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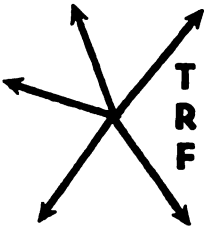

TRANSPORTATION RESEARCH FORUM

Analysis of Ocean Freight Rates By Multiple Regression

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ABSTRACT

Ocean freight rates have held a vicarious interest of many persons mainly because the means by which they are set is obscure. Yet they play a significant role in the activities of the international trader. So, too, with this author but perhaps to a greater degree because of direct familiarity with the industry. Here, in this paper, the freight rates established and published by the conferences are studied with an inquiring eye and econometric tools. One conference in particular, the North Atlantic Continent Conference and its tariff serves as the basis of the study. First some theoretical discussion of the economic basis of the rates, such as value theory and cost theory, is given to the subject. From this a series of possible explanatory variables are defined and considered for their influence on the ocean rate structure and level. Then, having gathered data for each, they are regressed against commodity rates from the above tariff as the dependent variable in a multivariate linear model. The results were tested for their significance, then discussed in terms of the introductory theory. The result suggest that in this one conference that rates were closely correlated with value of the commodity per ton and with stowage factor. Finally, the implications of these findings are considered.

INTRODUCTION

"OCEAN FREIGHT RATES can play an important role in the businessman's decision to enter the export field." This is the opening sentence in a publication, 'Ocean Freight Rate Guidelines for Shippers,' published by the U. S. Department of Commerce. As a statement, it applies equally to the decision to enter the import field as well. As an important part of the decision making process for the businessman, then, these rates have an effect on the volume of freight which moves in trade and is carried aboard ship, or aircraft, or whatever.

From this point, it can be argued that the rates are determinants of the flow of trade and have an effect on the balance of payments of this country. Such a thesis, however, puts a heavy burden on the role of the rate and or transportation as a determinant of trade. It is rare that transportation of a good is undertaken just for transportation's sake. It is not an expense a businessman would authorize without justification. In the case where a shipment is made as a part of a marketing or distribution plan it is likely to precede the actual sale. Then it is a move to assure a competitive posture and

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an ability to serve customers quickly. In any event, the ultimate sale is the purpose of the move. In this context, the movement effects the balance of trade, the balance of the flow of goods, but it is not the rates themselves. They are a secondary factor, but a factor.

But two points have to be clarified at this time: first, what is meant by ocean freight rates as considered in this paper; and second, to what services do they apply. This is because there are two distinct types of trade by water with distinct rate structures. In one case, carriers provide regular service and publish their rates. These hold over a period of time. In the other case, the carriers provide spot service under charter terms and rates to serve specific shipments with the terms and charges negotiated in each case.

The ocean freights being considered at this time are those charged by ship operators serving a specific set of ports on a given trade route. They provide regularly scheduled service between the ports and publish their rates for the goods transported in tariffs. Generally, the flow of goods is steady on the route in both directions. Yet while the flow is steady, the directional balance may be uneven. The range of commodities in the flow varies widely, as does the volume of the individual products.

Where the trade on the route is lively, more than one operator may engage in the business of providing regularly scheduled service. At times, the resulting competition for the freight in the flow has become disastrous. It has brought chaos to the service and to carriers. Associations of carriers have resulted, called shipping conferences. In this country, these conferences, or carrier associations, are specifically authorized by the Shipping Act of 1916. The act exempts them from the Sherman and the Clayton Acts. It permits the formation of the associations for the purposes of making and enforcing rules and rates and requires that they be published. The act also establishes what is now the Federal Maritime Commission with regulatory powers over conference actions. The Commission has power to suspend and investigate a rule or rate and to veto the rate on specific statutory grounds. The Commission can not make rates for the conferences. In short, we are considering the ocean freight rates made by shipping conferences on specific trade routes and published and applied under the supervision of the Federal Maritime Commission.

The services to which these rates apply are generally known as liner services, or liner trades. They are the regularly scheduled sailings between the named sets of ports as mentioned. In these liner operations, the schedule is frequently more important as a marketing point than is the quantity of cargo for a particular sailing. This is a long range selling view in which proven dependability is considered a sure generator of cargo against the competition. This is vital where price is removed as a sales tool. Yet, this is the distinguishing factor and the differentiating condition from the operation of tramps where carriers try to book only full cargos to any port.

Thus, in this paper we are scrutinizing the conference freight rates quoted by members who operate scheduled liner services between named sets of ports. These services and rates include, in addition to the transportation, such activities as receipt of the freight at the dock shed from the delivering rail or truck carrier, the accumulation of the cargo and handling pending ar-

rival of the specified ship, record keeping on the cargo, care and custody while on the pier, loading and stowage aboard ship at the origin port. At the destination port the cargo is unloaded and placed in the pier shed. Then essentially the same steps are repeated pending customs release and delivery to the landside carrier. Specific rules apply to container freight and pose a separate set of conditions for certain moves. But where freight moves from pier to pier, the conditions and rates are as with general commodities.

On occasion the conferences and their members are faced with outsider or non-conference competition. Such an outsider is one who chooses to operate independently and to publish his own tariff. These carriers frequently offer as fine a class of service in terms of frequency, regularity and quality as any of the member lines. One prime example is Meyer Line that operates between the North Atlantic United States and European ports on the same route under consideration. The non-conference carriers generally offer their service at rates which are 10 to 15 percent lower than those of the conference.

The opening sentence places considerable importance on the ocean freight rate in the businessman's decision to trade or not. This applies to the rates in effect at the time of the decision. It says in effect, if the rate is right, the cargo will move. It implies that demand for ship space is a secondary, or a derived demand, based not so much on the price of the transportation itself, but on that price as only one factor among others. This price is but one factor which the shipper considers in a contemplated foreign trade sale. Others include his own FOB plant price, The CIF price available at the destination market, delivery schedules, competition both from other carriers and from other nations. If a large quantity is involved, he might consider the impact of the ocean rate on his ability to grant a quantity discount to the purchaser. This analysis could lead him to request a rate adjustment or a special rate which would permit him to meet competition or make the sale. From this line of reasoning, it again appears that demand for ship space is related to the rate but secondary to the commercial sale. Once sold the goods become demand for transportation. The demand is derived and if the rate is right the goods will move.

RATE DETERMINATION
SOME THEORETICAL CONSIDERATIONS

But how is the right rate determined, or fixed by the conference? With exemption from anti-trust laws, the conference has authority to act as a monopoly in price setting under the regulatory eye of the FMC. As an association of member lines it is a cartel which performs several functions to set and publish the rates and rules; to administer the rates and rate structure; to police its members; to allocate sailings of members; and to penalize errant members. Most have been reasonably competent in these responsibilities.

In the rate making activity, the conference considers two main approaches, the rate level and the rate structure. The rate level is the price of a specific commodity in relation to the range of rates in the tariff and to competitive influences. The structure is the manner in which the rates are organized and assessed. In conference rate structures, the following are important elements:

I. Per ton rates charged on a weight or measure basis, where,
   weight ton = 2,000 lbs., 2,240 lbs., or 2,204.5 lbs. (metric)
   measure ton = 40 cubic feet, or 35.3 cft. (cubic Meter)

II. Add on charges, where there are
   heavy lift—charges per ton additional based on a weight scale and minimum
   extra length—charges per foot additional based on a scale and a minimum

III. Special conditions rates and rules
   Ad Valorum rates
   Unitized freight
   Container freight
   Refrigerated freight.

IV. Dual Rates—the practice of conferences to assure the cargo for member lines by means of the exclusive patronage contracts. A 10 to 15 percent reduction in rate is granted shippers who sign such contracts.

V. Open Rates—the practice of conferences or individual members to delete a published rate in favor of individual quotations. This can result from disagreement, but more frequently is the result of over capacity on the route, or over tonnage.

Knowing the structure of ocean freight rates helps a businessman achieve rate adjustments, but it does not answer his basic question, how are they made. If the conference is responsible for making and publishing the rates, what factors enter the rate decision? He may even want to know what economic theories operate in the structure? Or, is it as is so frequently said, that the rates are based on 'what the traffic will bear'? This statement says that somehow the level of rate is tied to the value of the cargo or commodity. Or in another sense it says the rates are based on an ability to pay. This is one approach and it has been seriously discussed by noted authorities. If it could be statistically shown as the case, we may have a start on a complex subject.

A rate based on what the traffic will bear is, in reality, a value of service rate. Here it is argued that the value of the commodity is an indicator of the worth of the transportation performed. It does not relate to any costs of producing the transportation. In fact, VS rates can be considered a convenient avoidance of costing out the transportation produced.

But, let's go back some years and look at another mode of transportation. Let's go back to, say, 1891 and take a look at some thinking on VS rates at that time. Professor F. W. Taussig took note of value of service rates in an article he published in *The Quarterly Journal of Economics* in July of that year. Professor Taussig was discussing rail rates in this work and entitled it 'Theory of Railway Rates.' He comments on the inherent discrimination of VS rates. That is, charging different prices for the same product to different buyers.

He attributes this situation to the virtual monopoly which the railroads had on goods transportation in 1891. In a resigned fashion, he accepts this discrimination as an inevitable condition of the time. The rails could price their services as a monopoly within the restraints of other rail competition, competition from waterways, and the Interstate Commerce Commission.

The main purpose of Professor Taussig's discussion was to consider another question, that of what he called 'joint costs.' These he defined as costs incurred in the production of transportation which were independent of the specific good or shipment. If the commodity shipped is homogenous, either for one move or over time, then the costs for the transportation can be allocated accurately. But, he said, transportation or commodities is not homogenous over time, or even over a single movement. It is this fact which gives rise to joint costs. In the context of rail rates, because a train hauls many cars with several commodities on each run, the costs of right-of-way, of maintenance, and operation of the train itself are common to all the shipments. Because many trains use the rails, it is impossible to allocate those common costs to any particular train or shipment.

There is one class of costs which can be associated with the specific transportation produced. These relate to collecting the train, handling the cars, moving them to destination and spotting at a siding. They are direct costs and assignable to the commodities moved. These out-of-pocket costs must be met in the rate for the service. They form a floor below which the rate level can not go. In other words the rates must generate revenue to cover these direct costs, whether they cover the joint costs or not. It is desirable that the revenue contribute to them to maximum degree possible. That degree is a function of demand for service derived from commercial transactions and of competition. Where competition is minimal or nonexistent, the rates may be set at levels which contribute substantially, or even cover, both the direct and joint costs. In competitive freight climates, the rates will be forced close to the level that meets out of pocket costs.

While Professor Taussig considered only rail rates in his article, a little reflection will show that his analysis is closely applicable to the situation found in ocean shipping. His definitions of out-of-pocket (direct) and joint costs have close parallels. A vessel, in its employment on a trade will carry many commodities on its manifest for each voyage. The quantities will vary for each item. The sizes will vary. The characteristics and the values will vary in each case. But, they will be part of the one voyage. Interestingly enough an ocean voyage has historically been called a joint venture.

Associated with the commodities on the manifest are two types of costs; those related to the readiness of the ship to perform her transportation task, and those related specifically to the cargo itself. The costs in the first instance include crew wages, subsistance for the crew, maintenance, fuel, insurance, depreciation, etc. These costs continue regardless of what is actually carried. They are joint costs in providing the transportation (and readiness to provide) for all the shipments. The dilemma of allocating these costs to specific shipments is as real here as it was for Professor Taussig. The second type of costs are those associated with the cargo operations. They are tho[se] activities offered by the carriers and described in the introducti[on] direct costs which can be assigned to each shipment or commod[ity]

difficulty. These latter costs can be called port costs and even some of them are fixed. The former cost group can be called voyage costs. But, in the same manner of analysis as Professor Taussig, the port costs are those which *have* to be covered in the rate level. The voyage costs are those to which maximum contribution must be made when competition and demand permit.

The value of service approach which Professor Taussig applied to rail rates, and his underlying cost analysis, applies equally well to ocean shipping. The monopolistic character of the conference cartel also fits his discussion in the rail context of 1891. The ocean carriers largely retain that advantage today, therefore his assumptions of value of service pricing and price discrimination have a particular pertinance to this study.

More recently, Dr. Benjamin Chinitz has worked with ocean conference rates specifically. From this work, he takes a different approach than did Professor Taussig. He argues that the primary purpose of the conference is to set rates. In this activity, they exercise varying degrees of monopoly power. This view he discussed in a paper prepared for the Econometric Society for its New York meeting of December 27-30, 1955. Dr. Chinitz said that this monopoly power could manifest itself in a number of ways, one of which was in the nature of the rate structure on ocean freight. He pointed out that the conferences behaved as discriminating monopolists and in setting rates it was presumed the conference was guided not only by the relative costs of transporting the different commodities, but also by the commodity elasticities of demand. He added further, that in the field of transportation, a fairly accepted rule of thumb is that the value of the freight ton is a reasonably accurate and reliable index of that elasticity. Here Professor Taussig and Dr. Chinitz may be expressing similar views. Taussig said that the rates respond to derived demand and contribute to joint costs in proportion to the demand for the commodity. Chinitz may be specifying how and to what degree the response is operative. They diverge on the question of value of service or cost of service as the basis for the rates. A presumption is made that Dr. Chinitz' costs are similar to those described earlier for ocean carriers.

Since the revenue generated to cover first the direct costs and then the joint or voyage costs is a product of the rate times the volume of each commodity on weight or measure terms, this question of elasticity of demand may be all important. This question is complicated by the fact it must be considered from two levels, that of the trade route and the conference as a whole, and that of the individual carrier. This is to say that while the conference, over all finds a certain rate - volume elasticity, one member line may find it to be a different relation either by circumstance, or by policy decision. The slope and sign of the elasticity becomes a factor to be reckoned. A positive sign would be expected on the basis of sound economic theory. A slope of less than one or approaching 0 would indicate an inelastic condition. In terms of volume it would indicate a lack of response of quantity to rate changes. This would support the derived demand concept. In terms of value per ton this inelastic condition would support the concept of value of service rates, i.e., a small change in value would have a large impact on the rate level. If the slope is greater than one then the effect of a rate change on volume and revenue could be substantial. With this point in mind it would be important to analyze carrier results under certain open rates.

Our question is whether these theories can be tested statistically. Also, it is a question of whether a model can be specified which expresses the relationships between ocean rates and any of the value, weight, measure, or various cost factors. In the next section we will hypothesize the model and the assumptions upon which it is based.

THE MODEL

It is the purpose of this study to attempt to define the ocean rate in terms of various factors, already alluded to, and to be defined in a later section. It is presumed that there is a linear relationship between the rate and these factors. The statement of this relationship can be as follows:

$$(1) \qquad Y_i = B_1 + B_2X_{2i} + B_3X_{3i} + \ldots + B_nX_{ni} + \xi_i.$$

where: Y_i = the ocean freight rate per ton

X_{ni} = the rate factors $(n = n+1 \ldots n$, variables$)$ $(i = 1 \ldots i$, observations$)$

B_n = the coefficients of the variables $(n = 1 \ldots n$, coefficients$)$

ξ_i = an error term $(i = 1 \ldots i$, observations$)$

This linear model can be estimated on the University of Chicago B 34 E program. Variables will be combined or altered as needed by trans-generation steps. These changes will be discussed in the next section.

THE VARIABLES AND DATA SOURCES

In the publication, 'Ocean Freight Guidelines . . .', the Department of Commerce lists several factors which it considers principal to rate making decisions. These are listed here and discussed more fully in the notes at the end of this article.

Demand Factors . . .

Value of the Commodity . . .

Volume of the Movement . . .

Competition . . .

Transportation Characteristics . . .

Length of the Voyage . . .

The first four of these factors have received comment in the previous discussion on rate theory. The remaining two need more explanation, however, Professor Paul Cherington does this in some of his work.

At a time when the Federal Maritime Commission was investigating the impact of ocean freight rates on trade flows to and from the United States, Professor Cherington made a statement to the Commission on September 2,

1966. The investigation was under Docket 65-45. In his statement, he listed 24 factors which are commonly held to be rate determinants. These are:

1. Value of the Goods
2. Stowage Factor
3. Volume of Movement
4. Outside Dimensions
5. Type of Packing
6. Need for Dunnaging or Blocking
7. Heavy Lift Requirement
8. Reefer Requirement
9. Tankage Requirement
10. Perishability
11. Proneness to Breakage
12. Pilferage
13. Ease of Stowage Aboard
14. Ease of Palletization
15. Ease of Sorting by Mark or count
16. Compatibility with Other Cargo
17. Dangerousness of the Cargo
18. Voyage Costs
19. Loading Costs
20. Port Costs
21. Discharging Costs
22. Competition from Non-Conference Carriers
23. Competition from Tramps
24. Competition from Other Routes via Transhipment

Looking at his list more closely, we see immediately that some of the factors are the same as those listed by the Department of Commerce. These may be compared as follows:

Demand Factors . . . No real comparable items, closest are No's. 22-24,

Value of the Commodity . . . Cherington No. 1,

Volume of the Movement . . . Cherington No. 3,

Competition . . . Cherington No's. 22-24,

Length of the Voyage . . . no comparable item,

Transportation Characteristics . . . Cherington No's. 2, 4-17,

At the same time there are several items in Professor Cherington's list that are not covered above. These are:

Voyage Costs . . .

Loading Costs . . .

Port Costs . . .

Discharging Costs . . .

While we can discern these similarities in the lists, a more exacting review shows that some of the items act on and influence others. For example: items 4 and 5, outside dimension and packaging type, are an influence on the stowage factor for the commodity, 2. Or again, items 8 and 9, and even 7, are characteristics which are not universally applicable to all commodities. Where they are, they influence, again, stowage factor. This is similarly true of items 16 and 17. Items 19 and 21 can be combined and since they are incurred in port, they can be collapsed into item 20, Port Costs. While items 6, 7, 13-15 are listed separately, basically, they influence productivity in cargo handling and thus are a part of port costs. Items 10-12, proneness to perishability, to

breakage, to pilferage, are normally covered under the carrier's insurance and thus become a part of voyage costs.

From this analysis, we find that these named items in both lists, can be narrowed down into a few influential factors. These may be summarized as:

Length of voyage, or distance . . .

Value of the commodity . . .

Volume of the Movement . . .

Stowage Factor . . .

Port Costs . . .

Voyage Costs . . .

If we assume a reasonable probability that these factors may have some substantial influence on the ocean rate, then let's take them as the variables of our model. It is, then, pertinent to name and define them and consider what results may be expected. At the same time, we can assign each a variable number, according to the model.

Here is what we have: But first let me point out that the source of data will be given as each variable is described. The variables:

$Y_1 =$ the ocean freight rate. It is the dependent variable in the equation. There are 204 observations of this variable selected at random from the freight tariff of the North Atlantic Continent Conference, No. 29, FMC - 31. The observations were selected by rate then the associated commodity name.

$B_1 =$ the constant term, or α, as in the generalized linear regression equation.

$X_2 =$ distance as an independent explanatory variable. It is the best or shortest sea distance between major ports on the trade route. In this instance, the port of New York was selected on the U. S. end of the route and Antwerp and Hamburg on the continent end. Thus the port of loading was New York with discharging taking place at the other two. Because of the nature of this distance, it is possible that it will have little influence and the null hypothesis (to be defined under 'tests') will be accepted. Data was taken from Reed's New Distance Tables.

$X_3 =$ total value of the commodity associated with each rate which moved on the route between the specified ports. Value is expressed in dollars for the year 1971. These values were obtained from Report SA 705, published by the Bureau of Census, U.S. Department of Commerce. Here, if the freight rates are, in fact, value of service rates, i.e., they increase with the value of the commodity, we will expect to reject the null hypothesis. The sign of the coefficient should be positive. If Dr. Chinitz' thesis of elasticity of demand is operative, then we would expect this value to be less than one and approaching

0. If his point that value per ton is the explanatory variable, then we could expect to accept the null hypothesis.

X_4 = total tons of the commodity whose value is stated in X_3. It is the quantity in tons of 2,240 pounds. The data source is the same as for X_3. Here, if volume of the commodity has a negative influence on the rate (as volume goes up, the rate goes down), we will expect to reject the null hypothesis and find a negative coefficient. If the elasticity thesis is justifiable, the elasticity should be low.

X_5 = port cost as an independent explanatory variable. These costs are associated with the call at the ports and with the handling of the cargo. They include stevedoring charges, receiving and delivery costs, port fees, agency fees, towage, docking and other charges incurred in order to work the cargo. Port costs were calculated for a service year using per diem expense data obtained from the Federal Maritime Commission. Gang hour costs for cargo work were obtained from data of the Port of New York and New Jersey Authority. Here, it is expected that the null hypothesis will be rejected and the coefficient will be positive. Such a finding would support Dr. Chinitz' view that ocean rates are cost of service rates (as costs go up, the rate goes up).

X_6 = vessel costs as an independent explanatory variable. These are the costs associated with having the ship in service and ready to take cargo. In this regard, they are a constant or a fixed cost consisting of wages, subsistance, fuel, maintenance, repair, depreciation and interest, etc. Vessel costs were calculated for a service year, 1971 (as with port costs), from per diem expense data obtained as in X_5. Being a constant cost, these costs on a per ton basis will decline as volume increases. Again, it is expected that the null hypothesis will be rejected, but because of the declining function, the coefficient is likely to be negative. This finding would also confirm Dr. Chinitz' view.

X_7 = stowage factor as an independent explanatory variable. This is the ratio of cargo density (space occupied/weight). It is expressed in cubic feet per ton. The values for this factor were taken from Garoche, *The Stowage and Handling of Cargo*. With the premium ship operators place on maximizing both the space and weight capacities of the ships, it is quite possible this density ratio will have a strong influence on the rate. If this is the case, a rejection of the null hypothesis can be expected. A positive coefficient would indicate the rate moves up with the stowage factor.

X_8 = value per ton as an independent explanatory variable. This is obtained by dividing total value (X_3) by total tons (X_4). Dr. Chinitz has said this value has an influence on the ocean rate and that it is an indicator of the elasticity of demand. If his thesis is valid, then rejection of the null hypothesis is likely with a positive coefficient. If the variable is an indicator of elasticity, then a larger value could be expected.

The above variables, as defined, are the data sample for this study. It remains to plug them into the equation (1) for estimation. The result will

be a cross-sectional analysis of just one trade route. In terms of activity, it is one of the most active. The next step is to describe tests which will be applied to the estimated output to determine the significance first, of the variables themselves, and second, of the equation.

TESTS AND TEST HYPOTHESIS

In analysis of the regression, four standard tests will be applied to the output. These will be the 't' and 'F' distributions, the R^2 test of determination, and the Durbin-Watson test for auto-correlation. Homoskedasticity will be tested by means on the Khalili test.

Using the 't' method, we will test the hypothesis that each coefficient (B_{ni}) of each explanatory variable is equal to 0. With a two tailed test and a 5 percent confidence interval, we will accept the null hypothesis if the observed value 't_o' is less than the calculated statistic '$t_{c,0.025,\infty}$' = 1.96. If the value of 't_o' is greater than 't_c' we will reject the null hypothesis and accept the alternate which says the coefficients are greater than 0. This is to say that the variables are significant and do influence the dependent variable. The sign of the observed 't_o' indicates the direction of relationship between the explanatory variable and the dependent variable.

In the 'F' test, we will test the hypothesis that the equation as a whole is equal to 0. If the observed value of 'F_0' is less than the calculated statistic '$F_{c,0.05,6,203}$' = 2.10, the null hypothesis will be accepted. If the observed 'F_o' is greater than the calculated 'F_c', we must reject the null hypothesis and accept the alternate. This is to say that the equation as a whole is not equal to 0. It says it is significant and regression does to some degree explain the value of the dependent variable.

To test the degree of relationship, or the goodness of fit, we will use the Multiple R^2 for the entire equation. By means of the R^2 statistic the relationship of each explanatory variable with the dependent variable. This relationship is expressed as a range: $0 \leqslant R^2 \leqslant 1$. A value of R^2 close to 0 indicates little or no relationship. A value close to 1 suggests a close relationship between the dependent variable and the explanatory variables or the equation. From the observed values of Multiple R^2, $\bar{R}^2$, and p, we will test the hypothesis that the relationship is equal to 0.

Through the performance of these tests, we will have a good idea about the significance of each explanatory variable and the equation as a whole to the dependent variable.

ANALYSIS OF THE RESULTS

For this study, actually, two approaches were taken: first, each independent variable was regressed against the dependent variable, ocean rate; second, the equation as a whole was regressed against the ocean rate. In each case an analysis of variance was obtained, and in the latter, it was obtained for each step of the stepwise program. From this procedure, we were able to see the effect of each variable as it entered, and at the end, the impact of each in the whole system. Though the study progressed through these stages, for this paper we will deal with final stage of the multiple regression. It must

be noted, however, that variable X_3 (total value) was deleted from the equation because of its insignificance in earlier steps.

Within these restrictions, 204 observations of seven variables were regressed in equation (1). The estimate of this system may be stated as follows:

$$(2)\quad \hat{Y}_1 = 36.6 + \underset{(.0361)}{.0075}\, X_2 + \underset{(.1785)}{-.0374}\, X_4 + \underset{(.0014)}{.0025}\, X_5 + \underset{(.0068)}{-.0022}\, X_6 + \underset{(.1612)}{.4696}\, X_7 + \underset{(.0006)}{.0026}\, X_8 + \hat{\xi}_1.$$

R square = .20259

Multiple R^2 = .45011

(The residuals represented by $\hat{\xi}_1$ (error term) are used in a regression with $\hat{Y}_1$ (ocean rate) in the Khalili test).

The 't_o' (observed) values and the elasticities obtained from this regression are shown below for each independent variable. The calculated statistic, for comparison, is '$t_{c,0.025,203}$' = 1.96.

	Variable	't_o'	Elasticity
X_2	Distance	0.2072	0.2587
X_4	Total Tons	−0.2098	−0.2350
X_5	Port Cost	1.7480	0.6237
X_6	Vessel Cost	−0.3274	−0.3605
X_7	Stowage Factor	2.9130	0.3046
X_8	Value/Ton	4.6660	0.0939

To complete the statistical evaluation of the estimated equation, the 'F_o' value for the system was 7.1139. Where, as you remember, the calculated value '$F_{c,0.05,6,203}$' = 2.10. Thus we find the equation as a whole to be significant as an explanation of the variable Y_1 (ocean freight rate). Yet when we take into account the value of the multiple R^2 statistic, we find this to be only at a level of 0.45011. This would say that the equation explains only 45 percent of the dispersion of the ocean rate. Other factors, then, must enter into the explanation which have not been included in the model. This is confirmed by the fact that only two of the independent variables were significant in the final estimation. The table above indicates these by the 't_o' values for variable X_7 (stowage factor) and variable X_8 (value/ton). Of the remaining, none approached significance to any degree except X_5 (port cost). As the variables were entering, one by one, only two made any substantial contribution to the value of multiple R^2. These were Variable X_4 (total tons) and

variable X_8 (value/ton). Yet the former variable had no significance at all based in the final estimation. Its negative sign was an expected result. The value of p for these two variables was 0.999. This indicates a high degree of multicollinearity, again a finding to be expected. The two significant variables had positive signs. Both results were expected and indicate the direct relationship between the ocean rate and these two variables, as either goes up (or both) the rate goes up.

INTERPRETATION OF THE RESULTS

In the earlier sections discussion was given to several approaches or explanations of ocean rates as they are published in the conference tariffs. The discussion of the variables in the context of these approaches, led to the selection of the variables included in the system. One of these, length of voyage mentioned by the Department of Commerce publication, or distance as used in the equation, turned out to have no significance under any condition. If the DOC use of the term was as a time interval (not miles), then this aspect was included in the vessel cost data. This leaves only miles which have no influence on the rate.

Professor Taussig's views on values of service rates and joint costs were given considerable discussion. The results of this regression analysis, in this one conference, give a strong support to his position. The significance of the variable Value per Ton (X_8), and the degree of that significance, point strongly to ability to pay as an important factor in rate setting. And, this ability to pay is measured by the value of the commodity per ton. The elasticity of this variable (X_8), or lack of it, gives further justification to this conclusion. With an elasticity value of .0939, it is essentially inelastic. Thus a very small change in the value per ton could result in a large change in the rate. With the positive sign of the coefficient, the movements of both are direct, up or down.

The behavior of two other variables lends support to this ability to pay interpretation. One is Total Tons (X_4). In the final analysis, it was not a significant variable, but its elasticity value is negative and relatively inelastic. From the view of economies of scale, his is a reasonable result, as tons go up the rate goes down. But the elasticity value is .2350 so it is not as inelastic as the value relationship. It takes more tons to bring about a rate change than it does based on value. The conference is more resistant here. The other variable is Stowage Factor (X_7). This is the other significant variable and its sign is positive. Thus as the density factor increases, the rate increases. This says that space is more valuable as a service factor and the less dense the commodity, the higher rate it should pay. The elasticity is positive but relatively inelastic at .3046. While supporting the value of service concept, in another sense it points out the importance the conference places on maximizing the revenue yield of space in the ships.

Discrimination was inherent in any pricing structure based on value of service, according to Professor Taussig, because of the different prices charged different commodities or shippers for the same product. Here it is transportation and when a large number of differing shipments on one vessel on one voyage are priced differently for no apparent reason than value/ton and space then it would seem a good example of his point. The very fact that the cost

variables were not significant removes any economic basis for the rates themselves.

Talking about rail rates in his paper, Professor Taussig placed the tendency to discrimination on the relative transportation monopoly held by the rails. This same argument applies in the case of the conferences in ocean trade. Still, today, there is relatively little competition on the conference trades, by air, by non-conference carriers, or by what have you. The Tramp carriers are not competition in the real sense because they seek out the specific movements. And, of course, the conferences are authorized by law to act as monopolistic cartels and to administer the price system. Under present procedures, there is little to act as real restraints and to eliminate price inequities.

On the other hand, Dr. Chinitz said that conferences set rates with the relative costs in mind and in the context of the elasticity of demand for the commodity. He suggests that the value of the freight ton is a reasonable index of this elasticity. The results of this study do not lend much comfort to his thesis regarding costs. Neither of the two cost variables remained significant in the final regression though Port Cost (X_5) was significant when it entered the equation. Its inability to retain its significance says something which only reinforces the value of service position. The behavior of the two cost variables Port Cost (X_5) and Vessel Cost (X_6) appears to be sound in terms of the rate and other variables as tons. Vessel Cost was negative and it should be; as rate declines and tons increases, this fixed cost declines on a unit basis. Port Cost was positive which says as they go up the rate goes up and this is consistent with points made above and with the Stowage Factor (X_7). It suggests that productivity declines as density declines, thus the costs are higher.

Value of the commodity as an indicator of its elasticity, Chinitz' other main point is, confirmed by the Value Ton (X_8) level of significance and its inelasticity. The behavior of Total Tons (X_4), negatively inelastic, tends to confirm this point. Both of these variables indicate a failure of the rate structure to respond to changes in quantity which would be a result of a discriminating monopoly inaction and a derived demand situation where the price of transportation had no direct effect on the cause of the transportation demand, the sale.

To raise the question of price discrimination as a result of a value of service rate structure makes it necessary to raise the point of reasonableness of the rates. With little sound economic theory for a value of service rate structure, this becomes a real question, indeed. Some have gone so far as to say the structure of ocean rates is irrational! The results of this regression hardly confirm such a position, but that doesn't make reasonable the fact that value appears to be the dominant determinant of the rates. The situation becomes even less equitable, because the burden is on the small shipper who is in no position to effect the rates which his goods must bear.

Earlier it was said, if the rate is right, the cargo will move. It would seem the rates have been right because volumes of freight move, both in terms of tons and value. But does that make the rate right? If the rate level or the rate structure were different, based on cost of service as a sound economic

criterion, would more freight be moving? This type of question is vital to this country with its difficulties in balance of trade and payments, but it is too large a policy question to answer here. In part, this has to go unanswered because this regression analysis of but one conference only is enough to raise the question. It is not enough to know if this conference is typical of the many others in existence.

IMPLICATIONS OF THE RESULTS

The policy type question asked above falls largely in the responsibility of the Federal Maritime Commission. And, the Commission has, in fact, explored the matter in Docket 65-45. This included the question of rate discrimination in the fact of different rate levels published by conferences serving the outbound and inbound trades of the same route. But implications of the findings of this study, if they were generally true, can be looked at briefly.

Regardless of the fact that rates may be shown as value of service in nature, the conferences and their members would no doubt continue to favor the present rate structure. Simply put, in general, the system works pretty well. But not always, or for all the members. Take the American flag carriers, for instance. They are at a disadvantage because they are a minority in the conferences and also because their costs are higher than their foreign competitors. In large part these are in higher vessel costs and certain overhead costs. (All carriers serving the same ports are faced with generally the same direct costs in cargo handling). But, being minority members in the conference they are not in a position to set rates at a level which contribute fully to these joint costs.

Containerships developed by American shipowners, and container technology, have helped them solve this problem through greater productivity. This productivity has helped to cut costs and increase the commodity's contribution to vessel costs. To meet the U. S. flag competition, foreign operators have built and employed containerships on the trade routes. The result has been a condition of severe over-tonnaging, particularly on the route under study. This has led to rate competition by the open rate procedure on substantial cargos. This presents a good example of the effect of ship space oversupply on rates on the trade. It would be interesting to learn whether the lower rates had any traceable effect on the volume of cargo.

The shippers view of the value of service nature of ocean rates could be quite different particularly since he is faced with the dilemma of freight density, quantity, and value. How can he adjust these factors in his product to take advantage of more competitive rates. He is fairly locked in on his product and by his market, that is, the demand he has in the overseas market and therefore the quantities he can ship. The shipper has the opportunity to make design or packaging changes to increase density. Or, he can work out a distribution and logistics program by which he can ship in larger quantities and as a result serve his customers better.

Faced with the knowledge of value of service rates which have little economic base than that they work for the carriers, the shippers could insist that the ocean rates be related more to costs of operation. Such cost of service rates would provide an economically sound base for the rate level. It

could in fact eliminate the current tendency to discrimination and at the same time subsidy of low rated cargo by some of the higher rated commodities.

An emphasis on cost of service rate structures would bring about an analysis of costs as they relate to commodities. In the process some refinement would more accurately allocate costs to commodities. Then marginal costs could be developed on significant commodities. With this tool, rates could be analyzed on the basis of market and shipper needs. Such an approach to rate making requires much analytical work on the carriers' part and yet the potential is for increased volumes of cargo and increased profitability of the operations. Another outcome could be through the computer as a tool to carry out these analyses by means of a model such as used here.

Still a further approach is through a rate structure change which would be formed around the pallet or container as a unit. Here the rate could be based on the unit which would conform to standards of measure and weight. As units costs are easily isolated and allocated both for vessel and for port costs. The unit could be the important criterion and not the freight loaded within. Its consist is not really important to the container as a rate base, or the pallet. The usual direct handling costs associated with individual commodities becomes superfluous in this situation. Handling and stowage is in terms of the box or pallet with measurable cost factors. A marginal cost schedule for each unit at different levels of utilization of the vessel. The tariff simplification possible with such a structure would in itself represent significant cost savings to carriers and ultimately shippers.

The above discussion presents a finding as the result of one analysis of one freight conference. That finding concludes that this conference's rates are based on value of service principals as opposed to any others. As a measure of rate reasonableness, value of service rates have little basis. As a structure, these value of service rates have served the carriers reasonably well and maintained suitable service levels and perhaps that is all that is required as a test of reasonableness. This structure may not serve the shipper and the market to their fullest advantage. This fact is not yet tested. Some alternatives in the order of cost of service rates and applying marginal costing techniques to rate determinations have been suggested. These latter approaches require considerable investigation but can offer substantial reward in terms of volume of cargo and profit to the carrier, and service to the customer . . . the shipper.

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