# MARKET POWER AND COLLUSION IN THE OCEAN SHIPPING INDUSTRY: IS A BIGGER CARTEL A BETTER CARTEL?

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*The regulatory structure of the ocean shipping industry allows carriers to enter into joint pricing agreements (conference agreements) that are free from antitrust scrutiny, and requires freight rates to be published and policed by a government agency. We test whether this regulatory structure leads to the exercise of market power, and identify whether that market power resides with conferences themselves or requires the participation of carriers outside the conference. The results suggest that liner conferences are not particularly effective cartels although some market power may exist in ocean shipping. Market concentration may be a contributing factor to this market power.* (*JEL* L12, L43, L92, K21)

## I. INTRODUCTION

The ocean shipping industry enjoys certain conditions that are extremely favorable for collusion, such as antitrust immunity for explicit pricing agreements, known as conference agreements, and enforcement of those agreements by the U.S. government. Consequently, studies[1] purporting to show evidence of price discrimination in ocean shipping were considered, by some, proof of the obvious: the ocean shipping industry exercises market power due to its unique regulatory environment. Policymakers presume that collusive behavior pervades the industry, as evidenced by Senator Metzenbaum's statement that "... the American people simply can't afford to give ocean shipping conferences unbridled discretion to raise prices, reduce capacity, neutralize low-cost competitors and eliminate services to ports or other customers."[2] Thus, the conventional view is that liner conferences act as effective cartels. If this view is correct, then the cartels should become more effective as they face less competition from outsiders that have refrained from joining the cartel. We test this hypothesis by examining how liner conferences behave as their competitive position changes.

Ocean shipping has a truly unique regulatory structure, reflecting fears about destructive competition and excess capacity that have existed since the late 1800s. At that time, joint price-setting behavior among ocean carriers became a common practice. Antitrust immunity for joint pricing agreements has been formally provided by U.S. legislation since 1916; policymakers granted that immunity in ex-

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1. Empirical research on the structure of freight rates includes Heaver [1973], Bryan [1974], Jansson [1974], Devanney, Livanos, and Stewart [1975], Zerby and Conlon [1983], and Jansson and Shneerson [1986].

2. See Advisory Commission on Conferences in Ocean Shipping [1992, 166].

**ABBREVIATIONS**
FMC: Federal Maritime Commission
TEU: Twenty-foot-equivalent unit



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change for active regulatory supervision.[3] Under the current regulatory structure, defined in the Shipping Act of 1984, each route contains a conference that consists of all carriers choosing to participate in an explicit joint pricing agreement which is free from antitrust action.[4] Some carriers typically choose to remain outside the pricing agreement; these carriers are known as independent carriers. Conferences must be open, so that any carrier may join or exit a conference with limited notice and without explicit penalties.

Both conferences and independent carriers are required to file their rates with the Federal Maritime Commission (FMC), an agency of the U.S. government. The FMC is charged with monitoring and enforcing the published rates. When the FMC detects secret discounting from published rates by either a conference or independent carrier, it punishes those parties involved by assessing fines.[5] However, conference members are allowed to publicly deviate from the conference rate by publishing their own freight rate on a particular transaction after notifying the conference of their intention to do so. With few exceptions (to be discussed later), conferences prohibit their members from independently entering into contractual arrangements with shippers.

Although the ocean shipping industry's regulatory structure appears conducive to collusion, other aspects of the industry are not hospitable to anticompetitive behavior. First, the absence of statutory restrictions on entry implies that carriers are free to transfer ships from one route to another (or to enter the industry *de novo*). Secondly, many countries subsidize shipbuilding which industry participants claim results in substantial excess capacity. Lastly, the heterogeneity of both carriers and shippers may impede collusive behavior.[6]

Previous empirical studies have argued that liner conferences effectively collude, based purely on their finding that freight rates increase as the value of the cargo increases. Since ocean shipping is now widely containerized (i.e., diverse commodities are shipped in uniform boxes that are handled in a largely uniform manner), these value-based rate differences are considered evidence of price discrimination by an effective cartel. The major flaw in these tests of collusive market power is that they do not account for costs that may be positively related to the product's value, such as implied damage liability costs or costs related to the quality of service.[7]

In this study, we directly examine the relationship between the conference market share on a given route and port-to-port freight rates for that route. Our approach has three distinct advantages over prior analyses. First, we use a fixed-effects model to circumvent the problems associated with accounting for any cost

3. In the late 1800s, steam-powered ships replaced sailing vessels in world trade, which reportedly led to substantial overtonnaging and price wars. In this environment, carriers began to jointly fix rates, set sailing schedules, and engage in other practices under so-called conference agreements. To discourage entry, the conferences offered "deferred rebates" to shippers that would exclusively use their vessels and employed "fighting ships" that competed directly with independent carriers by offering lower rates and similar sailing schedules.

These practices drew the attention of the House Committee on Merchant Marine and Fisheries, under Chairman J. W. Alexander. The Committee's report, issued in 1914, led to the Shipping Act of 1916, which outlawed the practices of deferred rebates and fighting ships. However, the 1916 Act provided immunity from the antitrust laws for conference pricing agreements and scheduling practices. The apparent policy rationale for preserving conference agreements is best summarized in the following passage from the Alexander Committee's report, which expresses substantial concern about the prospect of destructive competition:

The entire history of steamship agreements shows that in ocean commerce there is no happy medium between war and peace when several lines engage in the same trade. Most of the numerous agreements and conference agreements discussed in the foregoing report were the outcome of rate wars, and represent a truce between the contending lines. To terminate existing agreements would necessarily bring about one of two results: the lines would either engage in rate wars which would mean the elimination of the weak and the survival of the strong or, to avoid a costly struggle, they would consolidate through common ownership. Neither result can be prevented by legislation and either would mean a monopoly fully as effective, and it is believed more so, than can exist by virtue of an agreement.

4. Technically, section 6(g) of the 1984 Shipping Act allows the Federal Maritime Commission to challenge a conference agreement under certain conditions. To date, the FMC has never sought to enjoin a conference agreement.

5. From 1985 through 1988, the FMC assessed or collected approximately $6 million in fines. This amount is well below 0.1% of the liner shipping industry's revenue on U.S. international routes over this period.

6. For discussions of the effect of firm and customer heterogeneity on collusion, see Radner [1977], Choi, Menezes, and Tressler [1985], and Harrington [1991].

7. See Butz [1993] and Reitzes [1993] for further discussion.

differentials in transporting different commodities. Secondly, a positive relationship between freight rates and conference market share on a given route is consistent with a cost-based explanation only if the costs facing individual carriers increase along with a conference's market share. This is an unlikely proposition with respect to the port-to-port transportation rates examined in our sample because these services are provided by individual carriers and not by the conference itself.[8] Thirdly, the changes in conference market share in our sample arise principally from carriers' entering or exiting the conference (or the route), implying that the conference faces changing conditions with respect to outside competition. If conferences have substantial market power, reductions in outside competition should lead to generally higher freight rates and greater price discrimination on the basis of commodity value. Increases in outside competition should produce the opposite effect. Our model allows us to test whether these relationships hold.

We also consider the alternative hypothesis that the exercise of market power in ocean shipping requires the participation of independent carriers. Specifically, the interaction among conference members may not be that different from the interaction between conference members and independent carriers because the tariff filing and enforcement requirements apply to *all* carriers and conference members have the right to publicly post a freight rate that differs from the conference rate (after providing advanced notice). Consequently, our analysis tests whether market power in ocean shipping stems from liner conferences, or from the concentration among carriers serving a given route.[9]

Finally, our analysis examines the market power issue from another perspective. Between late 1984 and early 1986, some conferences in the Asian trades allowed their members to independently enter into contracts with shippers. During all other periods in our sample, only the conferences themselves could enter into service contracts (whereby a shipper guarantees a certain cargo volume in return for a guaranteed freight rate and assured service quality). Since the opportunity to contract independently may increase the incentive to cheat on a collusive arrangement, we analyze rate behavior under this contracting regime to gain further insight into the existence of market power in ocean shipping.

## II. THE MODEL

To test the hypothesis that market power is derived from liner conferences, we construct a model which presumes that these conferences act as effective cartels, and then empirically analyze whether market behavior is consistent with the model. Our paradigm treats a liner conference on a given route as a residual monopolist, maximizing the joint profits of its members in the face of competition from a fringe of independent carriers that have refrained from joining the conference.[10]

In order to maximize the joint profits of its members, a cartel operating on a given route would equalize across commodities the marginal contribution to its profits that it receives from transporting an additional container of any given commodity. Hence, for the cartel covering route $j$, it holds that:[11]

$$MP_{ij} = MR_{ij} - MC_{ij} = k_j, \tag{1}$$

where $MP_{ij}$ ($MR_{ij}$, $MC_{ij}$) is the marginal contribution to the cartel's profits (marginal revenue, marginal cost) from transporting an additional container of commodity $i$, and $k_j$ is

8. Contract transportation services are typically purchased from the conference directly rather than from individual carriers within the conference. Our sample specifically excludes freight rates for contract services.

9. One strand of the literature on ocean shipping contends that cooperation among carriers is necessary to overcome an empty core problem (i.e., the absence of a competitive equilibrium). Our study examines the behavior of liner conferences; it does not delve into reasons for their existence.

10. As discussed below, our model is sufficiently flexible to cover various types of behavior by fringe carriers. The existence of fringe carriers competing with the cartel may be attributable to a variety of factors. As more carriers join the cartel, the benefits increase from remaining outside the cartel and free-riding off of the relatively high cartel prices. Among others, Donsimoni [1985] and Deneckere and Davidson [1985] find that stable cartels are typically incomplete. Firms outside the cartel have no incentive to enter, and cartel members have no incentive to leave.

11. The subscripts denoting time have been dropped for expositional convenience.

the cartel's shadow value of capacity. The cartel is assumed to maximize short-run profits subject to the combined capacity of its members. Consequently, the marginal cost in Equation (1) is a short-run marginal cost. If the cartel is actually maximizing long-run profits, then $k_j$ equals the marginal cost of capacity.

Note that $MR_{ij} = r_{ij}(1 - 1/\eta^c_{ij})$, where $r_{ij}$ is the freight rate for commodity $i$ (on route $j$), and $\eta^c_{ij}$ is the cartel's perceived elasticity of demand (in absolute terms) for the transportation of that commodity. By definition, $\eta^c_{ij} \equiv -(dq^c_{ij}/dr_{ij})\, r_{ij}/s_{ij}\, q_{ij})$ where $q^c_{ij}$ is the quantity of commodity $i$ transported by the cartel covering route $j$, $q_{ij}$ is the total quantity of that commodity transported on that route, and $s_{ij}$ is the cartel's market share. Assuming for expositional purposes that consumers of the commodity bear the entire increase in transportation costs, and that independent carriers do not respond to changes in the cartel's output of transportation services, it holds that $dq^c_{ij}/dr_{ij} = dq_{ij}/dp_{ij}$, where $p_{ij}$ is the delivered price of commodity $i$ in the destination country on route $j$.[12] From this it follows that $\eta^c_{ij} = \eta^M_{ij}\, r_{ij}/p_{ij}\, s_{ij}$, where $\eta^M_{ij} \equiv -(dq_{ij}/dp_{ij})\ (p_{ij}/q_{ij})$ is the market elasticity of demand for commodity $i$ in the destination country on route $j$. Substituting this expression for $\eta^c_{ij}$ into our expression for $MR_{ij}$, and then substituting into Equation (1), we obtain:

$$r_{ij} = k_j + MC_{ij} + p_{ij}\, s_{ij}/\eta^M_{ij}. \tag{2}$$

Consider Equation (2). Within a group of commodities facing a similar market elasticity of demand (i.e., $\eta^M_{ij} = \eta^M\ \forall\ i$), a profit-maximizing cartel would generally set higher freight rates for the higher-valued commodities (since $dr_{ij}/dp_{ij} > 0$). Moreover, as the cartel's market share expands due to independent carriers joining the cartel, the rate differential would increase between two commodities of different value (since $d^2 r_{ij}/dp_{ij}ds_{ij} > 0$). *Hence, when an effective cartel faces less outside competition (which leads to an increase in the cartel's market share), it increases the degree of price discrimination and generally raises freight rates.*[13] This behavior would not occur if the rate differentials across commodities were based purely on cost factors.

The specification in Equation (2) would still be obtained under assumptions that are considerably more general. For instance, we can assume instead that the pass-through of transportation costs to consumers is incomplete but independent of commodity value. Also, we can assume that independent carriers do respond to changes in the quantity of transportation services supplied by the cartel, but their response is similar across commodities.

The above specification might not hold if independent carriers act as cream skimmers that transport only high-valued commodities which pay relatively high freight rates. If there is a sufficient amount of cream skimming, this will undermine the cartel's ability to price discriminate. However, assuming that liner conferences possess market power but independent carriers act as cream skimmers, freight rates should still increase when an independent carrier joins a liner conference. The size of the rate increase should be the same for all commodity values, though. Our empirical specification permits a test of this hypothesis, and the results suggest it is not going on.

Our analysis to this point considers liner conferences as the only potential source of market power. Market concentration may promote market power as well, particularly in a

12. In other words, the impact of a $1 increase in the freight rate for a given commodity on the quantity transported by the cartel is equivalent to the impact of a $1 increase in the delivered commodity price on the quantity of the commodity demanded in the destination country. As we explain below, a similar empirical specification will be obtained under more general assumptions pertaining to the pass-through of freight rates and the supply response of fringe carriers.

13. Under certain conditions, *increased* competition can lead to increased price discrimination (see Katz [1984] and Holmes [1989]). This result may arise when consumers have varying demand elasticities toward purchasing the product in general, and those consumers with a high demand elasticity consider competing varieties of the product to be more closely substitutable than those consumers with a low demand elasticity for the product. Under these conditions, increased competition causes prices to decline for all customers, but the price decrease may be greater for the most price-sensitive customers, implying greater price dispersion. Conversely, a reduction in competition would produce generally higher prices but less price dispersion. Our specification can be used to test whether reductions in outside competition to liner conferences lead to higher freight rates but less rate dispersion. As will be shown later, our empirical results are not consistent with this hypothesis.

regulatory environment where the prices of all firms are posted and policed to prevent discounting. In this situation, profit-maximizing behavior is still described by equation (2), except that an index of market concentration (based on the individual market shares of all carriers serving the route) replaces the cartel's market share. An increase in market concentration, resulting from the consolidation or the exiting of carriers on a given route, would then lead to increased price discrimination and generally higher freight rates.

## III. THE EMPIRICAL SPECIFICATION

Equation (2) shows that freight rates are a linear function of the shadow value of capacity ($k_j$), marginal cost ($MC_{ij}$), and an expression that includes the value of the transported commodity ($p_{ij}$), conference market share ($s_{ij}$), and the market elasticity of demand for the commodity ($\eta^M_{ij}$). An empirical test of the model specified in equation (2) requires a measurable expression for $k_j$ and $MC_{ij}$. The term, $p_{ij}s_{ij}/\eta^M_{ij}$, can be measured directly by assuming that the conference's market share is the same for transporting any commodity on a given route (i.e., $s_{ij} = s_j$), and that the market elasticity of demand is similar across commodities.[14]

The shadow value of capacity for a conference covering a given route ($k_j$) depends on the total capacity on the route ($CAP_j$), the destination country's income ($Y^d_j$) and price level ($P^d_j$), the origin country's price level ($P^o_j$), and the conference's share of total route capacity ($s_j$). With respect to equation (2), we assume that $k_j = f(CAP_j, Y^d_j, P^d_j, P^o_j, s_j)$ where $f$ is a linear function. As capacity increases, the shadow value of capacity is expected to decrease until it finally reaches zero (when capacity is no longer a binding constraint). An increase in the destination country's income or its domestic price level (relative to the foreign price level) is expected to raise import demand, and consequently, the demand for shipping services. Thus, when capacity is a binding constraint, we expect $k_j$ to be positively related to $Y^d_j$ and $P^d_j$, and negatively related to $P^o_j$.[15] Finally, as independent carriers join the conference, the benefit to the conference of increased output becomes progressively smaller for the same reason that marginal revenue is smaller for a monopolist than for a perfect competitor. The shadow value of capacity is therefore expected to decrease as conference market share increases.

The effect of these variables on freight rates is identical to their impact on the shadow value of capacity (see equation (2)). Thus, when the capacity constraint is not binding (i.e., $k_j = 0$), these variables do not affect freight rates.

Given that ocean shipping is containerized, implying that various commodities are packed in identical boxes that are handled in a largely uniform manner, the short-run marginal cost of transporting commodity $i$ on route $j$ (i.e., $MC_{ij}$) is likely to be similar across commodities except for such factors as implied damage liability and the need for special handling (e.g., refrigeration, fragile or hazardous cargo, and priority in loading and unloading). These factors are unlikely to change substantively over the four-year period that forms the basis of our study. Thus, we can account for the impact of these factors by using a fixed-effects model which includes dummy variables for each commodity on each route.

Dummy variables for each year (*1985,...,1988*) are included in the specification, and a dummy variable ($IA_j$) denotes those routes for which conference members were allowed to enter independently into service contracts in that specific year. While our data exclude rates for service contracts, we hypothesize that allowing conference members to autonomously enter into service contracts could have altered the entire rate structure by providing additional incentive for carriers to cheat on a collusive agreement.

14. Actually, assuming that $p_{ij}/\eta^M_{ij}$ is positively correlated with $p_{ij}$ is sufficient for our purposes. This relationship necessarily holds unless there is a strongly positive correlation between $p_{ij}$ and $\eta^M_{ij}$.

15. Of course, the price indices, $P^d_j$ and $P^o_j$, may capture also the movement of input prices, such as wages and fuel costs, that are relevant to transportation costs for carriers on a given route. This effect may cause $P^o_j$ to become positive in sign, and it reinforces the positive relationship between $P^d_j$ and freight rates. Our empirical results give some support to this interpretation.

In addition to considering the possibility of joint profit-maximizing cartel behavior, our specification allows us to consider the possibility that market concentration leads to market power independently of the conference system. We have included a Herfindahl index of market concentration (hereafter, $H_j$) in our specification to test this hypothesis.[16] This variable is included by itself and interacted with cargo value.

The complete specification is described as follows:

$$(3) \quad r_{ij} = \beta_1 s_j + \beta_2 s_j p_{ij} + \beta_3 H_j + \beta_4 H_j p_{ij} + \beta_5 CAP_j + \beta_6 Y^d{}_j + \beta_7 P^d{}_j + \beta_8 P^o{}_j + \beta_9 IA_j + \beta_{10} 1985 + \beta_{11} 1986 + \beta_{12} 1987 + \beta_{13} 1988 + \varepsilon_{ij}.$$

In the above specification, we avoid using dummy variables for each commodity on each route by instead expressing each observation as a deviation from the variable's mean (calculated over time) for that commodity on that route (see Judge, et al. [1982, 478–81] for proof of equivalence).

From the above specification, the change in freight rates associated with an increase in conference market share is expressed as: $dr_{ij}/ds_j = \beta_1 + \beta_2 p_{ij}$. Note that the sign of this derivative depends on commodity value, $p_{ij}$. If conference pricing is consistent with joint profit maximization, then an increase in conference market share resulting from a reduction in outside competition should be associated with an increased degree of price discrimination on the basis of commodity value (implying that $\beta_2 > 0$). In addition, when capacity is not a binding constraint (i.e., $\beta_1 = 0$), the increase in conference market share should be associated with higher freight rates for all commodity values. However, if capacity is a binding constraint (i.e., $\beta_1 < 0$), then the increase in conference market share should be associated with higher freight rates only for higher-valued commodities. This occurs because the cartel's assessment of its marginal revenue falls when independent carriers join the cartel and thereby increase its share of the market. This drop in marginal revenue is larger for those commodities where the derived demand for transportation services is less elastic. To put its price structure back in equilibrium, a capacity-constrained cartel would raise rates for those commodities with a relatively inelastic derived demand for transportation services (i.e., higher-valued commodities), and lower rates for those commodities with a relatively elastic derived demand (i.e., lower-valued commodities).[17]

The change in freight rates associated with an increase in market concentration is $dr_{ij}/dH_j = \beta_3 + \beta_4 p_{ij}$. When market concentration leads to market power, similar reasoning to that used above shows that $\beta_4 > 0$ and $\beta_3 < (=) 0$ if capacity is (not) a binding constraint.

In our model, conference market share and market concentration are treated as exogenous variables.[18] This econometric approach is therefore potentially subject to the same criticisms as those aimed at prior empirical re-

16. The Herfindahl index is the sum of the squared values of the individual market shares of both conference and independent carriers. Hence, this index is unrelated to the conference's market share.

17. Several sources (e.g., ACCOS [1992]) indicate that the ocean shipping industry was characterized by substantial unused capacity during the 1985–1988 period which our analysis is based upon. If so, then capacity may not have been a binding constraint. Of course, our model allows us to test whether the behavior of freight rates is consistent with a binding capacity constraint. We discuss these results later (see footnote 22).

18. The reported results also treat total route capacity as exogenous. Industry participants provided some support for this assumption. They indicated that ocean shipping and shipbuilding are highly subsidized industries, and that capacity decisions may be heavily influenced by government policies. To see whether capacity was more heavily influenced by traditional market forces or national policies, we regressed capacity on a variety of cost and demand factors (e.g., relative prices and gross domestic product pertaining to the given route and alternative routes) as well as route-specific dummy variables. Consistent with information gathered in interviews, all of the route dummies were statistically significant, but few cost and demand factors were statistically significant.

search treating market structure as exogenously determined.[19] We have several responses to these criticisms. First, by using a fixed-effects model, we avoid any bias stemming from the cross-sectional examination of rate behavior across routes. Instead, our approach examines rate behavior based on changes over time in conditions within a particular route. Secondly, through the use of price and income measures that apply to the countries served on a given route, we control for route-based demand and cost factors that may influence the decision of carriers to enter or leave the conference or the route. In this fashion, we avoid simultaneity bias that arises when changes in the demand or cost of transportation services lead to both changes in conference membership and changes in conference pricing that are related purely to those demand or cost variations. Thirdly, our conversations with ocean carriers and liner conferences indicate that the decision of carriers to enter or leave a conference (or route) frequently depends on firm-based factors, such as changes in the carrier's management or marketing strategy and carrier-specific cost changes. To the extent that these factors determine conference market share and market concentration, it is appropriate to treat those variables as exogenous. Lastly, our model predicts that increased conference membership leads to generally higher freight rates. One might suppose that the causality is reversed—that is, higher freight rates attract additional conference members. If so, then some ambiguity may exist in the interpretation of a statistical finding where freight rates are positively related to conference market share. However, no ambiguity exists in interpreting a finding where there is *no* relationship between conference market share and freight rates.

Our examination of the sample data confirms that most of the variation in conference market share (and route concentration) is, in fact, attributable to the movement of carriers into or out of the conference (or the route), and *not* to changes in the market shares of individual carriers. Our results thus reflect changes in actual competitive conditions facing liner conferences and carriers.

19. For discussion, see Bresnahan's and Schmalensee's [1989] chapters in *Handbook of Industrial Organization*.

## IV. DATA

The sample consists of port-to-port freight rates charged by liner conferences serving the United States between 1985 and 1988. Pursuant to Section 18 of the Shipping Act of 1984, the FMC collected conference freight rates for the most popular commodities on a given route, accounting for at least 50% of the volume on that route. Our sample covers fourteen conferences carrying outbound and inbound freight between the U.S. Atlantic, Gulf, and Pacific coasts and Japan, Germany, Italy, and Australia. Freight rates, which include all relevant surcharges, are expressed as total charges per twenty-foot-equivalent unit (i.e., TEU—the standard measure of container volume).

Commodity value ($p_{ij}$) is derived from export data collected by the Bureau of the Census and compiled by the U.S. Department of Transportation. Commodity value per long ton is translated to commodity value per TEU using conversion factors provided by the FMC.

Capacity ($CAP_j$), conference market share ($s_j$), and market concentration ($H_j$) are compiled from data furnished by Lloyd's Maritime Information Services. Lloyd's collects capacity data (in TEUs) for each carrier on a given route, and identifies whether the carrier belongs to the conference covering that route. Conference market share and market concentration are based on these capacity figures.

The nominal gross domestic product (in U.S. dollars), price deflator, and exchange rate of each country are obtained from *International Financial Statistics*, published by the International Monetary Fund. The price indices are adjusted for exchange rate movements.

The final data set contains 620 observations. Since there are four annual observations (from 1985 to 1988) for each commodity on each route, our sample contains 155 commodity-route combinations. Table I contains summary statistics for key variables.

**TABLE I**
Summary Statistics
(620 observations)

| Variable | mean | standard deviation | minimum | maximum |
|---|---|---|---|---|
| Freight Rate ($ per TEU) | 3,104 | 1,598 | 722 | 14,239 |
| Commodity Value ($ per TEU) | 60,814 | 70,628 | 568 | 415,493 |
| Conference Market Share (%) | 63 | 17 | 13 | 92 |
| Market Concentration (HHI) | 1,906 | 990 | 528 | 4,285 |
| Capacity (TEUs) | 580,026 | 693,365 | 50,644 | 3,048,461 |
| Importing Country GDP ($billions) | 2,848 | 1,836 | 160 | 4,435 |
| Destination Country Price Index | 118 | 26 | 100 | 190 |
| Origin Country Price Index | 124 | 30 | 100 | 190 |

## V. RESULTS

Table II presents OLS regression results for the entire sample of 620 observations.[20,21] The results offer limited support for the hypothesis that an increase in market concentration leads to higher freight rates. The effect of increased market concentration on freight rates (i.e., $dr_{ij}/dH_j = -.026 + .0000018p_{ij}$) is positive and statistically significant at the 10%(5%) level for commodity values exceeding $77,268 ($103,172), representing 24%(19%) of the total sample. Since the coefficient is positive and statistically significant (at the 10% level) for the variable that interacts market concentration with commodity value, our results are also consistent with the hypothesis that increased market concentration leads to greater price discrimination on the basis of commodity value.[22]

Although the relationship between market concentration and freight rates is statistically significant, it is questionable whether this relationship is economically significant. We examine in Table III the effect of a one-standard-deviation increase in market concentration on

20. Note that the $R^2$ statistic in Table II is based on the regression where each observation is expressed as a deviation from the variable's mean for that commodity on that route. In other words, $R^2$ omits the explanatory power provided by the dummy variables for each commodity on each route (which, if included, raises $R^2$ to 0.92 in the full sample). However, the calculation of the degrees of freedom must recognize that these 155 dummy variables are implicitly included (see Judge, et al. [1982]). Hence, the degrees of freedom equal 620 − 13 − 155 = 452. That is the number of degrees of freedom used in calculating the relevant $t$ and $F$ statistics for our results.

21. To test whether our fixed-effects model was appropriate from a statistical standpoint, we estimated regressions without dummy variables identifying either routes or commodities. We then added one set of dummy variables identifying each route, followed by another set of dummy variables identifying each commodity on each route. The $F$-statistics for including each set of dummy variables were significant at better than the 1% level. Specifically, the $F(13,594)$ statistic for the inclusion of dummy variables for each route equalled 18.2, and the $F(142,452)$ statistic for the inclusion of dummy values for each commodity on each route equalled 20.4. It also should be noted that the addition of dummy variables for each commodity on each route resulted in a greater number of statistically significant coefficients with respect to the variables of interest in our model. The inclusion of these dummy variables may have removed "noise" in assessing the impact of the market concentration variable and the variable identifying periods where conferences allowed their members to enter independently into contractual arrangements.

22. Since the coefficient on market concentration alone is not statistically significant, and the coefficient on market concentration interacted with commodity value is statistically significant, our results are consistent with profit-maximizing behavior in a concentrated market where capacity is not a binding constraint. Additional statistical tests further support that capacity is not binding; in particular, an $F$-test does not reject the null hypothesis that the coefficients equal zero on all variables relevant to the shadow value of capacity (i.e., $CAP_j$, $Y^d_j$, $P^d_j$, $P^o_j$).

**TABLE II**
Estimation of the Determinants of Ocean Freight Rates
($t$-values in parentheses)

| Variable | Full Sample | Inbound | Outbound |
|---|---|---|---|
| Conference Market Share ($s_j$) | −3.18 | −6.75 | −1.81 |
| | (−1.23) | (−1.58) | (−0.56) |
| Conference Market Share x Commodity Value ($s_j p_{ij}$) | .000017 | .000017 | .000047 |
| | (0.70) | (0.55) | (1.02) |
| Market Concentration ($H_j$) | −0.026 | 0.039 | −0.15 |
| | (−0.31) | (0.35) | (−1.09) |
| Market Concentration x Commodity Value ($H_j p_{ij}$) | .0000018 | .0000025 | .00000061 |
| | (1.80)* | (1.85)* | (0.40) |
| Capacity ($CAP_j$) | −.000032 | −.00034 | .00035 |
| | (−0.17) | (−1.29) | (1.21) |
| Destination Country GDP ($Y^d_j$) | 0.25 | | 0.38 |
| | (1.07) | | (1.13) |
| Destination Country Price Index ($P^d_j$) | 3.41 | | 3.35 |
| | (1.14) | | (0.79) |
| Origin Country Price Index ($P^o_j$) | 8.94 | 9.51 | |
| | (2.93)** | (2.15)** | |
| Independent Action Dummy ($IA_j$) | −590.47 | | −284.19 |
| | (−2.09)** | | (−1.06) |
| 1985 | 243.53 | 149.62 | 189.63 |
| | (2.05)** | (0.81) | (1.54) |
| 1986 | −43.93 | −112.98 | −9.66 |
| | (−0.78) | (−1.52) | (−0.15) |
| 1987 | −70.14 | −25.44 | −70.82 |
| | (−1.14) | (−0.26) | (−1.00) |
| 1988 | −129.46 | −11.21 | −109.14 |
| | (−1.14) | (−0.07) | (−0.93) |
| number of observations | 620 | 352 | 268 |
| (degrees of freedom) | (452) | (254) | (189) |
| $R^2$ | 0.18 | 0.21 | 0.20 |

*(**) indicates significance at the 10% (5%) level in a two-tailed test

freight rates, evaluated at key commodity values.[23] At the median commodity value (of $31,912), this increase in market concentration is associated with a rate increase of $12, which represents only 0.4% of the average freight rate. Calculated at the 95th-percentile commodity value, a one-standard deviation increase in market concentration is associated with a $118 increase in freight rates, or about 3.8% of the average freight rate.

Our results do not support the hypothesis that an increase in conference market share, due to independent carriers joining the conference, leads to higher freight rates or greater

23. In our sample, the average standard deviation of the market Herfindahl index for each route is 378. That this is a significant variation can be seen by comparing this number to the U.S. Department of Justice and Federal Trade Commission Horizontal Merger Guidelines [1992] which use industry Herfindahl measures over 1000 that experience a change of 100 as the thresholds which "raise significant competitive concerns" (the average Herfindahl for the routes in our sample is 1906).

**TABLE III**

The Effect on Freight Rates of a One Standard Deviation* Increase in Market Concentration (Evaluated at Key Commodity Values)

| | | | | | |
|---|---|---|---|---|---|
| **Full Sample** | | | | | |
| Commodity Value | $8,178 | $17,078 | $31,912 | $73,345 | $185,594 |
| Percentile** | 5% | 25% | 50% | 75% | 95% |
| Change in Freight Rates | –$4 | $2 | $12 | $41 | $118 |
| Change in Freight Rates as a percentage of the mean freight rate | –0.1% | 0.1% | 0.4% | 1.3% | 3.8% |
| **Inbound Routes** | | | | | |
| Commodity Value | $9,232 | $17,172 | $33,625 | $79,765 | $247,917 |
| Percentile** | 5% | 25% | 50% | 75% | 95% |
| Change in Freight Rates | $25 | $33 | $50 | $97 | $268 |
| Change in Freight Rates as a percentage of the mean freight rate | 0.7% | 1.0% | 1.4% | 2.8% | 7.7% |

*Our fixed-effects model essentially measures the relationship over time between the freight rate for a given commodity on a given route and the variables relevant in determining that rate. Since freight rates for a given route are influenced only by changes in market concentration on that route, we define the standard deviation of market concentration as the average of the individual standard deviations of market concentration for each route (calculated from changes in concentration over time).

**Percentile is the percentage of commodity values in the sample that lie below the specified dollar level (e.g., 5% of the observations in our full sample lie below $8,178).

price discrimination. The estimated effect of an increase in conference market share on freight rates (i.e., $dr_{ij}/ds_j = -3.18 + .000017p_{ij}$) is negative in sign for over 90% of the commodity values in our sample. Moreover, neither of the variables that include conference market share are statistically significant; an $F$-test does not reject the null hypothesis that the coefficients equal zero on both variables.

In apparent contrast to the previous results, the behavior of freight rates when certain conferences allowed their members to independently enter into service contracts provides some support for the existence of market power in ocean shipping. The coefficient on the dummy variable identifying the routes where conference members could enter independently into service contracts ($IA_j$) is negative and statistically significant, indicating that freight rates were, on average, about $590 lower on those routes during the period of independent contracting. This reduction represents about 19% of the mean freight rate. In contrast to the requirement that any contract must be issued by the conference itself, independent action on service contracts allowed individual conference carriers to contract with individual shippers without any conference restriction on the offered terms or services. Although these contracts were filed with the FMC, certain key information was not publicly available, including the names of the carrier and shipper and a formal description of the service provisions. Thus, this contracting regime could have impeded the exercise of market power in ocean shipping by both increasing the cost of monitoring the behavior of conference carriers and encouraging those carriers to offer selective discounts to large customers. The net result of this regime may

have been lower freight rates for all types of transactions, including the port-to-port transactions used in our sample.

Since the substantial U.S. trade deficit between 1985 and 1988 led to considerably heavier ocean traffic on U.S. inbound routes (and substantial unused capacity on U.S. outbound routes), we examined whether the results would change qualitatively if inbound and outbound routes were grouped separately. As shown in Table II, the results from the pooled data stem largely from the behavior observed on inbound routes.[24] The primary difference is that an increase in market concentration is associated with a statistically significant increase in freight rates for a larger percentage of commodities in the inbound sample than in the pooled sample (e.g., at the 10%(5%) level of significance, 45%(40%) of the sample as compared to 24%(19%)). In addition, as indicated in Table III, the magnitude of the rate increase is somewhat larger in the inbound sample.

On outbound routes, neither market concentration nor conference market share is a statistically significant determinant of freight rates. Perhaps, the presence of substantial unused capacity eliminated any sources of market power on those routes.

In closing this section, we should acknowledge Stigler's [1964] hypothesis that a cartel's ability to reach a joint profit-maximizing pricing agreement may be facilitated as the number of colluding firms declines. In other words, his model predicts that a cartel may be able to achieve higher prices when the cartel contains relatively few firms. More recent theoretical analyses of collusion have shown that the sustainable cartel price is affected also by the heterogeneity of the members of the cartel. Some of this literature indicates that the sustainable cartel price may fall as the disparity increases in the costs (and sizes) of firms within the cartel.[25] To test these hypotheses, we constructed a conference Herfindahl index, which consisted of the sum of the squared value of each conference member's share of conference capacity. We added this variable, by itself and multiplied by conference market share,[26] to our statistical specification. An *F*-test did not reject the null hypothesis that the coefficients equalled zero on the terms containing this variable, either in the full sample or the samples of inbound and outbound routes.[27]

## VI. CONCLUDING REMARKS

The evidence supporting whether liner conferences are effective cartels is, at best, mixed. Our empirical analysis was unable to identify a statistically significant relationship between conference market share and freight rates. Consequently, our results are *not* consistent with the hypothesis that reductions in outside competition to liner conferences (e.g., due to independent carriers joining liner conferences) lead to higher freight rates and increased price discrimination, as might be expected if conferences possessed substantial market power. We, however, find one piece of contradictory evidence: freight rates are significantly lower when individual conference carriers are allowed to enter into service contracts with individual shippers. These price reductions are large enough to suggest that there is market power in ocean shipping, and it is reduced when conference carriers are allowed further pricing freedom in dealing with individual customers.

There is another possible interpretation for our results regarding conference market share. As mentioned previously, the industry's antitrust immunity and tariff filing and enforcement requirements potentially facilitate the ability of all carriers to collude, not just those

24. We omitted from the inbound and outbound regressions certain variables that were invariant across inbound routes (i.e., destination-country price index and GDP) or outbound routes (i.e., origin-country price index). Since these variables only changed from year-to-year, they were perfectly collinear with the yearly dummy variables.

25. See, for example, Radner [1977], Choi, Menezes, and Tressler [1985], and Harrington [1991].

26. We included the variable, conference Herfindahl index multiplied by conference market share, to ascertain whether increases in conference concentration had differing effects depending on the size of the conference. One might expect that freight rates would be more profoundly affected by an increase in conference concentration when the conference has a relatively large market share.

27. For the full sample, the $F(2,450)$ statistic equalled 0.80. For the inbound and outbound samples, the $F(2,252)$ and $F(2,187)$ statistics equalled 0.24 and 0.19, respectively. Including interactions of the conference Herfindahl index (or the conference Herfindahl index multiplied by conference market share) with commodity value did not substantively alter the above results.

carriers that are conference members. Our market-share results are thus consistent with the hypothesis, that, on the margin, it makes little difference whether a carrier colludes from inside or outside the conference. As such, one should not conclude from our results that liner carriers behave competitively.

In fact, our empirical evidence offers some qualified support for the hypothesis that market power in ocean shipping may be linked to the concentration of carriers serving a given route, based on our finding that increased route concentration is associated with increased rate dispersion and generally higher freight rates. However, the limited economic significance of these results suggests that any anticompetitive effects from coordinated behavior are modest in size.

Our finding that freight rates are significantly lower when individual conference carriers are allowed to enter into service contracts with individual shippers is especially germane to current policy initiatives in the industry. It is likely that liner shipping will be subject to some form of deregulation in the near future, and one of the leading legislative proposals retains antitrust immunity for carriers but forces conferences to allow their members to individually enter into service contracts. Our paper indicates that this right of independent action on service contracts may serve as an important spur to competition.[28]

With respect to the literature on collusion, our results show that cartel behavior is far removed from the monopolist paradigm, even under the very favorable conditions that exist in ocean shipping. The results also offer empirical support for some accepted theories of cartel behavior, specifically the hypothesis that a cartel's market power is constrained by excess capacity, large customers, and multidimensional competition. In particular, this paper indicates that collusive prices are adversely affected by increased contracting, which makes it easier for firms to expand service offerings and engage in selective discounting to large customers. Moreover, no sources of market power could be identified on outbound routes, which were characterized by substantial unused capacity.

Finally, the question arises concerning why liner conferences exist if our results indicate that conferences may not possess substantial market power by themselves. There are several responses to this question. First, our results indicate that certain conference rules may make it easier for all carriers to monitor the behavior of one another, and therefore facilitate higher freight rates. For example, our finding that rates are lower when conference members individually enter into service contracts suggests that conference rules do affect competition even if market power cannot be exerted without the participation of independent carriers. Furthermore, the activities of certain carriers may be more difficult to monitor if those carriers remain outside the conference umbrella. Secondly, conferences are a means for carriers to exchange information concerning cost and demand conditions on a particular trade. Thirdly, as pointed out by Butz [1993], the interaction among carriers that occurs under the conference umbrella may serve to facilitate certain types of rationalization agreements that ultimately lower costs and improve carrier profitability. Whether conferences do facilitate these efficiencies, and whether these efficiencies would be realized in the absence of liner conferences with less risk of anticompetitive behavior, are important policy questions that require further investigation.

28. This conclusion must be tempered somewhat if it is true that the granting of independent action with respect to service contracts is a symptom, rather than a cause, of conference weakness. To investigate this proposition, we searched the *Journal of Commerce* and other maritime publications for information on the conditions facing the liner conferences that allowed their members to independently enter into service contracts during 1985 (and early 1986). Although we did not find any direct evidence indicating that conference weakness at the time led certain conferences to grant their members the right to individually negotiate service contracts, we did find that some carriers were claiming financial difficulties, and that excess capacity was in evidence on the U.S. outbound routes to Japan where independent action on service contracts was permitted. Notwithstanding that conference market share was relatively high on those routes (82% for U.S. East Coast to Japan, and 85% for U.S. West Coast to Japan), it is possible that the depressed demand conditions and substantial excess capacity may have caused friction within the conferences on those routes, which could have depressed rates whether or not independent action on service contracts was granted. It should be noted, however, that many liner carriers have made longstanding claims of financial difficulties (without exiting the market), and that demand was depressed on U.S. outbound routes to Japan during the entire 1985–1988 period, not just the period where independent action was found to be associated with lower freight rates. Moreover, as previously mentioned, excess capacity was present on other routes as well, without the same impact on freight rates.

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