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AN EMPIRICAL ANALYSIS OF OCEAN LINER SHIPPING (*)

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ABSTRACT: In this paper I estimate a model of the regulated international ocean liner shipping industry in which I examine conference rate determination in the context of trade route characteristics, including quality and market structure. Acting as a cartel, firms set a monopoly price collectively and then determine quality levels individually. The cartel does not attain monopoly profits, because each cartel member myopically determines quality without regard for overall cartel profits.

The model is modified to include other factors that affect price determination. The cartel is presented as the dominant firm in the market, instead of a monopoly as originally formulated, making cartel market share an additional factor in price determination. These modifications produce a three equation model, simultaneous in price, quality, and market structure.

The model is estimated both with ordinary least squares and two stages least squares regression analysis. A rate index is used as the measure of price for the eleven commodities included in the study.

In the market share and quality equations, quality and barriers to entry both have a significant positive effect on conference market share. Unit value has a positive effect on quality, and the "cream-skimming" hypothesis is strongly rejected.

In the rate equations, the effect of the number of firms in the conference on rate is negative and significant. Both increases in market share and cost tend to increase rate. The major disappointing result is the negative effect of quality on rate.

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INTRODUCTION

Ocean liner cartels, or shipping conferences, and the role of government in the ocean liner shipping industry have been the subject of controversy since the beginning of the conference system, before the turn of the century. In this paper, I estimate a model of shipping conference behavior, which improves upon existing empirical studies by examining conference rate determination in the context of trade route characteristics, including quality and market structure. This analytical framework has wider applications to other industries where individual firms have no effect on price, perhaps because of regulatory constraints, and engage in some form of non-price competition.

This paper consists of five sections. Section I is an introduction, which concludes with a review of the literature. Section II is a description of the model. Methodology of the estimation is described in Section III, and empirical results are presented in Section IV. Section V presents a summary and conclusions.

Ocean liner shipping is regularly scheduled service on established ocean routes between countries or areas. At the beginning of the twentieth century, carriers organized themselves into cartels, which are known as shipping conferences.

The chief purpose of the conference is to set rates on the commodities its members carry. Shipping conferences are basically cartels that engage in price fixing; all members must charge the agreed upon rate. All liners including conference carriers that call at U.S. ports are subject to the provisions of the 1916 Shipping Act. All agreements among carriers must be filed with the FMC (1916 Shipping Act, Section 15). Once the conference agreement itself is in effect, the conference is granted antitrust immunity (1916 Shipping Act, section 15).

REVIEW OF THE LITERATURE

Most of the empirical studies on ocean liner shipping use regression analysis to explain variations in freight rates. Results of some of these studies are discussed below.

Heavor (1973) finds that the most important factors affecting commodity freight rate levels on routes between the Pacific Coast of North America and

Japan and Australia are the commodity stowage factor and commodity unit value. Both of these variables have positive, significant coefficients in all three of his regressions.

Bryan (1975) tests two models of ocean freight rates for outbound Canadian trade routes. Although her results are not uniform across trade routes, she concludes in Model 1 that freight rates within a single trade route vary positively with unit value, indicating that conferences engage, to some extent, in price discrimination across commodities, and that freight rates vary positively with stowage of commodity, although the value of this coefficient varies widely across trade routes.

In Model 2, she examines freight rates for a single commodity across trade routes for about two dozen commodities on 19 to 31 trade routes. Her results in Model 2 vary quite extensively across commodities, both with respect to value and sign of coefficient and degree of significance. No conclusions are drawn about the effect of non-conference liners; the sign and degree of significance of this coefficient vary especially widely across commodities.

Jansson and Shneerson (1986 and 1987) analyze 46 trade routes worldwide. Their results support earlier findings that the commodity stowage factor and unit value of the commodity are very significant explanatory variables. The signs of the coefficients of both unit value and commodity stowage factor are consistently positive, although the value of the unit value coefficient varies widely. They suggest that differences in degrees of competition on the different trade routes may explain the variation in the value of the unit value coefficient but are unable to provide empirical evidence to support their assertion.

DESCRIPTION OF THE MODEL

Shipping conferences are price-fixing cartels. In the model that is estimated, price is determined jointly by the firms in the conference. The group-determined price is taken as fixed by member firms, which then set their own quality levels to maximize individual profits. The conference quality level is the sum of the individual firms' quality levels.

Initially, the conference is assumed to be a pure monopolist, and member firms are assumed to collude perfectly with respect to price. Nonetheless, the conference does not attain monopoly profits because of the myopic behavior

of member firms, who increase demand for their output by increasing a quality variable without regard for the effect on conference profit.

The first two equations of the model describe conference price and quality level, where price is the monopoly price, assuming perfect collusion by member firms, and quality is the sum of the member firms' individual profit maximizing quality levels.

$$P = P(E,m,C) \quad [1]$$

$$A = A\ (E,m,P,C), \quad [2]$$

where P is conference price, A is conference quality, E is elasticity of demand, m is the number of firms in the conference, and C is cost. Price is expected to increase as cost increases and to decrease as elasticity and the number of member firms increases. Quality is expected to increase as elasticity, number of member firms and price increase and to decrease as cost increases.

The assumption of perfect collusion with respect to price is now dropped. Instead, interfirm rivalry prevents the firms from agreeing on the monopoly price. Any factor that makes agreement more difficult among the firms in the cartel will tend to reduce the success of joint profit maximization, causing price to fall from the monopoly level (1).

Homogeneity of values tends to lessen rivalrous conduct within the cartel (Phillips, 1962). Rivalry increases as the number of firms in the group increases. The effect on price of an increase in the number of firms is ambiguous, however, because an increase in the number of firms increases the level of conference quality, which raises the profit maximizing price.

MARKET SHARE

Finally, the reality of non-conference lines is introduced to the model, which makes the conference a dominant firm, rather than a pure monopolist

(1) The difficulty of coordination is mitigated somewhat in the case of shipping conferences, because they are legal cartels whose coordination is encouraged and policed to some degree by government regulation. A coordination problem still exists.

and further thwarts the conference's attempts to achieve monopoly profits. The conference, acting as a dominant firm in the market, does, however, retain the ability to charge a higher than competitive price; that ability depends on the strength of the cartel's maket power.

The change in the conference from pure monopolist to dominant firm introduces several changes into the model. Conference market share, as well as other aspects of market structure, become additional factors in price determination. Market share is an endogenous variable, which adds a third equation to the model . Each of these effects is discussed below.

Monopoly, or market, power is defined to be the ability of a firm to raise price above marginal cost. Market power is directly related to the dominant firm's market share (Landes and Posner, 1981). We therefore expect a higher price where the conference's market share is larger.

The cartel's ability to set a monopoly price is strengthened were there are fewer viable alternatives available to shippers. Thus, to the extent that barriers to entry limit the number of rivals, we expect the cartel price will be higher when the barriers are higher.

The advent of containerization introduced an alternative means of transportation, intermodal shipping. Containerization allows cargo to be moved overland, via rail or truck, to a port for water transportation. On routes where there is no opportunity for intermodalism, fewer alternatives will be available to shippers, and the all-water conferences operating on these routes will be able to set a higher price. The introduction of market share modifies the price equation as indicated below:

$$P = P\,[E,C;m;A;S;H;BE;IM] \qquad [3]$$

where S is the cartel's market share, H is homogeneity of values (acting via rivalry), BE is barriers to entry, and IM is the possibility of intermodalism. Conference price is expected to increase as quality, market share, homogeneity of value and barriers to entry increase and to decrease as elasticity and intermodalism increase. The effect of the number of firms on price is now uncertain; more firms increase rivalry, reducing the ability of the cartel to agree on a monopoly price, but more firms also add to the cartel's quality, raising price.

Market share is in large part determined by other characteristics of market structure. Generally stated, anything that enables the cartel to compete more effectively with its rivals will tend to increase its market share. Conversely,

anything that helps rivals to compete effectively will tend to lower the cartel's market share. Barriers to entry and quality level offered by the cartel lie within the former category, and intermodalism and cream skimming in the latter. As member firms' quality levels increase, cartel quality increases, and cartel demand (and hence market share) increases. Price is among the most effective methods of competition available to the dominant firm. The lower the price it sets, the less will be supplied by the fringe firms. Therefore, as the monopoly price decreases, the cartel's market share will increase.

Effective competition by rivals will tend to reduce cartel market share. Non-conference carriers are frequently alleged to engage in "cream-skimming"; i.e. they carry only, or mostly, higher-valued cargo (2). Under this scenario, the rates for higher-valued goods subsidize the carrier that sets a below-cost rate for lower valued-goods. Thus, an independent that skims the cream can afford to charge a lower rate, and the conference will lose demand. The existence of the intermodal alternative will tend to decrease the market share of the all water conference on that route.

The market share equation is:

$$S = S\,(BE,CS,A,IM,P) \qquad [4]$$

where S is the market share of the conference, BE is barriers to entry, CS is cream skimming by independents, A is conference quality level, IM is the possibility of intermodalism, and P is conference price. Conference market share is expected to increase as barriers to entry and quality increase and to decrease as cream-skimming, intermodalism and price increase.

METHODOLOGY

Variables Used in Estimation

Unit value of the commodity is used to measure both price and quality

(2) See Marx, Jr. (1953, p. 195); The Transportation Center Northwestern University (1978, p. 16); Note. "The Shipping Act of 1916" (1981, p. 659); and UWIST (1978, p. 161).

elasticity of demand (3). As unit value increases, transportation costs become a smaller percentage of total commodity price, and therefore demand for the commodity becomes less sensitive to changes in transportation costs (Stigler, 1969). Rates are therefore expected to be higher as the unit value of the commodity increases.

Unit value is also used to measure quality elasticity of demand, following Graham, Kaplan and Sibley's (1983) opportunity cost notion of response to changes in quality. The higher the unit value, the more responsive will demand be to changes in quality. Other ocean freight rate studies include distance as a proxy for cost and find a positive effect on price (Binkley and Harrer, 1981).

Homogeneity of values will be measured in three different ways. The more diverse the nationalities in the conferences, the less homogeneous values will tend to be. The number of different countries represented in the conference is an indicator of this diversity. Alternatively, since all of the trade routes studied are from U.S. ports, the percent of carriers that are American companies is also a measure of homogeneity: the higher the percentage of United States carriers, the more homogeneous the values of the conference.

The open nature of conferences in the U.S. trades provides a third method of measuring homogeneity. A greater turnover in membership, as measured by the average number of years of membership in the conference per carrier, leads to greater heterogeneity of values (4).

We will use two alternative variables to account for barriers to entry: the dual rate contract and consumer loyalty. A dummy variable for the existence of dual rate authority will be included (5).

Consumer loyalty is captured with the variable AGE, the number of years since the conference was established. The longer a conference has been in existence, the more opportunities shippers have had to obtain information

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(3) See Lipsey and Weiss (1974), Jansson and Shneerson (1986 and 1987), and Frankel (1987, p. 140).

(4) These last two measures, percent of U.S. carriers and turnover in conference membership, may contradict each other. On the one hand, greater frequency of entry decreases the chances of homogeneity. On the other hand, suppose all that new entry is by US carriers. Then the increase in entry will increase the percentage of U.S. carriers, which by my measure will increase homogeneity.

(5) Section 10 (b) (9) of the Shipping Act of 1984 virtually elimanated dual rate contracts as a conference option.

about it. The "older" conference has had more opportunity to demonstrate its reliability and develop loyalty and goodwill with shippers (6).

Shippers are interested primarily in transporting their cargo as cheaply and quickly as possible. The more options they have available to them with respect to scheduling, the more easily they can accomplish the second goal. Frequency of sailings is, accordingly, among the non-price competition variables used in the transportation literature. (See Graham, Kaplan and Sibley, *op. cit.*). The number of conference sailings will be used to measure quality.

Market share is measured by the percent of sailings by conference carriers. A dummy variable takes on the value of "1" to indicate the existence of the intermodal alternative. The cream-skimming hypothesis predicts that conference market share will be smaller where average unit value is higler. Accordingly, unit value is used to measure the possible effect of cream-skimming.

Price will be measured by PBAR, an index of the eleven conference rates per commodity on each route. Two alternative versions of the rate index are used: PBAR, which includes rates for all eleven commodities, and PBAR2, which exclude rates for NOS and NOSR. The "commodities" NOS and NOSR have no unique characteristics and are therefore considered to play a different role from more "specific" commodities.

On each trade route, a different number of observations exists for each commodity. PBAR is not, therefore, a simple average of rates for all commodities on each route but an average of rates for commodities for which rate data exist on each route. Therefore, not only does the value of PBAR vary on each route, as any variable would because of different values on each observation, but PBAR is essentially a different variable on each route, depending on what commodities are included in the average.

In order to account for this, dummy variables for each commodity are included as regressors in each regression. The dummy variable takes on the value "1" if the commodity is included in PBAR for that observation and "0" otherwise.

The Sample

The sample covers the year 1977 for outbound conferences serving United

(6) A problem with AGE is that it does not account for possible changes in conference membership.

States ports. Each observation is a port pair, e.g., New York to Oslo; there are 124 observations.

The commodities included in the study are televisions (with and without parts), building cement, refractory cement, cigarettes, tallow, television tubes, photographic equipment, and refrigerators. Also included are the two "commodities" carried by all conferences, NOS, not otherwise specified, and NOS, refrigerated.

All rates are taken from the conference tariffs and were converted to long tons from metric or short ton equivalents. Surchages for refrigeration, heavy weight, port congestion, etc. were not included.

All equations will be estimated across trade routes. All equations will be log linear (7). The three equations that will be estimated are

$$PBAR = PBAR\ (UV, DIST, m, A, S, H, BE, IM) \quad [5]$$

$$A = A\ (UV, m, PBAR, DIST) \quad [6]$$

$$S = S(BE, UV, A, IM, PBAR), \quad [7]$$

where

PBAR = an index of conference rates (dollars per long ton on a particular port pair)

UV = unit value

m = number of carriers in the conference

A = number of conference sailings

S = percent of sailings by conference carriers

H = a measure of homogeneity, measured by one of the following variables:

memage = average years of membership in conference per carrier

%US = percent of US flag carriers in the conference

CTYS = the number of different nationalities in the conference

DRC = a dummy variable indicating FMC approval of dual rates

AGE = the number of years since the conference was established

IM = a dummy variable indicating the presence of an intermodal alternative to the all water route.

Dist = distance between port pairs.

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(7) See Lipsey and Weiss (*op. cit.*) and Jansson and Shneerson (1986) for discussions of the use of the log form.

EMPIRICAL RESULTS

Results appear in Tables 1 through 6 and begin with the OLSQ results.

OLSQ Results

Rate

The strongest result of the PBAR and PBAR2 OLSQ regressions is the negative and significant coefficient for the variable MEM. This result supports the hypothesis that the ability to set the higher monopoly price decreases as the number of firms in the cartel increases.

The coefficients of MEMAGE, market share and distance are all positive and significant, as expected, suggesting that homogeneity of values, larger market share, and distance, which increases costs, each contributes to increasing rates on the particular route.

The coefficients on DRC and IM, negative and positive, respectively, and significant in most cases, are different from expected. An explanation for the DRC result is not readily apparent, but two for the IM result present themselves.

IM measures one form of competition to all water routes. The existence of rivals theoretically reduces the firm's ability to set a higher than competitive price. Because of the sample, however, the values of IM do not vary much across routes. It is possible for IM to have a non-zero value only on a route that crosses the American continent. This constraint restricts IM equal to 1 to routes from the West Coast to Europe and Africa and from the East Coast to the Pacific, for which there are only, at most, 40 observations. When the sample size is further restricted by the peculiarities of the commodities, the explanatory power of the variable IM becomes negligible.

In addition, since the variable IM takes on the value "1" only on transcontinental routes, those observations for which IM equals 1 are, by definition, among the longest routes. The postive correlation between the variables IM and DIST implies that IM measures distance, as well as potential competition, and it is the effect of distance that is more strongly reflected by IM, thus explaining the positive coefficient.

TABLE 1

Ordinary Least Squares Rate Regression with Rate Index
(t-statistics are in parentheses.)
(All variables are logarithms.)

DEP VAR	N	R^2	C	MEM	AGE	MEMAGE	CTYS	PCTUS	A	S	DIST	DRC	IM
PBAR	124	.89	2.68	.13	-.03	.50			-.07	.20	.19	-.19	.05
			(3.07)	(2.98)	(-.43)	(3.84)			(-4.11)	(4.77)	(3.88)	(-3.09)	(.73)
PBAR	124	.92	5.28	-.70	-.30		.65		-.06	.15	.26	.04	.21
			(10.12)	(-7.30)	(-5.01)		(8.01)		(-3.89)	(4.19)	(6.19)	(.87)	(4.36)
PBAR	124	.93	8.43	-.34	-.46			-.32	-.05	.11	-.02	-.04	.17
			(14.3)	(-7.32)	(-7.56)			(-9.88)	(-3.37)	(3.45)	(-.56)	(-1.03)	(3.83)
PBAR2	124	.91	-.07	-.10	.23	.31			-.08	.19	40	-.17	.26
			(-.12)	(-2.54)	(5.57)	(2.75)			(-4.67)	(4.79)	(9.25)	(-3.30)	(3.39)
PBAR2	124	.91	.22	-.31	.28		.16		-.06	.14	.43	-.13	.44
			(.41)	(-3.86)	(6.21)		(2.24)		(-3.18)	(3.38)	(8.67)	(-2.61)	(7.94)
PBAR2	124	.91	.81	-.22	.26			-.08	-.05	.13	.37	-.16	.44
			(1.78)	(-5.07)	(6.28)			(-2.69)	(-2.85)	(3.03)	(8.81)	(-3.11)	(8.11)

PBAR = index of commodity rates on route, including NOS and NOSR
PBAR2 = index of commodity rates on route, excluding NOS and NOSR
MEM = number of carriers in conference
AGE = years since conference was established
MEMAGE = average years of membership in conference per carrier
CTYS = number of different nationalities in conference
PCTUS = percent of U.S. flag carriers in conference
A = sailings per month by conference
S = conference sailings as percent of all sailings
DIST = distance, from port of departure to port of destination
DRC = 1 if conference has dual rate authority, 0 otherwise
IM = 1 if intermodal service exists on the route, 0 otherwise

TABLE 2

Ordinary Least Squares Market Share Regressions
(t-statistics are in parentheses.)
(All variables are logarithms.)

DEP VAR	N	R^2	C	VLVL	A	AGE	PBAR	PBAR2	DIST	DRC	IM
S	124	.81	-6.11 (-4.02)	.04 (1.68)	.34 (14.24)	.33 (2.39)	.80 (4.43)		-.10 (-1.06)	.04 (.34)	-.20 (-1.56)
S	124	.77	.18 (.17)	.02 (.74)	.34 (12.93)	-.36 (-3.75)		.81 (4.34)	-.40 (-4.29)	.28 (2.51)	-.52 (-4.01)
S	124	.47	-1.43 (-.57)	.13 (3.30)		04 (.16)	.41 (1.36)		-.13 (-.85)	-.11 (-.65)	-.47 (-2.20)
S	124	.45	1.97 (1.26)	.13 (3.27)		.22 (-1.54)		.12 (.45)	-.20 (-1.41)	-.04 (-.25)	-.51 (-2.53)

TABLE 3

Ordinary Least Squares Quality Regression
(t-statistics are in parentheses.)
(All variables are logarithms.)

DEP VAR	N	R^2	C	VLVL	MEM	PBAR	PBAR2	DIST	VOLOB
A	124	.56	4.12 (1.61)	.48 (5.72)	.36 (1.39)	-.96 (-1.52)		.14 (.53)	.20 (4.86)
A	124	.58	4.21 (2.11)	.50 (6.22)	.19 (.76)		-.148 (-2.67)	.38 (1.39)	.19 (4.79)

S = conference sailings as percent of all sailings
VLVL = average unit value of all cargo on route
A = sailings per month by conference
AGE = years since conference was established
PBAR = index of commodity rates on route, including NOS and NOSR
PBAR2 = index of commodity rates on route, excluding NOS and NOSR
DIST = distance, from port of departure to port of destination
DRC = 1 if conference has dual rate authority, 0 otherwise
IM = 1 if intermodal service exists on the route, 0 otherwise
MEM = number of carriers in conference
VOLOB = outbound tonnage

TABLE 4

Two Stage Least Squares Rate Regression with Rate Index
(t-statistics are in parentheses.)
(All variables are logarithms.)

DEP VAR	N	R^2	C	MEM	AGE	MEMAGE	CTYS	PCTUS	A	S	DIST	DRC	IM
PBAR	124	.86	2.82	.11	-.04	.45			-.03	.34	.20	-.16	.12
			(2.68)	(2.14)	(-.45)	(3.05)			(-2.12)	(3.01)	(3.63)	(-2.19)	(1.31)
PBAR	124	.90	5.42	-.59	-.29		.54		-.11	.33	.24	.04	.24
			(8.61)	(-4.83)	(-4.18)		(5.20)		(-2.98)	(3.37)	(5.03)	(.71)	(4.03)
PBAR	124	.92	8.00	-.29	-.42			-.27	-.08	.27	.01	-.03	.21
			(11.35)	(-4.82)	(-5.85)			(-5.97)	(-2.35)	(2.80)	(.22)	(-.63)	(3.79)
PBAR2	124	.88	-.27	-.12	.25	.29			-.07	.31	.42	-.14	.33
			(-.40)	-2.58)	(4.86)	(2.27)			(-1.79)	(2.40)	(8.12)	(-2.16)	(3.56)
PBAR2	124	.87	.21	-.25	.29		.08		-.07	.33	.44	-.10	.50
			(.32)	(-2.02)	(5.46)		(.75)		(-1.76)	(2.70)	(7.21)	(-1.62)	(7.21)
PBAR2	124	..87	.50	-.20	.28			-.04	-.07	.32	.40	-.11	.50
			(.91)	(-3.14)	(5.59)			(-.84)	(-1.55)	(2.51)	(7.72)	(-1.81)	(7.32)

PBAR = index of commodity rates on route, including NOS and NOSR
PBAR2 = index of commodity rates on route, excluding NOS and NOSR
MEM = number of carriers in conference
AGE = years since conference was established
MEMAGE = average years of membership in conference per carrier
CTYS = number of different nationalities in conference
PCTUS = percent of U.S. flag carriers in conference
A = sailings per month by conference
S = conference sailings as percent of all sailings
DIST = distance, from port of departure to port of destination
DRC = 1 if conference has dual rate authority, 0 otherwise
IM = 1 if intermodal service exists on the route, 0 otherwise

TABLE 5

Two Stage Least Squares Market Share Regressions
(t-statistics are in parentheses.)
(All variables are logarithms.)

DEP VAR	N	R^2	C	VLVL	A	AGE	PBAR	PBAR2	DIST	DRC	IM
S	124	.52	-1.97	.10	.12	.11	.21		.01	-.08	-.31
			(-1.85)	(2.48)	(2.24)	(1.50)	(1.26)		(.16)	(-.78)	(-3.95)
S	124	.50	-1.43	.10	.12	.08		.11	.02	-.07	-.29
			(-1.61)	(2.53)	(2.08)	(1.21)		(88)	(.24)	(-.070)	(-3.76)

TABLE 6

Two Stage Least Squares Quality Regressions
(t-statistics are in parentheses.)
(All variables are logarithms.)

DEP VAR	N	R^2	C	VLVL	MEM	PBAR	PBAR2	DIST	VOLOB
A	124	.45	4.54 (2.71)	.54 (6.89)	.21 (1.31)	-.06 (-17)		-.37 (-2.86)	.22 (5.41)
A	124	.44	4.50 (2.89)	.54 (6.81)	.20 (1.29)		-.05 (-.17)	-.38 (-2.98)	.22 (5.47)

S = conference sailings as percent of all sailings
VLVL = average unit value of all cargo on route
A = sailings per month by conference
AGE = years since conference was established
PBAR = index of commodity rates on route, including NOS and NOSR
PBAR2 = index of commodity rates on route, excluding NOS and NOSR
DIST = distance, from port of departure to port of destination
DRC = 1 if conference has dual rate authority, 0 otherwise
IM = 1 if intermodal service exists on the route, 0 otherwise
MEM = number of carriers in conference
VOLOB = outbound tonnage

Market Share

These results strongly support several of the predictions of the model. The coefficient on quality, A, is positive and strongly significant, indicating that increasing quality tends to increase the conference's market share, as do barriers to entry, as indicated by the positive, significant coefficient on DRC. The negative, significant coefficient on IM supports the hypothesis that the existence of competition, which in this case takes the form of all water routes, reduces the conference's ability to raise price above the competitive level. As predicted, the coefficient on DIST is negative and significant, indicating that longer distances tend to increase price, which decreases market share.

The only disappointing result is for the variable PBAR, which is expected to have a negative effect on market share. Here the coefficient is consistently positive and significant.

Quality

These results generally are quite good. Outbound tonnage is included as an explanatory variable to scale the quality variable (8).

The coefficients on unit value and outbound tonnage are positive and significant, as expected. The coefficients on MEM and DIST are positive, as predicted by the model, but they are not significant. The sign on DIST is negative but not significant.

The results of the rate index variable are puzzling. The coefficients on both PBAR and PBAR2 are negative and significant.

Two Stage Least Squares

Generally, the two stage least squares results are similar to the results of the ordinary least squares regressions.

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(8) The use of VOLOB (outbound tonnage) as a right hand variable actually adds an endogenous variable, quantity, to the model, since quantity is a function of price in both a supply and demand relation. Since the volume of trade depends more crucially on GNP and distance and only weakly on the freight rate, a fourth equation will not be included in the model; instead, I will treat VOLOB as an exogenous variable.

Rate

When the rate index is measured by PBAR, these results are virtually identical to the ordinary least squares results in the PBAR regressions. The only exception is the coefficient on DIST, which changes from negative to positive, but it is not significant in either situation.

All of the coefficients retain the same signs when the rate index is measured by PBAR2, instead of PBAR. The significance of several of the coefficients, however, is much lower in the two stage least squares regressions when PBAR2 is used as the rate index. In all three regressions, the t-statistic for quality (A) is significant at the 10% level. In two equations, the t-statistic for DRC also is significant at the 10% level, and the coefficients on the variables measuring homogeneity lose their significance.

Market Share

The coefficient on unit value is positive but has a larger t-statistic, which enables us to reject the cream-skimming hypothesis.

The coefficients on quality (A) and AGE retain their predicted positive signs but the t-statistics are much lower than in the OLSQ regressions, so much so that the variable AGE loses its significance, even at the 10% level.

The coefficient on the rate index, regardless of whether PBAR or PBAR2 is used, retains its unexpected positive sign, but its t-statistic drops below 1.00.

The coefficient on IM remains negative, but in the two stage least squares regressions it is significant. The signs of coefficients on DIST and DRC change to positive and negative, respectively, but they both remain insignificant.

Quality

With the exception of the rate index variables and DIST, the two stage least squares results are basically similar to the ordinary least squares results.

The coefficients on PBAR and PBAR2, although of opposite sings, are both negligibly small with t-statistics barely different from zero. The coefficient on DIST changes to negative and becomes significant.

SUMMARY OF RESULTS AND CONCLUSIONS

Several major conclusions can be drawn from the regression results. In the rate regressions, there are three particularly strong results. (1) As the number of carriers in the conference increases, the freight rate falls. This supports the hypothesis that collusion to achieve a higher-than-competitive price becomes more difficult as the number of firms in the cartel increases. (2) As market share increases, the freight rate increases, which supports the hypothesis that a large market share confers some degree of market power on a firm (here, a cartel), enabling it to set a price higher than the competitive level. (3) As distance increases, the freight rate increases, which is consistent with the results of earlier freight rate studies.

In the market share share regressions, there are two main results. (1) We are consistently and strongly able to reject the frequently-advanced cream-skimming hypothesis. (2) An increase in quality tends to increase market share. The primary result from the quality regressions is the positive effect that unit value has on quality.

There are, however, some disquieting results. In the rate regressions, the coefficient on quality is negative and significant, contrary to expectations that a higher level of quality should enable the conference to charge higher rates. In the market share regressions, the coefficient on rate is positive and significant, contrary to the hypothesis that as conferences raise rates they will lose market share to competitors. And in the quality regressions, the coefficient on rate is negative and significant, which is different from the hypothesis that quality will increase as its marginal value product increases.

This paper has improved on earlier empirical studies of the international ocean liner shipping industry by examining conference rate determination in the context of trade route characteristics, conference market share and conference quality level in particular. The results indicate that conference freight rates increase as conference market share increases. Conference quality level is among the factors that increase conference market share, which indicates that non-price competition among conference members will contribute to increases in conference freight rates, as will barriers to entry. An increase in conference membership has the opposite effect on conference freight rates.

Despite the importance of regulated industries as a topic of study for industrial organization economists, the international ocean liner shipping industry has not been studied to the extent that other regulated industries have

been. This gap is unfortunate, because it leaves public policy makers with little economic foundation on which to base decisions. The results of this paper may serve as guidelines to public policy makers as they continually seek to revise the regulations that govern the international ocean liner shipping industry.

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