Abridgment

Study of Barge Line-Haul Rates

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Waterway rate characteristics are an essential part of benefit analysis of waterway investment. For the first time, waterway rates have been collected and analyzed over the entire Mississippi River and its tributaries as opposed to other studies that covered only a part of that system. The study is most unique in that rates were verified from the actual records kept by the carriers. A total of 1700 rates were stratified based on season, origin-destination pairs, and commodity groups. Simple regression analysis suggests that major commodity groups, such as grains, exhibit respectable regression characteristics. The results of the study would be an input to other major investment studies as well as more complex rate analysis.

Benefit-cost analysis is an essential part of waterway transportation investment decisionmaking. Waterway rate analysis is a major component of benefit calculation. This study is the first attempt to evaluate waterway rate characteristics on the entire Mississippi River and its tributaries. Furthermore, this study is most unique in that "rate data" provided by the carriers were verified from actual carrier records. The data obtained by using this study approach, therefore, are more credible than some data that might have been gathered by telephone.

STUDY PURPOSE

The purpose of this study was to collect and analyze rate data on approximately 1700 actual barge shipments and to do this in a manner that (a) would be statistically valid and (b) could, if necessary, stand up in court proceedings.

PRELIMINARY VISITS

It was recognized that collection of confidential rate data, including verification from actual shipper records, was beyond the industry's experience to date. Thus, careful preliminary contact was made with influential industry groups and companies to explain the purposes of the project. Early contact was made with American Waterway Operators, Inc., and with leading individuals.

These early visits were also important in that the study team gained a clear understanding of industry record-keeping procedures, which would influence the project, and the concern of the industry about confidentiality. Through these discussions, it was possible to work out a data collection procedure that would sufficiently protect confidentiality on the one hand while yielding verified rate data on the other.

DATA COLLECTION VISITS

A number of follow-up trips were required to com-

Table 1. Commodity classes for sample selection.

Commodity Class	Code[a]	Commodity
1	0103	Corn
2	0107	Wheat
3	0111	Soybeans
4	2049	Grain mill products[b]
5	0102	Barley and rye
	0104	Oats
	0105	Rice, rough
	0106	Sorghum grains
	0119	Oilseeds[b]
6	0911	Fresh fish, except shellfish
	0913	Menhaden
	0912	Shellfish, except fresh
7	0931	Marine shell
8	1011	Iron ore and concentrates
	1021	Copper ore and concentrates
	1051	Bauxite and other aluminum ores and concentrates
	1061	Manganese ores and concentrates
	1091	Nonferrous metal ores and concentrates[b]
9	1121	Bituminous coal
10	1311	Crude oil
11	1442	Sand and gravel
12	1471	Phosphate rock
	1479	Natural fertilizer materials[b]
13	1491	Salt
	1499	Nonmetallic minerals, except fuel[b]
14	1493	Liquid sulfur
15	2014	Tallow, animal fats, and oils
	2042	Prepared animal feeds
	2061	Sugar
	2062	Molasses, inedible
	2091	Vegetable oils
	2092	Animal oils
16	2810	Sodium hydroxide
17	2811	Crude products from coal tar, petroleum and natural gas
	2920	Petroleum coke
18	2813	Alcohols
	2817	Benzene and toluene
19	2818	Sulfuric acid
20	2819	Basic chemicals and products[b]
21	2871	Nitrogenous fertilizer and fertilizer materials, manufactured
	2879	Fertilizers and fertilizer materials[b]
22	2872	Potassic fertilizer materials
	2873	Superphosphate
23	2911	Gasoline
	2912	Jet fuel
	2913	Kerosene
24	2914	Residual fuel oil
25	2915	Distillate fuel oil
26	2916	Lubricating oil and greases
27	2917	Naptha and other petroleum solvents
28	2918	Asphalt, tar and pitches
29	2921	Liquid petroleum gases, coal gases, natural gas, natural gas liquids
30	2991	Petroleum and coal products[b]
31	3311	Pig iron
	3312	Slag
	3313	Coke, pitches, etc.
	3318	Ferroalloys
	3319	Primary iron and steel products[b]
	3321	Nonferrous metals, primary smelter products
	3323	Lead, zinc and alloys, unworked
	3324	Aluminum and alloys, unworked
	3322	Copper alloys, unworked
32	3314	Iron and steel ingots, forms, etc.
	3315	Iron and steel bars, rods, etc.
	3316	Iron and steel plates and sheets
	3317	Iron and steel pipe and tube
33	4011	Iron and steel scrap
	4012	Nonferrous metal scrap
	4022	Textile waste scrap and sweepings
	4024	Paper waste and scrap
	4029	Waste and scrap[b]
34	0101	Cotton, raw
35	1411	Limestone flux and calcareous stone
36	4118	Waterway improvement material
37	3241	Building cement

[a]Waterborne Commerce Statistics Center. [b]Not elsewhere classified.

Table 2. Regression of miles on line-haul rate (1977) by commodity class.

Commodity Class	No. of Observations	R^2	Standard Error	Intercept	Slope per 100 Miles	Commodity Class	No. of Observations	R^2	Standard Error	Intercept	Slope per 100 Miles
1	33	0.72	0.85	1.844	0.306	20	38	0.30	3.34	2.870	0.365
2	21	0.75	1.20	1.339	0.388	21	105	0.36	1.84	2.842	0.257
3	30	0.78	1.00	1.664	0.301	22	25	0.25	1.31	2.470	0.173
4	21	0.43	1.34	2.222	0.253	23	38	0.56	1.47	1.136	0.287
5	11	0.74	1.45	-0.14	0.663	24	34	0.53	1.73	1.182	0.342
6	-	-	-	-	-	25	59	0.83	1.25	0.417	0.447
7	4	-	-	-	-	26	57	0.77	1.42	0.338	0.486
8	51	0.43	1.85	1.770	0.273	27	22	0.61	2.35	2.657	0.453
9	69	0.61	1.14	1.426	0.274	28	21	0.50	2.09	3.022	0.399
10	15	0.55	1.31	2.028	0.280	29	8	-	-	-	-
11	15	0.70	0.47	1.305	0.249	30	9	-	-	-	-
12	6	-	-	-	-	31	61	0.49	2.43	2.217	0.386
13	34	0.27	2.79	2.802	0.244	32	82	0.53	2.88	3.182	0.589
14	-	-	-	-	-	33	44	0.19	1.92	4.689	0.233
15	27	0.47	1.52	3.226	0.327	34	20	0.29	4.63	3.923	0.522
16	7	-	-	-	-	35	31	0.57	2.22	0.045	0.684
17	49	0.48	2.66	2.231	0.350	36	2	-	-	-	-
18	60	0.66	2.49	1.970	0.511	37	8	-	-	-	-
19	8	-	-	-	-						

Note: Does not include shipments with fuel surcharge or minimum tonnage rate.

plete the data collection due to the geographic dispersion of the companies and the fact that many had to be visited twice for the data collection because they had not fully understood how to respond to the information request. Although almost all of the companies cooperated, in some cases data were unavailable or partly or wholly unusable, which reduced the actual number of rates gathered.

DATA BASE (1977)

The general type of sampling plan is a stratified one-stage design. For the selection, the sampling unit is defined as a commodity movement of a given commodity group by a given towboat operator between a given set of origin-destination (O-D) docks in a given season of the year. These units are then stratified by (a) season of the year (4), (b) commodity group (36), and (c) O-D area (14x14). From each stratum of this three-way stratification, one unit is selected, the probability of selection being proportionate to the tonnage for that unit (as related to total stratum tonnage). All of the commodity movements thus selected constitute the sample for waterway rates.

CONSIDERATIONS IN SAMPLE DESIGN

As in all sample designs, one consideration was the limitations on the sample size imposed by costs. A total of 1700 samples were selected out of a desirable sample size of 4100.

The second major consideration was the manner in which estimates would be made from sample data. Since parametric estimates were contemplated, it was considered essential that commodity movements be stratified by origin and destination so that the whole range of variables highly correlated with rates would be represented. Thus, one obtains the full range of such variables as mileage, river direction, and number of locks traversed for each commodity. Representing the extreme ends of the range in the sample will contribute to more precise sample estimates, since regression estimates are more precise for interpolated values than for extrapolated values.

The third major consideration in the design involved the considerable variation expected in tonnage among individual shipments as well as from dock to dock. Because of the large number of strata involved in the season/commodity/O-D stratification, it was not possible within the sample-size limitation to provide for a size stratification. Making the selection so that probability of selection is proportionate to tonnage approximates a size stratification.

SIMPLE REGRESSIONS

As a first step in the regression analysis, the regression of river miles on line-haul rate has been calculated for each commodity group. No regression statistics are given for any class for which there are less than 10 degrees of freedom (12 observations). The commodity classes are given in Table 1, and the regression values are given in Table 2.

The values of R^2 (the percentage of variation in line-haul rate that is explained by the relation with miles) are rather modest for most commodity groups. Indeed, they are very low for commodity groups such as 20, 23, 24, and 34. However, it is hoped that there will be substantial improvement as more variables are added in further analysis. The desirability of splitting up these commodity classes should also be investigated. There were 10 commodity classes for which the sample was too small for the computation (it is hoped that these can be included when the whole sample becomes available); e.g., Y = 1.844 + 0.306 (distance/100) for corn. It should be noted that the slope of the regression line is given for miles expressed in units of 100 miles.

The regression values reported were calculated from the full data base without any deletions for "outlier" observations. Examination of the residual plot for each of the regressions indicates a number of such "outliers", but they will not be considered for deletion until a much later stage in the analysis.

SUMMARY

With the cooperation of the waterway carrier industry, it was possible to develop baseline characteristics of line-haul rates. This study is most unique in that all the rates were verified. Major commodity groups exhibit reasonable regression characteristics. Other commodity groups, due to the small sample size, exhibit a low level of regression. The results of this study will be a critical input to investment analysis as well as future rate analysis (e.g., 1980).

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