of firms in all other cartels, including cartels the organizational form of which we are not able to study.

By this measure, the mean level of multi-market contact for the cartels in our sample is approximately 4, ranging from a minimum of 0 to a maximum of 15.84.
The value of the “Reciprocal Index” \([\text{RecipIndex}]\) of multi-market contact for cartel \(X\) is the number of instances that at least fifty percent of the firms in conference \(X\) are members of another conference \(Y\) and vice versa. The possible values of the reciprocal index are thus integers. As shown by Table 1, the mean interaction according to this measure is 1.21, ranging from zero to a maximum of 4.

We employ two indices because each implies a different mechanism through which multi-market contact actually affects collusion in ocean shipping. The continuous interaction index implies that there are no threshold effects: any increase in contact leads to more collusion. Formally, this is consistent with Bernheim and Whinston’s (1990) theoretical model, because our specification assumes that a firm A will punish a deviation by another firm B in cartel \(X\) by a price war in another market \(Y\) even if most firms in that other market are not members of cartel \(X\). In practice this is not very likely because it may cause counter-retaliation by the other firms of cartel \(Y\) who are “innocent bystanders” in the dispute between A and B. For example, assume that firms A and B constitute a conference in the trade from the United States to South Africa. Assume that these two firms also are members of a conference in the United States to Australia trade, but that in that trade they are joined by firms C, D, and E. If firm B cheats on the agreement in the United States to South Africa trade, firm A would be tempted to punish firm B by initiating a rate war in the United States to Australia trade. How would firms C, D, and E respond to firm B’s behavior? Would firm A be considered the “first offender” in United States to Australia trade? What if firm A interacts with one of these firms elsewhere?

\begin{table}[h]
\centering
\begin{tabular}{lcccc}
\hline
 & Mean & Std. Dev. & Min. & Max. \\
\hline
Influx & 0.49 & 0.51 & 0 & 1 \\
INTER & 4.09 & 3.65 & 0 & 15.84 \\
RecipIndex & 1.21 & 1.25 & 0 & 4 \\
HHI & 0.43 & 0.19 & 0.08 & 0.80 \\
NumFirms & 5.53 & 4.41 & 2 & 20 \\
Tonnage\textsuperscript{a} & 0.70 & 0.51 & 0.02 & 1.79 \\
NumShips\textsuperscript{b} & 2.61 & 1.84 & 0.14 & 6.46 \\
Miles\textsuperscript{c} & 4.89 & 3.15 & 0.603 & 13.06 \\
Europe & 0.36 & 0.49 & 0 & 1 \\
Central America & 0.26 & 0.44 & 0 & 1 \\
Pacific & 0.11 & 0.31 & 0 & 1 \\
Age & 11.98 & 2.21 & 7 & 21 \\
\hline
\end{tabular}
\caption{Cartel Agreement Summary Statistics}
\end{table}

Notes: \textsuperscript{a}in thousands of tons.  \\
\textsuperscript{b}in hundreds of ships.  \\
\textsuperscript{c}in thousands of nautical miles. \\
Number of Observations is equal to 47.
Would there be retaliation in these other markets against firm A? We feel that it is not very likely for firm A to retaliate against firm B in the United States to Australia trade unless it has the tacit acceptance from the other firms in the conference. This is more likely to happen if the cartels are “inter-locked,” that is, if the majority of the members in the one cartel are also members of the other cartel and vice-versa. In other words, the reciprocal index is more likely to capture the fact that multi-market contact facilitates collusion through punishment in other markets.28

Even if Bernheim and Whinston’s theory is not applicable to the case of liner shipping, multi-market contact might still be important if it enables firms to cooperate more effectively. Firms that interact frequently and in many markets have a better understanding of each other’s operations, their capabilities, and the constraints under which they must function. Of equal importance may be the fact that interaction in many conferences increases familiarity at the personal level. All of these factors make it easier for the member firms to cooperate closely by reducing the negotiating costs of any pooling agreement. If this is an important channel through which multi-market contact increases the likelihood of a tight cartel, then there should be no threshold effects. For instance, even if only 2 out of 5 firms in a conference have a close working relationship because of repeated interactions, this will make negotiations between all 5 firms easier compared to the case in which no two firms have a close working relationship. Similarly, even a little interaction between a subset of these firms is better, in terms of facilitating co-operation, than no interaction between any of the firms. In other words, if interaction is the “grease that oifs the wheels” of cooperation, then there should be no strong threshold effects: there should be a smooth relationship between interaction and the probability of an inflexible cartel agreement.

C. Other Variables

Multi-market contact is only one of the many factors that influence the ease of collusion. Other important factors include: (1) heterogeneity in the size of member firms, (2) the number of member firms, (3) total global capacity of the member firms, and (4) ease of entry by outsiders.

The first two of these factors are not related to the ability of cartels to enforce the agreement. In particular, a large number of firms increases the incentives for deviation by one of the members, but it also increases the benefits of co-operation. The overall effect on the enforceability of a cartel agreement is ambiguous. Similarly, if the cartel consists of some big and some small firms, as opposed to firms of equal size, the large firms will have the ability to inflict stronger punishments on the smaller firms, thereby ensuring their cooperation. On the other hand, the larger firms will bear a bigger share of the costs of a price war. Even though one would expect the first factor to outweigh the second (as the anecdotal evidence presented below indicates) the impact of firm heterogeneity in firm size on the enforceability of the cartel is not clear.
However, both of these factors facilitate collusion by reducing the costs of organizing and negotiating the agreement. A small number of firms would clearly make it easier, all things equal, to reach a mutually satisfying agreement and to coordinate sailing schedules. Also, large firms are able to exert disproportionate influence over the negotiations, naturally taking the position of leaders, not only because of their size, but also because they typically are more experienced players in the international trade arena.

An example from our data set, in which a dominant firm essentially dictates the rules of a cartel agreement, is the agreement between the Red Star Line and the Phoenix Line in the trade from Antwerp to New York. Red Star was a much larger company and was able to impose its will on the Phoenix Line. The smaller firm operated only one ship every other week and Red Star sailed weekly. Phoenix Line agreed to carry no passengers or high-value commodities and maintain rates no more than ten percent below those of Red Star. The U.S. Consul in Antwerp reported that in general

secondary lines were glad to accept these terms, for the reason that if open competition were to be resumed... it would be impossible for the smaller firms to exist at all on the North Atlantic.

... From my interviews with the ship agents here I find that they are only too glad to be able to work with [Red Star]... They admit, however, that [Red Star does] make it a point to crush any independent Atlantic service that will not enter into agreement with them (U.S. House Committee on Merchant Marine and Fisheries, pp. 68–69).

In order to evaluate the empirical relevance of these two factors, we use the number of firms and a measure of concentration as regressors. Our measure of concentration is the Herfindahl index (HHI), which is constructed from global rather than route shares; that is, we include all vessels owned by the firms and not just the vessels allocated by each firm to the route at a specific point in time. Because ships can be moved from port to port, and because firms are typically involved in several markets, this global figure measures firm strength more accurately. We construct the index as follows: First, we calculate the total tonnage of all vessels owned by the member of firms of the conference in question. Then we compute the share of that total tonnage that is owned by each individual member. Finally, we sum the squares of those fractions to get the Herfindahl index. The higher the value of HHI for a given conference, the smaller is the number of members and the more unequal is the distribution of tonnage among them. The maximum HHI is 0.80 and the minimum is 0.08.

The last two factors discussed in this section are related to the ability of the cartel to enforce and maintain a cartel agreement. The higher the global tonnage or number of ships that member firms have at their disposal, the more credible is any threat to carry out a destructive price war. The firms could easily reallocate ships and capacity from other lines to the route in which a price war takes place without severely disrupting their global schedules. On the contrary, if member firms have small fleets, they can not credibly threaten a violator with effective retaliation.
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<th>HHI</th>
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*Table 2. Correlation Matrix of Cartel Agreement Data and Interaction Indices*
Also, the higher the likelihood that there will be opportunisti
c entry into the route, the higher the likelihood that a complicated agreement will not be sus
tainable: If firms have simple rate agreements, it will be easier for them to respond to opportunisti
c entry (such as higher than average number of tramps in a particular season) by changing their schedules and/or load factors. Since firms in a conference may not have the same information or beliefs about market conditions and the extent of opportunisti
c entry, a change of schedules and load factors might be perceived as “cheating” on the cartel rather than as a response to outsiders. Therefore, in an inflexible cartel agreement, response to opportunisti
c entry would risk triggering a cartel breakdown. We measure the ease of opportunisti
c entry by the length, in nautical miles, of the route. Tramps could enter short routes, especially those in the Atlantic, much easier than long routes, such as those to the Far East and Australia. This is not only due to the bigger time commitment (and hence higher risk) that putting a ship on a long voyage would entail. It is also because longer routes require larger vessels, which fewer firms possess. Longer routes would also increase the ability of firms to sustain collusion because attempts to increase capacity secretly by, for example, cheating on quantity or quality agreements, are more costly on longer routes. On a long route it takes more ships to increase service by any given frequency. In addition, a firm can not use all of its vessels in long routes because they require larger ships.

In addition to the factors that we described above, we consider the possible effects, if any, that the average global quality of vessels by member firms has on the type of cartel these firms form. The age of a vessel is a good indicator of its quality. Age is negatively correlated with both speed and safety. Slower vessels constitute lower capacity. For example, a slow ship can make fewer voyages per year than fast ships, holding the length of the voyage constant. Using the data in Lloyd’s Register of Shipping we calculated the average age of the vessels owned by all the firms in a given conference. The conference with the newest ships had an average age of 7 years and the conference with the oldest had an average of 21 years.

V. GRAPHICAL ANALYSIS

Before any formal investigation of the relationship between the above factors and the form of the cartel agreement, we proceed to an informal analysis of the data. In particular, we will examine how the distribution of these key cartel characteristics differs for the two types of cartels. Examining these distributions will not only give us a feel for the data, it will provide strong evidence that the results obtained by formal econometric analysis are not driven by a few statistically influential cartels. In addition, examining the histograms of variables by cartel type allows us to examine the entire distribution of the data rather than focusing exclusively on the mean. Because the histograms do not permit us to control for cross-effects, however, we must be careful in their interpretation.
Figure 2 illustrates the relationship between the multi-market contact indices and the extent of collusion. In the upper-left hand panel, we see a nearly uniform distribution of the continuous interaction index for inflexible (tight) cartels. In contrast, the upper-right panel shows that price agreements (flexible cartels) are predominately ones where the level of multi-market contact is low. The lower panels indicate a similar, though weaker, pattern for the reciprocal index. Measures of global firm size are shown in Figure 3. Both high global tonnage of member firms and a large number of ships owned by member firms seem to be related to more restrictive cartel agreements. The evidence in both Figures 2 and 3 therefore supports the hypotheses that these variables are positively related with more collusive behavior.

Figure 4 is more difficult to interpret. The distribution of HHI for inflexible cartels is somewhat bell-shaped, whereas the corresponding distribution for price agreements is more uniform. Indeed, there appears to be no correlation between concentration, as measured by global market shares, and the intensity of collusion. The primary reason for this is that concentration is negatively correlated with total capacity of firms and route distance. Cartels that have many large firms are less likely to be highly concentrated. Similarly, long distance routes appear not be highly concentrated. Given these negative correlations and the fact that total firm capacity and distance are strongly correlated with tight cartels, it is not surprising that the correlation of HHI with cartel form is near zero. The lower panels highlight the fact that extremely long distance trades tend to be governed by inflexible cartels, and

![Figure 2. Multimarket Contact by Cartel Type](image-url)
Figure 3. Global Capacity of Member Firms by Cartel Type

Figure 4. Global Market Concentration of Member Firms and Route Length by Cartel Type
corroborate the evidence presented in the map shown in Figure 1. Finally, Figure 5 shows that a larger proportion of tight cartels than price agreements have only a few firms. It also shows that conferences with only price agreements are composed of firms that, on average, have slightly older ships.

VI. ECONOMETRIC RESULTS

A. Choice of Cartel Agreement

In this section we formally investigate the relationship between the above factors and the organizational form of the shipping conferences. The results of the probit analysis are summarized in Table 3. Due to the relatively small number of observations, our models include one measure of multi-market contact, one measure of concentration, and one measure of firm size at a time. Model 1, our benchmark model, shows that multi-market contact, as measured by the continuous interaction index, global capacity of firms, as measured by tonnage, concentration, as measured by the Herfindahl index, and the length of the route, all contribute to the likelihood that a conference will be tight. These results provide empirical support for the theoretical discussion in the previous sections. It indeed appears that both factors that increase the enforceability of the cartel and factors that reduce the organizational cost of the complex agreements are important determinants of pooling agreements and of agreements with sailing restrictions.
Models 2 and 3 check the robustness of these results to different measures of concentration and global firm capacity. The results are essentially unchanged when the number of ships replaces global tonnage as a measure of capacity. They are also unchanged when the number of firms replaces HHI as a measure of concentration with the exception that the effect of multi-market contact is reduced. However, the number of firms does not capture concentration as well as the Herfindahl index because it does not take into consideration the asymmetries in firm size.\textsuperscript{32} Firm asymmetries clearly are important in explaining cartel formation, as can be seen by the comparison of the log-likelihood of Models 1 and 3.\textsuperscript{33}

Model 4 investigates the robustness of the inferences with regards to multi-market contact, firm size, and concentration, when route length is treated as a nuisance parameter and controlled via a series of regional dummies. In addition, this model tests whether route length picks up mostly regional effects rather than any direct distance effects. The results indicate that inferences about the remaining variables are not noticeably affected by the treatment of the route variable. Standard errors increase slightly, however, due to the loss of some degrees of freedom. A comparison of fit between Model 4 and Model 1 must take into consideration that the former model includes more explanatory variables and that the two specifications are not nested. However, the value of the log-likelihood with the regional dummies is higher than that obtained with the distance variable by 1.5, only a very slight improvement for an additional two degrees of freedom.\textsuperscript{34}

Finally, Model 5 tests which of the two measures of multi-market contact best predicts cartel formation. Even though the reciprocal index is still positively associated with tight cartels and is significant at the 10 percent level, it explains cartel formation more poorly than the smooth interaction measure. This can be easily seen by observing the relative \( t \)-statistics and values of the log-likelihood. It appears, therefore, that there are no strong threshold effects and that increased interaction, even at low levels and by a few firms, has some positive impact on forming a tight cartel agreement. Given our discussion in the previous sections, this can be considered as evidence that closer working relationships foster higher cooperation. It is not necessary for the majority of firms to have close interaction for this interaction to yield tangible benefits in terms of attaining a higher level of collusion. The results can also be interpreted as evidence that multi-market contact does not help foster collusion primarily by improving the enforceability of cartel agreements via the use of stronger punishments. These stronger punishments would most likely require the acquiescence of the majority of the firms, and if this was the case, then the reciprocal index, which captures interaction of majorities of cartel members in other cartels, would be as good a predictor of inflexible cartel formation as is the smooth interaction index. The results also indicate that the average quality of member firms’ fleets, as measured by the average age of the ships, appears to have no effect on the choice of cartel agreement.
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### Table 3. Estimation Results

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*Note:* Standard errors are shown in italics below the parameter estimates. N = 47.

### B. Firms and Cartel Agreements

The analysis of the previous section relates route characteristics to the choice of the cartel agreement. Firm characteristics and heterogeneity were aggregated up to the conference level, and the aggregated characteristics related to the choice of agreement. In this section we focus on the firms and their characteristics. In particular, we investigate whether firms that are members of tight cartels are systematically different from firms that are members of rate agreements. To do so, we organize the data by firm rather than by cartel. There is a total of ninety-one firms in our sample. Of these, we have detailed information for all but five. For each firm we have information of the total tonnage and number of ships under its control, as well as the average age of its ships. We also know in how many American conferences the firm participates and how many of these are tight cartels.
Table 4 shows the summary statistics of the firms in our data. It is evident that there is a wide variability in the size of firms. Global firm tonnage varies from only 2.25 thousand tons to almost 550; the smallest firm in our sample has only a single ship while the largest has 201 ships. There is considerable skewness in the distribution of firm sizes: the average firm owns 30 ships with a total of 77 thousand tons. The average firm participates in 3 conferences. Here, again, there is wide heterogeneity with 53 firms participating in only one or two agreements while seven firms participate in seven or more. Almost half of these agreements are tight cartels.

We then decompose these firms into three groups: (1) those that participate in tight conferences only, (2) those that participate in rate agreements only, and (3) those that participate in both. Table 4 reports the averages for the first two groups and for the full sample of all firms. As expected, firms that participate in only one type of agreement participate in fewer agreements of either type. Simply put, the more agreements a firm participates in, the less likely it is that all of them are of a particular type. Similarly, firms that participate in only one type of agreement tend to be smaller than firms that participate in both types of agreements. We focus, then, on firms that participate only in one type of conference. If there was no relationship between firm characteristics and the organizational form of the conference, there should be no difference in the average values of these variables between these two groups. However, the firms that only participate in price agreements are noticeably smaller both in total tonnage and number of ships under their control than firms that only participate in tight conferences. In contrast, there appears to be no dramatic difference between the firms in terms of average fleet age.

This decomposition suggests that the members of tight cartels not only have large global capacity in aggregate, as the results of the previous section indicate, but include members that are disproportionately large individually. One possible interpretation is that big firms tend to facilitate the evolution of a conference from a rate agreement to a pooling agreement, perhaps acting as a "seed" around which the other firms organize.

To formally test the possibility that larger firms are more likely be participants of tight cartels rather than price agreements, we adopt the following empirical framework: Let $p_i$ be the frequency with which firm $i$ participates in an inflexible cartel, and $N_i$ the number of cartels in which it participates. Denote by $K_i$ the number of inflexible cartels that this firm is a member of. Then, $K_i$ is binomially distributed with $N_i$ trials and probability of "success" per trial equal to $p_i$.

We first parameterize $p_i$ by the function:

$$p_i = \frac{\alpha \cdot SHIPS_i^8}{1 + \alpha \cdot SHIPS_i^8}$$

where SHIPS is the number of ships owned by firm $i$. This specification is essentially equivalent to the specification of probabilities in the logit model. The estimate of $\alpha$ is equal to 0.00008443, while that of $\beta$ is equal to 1.946616.\(^{35}\) The
Table 4. Summary Statistics of Firm Characteristics

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</tbody>
</table>

t-statistic of \( \beta \) is 1.841, which is significant at the 10 percent level.\(^36\) This shows that large firms, with size measured in terms of number of ships, have a higher propensity of belonging in tight cartels. When TONNAGE is used as a measure of size, the estimates of \( \alpha \) and \( \beta \) become 9.7 * 10\(^{-6}\) and 1.972124, respectively. The \( t \)-statistic of \( \beta \) is equal to 1.488, with a \( p \)-value of 0.137. That is, when TONNAGE is used a measure of size, the relationship between firm size and propensity to belong to a tight cartel is no longer statistically significant.\(^37\)

VII. CONCLUDING REMARKS

This paper surveys the structure of shipping conferences in the United States before 1914. We focus on the diversity of collusive agreements formed by liner companies. These agreements can be broadly classified into two groups: (1) those that are limited to rate-fixing, and (2) those that include agreements on other aspects of business operations. More comprehensive agreements yield increased benefits to their members but are also more costly to implement and leave the members firms more vulnerable to cheating from other members. We have shown that both factors that
reduce the organizational costs of forming a complex agreement and factors that improve the enforceability of such an agreement are important in determining the degree of collusion.


Eastward Agreement

United States of America to the Straits, Manila, China, and Japan

For the better regulation of the trade between the Atlantic Ports of the United States of America and Eastern Asiatic Ports, it is hereby agreed as follows:

1. That on the basis of forty-one sailings per annum the total shall be divided as follows:

   United States and China-Japan Line  
   Messrs. Barber & Co.'s Line  
   The American and Oriental Line  
   The American-Asiatic S.S. Co.  

   13 sailings.  
   13 sailings.  
   8 sailings.  
   7 sailings.  

   41 sailings.

   No other sailings can be admitted without the consent of two-thirds of the signatories based on their respective number of sailings.

   The sailings allotted to each of the signatories shall be distributed as nearly as possible at regular intervals throughout the twelve months, and the order of taking the berth shall be mutually arranged by the agents in New York.

2. That the fundamental condition of this agreement is to be close cooperation, and in order to secure this result the rates of freight from America to the East shall be controlled and mutually determined by the agents in New York, who before naming or altering a rate on any commodity shall first confer and agree amongst themselves as to the rate to be named and/or the reduction to be made.

   All engagements shall be reported to one another by the Agents in Conference the first business day of each week, and copies of the freight lists are to be exchanged not less than three weeks after the departure of each steamer.

3. That all contracts shall be taken for joint account, and where such contracts cannot be divided such shortages shall be made good to the parties in arrear.
out of the other contracts previously or subsequently secured, it being the purpose to equitably divide all bookings.

10. That the whole purpose of this Agreement is an equitable and fair division of the traffic between the services, to work openly and fairly with one another, and to avoid any and all steps by which even the appearance of undue advantage is given.

11. That no steamer of a greater carrying capacity than 8,000 tons all told is to be loaded under this Agreement, except by unanimous consent of the Agents.

12. That should any disputes arise under this Agreement they are to be left to the decision of the signatories to this Agreement, whose voting power shall be _pro rata_ to their share in the business.

Should any decision so arrived at be objected to by any party or parties hereto, the matter shall be referred to the decision of two Arbitrators, who shall be commercial men in London, New York, or Hong Kong, whichever place in the opinion of the majority of the signatories, as above, is best suited for the purpose, one to be appointed by the party or parties claiming or objecting as the case may be, and the other by the party or parties against whom the claim or objection is made...for the purposes of any such reference this Agreement shall be deemed to be a submission to Arbitration within the meaning of the Arbitration Act, 1899...

13. That this Agreement is to commence with steamers sailing from their first loading port in the U.S., on or after April 1, 1905, and to remain in force until canceled by any of the parties there off given six months' written notice of their desire to withdraw, such notice not to be given previous to 1st day of July, 1906.

By authority of Barber & Co. Incld., Walter Chambers.

William Adamson & Co., on behalf of Shewan Tomes & Co.

Per Pro. T.B. Royden, and by written authority of the Hamburg Amerika Line and the Union S.S. Co. of Hamburg, P.L. Rooper.

For the American & Oriental Line, Howard Houlder & Partners, Ltd., Alex Freeland, Director,

General Managers.

Witness to the signatures of
Wm. Adamson & Co., P.L. Rooper, and Alex. Freeland,
Archd. Maclean
Anglo-American Oil Co., Ltd.,
22, Billiter Street, London, E.C.

Source: Excerpts from Exhibit 1, Petition in Equity, pages 27–30.
APPENDIX B. POOLING AGREEMENT

Pooling Agreement between the Owners (including Chartered Owners) of the Steamers now being run or to be run in the trade between the Atlantic Ports of the United States and the Far East as set forth in the Agreements dated 13th day of April, 1905.

In order to consolidate the position of the Associated Lines and to provide a method of meeting outside opposition that may be effective, and at the same time fair and equitable to all concerned, it is hereby agreed that the net freights earned by all steamers loaded from the Atlantic Ports of the United States to the Far East, and vice versa in accordance with the terms of the Eastward and Westward Agreements, dated 13th April, 1905, shall be Pooled and treated as hereinafter provided.

1. The Steamers run in the trade Eastward and Westward respectively shall be managed and disbursed by their respective Owners as at present, who shall make up as soon as possible after the termination of each steamer's voyage Eastward and/or Westward a statement showing all the necessary Pooling particulars in the forms prescribed and attached. These statements, together with all supporting vouchers, copies of Manifests, Certificates of Cargo space and deadweight capacity and time statements showing dates and times of all arrivals and departures in prescribed form, are to be forwarded as soon as possible to T.B. Royden, Liverpool, who shall prepare at the end of each year two general Pooling Accounts, one for all the Eastward Voyages and one for all the Westward Voyages during the year, in which the Owners of each of the said Steamers shall be debited with all net freights received by them of such voyages, and the respective Pooling Accounts credited with the same, and a proper distribution of the balance of such Pool shall be made as below.

2. The net freights above referred to shall be arrived at by deducting from the whole gross freights...the following:
   (a) [port expenses and taxes]
   (b) All loading and discharging expenses, viz., Stevedoring Bills...
   (c) All loading commissions (paid to brokers)...
   (d) All discounts, rebates, or allowances...are to be credited back to the Pool.

3. The respective Pooling Accounts shall then be debited, and the Owners of the several steamers shall be credited with the following:
   EASTWARD POOL. Initial Hire and Coaling Allowances as specified in sub-clauses A. and C.

INITIAL HIRE is to be reckoned at the rate of .60d. per day of 24 hours per ton of 40 cubic feet of bale space provided for cargo while the steamer is on hire to the Pool...The total times, while in Port, are to be added together...While at sea Initial Hire is to be counted as one day for each 240 nautical miles steamed as per schedule of distances attached hereto,
the total distance steamed being divided by 240 miles...

It is understood that under no circumstances can a steamer be earning Initial Hire at one and the same time from both the Eastward and Westward Pools, nor does a steamer earn Initial Hire when [in] dry-docking, or repairs, or other causes...

**COALING ALLOWANCE** is to be reckoned at the rate of .16d per unit ton of 40 cubic feet of bale space provided for cargo for each 50 nautical miles steamed, as per schedule attached hereto, the total distance steamed being divided by 50...Owners are to guarantee that their Steamers shall proceed at full usual speed whenever practicable, but not necessarily at exceeding 10 knots average.

(A) Initial Hire Eastward is to begin when the steamer is ready to go on the loading berth at her assigned first port of loading...Initial Hire is not to count before the date allotted to the steamer by the New York Conference Committee...

(C) **COALING ALLOWANCE EASTWARD** is to be reckoned according to the total Schedule distances steamed, such distances to be those for which the steamer is credited with Initial Hire

4. The balances of the said Pooling Accounts, after crediting them and debiting them with the amounts as aforesaid, shall be ascertained, and the rate per cent which such balances bear to the total Initial Hire credited to the Owners of all the steamers...shall be calculated. The Owners of each steamer are to be then credited with an amount the equivalent of the rate per cent so ascertained upon the amount of the initial hire of each of such owners' steamers included in [the] Poolas for instance, should the balance remaining equal to 10 percent on the total Initial Hire paid for all the steamers...the Owners of each steamer will be credited with an additional 10 percent upon the Initial Hire money of their steamer. Those Owners who are then found to be indebted to the Pool shall forthwith pay the amount of such indebtedness to the Pool Managers, and the Managers upon receipt of the same shall pay to the Owners who have a balance in their favour the amount of the balance...

5. [deals with force majeur]

16. [enforcement, copy of clause 12 in Appendix A, the conference agreement]

17. This agreement is in force as regards the Eastward Pool from the first steamer leaving New York on or after April 1st, 1905...

Notice to terminate this Agreement may be given by any of the signatory parties at any time not less than 12 months from the date of signature: such notice shall only take effect at the end of the current Pool period, but if the notice be given within three months of the end of a current Pool period it shall not take effect till the end of the Pool period next succeeding; provided always that it does not continue after the termination of the Eastward or Westward Agreements as the case may be.
This Agreement was completed in London, on the 13th April, 1905, as per Signatures attached on the following page.

DODWELL & Co., LTD.,

THOS. M. DERMER.

p.p. T.B. ROYDEN, and by written Authority of the HAMBURG AMERICAN LINE, and the "UNION" S.S. Co., of Hamburg,

P.L. ROOPER

By Authority of Barber & Co., INCD.,

WALTER CHAMBERS.

FOR THE LANCASHIRE SHIPPING COY.,

JAMES CHAMBERS & CO.

By Authority of RANKIN, GILMOUR & CO.,

WALTER CHAMBERS.

WILLIAM ADAMSON & CO.,
on behalf of Messrs. Shewan, Tomes & Co.
For the AMERICAN AND ORIENTAL LINE,
HOWARD HOULDER & PARTNERS, LTD.,

ALEX. FREELAND, Director,
General Managers.

p. pro. ANGLO-AMERICAN OIL CO., LTD.,

Jas. McDonald, Director.

Witness to the Signatures of THOS. M. DERMER, P.L. ROOPER, WM. ADAMSON & CO., ALEX. FREELAND AND JAS. MCDONALD,

RCH. MACLEAN,
Manager Shipping Department,

ANGLO-AMERICAN OIL CO., LD.,
22, Billiter Street, London, E.C.

Witness to the Signatures of WALTER CHAMBERS, and MESSRS. JAS. CHAMBERS & CO.,

THOS. M DERMER.

Source: Excerpts from Exhibit 3, Petition in Equity, pages 38–47.

**APPENDIX C. PACIFIC MAIL STEAMSHIP COMPANY**

Dear Sirs: To those exporters from Japan Ports to Pacific Coast Ports of the United States and Canada, who, from the 15th February, 1911, to the 31st December, 1911, may have found it to their interest to confine their support and shipments to the
Pacific Mail Steamship Co. we have decided to allow a rebate on the freight paid as per Bill of Lading as follows:

On Pacific Coast Cargo: All cargo (except Raw Silk, Silk Goods, Rice, Peanuts, and Cement), a rebate of $1.00 gold per ton weight or measurement as per Bill of Lading.

- Raw Silk, Net.
- Silk Goods, Net.
- Rice.
- Peanuts.
- Cement, a rebate of 10 cents per cask.

On Ocean Proportion of through rates to Overland Points:

All cargo (except Raw Silk and Silk Goods) a rebate of 20 percent off the Ocean proportion of the through rate.

- Raw Silk, Net.
- Silk Goods, Net.

On the 1st July, 1911, to those exporters from Japan, who, from the 15th February, 1911, to the 30th June, 1911, may have found it in their interest to confine their support and shipments during that period to the Pacific Mail Steamship Co. we shall be glad to allow a return of fifty percent of the above rebate on the freight paid as per Bill of Lading.

On the 2nd of January, 1912, to those exporters who, on the 31st December, 1911, may have found it in their interest to confine their support and shipments during the previous ten and a half months to the said Line, we will allow a further fifty percent of the above rebate, on freight contributed from 15th February, 1911 to the 30th June, 1911, and fifty percent of the above rebate on freight contributed during the six months from the 1st July, 1911, to the 31st December, 1911.

On the 1st July, 1912, to those exporters who, on the 30th June, 1912, may have found it in their interest to confine their support and shipments during the previous sixteen and a half months to the said Line, we will allow a further fifty percent of the above rebate, on freight contributed from 1st July, 1911 to the 31st December, 1911, and fifty percent on freights contributed during the six months from the 1st January, 1912, to the 30th June, 1912.

Until further notice future rebates will be payable Semi-Annually on the same terms and conditions as above set forth.

Until further notice, shipments made by Toyo Kisen Kaisha, Portland & Asiatic S.S. Co., Canadian Pacific Railway Co.'s Royal Mail Steamship Line, Nippon Yusen Kaisha, Great Northern S.S. Co., Ocean S.S. Co., Ltd., China Mutual S.N.
Co., Ltd., The Bank Line, Ltd., and Osaka Shosen Kaisha, will not invalidate claims for the above.

No rebates will be payable to any exporter, shipper, or consignee who has accepted concessions of any nature from any steamship Line other than the above agreed rebates.

Exporters applying for the rebate which will be payable in Yokohama and Kobe on and after the 1st of July, 1911, 2nd January, 1912, and 1st July, 1912, respectively, must fill up and sign forms in accordance with the above terms and conditions.

These forms can be obtained from the Agents of the Company.

Yours Truly

(Sgd) B.C. Howard, Agent, Yokohama.
Yokohama, January 25th, 1911.

Source: Committee, volume 4, pages 131–132.

APPENDIX D. AGREEMENTS IN THE AMERICAN TRADES

<table>
<thead>
<tr>
<th>Carrier Agreement and Trade</th>
<th>Nature of Agreement</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trans-Atlantic Freight Conference, covering the eastbound trade to Great Britain from Canada and northern ports of the United States.</td>
<td>Sets minimum freight rates. The agreement does not include bulk commodity rates.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Conference covering the westbound trade from Great Britain to Canada and northern ports of the United States.</td>
<td>Sets minimum freight rates.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>N.D.L.V. Westbound Freight Agreement, covering the westbound trade from northern Germany, Holland, and Belgium to the United States carried by the Hamburg-American Line, North German Lloyd, Holland-American Line, and the Red Star Line.</td>
<td>Sets minimum rates and sailing schedules, and allots freight receipts according to determined proportions.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Trade eastbound from the United States to Belgium, Holland, and Germany.</td>
<td>No identifiable agreement on either prices or quality, yet there is extremely close communication between the lines on trade matters.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Agreement between the N.D.L.V. Lines and Compagnie Generale Transatlantique.</td>
<td>The port of Havre (closest link to Paris) is reserved for the CGT for traffic to and from the United States. The CGT agrees not to sail to or from any port between Cronstadt and the French border.</td>
<td>Inflexible.</td>
</tr>
</tbody>
</table>
### American Shipping Cartels

<table>
<thead>
<tr>
<th>Carrier Agreement and Trade</th>
<th>Nature of Agreement</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreement between Holland-American Line and the Russian East Asiatic Line in the trade from the United States to Rotterdam.</td>
<td>The Russian East Asiatic Line promises not to offer rates below those of Holland-American Line.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Agreement between the Red Star Line and the Phoenix Line in the trade between Antwerp and New York.</td>
<td>The Phoenix Line agrees not to charge rates more than ten percent below those of the Red Star Line. The Phoenix Line also commits not to carry certain high-value commodities.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Agreement between the leading lines from Galveston to Liverpool.</td>
<td>“Absolute harmony” leading lines’ rates. Lines notify one another of rates and consult each other on rate changes.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>The Baltic Pool from the North Atlantic ports of the United States to Baltic ports.</td>
<td>Earnings are pooled and divided according to determined proportions. Fixes rates.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>The Baltic Pool from Baltic ports to northern ports of the United States.</td>
<td>Fixes rates and pools earnings as above.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Mediterranean Freight Traffic Agreement covering westbound traffic from Italy to the United States.</td>
<td>Determines common freight rates and specifies minimum number of sailings, Pools and distributes earnings.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Mediterranean Eastbound Freight Agreement covering eastbound trade from the United States to Italy.</td>
<td>Rates fixed in New York by representatives of the lines.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Direct traffic between Spain and the United States.</td>
<td>Agreement to fix freight rates.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Cargo from Turkey to the United States that is trans-shipped in England (the majority of the cargo).</td>
<td>Fixes the sailing rotation of lines from Constantinople to Liverpool. Also controls freight rates.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Carrier Agreement and Trade</td>
<td>Nature of Agreement</td>
<td>Classification</td>
</tr>
<tr>
<td>----------------------------</td>
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</tr>
<tr>
<td>Trade from New York to South African ports.</td>
<td>Fixes the proportion of sailings for each line. Freight earnings are pooled and distributed based on the proportion of sailings. Fixes rates.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Agreement covering the trade from New York to West African ports.</td>
<td>Fully coordinated joint service among seven lines in which rates and sailing schedules are fixed. Earnings are pooled.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Agreement on trade from the U.S. Atlantic ports to Australia and New Zealand.</td>
<td>Tonnage is provided according to determined percentages and profits are divided according to those same percentages.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Eastward agreement from U.S. Atlantic ports to East Asia via Suez.</td>
<td>Rates and sailings are fixed. Pooling agreement.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Westward agreement from East Asia to the US Atlantic via Suez.</td>
<td>As above.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Direct trade from U.S. East Coast to India. (Does not include cargo that is trans-shipped in England.)</td>
<td>Joint service between two firms that fixes tonnage, rates, and pools revenue.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Direct trade from India to the U.S. East Coast. (Does not include cargo that is trans-shipped in England.)</td>
<td>The joint service above has an agreement with a third line to fix rates and allot sailings.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Direct service from New York to Java. (Does not include cargo that is trans-shipped in Holland).</td>
<td>Joint arrangement between two lines in which rates and tonnage are coordinated.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Trans-Pacific Tariff Bureau (Hong Kong and China to U.S. Midwest via the U.S. West Coast).</td>
<td>Fixes rates from Hong Kong, Keelung, and ports of call in China and the Philippines to overland (not west coast) common points in the United States.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Trans-Pacific Tariff Bureau (North American West Coast to East Asia).</td>
<td>Publishes common tariff for freight movements from Portland, Tacoma, Seattle, Victoria, and Vancouver to Japan, Shanghai, Hong Kong, and Manila, among other Asian ports.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Agreement between the Pacific Mail Steamship Company and Toyo Kisen Kaisha in the trade from San Francisco to East and Southeast Asia.</td>
<td>Fixes rates and coordinates sailings. These are the only two liner companies serving these trades.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Carrier Agreement and Trade</td>
<td>Nature of Agreement</td>
<td>Classification</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Calcutta-Pacific Conference covering traffic from Calcutta for the United States that is trans-shipped in Hong Kong.</td>
<td>This is an agreement between, on the one hand, the two lines that carry freight from Calcutta to Hong Kong and, on the other, the nine lines that carry freight from Hong Kong to the west coast of the United States that fixes through rates from Calcutta to the U.S. west coast and divides the revenue such that one-third goes to the Calcutta lines and two-thirds go to the Trans-Pacific lines. Inflexible.</td>
<td></td>
</tr>
<tr>
<td>Trade from southern and central Brazil to the United States.</td>
<td>The only commodity of note is coffee. The rates on this commodity are strictly fixed “at the highest possible level.” This agreement between four firms excludes two from serving New Orleans, and limits a third's sailings to New Orleans. The same three lines are restricted in their sailings to New York. The fourth line is free to send as many ships as it wishes to either port.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Trade to southern and central Brazil from the United States.</td>
<td>Limits sailings of each line from New York (there is little freight for Brazil that does not originate there). Fixes rates.</td>
<td></td>
</tr>
<tr>
<td>Agreement between the lines serving southern and central Brazil to and from the United States and the line serving the trade between northern Brazil and the United States.</td>
<td>The ports from Pernambuco to the Amazon are allotted to the Booth Line. The Booth Line commits to not enter the trade between the United States and Brazilian ports south of Pernambuco.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>The trade from New York to the River Plate.</td>
<td>Carriers meet weekly to review and fix freight rates.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Northbound trade from the River Plate to the United States.</td>
<td>Agreement to fix freight rates.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Agreement between Royal Dutch West India Mail and the Red “D” Line in the trade between New York and Venezuela.</td>
<td>Royal Dutch promises not to undercut the Red “D” Line by more than ten percent.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Carrier Agreement and Trade</td>
<td>Nature of Agreement</td>
<td>Classification</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Pooling Agreement between the Hamburg-American Line and the Royal Mail Steam Packet Line in the trade between New York and the Caribbean.</td>
<td>Royal Mail promises not to call on Haitian ports or Port Limon, Costa Rica. Hamburg-American Line promises not to call at Trinidad or Granada except with “cruising steamers.” Services to and from Jamaica, Colombia, and Panama are coordinated, rates are fixed, and fifty percent of their total freight revenues on those three.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>Traffic from the United States to Panama (including freight for trans-shipment to the west coast of South America).</td>
<td>The U.S. government, through the Panama Railroad Co., operates a line of steamships. All of the lines adopt the rates of the U.S. government. The lines consult with one another.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Traffic from the west coast of South America to Panama for trans-shipment to the United States.</td>
<td>Agreement to fix freight rates.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Traffic from the west coast of South America to New York via the Straits of Magellan.</td>
<td>“Agreement to regulate freight rates.”</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Trade between San Francisco and Mazatlan, Mexico and ports on the west coast of Central America.</td>
<td>Agreement on freight rates.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Rate understanding between the United Fruit Company and Royal Mail/Hamburg-American in the trade from New York to Port Limon, Costa Rica.</td>
<td>United Fruit agrees to observe identical freight rates as the pooling lines.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>New York, Boston, and Baltimore to Havana.</td>
<td>Rate cooperation between the lines: “Arrangement as a matter of business policy of talking over what the rates might be.”</td>
<td>Flexible.</td>
</tr>
<tr>
<td>The Gulf Foreign Freight Committee. U.S. Gulf ports to Havana.</td>
<td>These lines fix rates and publish a common tariff (list of rates).</td>
<td>Flexible.</td>
</tr>
<tr>
<td>New York to and from Haiti.</td>
<td>Royal Dutch West India and Hamburg-American Line divide Haitian ports, pool sixty percent of the freight earnings, and maintain the same rates.</td>
<td>Inflexible.</td>
</tr>
<tr>
<td>From Trinidad to the United States.</td>
<td>Agreement to maintain freight rates and publish a joint tariff.</td>
<td>Flexible.</td>
</tr>
<tr>
<td>Between Bermuda and the United States.</td>
<td>Agreement to fix rates.</td>
<td>Flexible.</td>
</tr>
</tbody>
</table>
ACKNOWLEDGMENT

We would like to thank the participants of the 38th Annual Cliometrics Conference for numerous helpful suggestions and discussion. We would also like to thank an anonymous referee for many useful comments that have improved this paper. Financial support from CIBER is gratefully acknowledged. We alone remain responsible for any errors.

NOTES

1. Advisory Commission on Conferences in Ocean Shipping (1992, p. 17.2).
3. The U.S. Congress recently passed the Ocean Shipping Reform Act of 1998, which was signed by the President on October 14, 1998. The law continues the antitrust immunity for conferences, but does increase member firms’ legal right to diverge from conference rates. Conference agreements must permit member firms to sign long term (usually one year) “service” contracts with exporters in which exporters will receive discounts based on volume. Previously, some conferences discouraged or prohibited their members from doing this, although they were permitted to offer independent rates on individual shipments, with advance warning, beginning in 1984. Policy interest is strong on the other side of the Atlantic as well. In September 1998 the European Competition Commission fined members of the Trans-Atlantic Conference Agreement $318 million for abuse of market power. This fine is the largest the Competition Commission has ever levied in a price-fixing case. See Wall Street Journal Interactive Edition, September 16, 1998, “E.U. Fines Group for Abuse of Dominant Position” and Freudmann (1998).
4. See Marx (1953, pp. 260–262) and Deakin and Seward (1973, pp. 119–123). Scott Morton (1997) documents that a source of price wars was the desire to push new entrants out of some routes.
5. During this era all major routes were cartelized.
7. Some of these other routes may also be covered by restrictive agreements.
8. Throughout this paper, the term “global” refers to the total capacity or tonnage of firms on all the routes where they operate.
9. See Pirrong (1992, p. 96). Hyde (1975, p. 109), also describes how conferences on the Liverpool-U.S. route “disintegrated as soon as trading conditions began to worsen.” Indeed, it has been observed that shipping conferences are particularly designed to avoid these price wars. Marx (1953, p. 5), notes that “Shipping conferences appear to achieve their greatest activity in commercially stormy weather when the supply of shipping is superfluous and rate-cutting is threatened or rampant. When space is tight the conferences have...in extreme cases disbanded.”
10. Gottheil (pp. 66–67). American Asiatic was operated by the Hong Kong based trading firm Shewan, Tomes, and Co. American and Oriental Line was a joint service of Prince Line, Howard Houlder and Partners, Andrew Weir and Co., and Houlder, Middleton and Co. Other parties to the conference agreement included Barber Line, which had provided intermittent service on the route for some time, the Anglo-American Oil Co. (Standard Oil), and the American and Manchurian Line. The latter only operated vessels from the Far East to the U.S. east coast (House Committee on Merchant Marine and Fisheries, Vol. 4, pp. 110–111).
12. Some very small trade routes were monopolized by joint ventures, such as the direct trade from the U.S. eastern seaboard to India and the direct trade between New York and West African ports. Joint ventures typically required cooperation and coordination of both operations and finances to a degree
beyond what was accomplished by most cartels. This was difficult to maintain when there were more than two firms or when the trade grew to a significant level, requiring even closer management.

13. The most famous of these was the creation of the International Mercantile Marine Corporation through the merger of five steamship lines—White Star, Leyland, Dominion, Atlantic Transport, and International Navigation. This merger took place in 1902. The firm faced severe financial difficulties that were only helped by the extreme shipping conditions of the war. See Navin and Sears (1954); Marx (1953, p. 239), also points out that “national-flag considerations” of countries that wish to maintain a merchant marine frequently impede merger.

14. Whether firms would have chosen to merge in the absence of collusion as a practical or legally-permissible option is an interesting question, but one beyond the scope of this paper.

15. This copy is presented in Appendix A.

16. This may be contrasted with the enormous competition between firms to build ever-larger vessels on the Trans-Atlantic trade.

17. The key features of the pool are presented in Appendix B.


19. A copy of such a contract is included in Appendix C.

20. The New York-Far East conference offered service to these inland points in the Midwest and South through their service via the Suez Canal. Examination of the rebate contract in Appendix C shows that the rebate on general cargo from Japan to the Pacific Coast was $1.00 gold per ton weight or measurement (2,200 pounds or 40 cubic feet) and the rebate on such cargo to overland points was 20 percent. For most manufactured items the rebate to overland points was considerably higher because they were not typically shipped in large quantities. Extremely bulky items such as most agricultural products, however, would receive a higher rebate in percentage terms when shipped to the coast. As noted above, nonetheless, rice was exempt from any rebate on shipments to the coast. Effectively, the percentage rebate was much higher for most conceivable imports on the overland route than the coastal route.

21. It should be noted that the New York-Far East conference did not offer a deferred rebate eastbound (to the Far East from New York), but it did offer one westbound (from the Far East to New York). Similarly the Trans-Pacific westbound (to the Far East from the United States and Canadian Pacific ports) conference did not offer a deferred rebate to its customers either. The conference from Hong Kong and China to the Pacific Coast of North America also did not offer a deferred rebate. For a discussion of the deferred rebate contract and its effectiveness, see Sicotte (1997).

22. We choose this terminology because firms’ decisions about their own quantity are more “flexible” when they do not coordinate it with others.

23. In this time period, all major routes were subject to a cartel agreement. We were able to include 80 percent of them in our data-set.

24. We adopted this definition of flexibility because of its lack of ambiguity. Any other definition would be more problematic since it is more difficult to rank the non-price clauses of a cartel agreement in terms of their restrictiveness to the firms or the required degree of co-ordination. Our definition makes the natural distinction between simple rate fixing agreements and agreements that go beyond rate-fixing. The latter group can clearly be thought of as involving a higher degree of integration among the firms.

25. Appendix D provides an annotated list of the conferences included in our sample.

26. Summary statistics and correlations of the variables in the data-set are shown in Tables 1 and 2, respectively.

27. The intuition for this is that some of the “threat-capacity” of these markets is used to enforce collusion on the other markets, thereby weakening the degree of co-operation that can be sustained in them.
28. Notice that, since in all major routes are subject to a conference agreement, there is no interaction between firms in non-cartelized markets. It is the absence of such an interaction which makes the possibility of unilateral retaliation remote.

29. These larger vessels imply increased fixed or "lumpy variable" costs for the firms. Pirrong (1992) and Sjostrom (1989) point out that such cost function characteristics increase the likelihood that competitive prices will not be sufficient to sustain the industry.

30. One might think that this also makes retaliation more difficult. However, retaliation can take place in other markets.

31. Recall that during this time period all major routes are cartelized, and that we were able to include 80 percent of them in our data-set. Therefore, we need not be concerned about any possible selection bias and standard probit analysis is an appropriate way to analyze the data.

32. For instance consider a cartel with two equal sized firms. The Herfindahl index for this cartel is equal to 0.25. Consider, next, another cartel with two firms, one of which has a global capacity that is 10 times that of the other. The Herfindahl index for this cartel is 0.835. The Herfindahl index captures the fact that the second cartel is more concentrated than the former, whereas using the number of firms as an index of concentration would treat these two cartels as being of equal concentration.

33. These two models have an identical specification except that in Model 1 the Herfindahl index is used as a measure of concentration whereas in Model 3 the number of firms is used as a measure of concentration. Both models indicate that concentration increases the likelihood of a tight cartel agreement, but the log-likelihood of Model 1 is much higher than that of Model 3.

34. A commonly used model selection criterion for this case is the Schwarz criterion. For models with 47 observations, a model with $K_1$ regressors and maximized value of log-likelihood equal to $L_1$ is selected over a more parsimonious model with $K_2$ regressors and log-likelihood $L_2$ if $(K_1 - K_2)\times 1.925 L_1 - L_2$. It can be immediately seen that the model with the regional dummies does not yield a sufficient increase of the log-likelihood to be selected over the model with route length as a regressor. [The Schwarz criterion selects the model with the highest value of $\ln(L) - \frac{1}{2} K \ln(N)$, where $L$ is the model likelihood, $K$ the number of estimated parameters and $N$ the number of observations. See Schwarz (1978) for details.]

35. The log-likelihood of this model is given by $\ln(L) = \Sigma_i B_i (N_i, K_i, p_i)$, where $B_i$ is the density of the binomial distribution, $N_i$ is the number of cartels a firm participates in, $K_i$ is the number of tight cartels it participates in, and $p_i$ is the probability function parameterized as shown above.

36. The value and statistical significance of $\alpha$ is, of course, not important.

37. When both TONNAGE and SHIPS are included in the parameterization of $p_i$, neither is statistically significant. This is not surprising given that these two variables are highly correlated ($\rho = 0.88$). The coefficient for SHIPS remains almost the same, at 1.525929, while that of TONNAGE reduces to only 0.4945916. This leads us to believe that the number of ships is the relevant measure of firm size for determining the membership of firms into cartels of different types, with tonnage acting only as a proxy.

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