The National and Regional Economic Benefits Of Commercial Navigation on the Snake River

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INTRODUCTION

The system of navigation on the Columbia, Snake, and Willamette Rivers includes more than 400 miles of waterway. stretching from the Pacific coast to the interiors of Oregon, Washington, and Idaho. This navigation is facilitated by eight locks located throughout the system. In addition to commercial navigation, the lock and dam structures located along this system also provide flood control, irrigation, recreation, municipal water supply, and valuable hydro-electric generating capacity. While this system clearly yields numerous economic benefits to both the region and the national economy, it is also perceived as imposing significant costs because of its impacts on fish and wildlife habitat. Consequently, it is important to periodically review the uses and influence of this waterway system to ensure that the benefits it confers warrant its continued maintenance and operation. In conjunction with such an inquiry, the Institute for Water Resources (IWR) has contracted with the Tennessee Valley Authority (TVA) to investigate and document some of the many economic influences associated with commercial navigation on the Columbia-Snake-Willamette system. Specifically, the current document provides estimates of the savings that accrue to shippers directly using the Snake River portion of the Columbia-Snake-Willamette system and the savings enjoyed by shippers who, although not shipping via this system, nonetheless benefit from its competitive influence.

In terms of outcomes, the presence of a navigation alternative can enhance the level of competition in two distinct ways, Available navigation may win the patronage of some shippers -- presumably by reducing their transport costs and/or offering better service. At the same time, the mere presence of a barge alternative may also reduce the rates paid by other shippers who continue to opt for their traditional mode of transportation. Within the context of assessing the benefits of transportation projects or policies, these two outcomes must be treated differently, but the competitive force that brings them to evidence is, in fact, the same. The distinction between the savings that accrue directly to barge users and the water-compelled rate savings enjoyed by rail or motor carrier customers is important. The former set of benefits reflects net additions to overall economic welfare, while the latter set of effects largely represents transfers from carriers to shippers. Thus, shipper savings are counted as National Economic Development (NED) benefits, while water-compelled rate savings are tallied in regional accounts.

The remainder of this document provides estimates of both the shipper-related NED benefits attributable to commercial navigation on the Snake River and the water-compelled rate savings that accrue to railroad customers throughout the region, The first volume, Volume I, describes methods used to calculate NED benefits and provides a commodity-specific summary of these benefits. Volume II provides estimates of water-compelled railroad rate effects and discusses how these benefits relate to the shipper savings developed in Volume II.

VOLUME I
NATIONAL ECONOMIC DEVELOPMENT BENEFITS FROM SHIPPER SAVINGS

I-1 SUMMARY OF FINDINGS

Based on a 35-movement sample, barge movements from or to the Snake River Navigation System are estimated to have saved, on average, more than $5.95 per ton in transportation and handling charges when available barge costs are compared to the next-best, all-land transportation alternative.[1] These savings are calculated across 11 commodities and range between a high of $9.05 per ton for alfalfa hay and low of $1.84 per ton for lumber. A summary of all rate calculations is provided in Appendix 1. In total, the shipper savings attributable to CSW navigation for the 35 1996 movements amounted to more than $16 million. Thus, savings for the entirety of the commercial traffic originating or terminating on the Snake River likely exceeded $20 million for the same period.

I-2 STUDY PARAMETERS, JUDGMENTS, AND ASSUMPTIONS

General Parameters, Judgments, and Assumptions

Freight rates for each of 35 sample movements were calculated based on the actual water-inclusive routing, as well as for a competing all-land alternative and a land water alternative over Pasco, Washington when such an alternative is possible. All computations reflect those rates and fees that were in effect in the first calendar quarter of 1998. Dock-to-dock tonnages over the included origin-destination pairs range between 688 tons and 423,000 tons annually, representing 11 individual commodities. Reported rates for both the water movement and the all-land alternative are based on the actual location of shipment origins and destinations.

Because many of the sample movements have off-river origins and or destinations, a fill accounting of all transportation costs for waterborne movements requires the calculation of railroad and/or motor carrier rates for movement to or from the nearest appropriate port facility. Additionally, all calculations reflect the loading and unloading costs at origin and destination, all transfer costs to or from barge, and any probable storage costs. Likewise, many all-land routes would require the use of more than one transport mode. Therefore, when appropriate, calculations include all requisite transfer charges for land movements as well.

Based on information collected from shippers, receivers, carriers, river terminal operators, stevedores, Federal agencies. and private trade associations, TVA was able to identify probable origins and destinations for the majority of those movements originating or terminating at off-river locations. In the absence of specific shipper/receiver information, it was assumed that the river origin and destination are the originating and terminating points for both the river and alternative modes of transportation.

For movements originating or terminating at a river port location, it was assumed that rail service could also be used by the shipper or receiver if that port is rail served. When the shipper or receiver is served by truck only, a railroad team track or transfer facility at the station nearest the off-river shipper or receiver was used for the land alternative.[2] Only those customers who ship more than 100,000 tons annually and who are already adjacent to rail trackage would be assumed to undertake the significant capital expenditures necessary to acquire direct rail service. No consideration is given to private car leasing cost and mileage allowances made by carriers to shippers for the use of private equipment are, similarly, ignored. In nearly every case, it was assumed that the alternative modes of transportation would have the physical capacity to accommodate the additional tonnage represented by each commodity movement.[3]

Commodity Specific Parameters, Judgements, and Assumptions

Grains. Notable within the computational method is the use of both rail costing models and tariff rates depending on which value is the lowest.[4] Since the rail tariff rates generally use the short line miles, the actual tariff miles were computed for both the cost model and grain tariff rates. Neither the Burlington Northern - Santa Fe’s Certificate of Transportation (COT) program, nor OT-5 authority practices were considered in the development of rates, However, the analysis included rates based on the use of oversized C6-X covered hopper cars.[5]

Fertilizers. Primary fertilizer materials are divided into four groups, Nitrogen (N), phosphates (P), potassium products - primarily potash, (K), and micro or secondary nutrients. These materials are moved by truck, rail, barge, and pipeline to a terminal facility for distribution to local dealers. Though some large users purchase primary fertilizer materials for self-blending, most end users generally purchase a prepared fertilizer blend from the local dealers either in a bagged or bulk form.

Fertilizer distribution and applications are highly seasonal which significantly impacts modal choice, Typically, fertilizer manufacturers use rail and barge to build initial warehouse inventories and rail and truck to stock local dealers. Once an application season starts, truck re-supply is the dominant mode. Seasonality and weather conditions also affect fertilizer transportation patterns by requiring the post-season repositioning of liquid fertilizer products to warm weather winter storage locations.

Forestry products consist of wood chips, pulp wood, and saw logs, each moving in railroad owned equipment. Wood chips were assumed to move in high cube open hopper cars while pulp wood and saw logs were rated in special rack flat cars. A further rate differentiation was used in contrasting domestic and export wood chip movements.

I-3 METHODS FOR DETERMINING RATES

As a result of the flexibility created by surface transportation deregulation, it is sometimes difficult to determine the exact rate charged by a carrier on shipments moving under contract. Barge rates are a matter of negotiation between shipper and barge line operator, and these rates are not published in tariff form. Each carrier bases its rates on individual costs and specific market conditions, so that these rates will vary considerably between regions, across time. and from one barge line to another.

Contract rates are also common in pipeline, rail, and motor carrier transportation and, like barge rates, may be maintained in complete confidentiality. In other cases (particularly grain and fertilizer), tariff rates are still applied. However, there are rarely dependable means for determining whether a contract rate or a tariff rate should be used to price a particular movement.

For the purposes of this study, actual rates, as provided by shippers, receivers, or river port operators, are used whenever possible. All other rates were obtained from published sources or, when this was not possible, estimated by TVA based on the mode of transportation, the tonnage, and other shipment characteristics. All rates, whether actual or estimated, are those in effect on March, 1998. However, when necessary, reported rates have been refined to eliminate seasonal impacts or the effects of abnormal market conditions. The methodologies employed in the estimation of unobservable rates have been developed through extensive contacts with shippers, railroads, motor carriers, and the barge industry, This information was often integrated with confidential Federal data and/or the output of computerized simulation and costing models. In-house TVA rating and costing expertise developed through decades of experience as a major shipper of coal and other bulk commodities and through the implementation of navigation-based economic development programs throughout the Tennessee River Basin both guided and augmented this process.

Barge Rates

With the exception of grain and feed ingredients, unobservable barge rates are calculated through the application of a computerized Barge Costing Model (BCM) developed by the Tennessee Valley Authority. The TVA model has been refined to include 1997 fixed and variable cost information obtained directly from the towing industry and from 1996 data published within the Corps' annual *Estimated Towboat and Barge Line-Haul Cost of Operating on the Mississippi River System*.[6]

The TVA model contains three costing modules - a one-way, general towing service module; a round-trip, dedicated towing service module; and a round-trip, general towing service module. The one-way module calculates rates by simulating the use of general towing conditions between origin and destination, including the potential for a loaded return. The dedicated towing service module calculates costs based on a loaded outbound movement and the return movement of empty barges to the origin dock. The round-trip general towing service module is similar to the one-way, except that it provides for the return of empty barges to the point of origin. This module does not calculate costs for towboat standby time during the terminal process but includes barge ownership costs for both the terminal and fleeting functions. It does not require that the empty barges be returned using the same towboat. Depending on the module in use, inputs may include towboat class, barge type, shipment tonnage, the interchange of barges between two or more carriers, switching or fleeting costs at interchange points or river junctions, barge ownership costs, fuel taxes, barge investment costs, time contingency factors, return on investment, and applicable interest rates.

Barge rates on dry commodities are calculated using the general towing service round-trip costing module. Inputs, based on information from carriers and the Corps' Lock Performance Monitoring System (LPMS) database and the Corps' Waterborne Commerce of the United States, were programmed into the module to simulate average towboat size (horsepower) and corresponding tow size (barges) for each segment of the Inland Waterway System, Other inputs include barge types, waterway speeds, horsepower ratios and empty return ratios.[4]

Barge rates calculated by the using TVA model reflect charges that would be assessed in a period of traditional demand for waterway service. It should be noted that the model does not explicitly consider market factors such as intra or inter modal competitive influences, favorable back haul conditions created by the trafiic patterns of specific shippers, or the supply and demand factors which affect the availability of barge equipment, These and other factors can influence rate levels negotiated by waterway users. However. the model calculates rates based on the overall industry's filly allocated fixed and variable cost factors, including a reasonable rate of return on assets. It is TVA's judgment that the rates adequately represent the industry and provide a reasonable basis for the calculation of NED benefits.

Railroad Rates

Reported rail rates, like barge rates, are used in every case for which they are available. However, in the face of incomplete information, most movements require the calculation of probable railroad rates. For grain and feed ingredients, two methods are used. First, the appropriate tariff rate is identified. Next, the Rebee Rail Costing Model is used to generate an estimate of rail movement cost. This cost is then inflated to reflect rail carrier market power in order to produce a final estimate of the most likely rail rate. For those cases in which the published tariff is lower than the estimated rate, the tariff rate is selected for use. Conversely, when the estimated rate is lower than the tariff rate, it is the estimated rate that is included in the surface and alternative rate analysis. Estimated fill and variable railroad costs based on the Uniform Rail Costing System are also included for each movement.[7]

Rates for all other commodities are calculated based on the Rebee cost estimates plus an appropriate mark-up. Mark-up factors and shipment characteristics were determined through a variety of means, with shipper information being, the preferred source. However. in the absence of a superior source, information from the Surface Transportation Board's Carload Waybill Sample was used.[8] For shipments originating in Canada, the rail rates are converted to U.S. currency through the exchange rate and surcharge published for March 1998.

Motor Carrier Rates

Actual truck rates for off-river movements are used whenever possible. All other rates are estimated based on published motor carrier tariffs or regional rate quotations from truck brokers and contract motor carriers.

Handling Charges

Handling charges between modes of transportation are estimated using information obtained from shippers, receivers, stevedores, and terminal operators. Handling charges for transfer of commodities from or to ocean-going vessels are based on information obtained from ocean ports or stevedoring companies. For import or export movements that involved mid-stream transfer operations, handling costs to or from land modes at a competing port with rail access are applied.

The primary influences on the transfer rate levels are the work rules and stevedore labor rates assessed in the mouth of the Columbia region for foreign commerce. The stevedores at the Port of Portland impose relatively high rates when compared to similar charges in New Orleans, Chicago, or Houston for like commodities.

Unless otherwise noted, it was assumed that movements of bulk products (for example, grain or fertilizer) would be handled through elevators or storage facilities. It was also assumed that liquid commodities transferred between modes would require tank storage. Additional costs are incurred at both river and inland locations if shipments remain in storage past the free-time period allocated by the facilities involved. Storage charges are usually assessed on a monthly basis.

Loading and Unloading Costs

Because loading and unloading costs are not usually documented by shippers and receivers, they are particularly difficult to obtain.[9] Moreover, these costs can vary considerably across firms. In an attempt to provide the best possible estimates of these costs, the analysis used available shipper and receiver information combined with data from Corps studies performed by other researchers, as well as previous TVA studies. These data were revised to reflect 1997 conditions, then averaged, as required. In those cases where varying sources produced disparate estimates, the methodology relied most heavily on shipper and receiver estimates. A table of handling and transfer costs is included in Appendix 2.

Methodological Standards

Two points should be noted regarding the methodological standards applied within this study. First, the standards described above reflect essentially the same processes TVA has applied (or will apply) in developing transportation rates for other recent (or ongoing) Corps studies. Specifically, the outlined methodology was used in the Upper Mississippi Navigation Feasibility Study, the Ohio River Main Stem Study, the Port Allen Cutoff Assessment, and the Missouri Master Manuel Project. Thus, this uniform approach makes inter-project comparisons more possible. More importantly, recent methodological improvements enable TVA to produce transportation rate/cost materials that are, at once, more complete and more reliable than the transportation data TVA (or any other agency) has produced in similar studies.

I-4 SAVINGS TO USERS

Based on the First Quarter 1998 cost levels. users of the Snake River system represented by the 35 sampled movements saved, on average, $5.95 per ton over the best possible all-land routing alternative. Savings for each of the 11 commodity groupings identified for this analysis are summarized below.

Table I-1

Commodities	Average Per-Ton Water Route Cost	Average Least-Cost Alternative Per-Ton[10]	Average Per-Ton Water Route Saving
Alfalfa Hay	$19.59	$28.64	$9.05
Anhydrous Ammonia	$16.60	$23.84	$7.24
Barley	$12.22	$16.68	$4.46
Distillate Fuel	$11.50	$16.12	$4.62
Logs (Pulpwood)	$11.45	$19.12	$7.67
Logs (Saw)	$11.15	$18.62	$7.48
Lumber	$20.33	$22.17	$1.84

Nitrogen Fertilizer Solution	$10.44	$12.78	$2.34
Wheat	$11.72	$19.03	$7.31
Wood Chips	$9.05	$14.60	$5.55

When applied appropriately, the rate information summarized affords many opportunities for interpretation. There are, in general, several caveats or exceptions that are worthy of note. Moreover, at the commodity level, there are a number of specific circumstances that significantly affect the magnitude of the observed benefit from barge transportation.

The pattern and pricing of grain movements from the vicinity of the Snake River illustrate the complex interrelationship between rail and barge transport in the region and the general inability (or unwillingness) of rail carriage to satisfy the totality of the region’s transport demand, First, there is ample evidence of "differential pricing."[11] Specifically, barge movements of barley and wheat are priced the same for each particular origin. However, rail carriers apply a 20-25% rate reduction for barley, Likewise, both the BNSF and the UP discount the use of C6X covered hopper cars for both barley and wheat; yet waybill sample data suggest that, due to car supply or other causes, this equipment is not utilized in the Snake River region. Finally, the spread between available barge rates and rail rates over the same origin-destination pair is influenced by the single car and small-number multiple car shipping patterns evidenced for grain. Snake River grain shippers do not use unit trains, nor do they use private covered hopper cars.

Differential pricing practices are not confined to grain products. Wood chip shippers in the Snake River region are equally affected. While barge rates do not differentiate between domestic or export destinations, the rail carriers in the region heavily discount chip rates for export movements. These price differentials do not owe to any difference in the cost of providing service. Instead they, reflect the fact that export purchasers have a greater breadth of supply choices than regional paper producers.

VOLUME II
WATER-COMPELLED RAILROAD RATES

II-1 SUMMARY OF FINDINGS

The presence of available inland navigation in the Pacific Northwest provides a disciplining force that reduced regional aggregate payments to railroad rates during 1996 by nearly $8 million, This having been noted, the overall water-compelled railroad rate effects attributable to available commercial navigation on the Snake River is considerably smaller than similar effects on other river systems. This outcome is very probably attributable to the region’s geography and to the independent presence of other market forces that make the waterway's influence redundant.

II-2 WATER-COMPELLED RATES AS A SOURCE OF RED BENEFITS

Prior to 1980, and the implementation of the Staggers Rail Act of that year, the Interstate Commerce Commission (ICC) maintained regulatory control over railroad rates, making any discussion of waterborne competition largely inappropriate, Presumably, the Page ICC sanctioned rail rates based on some quasi-optimal departure from marginal cost pricing aimed at minimizing market distortions while providing rail carriers with an adequate rate of return on capital. Under such a scenario, the increased availability of barge water transportation might affect transfers of wealth from shippers in regions without a alternative to shippers located at or near a waterway improvement. However, the absence of extant super-normal rail profits would preclude any transfer of welfare from carrier to shipper or the achievement of any aggregate welfare gains.[12]

With deregulation, an environment in which rail carriers are presumed to act to maximize firm profits replaces the outcome outlined above. This profit maximizing behavior dictates that railroads charge different rates for the transport of various commodities within different regions of the country if the demand elasticities in these markets are different, if there is no opportunity for arbitrage, and if the railroads have sufficient market power to affect rates at all. Assuming these conditions are met, the railroads will impose a set of often disparate prices which will maximize profits in each market and, consequentially, maximize total profits for the firm. Except for any common costs that are affected by the volume of traffic in some combination of markets, these profit-maximizing rates exist independent of each other. It follows that increased waterborne competition in one market may reduce prices in that market without affecting prices in other markets lying beyond the range of effective barge competition. The most obvious result is a loss of railroad profits to rail shippers within the affected region. Further, the railroads cannot recover these lost profits by imposing higher prices elsewhere, If they possess the power to impose profitable price increases, they would have already exercised it. Instead, improved water transportation leads to a transfer of wealth from the providers of rail transport to its consumers. This does not imply that the railroads are earning zero economic profits, even in the affected market, only that the level of rail profits is less than it would have been in the absence of the navigation improvement.

The actual functioning of rail-barge competition is somewhat confounding, The competitive impact of available navigation need not produce significant levels of barge traffic to affect rail rates. To the contrary, when barge operating costs are only modestly lower than rail costs, responsive railroad rates may decrease to the point where waterborne commerce becomes virtually nonexistent. Nonetheless, the lower railroad rates that void the river of traffic would not exist without the competitive threat of navigation. The fact that some river systems retain significant volumes of traffic indicates that these systems can sometimes offer transportation at rates too low for the railroads to match.

In a more generic setting, one might expect that a structural change which enhances competition between rivals and lowers price would lead to aggregate gains in economic welfare extending beyond a simple transfer of wealth from seller to buyer. Indeed, there may be NED benefits attributable to a reduction of railroad rates for existing and new railroad customers. However, it is our judgment that the magnitude of these welfare gains is likely to be extremely small. In order for a change in rail rates to induce substantial changes in welfare it would be necessary for output quantities to vary considerably as rail prices change. Empirical evidence suggests that this is not the case. Even long-run elasticities of supply with respect to transport rates are very low and, in the short-run these elasticities probably approach zero. Because falling transport rates cannot significantly affect the quantities of agricultural inputs and outputs produced each year, the number of kilowatt hours of electricity generated, or the number of new housing starts, it is likely that such declines would lead to only marginal welfare gains for the economy as a whole.[13]

II-3 MODELS, DATA, AND ESTIMATION TECHNIQUES

Theoretical Setting

Based on the discussion in the previous section, it is assumed that all rail carriers act to maximize current period profits in each of the markets in which they operate. Further, it is assumed that there are no opportunities for the resale of rail services, and that railroads possess some degree of market power, so that they may establish differential rates when customers in distinct markets have different demand elasticities. Markets are distinguished from one another by geographic location and by commodity or shipment characteristics. Though the demands of individual shippers may be discontinuous, market demand curves are assumed to be continuous and well behaved functions of railroad prices, the pricing and availability of competing transport modes, commodity characteristics, and the down-stream demand for shippers' products. Railroad costs of providing service in a particular market during some time period are assumed to be a function of the quantity of service provided, shipment characteristics, route characteristics, and factor prices. These functions are also assumed to be continuous, twice differentiable and, otherwise, well behaved, These market demand and cost functions may be combined to yield a current period profit function from which the railroad may determine the profit maximizing price, This optimal price is, of course, a function of the same variables which determine demand and costs. This relationship may be summarized by:

(1) $P_i^* = f(M_i, A_i, S_i, R_i, F_i)$

where P_i^* is the profit maximizing price to be charged to the i^{th} customer, M_i is the set of variables denoting the pricing and availability of both intramodal and intermodal transport alternatives as defined by the origin/destination pair and the commodity characteristics. A_i is the aggregate demand for the shipped commodity. S_i is a set of shipment characteristics such as shipment size, special handling requirements or equipment considerations. R_i is a set of route characteristics including the frequency of interchange or line density, and F_i denotes a set of factor prices.[14]

Data and Estimation

The principal data source for the estimation of Equation (1) is the Surface Transportation Board's annual Carload Waybill Sample for 1996. All data remain fully disaggregate. Inter-commodity variations are captured through separate estimations for each good, All commodity groups are defined at a five digit Standard Transportation Commodity Code (STCC) level. A summary of those commodities considered within the analysis is included be low in Table II-1.

Table II-1			
STCC	**Commodity**	**STCC**	**Commodity**
1131	Barley	28181	Urea
1137	Wheat	28712	Phosphate Fertilizer
11212	Coal	28713	Liquid Nitrogen Fertilizer
14714	Phosphate Rock	28714	Other Dry Fertilizers, NEC
24111	Saw Logs	32411	Cement
24115	Wood Chips		

To account for the dependent variable and the various explanatory components contained in Equation (1), the actual empirical specification includes a number of variables as described in Table II-2.[15] While the relationship between the origin and destination distances to water and the observed rail rate may be continuous over some range of distances, these effects may be presumed to end abruptly. At some critical distance, escalating motor carrier charges render the barge-truck alternative ineffective as a competitive influence. Therefore, beyond this distance the coefficient estimates for $OD2W_i$ and $TD2W_i$ should be zero. TO account for this discontinuity, the actual estimated models embody a spline function. The specific construction of this function and process for determining the appropriate critical distances are discussed in Appendix 3.

Table II-2		
Variable	**Description**	**Expected Sign**
RTM_i	Revenue per ton-mile for shipment *i*.[16]	Dependent variable
$UCAR_i$	The number of carloads in shipment *i*.	Negative
$TONS2CAR_i$	The average tonnage per carload in shipment *i*	Negative
$TDIS_i$	The total shipment distance for shipment *i*	Negative
$OD2W_i$	Straight-line origin distance to nearest navigation. [17]	Positive
$TD2W_i$	Straight-line destination distance to nearest navigation	Positive
$NUMRR_i$	The number of railroads participating in shipment *i*.	Positive/Negative [18]

$RRCON_i$	Carrier concentration in originating and terminating markets	Positive
$DENSITY_i$	State-to-state route density for the carrier or carrier combination responsible for shipment *i*	Positive/Negative [19]
$SYSCAR_i$	Zero/one dummy variable assuming a value of one if equipment was railroad owned, zero otherwise.	Positive
Cd_{ij}	Zero/one dummy variables denote whether or not carrier *j* participated in shipment *i*	No prior expectations

However, the process mandates the inclusion of two additional dummy variables, $OCDUM_i$ and $TCDUM_i$, Finally, we add a quadratic term on shipment distance, TDIS2, to produce the sort of gentle distance-rate taper typically hypothesized, so that the model estimated for each of the individual commodities may be written as:

(2) $RTM_i = \beta_0 + \beta_2(UCAR_i) + \beta_2(TONS2CAR_i) + \beta_3(TDIS_i) + \beta_4(TDIS2_i) + \beta_5(OD2W_i)$[20] $+ \beta_6(TD2W_i) + \beta_7(OCDUM_i) + \beta_8(TCDUM_i) + \beta_9(NUMRR_i) + \beta_{10}(RRCON_i) + \beta_{11}(DENSITY_i) + \beta_{12}(SYSCAR_i) + \Sigma y_j CD_{ij} + \epsilon_i$

Past work indicates that any heteroskedasticity generally owes to inter-commodity or inter-regional variations in the error structure. Given that the analysis accounts for both factors by estimating Equation (2) separately for each commodity group and that the investigation is confined to the Pacific Northwest, there is little need to correct for any heteroskedasticity which maybe evident. Consequently, we use Ordinary Least Squares (OLS) to fit Equation (2) and also rely on the OLS estimates in calculating the standard errors.[21]

II-4 ESTIMATION RESULTS

Of the eleven commodities originally considered within this analysis, water-compelled railroad rates were identified in only two cases -- barley and wheat. Estimation results for these two goods are contained in Table II-3.

Table II-3

Variable	Barley	Wheat
INTERCEP	0.114820000 ** (0.018601620)	0.089435000 ** (0.005631560)
UCAR	-0.000244000 ** (0.000090380)	-0.000002593 (0.000012360)
TON2CAR	-0.000851000 ** (0.000174540)	-0.000615000 ** (0.000049260)
TDIS	-0.000010034 (0.000008410)	-0.000002829 (0.000002400)
TDIS2	0.000000000 (0.000000000)	-0.000000004 ** (0.000000000)
OD2W	0.001073000 ** (0.000134280)	0.000118000 ** (0.000079510)
OCDUM	-0.017912000 ** (0.003996490)	-0.105620000 ** (0.001033790)
NUMRR	0.003678000 (0.004413870)	0.006872000 ** (0.001420070)

RRCON	-0.002316000 (0.004638000)	0.001045000 (0.001260450)
DENSITY	0.000068706 ** (0.000017740)	-0.000015970 ** (0.000003290)
SYSCAR	0.001519000 (0.002268100)	0.000351000 (0.000447470)
CD76	Confidential Result	
CD802	Confidential Result	
Model R^2	0.9813	0.8135

The overall model fit in both cases is extremely good given the cross-sectional nature of the data. However, some of the variables which normally perform quite well as predictors of railroad rates are either insignificant or have unexpected signs. In particular, the two shipment distance variables TDIS and TDIS2 perform very poorly in the estimations. The variables denoting shipment size, UCAR and TON2CAR are both negative in both cases as expected. However, the statistical insignificance of UCAR in the case of wheat is, again, unusual. Finally DENSITY is statistically significant in both estimations, but positive in the case of barley and negative in the case of wheat. There is no immediate explanation for this seemingly inconsistent result.

With regard to the influence of available navigation on railroad rates for the movement of barley and wheat, there is no ambiguity. The two variables denoting the destination distance to the nearest port facility were statistically insignificant and, therefore, dropped from the specification. The origin-to-water variables are, however, significant in both cases, displaying signs that indicate a measurable competitive role for barge transport, Essentially, the negative signs for OCDUM indicate the maximum (water's edge) competitive impact of available navigation, while the coefficients for OD2W indicate the rate (per mile) at which rail rates increase as available navigation grows more distant.

Based on these estimation results, Table II-4 summarizes the aggregate water-compelled rail rate savings attributable to Snake River navigation in 1996. One of the most poignant findings is that very little of the grain (barley-8%, wheat-15%) moved by rail to, from, or within the Pacific Northwest has its origin within the effective range of the Snake River system. With the exception of five interior counties in Washington, the vast majority of the grain loaded to rail comes from locations that are simply too distant for the Snake River system to exercise it's influence. It is also worth noting that 20% of the barley and 28% of the wheat arriving in the PNW originates outside the region as a whole. Thus, it is probable that competitive conditions in and to other export locations affect railroad rates within the Pacific Northwest. These results, in combination with the information contained in Volume I, suggest that where barge and rail are both viable options, available barge transportation significantly effects railroad pricing, Unfortunately from the standpoint of shippers, the opportunities for this competitive interaction are limited.

	Barley	**Wheat**
Total Regional Rail Tonnage (1996)	2,101,838	11,066,224
Max Range - Barge Influence (miles)	60	150
Number of Effected Rail Tons (1996)	172,000	1,645,520
Maximum Rate Effect (per ton-mile)	$0.01768	$0.01238
Mean Rate Effect (per ton-mile)	$0.01791	$0.01053
Aggregate Water-Compelled Savings	$1,339,410	$6,563,487

Footnotes:

[1]While this sample size appears small relative to samples used in similar studies, the 2.7 million tons it captures represents more than

79% of total 1996 traffic.

[2]A team track is a railroad owned siding that is available for public use. Often, they are accompanied by ramps or other limited load facilities.

[3]The one exception to this assumption is the availability of covered hoppers for rail shipments from smaller elevators during harvest.

[4]Use of contract rates for the movement of grains appears to have peaked in 1986, when approximately 40% of all grain moved under contract. Since that time, a number of Class I carriers have returned to the use of traditional tariffs as the basis for rate calculations.

[5]C6-X cars are the over-sized covered hoppers, holding 110 tons of grain each. They were introduced by some carriers in 1994. Certificate of Transportation (COT) programs are carrier programs in which rail carriers sell period-specific car guarantees to shippers. These COT's may also be resold. OT-5 authority is the authority rail carriers grant to shippers for the use of privately-owned cars.

[6]BCM estimates were based on a number of parameters that included a 100-percent empty return ratio, 2,700 horse-power towboat engines, 2,800 tons per barge loadings, a tow size of four barges for dry-bulk movements, and a tow size of two for liquid movements.

[7]Reebee is an URCS-based model.

[8]In addition to shipper information and the Carload Waybill Sample, shipment characteristics were also identified from Association of American Railroads publications.

[9]Loading and unloading costs are often considered a part of through-put or production costs.

[10]As indicated within the text, this "Least-Cost" alternative considers both the all land routing and a water/land combination over the Port of St. Louis.

[11]"Differential Pricing" is the euphemism developed by the industry to describe the practice of price discrimination.

[12]In a formal sense, the improved availability of water transportation would increase the elasticity of demand for rail services in that region. All else being equal, this greater elasticity would lead to a lower price-cost margin in the region with improved navigation. If all price-cost deviations are scaled so that railroads are allowed only the necessary rate of return, then lower water-compelled rates in one region would lead to higher rates in another region of the railroads would be left with inadequate profits.

[13]If this discussion is expanded to include export markets, it is possible to demonstrate additional welfare gains from increased rail-barge competition. Still, the magnitude of these potential gains is relatively small. For a full exposition of this topic, see *Water-Compelled Railroad Rates and the Calculation of Navigation Project Benefits: A Preliminary Application to the Upper Mississippi River Basin,* (1994), available from the Tennessee Valley Authority or the U.S. Army Corps of Engineers.

[14]For a good discussion of the importance of traffic density, see Braeutigam *et al.*, 1985.

[15]Again, a more lengthy description of variable construction is provided in the methodological appendix to this study.

[16]To account for the use of ICC Accounting Rule Eleven and other reporting anomalies, observations for which the RTM was greater than two standard deviations above the mean were deleted from the estimation process.

[17]In fact, a number of different distance-to-water measures were included in model specifications, depending on the community in question.

[18]Generally, the additional costs of interchange would cause us to anticipate a positive coefficient estimate. However, to the extent that pricing coordination dampens carriers' abilities to capture profits, this variable may display a negative sign.

[19]The expected sign depends o whether the carrier and route in question are beyond or short of the optimal traffic density.

[20]In addition to the variables denoting the distance to the CSW system, the actual estimated model also contained variables denoting the distance to the Mississippi River for those shipments that had an origin in the upper Mississippi basin.

[21]The reader will recall that heteroskeadisticity does not bias the OLS estimators. It merely reduces their efficiency. Indeed, adoption of asymptotically unbiased estimators will not change coefficient estimates at all.

APPENDIX A-1
NED Rate Calculations

Ref No	Shipment Information			
	Commodity Name	**Dock-to-Dock**	**Origin Name**	**Destination Name**
1	Wheat	82, 563	Clearwater River, Idaho	Kalama, Washington
2	Barley	82, 563	Clearwater River, Idaho	Kalama, Washington
3	Wheat	120, 826	Clearwater River, Idaho	Vancouver, Washington
4	Barley	120, 826	Clearwater River, Idaho	Vancouver, Washington
5	Wheat	109, 290	Clearwater River, Idaho	Portland, Oregon

6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35	Barley Wheat Wheat Wheat Wheat Wheat Barley Barley Barley Wheat Barley Wheat Barley Wheat Barley Alfalfa Hay Distillate Fuel Wood Chips Logs (Saw) Logs (Pulpwood) Wood Chips Logs (Saw) Logs (Pulpwood) Wood Chips Logs (Saw) Lumber Nitrogen Fertilizer Anhydrous Ammonia Nitrogen Fertilizer Nitrogen Fertilizer	109, 290 27, 485 14, 262 168, 370 17, 517 29, 625 101, 886 160, 169 423, 387 21, 244 86, 211 354, 365 26, 369 27, 941 15, 735 35, 574 91, 361 29, 777 688 29, 778 138, 923 47, 103 47, 103 155, 912 26, 000 13, 207 8, 041 8, 042 4, 096 6, 373	Clearwater River, Idaho Sheffler, Washington Windust, Washington Windust, Washington Lyons Ferry, Washington Lyons Ferry, Washington Central Ferry, Washington Central Ferry, Washington Central Ferry, Washington Almota, Washington Almota, Washington Wilma, Washington Wilma, Washington Clarkston, Washington Clarkston, Washington Clearwater River, Idaho Portland, Oregon Clearwater River, Idaho Clearwater, Idaho Clearwater River, Idaho Wilma, Washington Wilma, Washington Wilma, Washington Clarkston, Washington Clarkston, Washington Clearwater River, Idaho Portland, Oregon Portland, Oregon Finley Beach, Washington Finley Beach, Washington	Portland, Oregon Kalama, Washington Kalama, Washington Portland, Oregon Kalama, Washington Vancouver, Washington Kalama, Washington Vancouver, Washington Portland, Oregon Kalama, Washington Vancouver, Washington Portland, Oregon Vancouver, Washington Kalama, Washington Vancouver, Washington Portland, Oregon Wilma, Washington Longview, Washington Portland, Oregon Longview, Washington Longview, Washington Troutdale, Oregon Troutdale, Oregon Home Valley, Washington Bingen, Washington Portland, Oregon Central Ferry, Washington Central Ferry, Washington Wilma, Washington Central Ferry, Washington

Ref No	**Mode**	**Miles**	**Cost**	**Mode**	**Miles**	**Cost**	**Mode**	**Miles**	**Cost**	**Mode**	**Miles**
Water Route											
1	0.50							Truck	20	2.00	
2	0.50							Truck	20	2.00	
3	0.50							Truck	20	2.00	
4	0.50							Truck	20	2.00	
5	0.50							Truck	20	2.00	
6	0.50							Truck	20	2.00	
7	0.50							Truck	20	2.00	
8	0.50							Truck	20	2.00	
9	0.50							Truck	20	2.00	
10	0.50							Truck	20	2.00	
11	0.50							Truck	20	2.00	
12	0.50							Truck	20	2.00	
13	0.50							Truck	20	2.00	
14	0.50							Truck	20	2.00	
15	0.50							Truck	20	2.00	

16	0.50							Truck	20	2.00	
17	0.50							Truck	20	2.00	
18	0.50							Truck	20	2.00	
19	0.50							Truck	20	2.00	
20	0.50							Truck	20	2.00	
21	2.00							Truck	40	4.55	
22	0.75										
23	1.25										
24	2.50										
25	2.50										
26	1.25										
27	2.50										
28	2.50										
29	1.25										
30	2.50										
31	6.75										
32	1.50										
33	0.75										
34	1.50										
35	1.50										

Ref No	Cost	Mode	Miles	Cost	Mode	Miles	Cost	Mode	Miles	Cost	Mode
1	1.67	Barge	390	5.82							
2	2.08	Barge	390	5.82							
3	1.67	Barge	359	5.43							
4	2.08	Barge	359	5.43							
5	1.67	Barge	355	5.38							
6	2.08	Barge	355	5.38							
7	1.67	Barge	279	4.42							
8	1.67	Barge	289	4.55							
9	1.67	Barge	262	4.21						2.50	
10	1.67	Barge	311	4.83							
11	1.67	Barge	280	4.43						2.50	
12	2.08	Barge	334	5.12							
13	2.08	Barge	302	4.71							
14	2.08	Barge	297	4.65							
15	1.67	Barge	344	5.24							
16	1.67	Barge	312	4.84							
17	1.67	Barge	358	5.42							
18	2.08	Barge	353	5.36							
19	1.67	Barge	388	5.80							
20	2.08	Barge	356	5.39							
21	2.95	Barge	363	6.69							
22		Barge	358	10.00							
23		Barge	399	6.63							
24		Barge	363	6.63							
25		Barge	363	6.63							
26		Barge	393	6.55							
27		Barge	339	6.26							
28		Barge	339	6.26							
29		Barge	304	5.72							
30		Barge	293	5.55							
31		Barge	361	6.83							

32		Barge	307	10.64							
33		Barge	307	15.10							
34		Barge	136	6.66							
35		Barge	86	4.72							

								Land Route			
Ref No	**Miles**	**Cost**	**Mode**	**Miles**	**Cost**	**Miles**	**Cost**	**Mode**	**Miles**	**Cost**	**Mode**
1		2.50				410	12.49			0.50	Truck
2		2.50				410	12.90			0.50	Truck
3		2.50				379	12.10			0.50	Truck
4		2.50				379	12.51			0.50	Truck
5		2.50				375	12.05			0.50	Truck
6		2.50				375	12.46			0.50	Truck
7		2.50				299	11.09			0.50	Truck
8		2.50				309	11.22			0.50	Truck
9						282	10.88			0.50	Truck
10		2.50				331	11.50			0.50	Truck
11						300	11.10			0.50	Truck
12		2.50				354	12.20			0.50	Truck
13		2.50				322	11.79			0.50	Truck
14		2.50				317	11.73			0.50	Truck
15		2.50				364	11.91			0.50	Truck
16		2.50				332	11.51			0.50	Truck
17		2.50				378	12.09			0.50	Truck
18		2.50				373	12.44			0.50	Truck
19		2.50				408	12.47			0.50	Truck
20		2.50				376	12.47			0.50	Truck
21		3.40				403	19.59			2.00	Truck
22		0.75				358	11.50			1.00	
23		1.50				399	9.38			1.25	
24		2.50				363	11.63			2.50	
25		2.50				363	11.63			2.50	
26		1.50				393	9.30			1.25	
27		2.50				339	11.26			2.50	
28		2.50				339	11.26			2.50	
29		1.50				304	8.47			1.25	
30		2.50				293	10.55			2.50	
31		6.75				361	20.33			4.50	
32		1.60				307	13.74			1.50	
33		0.75				307	16.60			1.00	
34		1.60				136	9.76			1.50	
35		1.60				86	7.82			1.50	

Ref No	**Miles**	**Cost**	**Mode**	**Miles**	**Cost**	**Mode**	**Miles**	**Cost**	**Mode**	**Miles**	**Cost**	**Mode**
1	20	2.00			1.67	Rail	403	11.94				
2	20	2.00			2.08	Rail	391	9.86				
3	20	2.00			1.67	Rail	374	11.94				
4	20	2.00			2.08	Rail	358	9.86				
5	20	2.00			1.67	Rail	386	11.94				
6	20	2.00			2.08	Rail	354	9.86				
7	35	3.50			1.67	Rail	250	11.50				
8	30	3.00			1.67	Rail	285	11.36				
9	30	3.00			1.67	Rail	269	11.36				

10	35	3.50			1.67	Rail	314	10.05
11	35	3.50			1.67	Rail	285	10.05
12	20	2.00			2.08	Rail	330	7.51
13	20	2.00			2.08	Rail	297	7.51
14	20	2.00			2.08	Rail	293	7.51
15	20	2.00			1.67	Rail	371	10.74
16	20	2.00			1.67	Rail	342	10.74
17	20	2.00			1.67	Rail	348	16.60
18	20	2.00			2.08	Rail	352	14.13
19	20	2.00			1.67	Rail	426	11.94
20	20	2.00			2.08	Rail	359	9.86
21	40	4.55			2.95	Rail	354	15.74
22						Rail	348	13.87
23						Rail	399	11.36
24						Rail	354	14.07
25						Rail	399	14.56
26						Rail	393	11.25
27						Rail	332	13.65
28						Rail	332	13.67
29						Rail	348	12.94
30						Rail	327	13.12
31						Rail	354	13.17
32						Rail	293	12.16
33						Rail	293	21.84
34						Rail	155	8.08
35						Truck	95	9.90

Ref No	**Cost**	**Mode**	**Miles**	**Cost**	**Mode**	**Miles**	**Cost**	**Miles**	**Cost**	**Mode**	**Miles**
1				2.50				423	18.61		
2				2.50				411	16.94		
3				2.50				394	18.61		
4				2.50				378	16.94		
5				2.50				406	18.61		
6				2.50				374	16.94		
7				2.50				285	19.67		
8				2.50				315	19.03		
9				2.50				299	19.03		
10				2.50				349	18.22		
11				2.50				320	18.22		
12				2.50				350	14.59		
13				2.50				317	14.59		
14				2.50				313	14.59		
15				2.50				391	17.41		
16				2.50				362	17.41		
17				2.50				368	23.27		
18				2.50				372	21.21		
19				2.50				446	18.61		
20				2.50				379	16.94		
21				3.40				394	28.64		
22				1.25				348	16.12		
23				1.50				399	14.11		
24				2.50				354	19.07		
25				2.50				399	19.56		

26				1.50				393	14.00		
27				2.50				332	18.65		
28				2.50				332	18.67		
29				1.50				348	15.69		
30				2.50				327	18.12		
31				4.50				354	22.17		
32				1.60				293	15.26		
33				1.00				293	23.84		
34				1.60				155	11.18		
35				0.50				95	11.90		

Ref No	Cost	Mode	Miles	Cost	Mode	Miles	Cost	Mode	Miles	Cost	Mode
1	0.50	Truck	20	2.00			1.67	Rail	152	9.88	
2	0.50	Truck	20	2.00			2.08	Rail	152	8.50	
3	0.50	Truck	20	2.00			1.67	Rail	152	9.88	
4	0.50	Truck	20	2.00			2.08	Rail	152	8.50	
5	0.50	Truck	20	2.00			1.67	Rail	152	9.88	
6	0.50	Truck	20	2.00			2.08	Rail	152	8.50	
7											
8	0.50	Truck	20	2.00			1.67	Truck	40	3.50	
9	0.50	Truck	20	2.00			1.67	Truck	40	3.50	
10	0.50	Truck	20	2.00			1.67	Truck	65	5.50	
11	0.50	Truck	20	2.00			1.67	Truck	65	5.50	
12	0.50	Truck	20	2.00			2.08	Rail	91	7.04	
13	0.50	Truck	20	2.00			2.08	Rail	91	7.04	
14	0.50	Truck	20	2.00			2.08	Rail	91	7.04	
15	0.50	Truck	20	2.00			1.67	Rail	170	10.17	
16	0.50	Truck	20	2.00			1.67	Rail	170	10.17	
17	0.50	Truck	20	2.00			1.67	Rail	146	11.24	
18	0.50	Truck	20	2.00			2.08	Rail	146	9.54	
19	0.50	Truck	20	2.00			1.67	Rail	152	9.88	
20	0.50	Truck	20	2.00			2.08	Rail	152	8.50	
21	2.00	Truck	167	11.37			2.95	Barge	219	4.45	
22	0.75							Barge	225	6.71	
23	1.25	Rail	152	6.87			1.50	Barge	262	4.62	
24	2.50	Rail	152	9.75			2.50	Barge	226	4.51	
25	2.50	Rail	152	9.60			2.50	Barge	262	5.07	
26	1.25	Rail	146	6.76			1.50	Barge	262	4.62	
27	2.50	Rail	146	9.75			2.50	Barge	208	4.25	
28	2.50	Rail	146	9.60			2.50	Barge	209	4.25	
29	1.25	Rail	152	8.91			1.50	Barge	173	3.69	
30	2.50	Rail	152	9.75			2.50	Barge	158	3.47	
31	4.50							Truck	336	21.00	
32	1.50							Barge	226	8.12	
33	0.75							Barge	226	11.33	
34											
35											

Ref No	Miles	Cost	Mode	Miles	Cost	Mode	Miles	Cost	Mode	Miles	Cost
1		1.67	Barge	254	4.11			2.50			
2		2.08	Barge	254	4.11			2.50			
3		1.67	Barge	223	3.71			2.50			
4		2.08	Barge	223	3.71			2.50			

5		1.67	Barge	219	3.66			2.50
6		2.08	Barge	219	3.66			2.50
7								
8		1.67	Barge	254	4.11			
9		1.67	Barge	223	3.71			2.50
10		1.67	Barge	254	4.11			2.50
11		1.67	Barge	223	3.71			2.50
12		2.08	Barge	254	4.11			2.50
13		2.08	Barge	223	4.71			2.50
14		2.08	Barge	219	3.66			2.50
15		1.67	Barge	254	4.11			2.50
16		1.67	Barge	223	3.71			2.50
17		1.67	Barge	219	3.66			2.50
18		2.08	Barge	223	3.71			2.50
19		1.67	Barge	254	4.11			2.50
20		2.08	Barge	223	3.71			2.50
21								3.40
22		1.00	Rail	146	7.79			1.25
23								1.50
24								2.50
25								2.50
26								1.50
27								2.50
28								2.50
29								1.50
30								2.50
31								4.50
32		1.60	Truck	95	9.90			0.50
33		1.00	Rail	91	11.02			1.00
34								
35								

			Route Total Costs		
Ref No	**Miles**	**Cost**	**Cost**	**Cost**	**Cost**
1	426	22.33	12.49	18.61	22.33
2	426	21.77	12.90	16.94	21.77
3	395	21.93	12.10	18.61	21.93
4	395	21.37	12.51	16.94	21.37
5	391	21.88	12.05	18.61	21.88
6	391	21.32	12.46	16.94	21.32
7	0	0.00	11.09	19.67	0.00
8	314	13.45	11.22	19.03	13.45
9	283	15.55	10.88	19.03	15.55
10	339	17.95	11.50	18.22	17.95
11	308	17.55	11.10	18.22	17.55
12	365	20.31	12.20	14.59	20.31
13	334	20.91	11.79	14.59	20.91
14	330	19.86	11.73	14.59	19.86
15	444	22.62	11.91	17.41	22.62
16	413	22.22	11.51	17.41	22.22
17	385	23.24	12.09	23.27	23.24
18	389	22.41	12.44	21.21	22.41
19	426	22.33	12.47	18.61	22.33

20	395	21.37	12.47	16.94	21.37
21	386	24.17	19.59	28.64	24.17
22	371	17.50	11.50	16.12	17.50
23	414	15.74	9.38	14.11	15.74
24	378	21.76	11.63	19.07	21.76
25	414	22.17	11.63	19.56	22.17
26	408	15.63	9.30	14.00	15.63
27	354	21.50	11.26	18.65	21.50
28	355	21.35	11.26	18.67	21.35
29	325	16.85	8.47	15.69	16.85
30	310	20.72	10.55	18.12	20.72
31	336	30.00	20.33	22.17	30.00
32	321	21.62	13.74	15.26	21.62
33	317	25.10	16.60	23.84	25.10
34	0	0.00	9.76	11.18	0.00
35	0	0.00	7.82	11.90	0.00

APPENDIX A-2
Summary of Handling and Transfer Chargers

Commodity	Barge		Rail		Truck	
	Load	Unload	Load	Unload	Load	Unload
Acetone	1.50	1.60	1.50	1.60	1.50	1.60
Acrylonitrile	1.50	1.60	1.50	1.60	1.50	1.60
Alcohols (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Alumina	1.65	2.25	1.85	1.85	1.85	1.85
Aluminum	2.50	2.50	2.50	2.50	2.50	2.50
Aluminum Ingos	3.00	2.50	3.00	2.50	3.00	2.50
Ammonia Nitrage	1.25	2.00	1.25	2.00	1.25	0.50
Anhydrous Ammonia	0.75	0.75	1.00	1.00	1.00	1.00
Aniline Oil (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Animal Oils (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Animal/Poultry Feed	1.75	2.50	1.25	2.50	1.35	1.35
Asphalt (Lit)	1.00	1.00	2.50	2.50	1.10	1.10
Bauxite (Aluminum Ores)	1.65	2.25	1.85	1.85	1.85	0.50
Benzene (Liq)	0.75	0.75	1.00	1.25	1.00	1.25
Butadiane	0.75	0.75	1.00	1.25	1.00	1.25
Butane	0.75	0.75	1.00	1.25	1.00	1.25
Butyl Alcohol	1.50	1.60	1.50	1.60	1.50	1.60
Calcium Chloride	0.75	0.75	1.00	1.25	1.00	1.25
Calcium Flouride	1.25	2.00	1.25	2.00	1.25	0.50
Carbolic Acid	1.50	1.60	1.50	1.60	1.50	1.60
Carbon, Deactivated	1.75	1.75	1.75	1.75	1.75	0.50
Carbon Black Oil	1.00	1.00	1.00	1.25	1.00	1.25
Carbon Dioxide (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Carbon Electrodes	1.50	2.00	1.50	1.50	1.50	1.50
Carbon Tetrachloride (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Caustic Soda (Liq)	0.75	0.75	1.00	1.25	1.00	1.25

Cement	1.50	1.50	1.50	1.50	1.50	1.50
Chemical Waste (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Chlorinated Solvents	1.50	1.60	1.50	1.60	1.50	1.60
Chlorine	1.50	1.60	1.50	1.60	1.50	1.60
Chloroform	1.50	1.60	1.50	1.60	1.50	1.60
Clay	1.25	2.25	1.25	2.25	1.25	0.50
Coal Tar (Liq)	0.75	0.75	1.00	1.25	1.00	1.25
Coal (Export Mobile)	1.60	2.88	1.00	2.88	1.15	0.75
Coal (Export New Orleans)	1.60	2.10	1.00	2.10	1.15	0.75
Coal (Non-Utilities)	1.60	1.75	1.00	1.75	1.15	0.50
Coal (Utilities)	1.60	1.60	1.00	1.60	1.15	0.50
Coke	1.75	1.75	1.75	1.75	1.75	0.50
Concrete Beams (Pre-Cast)	3.00	3.00	3.00	3.00	3.00	3.00
Copper Ores	2.00	2.00	1.50	1.50	1.50	1.50
Corn	1.07	1.07	1.07	1.07	0.20	0.50
Creosote	0.75	0.75	0.78	0.78	0.78	0.78
Crude Petroleum (Liq)	0.75	0.75	1.00	1.25	1.00	1.25
Crushed Stone	1.25	1.25	1.25	1.25	1.25	0.50
Cryolite	1.65	2.25	1.85	1.85	1.85	1.85
Cumene (Hydroproxide)	1.50	1.60	1.50	1.60	1.50	1.60
Distillate Fuel Oil (Liq)	0.75	0.75	1.00	1.25	1.00	1.25
Ethyl Acrylate	1.50	1.60	1.50	1.60	1.50	1.60
Ethyl Alcohol (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Ethylene Dichloride	1.50	1.60	1.50	1.60	1.50	1.60
Ethylene Glycol	1.50	1.60	1.50	1.60	1.50	1.60
Ferro Alloys	2.25	2.25	2.25	2.25	2.25	0.50
Fertilizer, Nitrogen (Dry)	1.25	2.00	1.25	2.00	1.25	0.50
Fertilizer, Nitrogen (Liquid)	1.50	1.60	1.50	1.60	1.50	1.60
Fertilizer, Phosphatic (Dry)	1.00	2.00	1.00	2.00	1.00	0.50
Fertilizer, Phosphatic (Liquid)	1.50	1.60	1.50	1.60	1.50	1.60
Fertilizer, Urea (Dry)	1.25	2.00	1.25	2.00	1.25	0.50
Fluorspar	1.25	2.00	1.25	2.00	1.25	0.50
Fly Ash	1.50	0.75	1.50	0.75	1.50	0.50
Furnace Mill Scale	1.50	1.50	1.50	1.50	1.50	0.50
Gasoline (Liq)	0.75	0.75	1.00	1.25	1.10	1.25
Grain Mill Products	1.75	3.00	1.25	1.25	1.35	1.35
Gypsum	1.50	1.50	1.50	1.50	1.50	0.50
Iron Ores	2.00	2.00	1.50	1.50	1.50	0.50
Iron and Steel Barge Pipe Tubes	3.25	3.25	3.25	3.25	3.25	3.25
Iron and Steel Castings	2.50	2.50	2.50	2.50	2.50	2.50
Iron and Steel Coils	3.25	3.25	3.25	3.25	3.25	3.25
Iron and Steel Ingots	2.50	2.50	2.50	2.50	2.50	2.50
Iron and Steel Pipe	3.25	3.25	3.25	3.25	3.25	3.25
Iron and Steel Plate	3.25	3.25	3.25	3.25	3.25	3.25
Iron and Steel Scrap	2.50	3.25	3.25	3.25	1.50	1.50
Iron and Steel Sheet	3.25	3.25	3.25	3.25	3.25	3.25
Iron and Steel (Fabricated)	3.25	3.25	3.25	3.25	3.25	3.25
Jet Fuel (Liq)	0.75	0.75	1.00	1.25	1.10	1.25
Kerosene Liq)	0.75	0.75	1.00	1.25	1.10	1.25
Lead and Zinc Alloys	2.50	2.50	2.50	2.50	2.50	2.50
Lime	2.00	1.00	2.00	1.00	2.00	0.50
Limestone	1.25	1.25	1.25	1.25	1.25	0.50
Limestone Flux	2.00	1.00	2.00	1.00	2.00	0.50

Liquid Petroleum (Liq)	2.00	2.50	2.00	2.50	2.00	2.50
Logs	2.50	2.50	2.50	2.50	2.50	2.50
Lubricating Oil	0.75	0.75	1.00	1.25	1.00	1.25
Lumber	6.75	6.75	4.50	4.50	4.50	4.50
Machinery, Electrical	5.25	5.25	5.25	5.25	5.25	5.25
Machinery, Excluding Electrical	5.25	5.25	5.25	5.25	5.25	5.25
Machinery, Noi	5.25	5.25	5.25	5.25	5.25	5.25
Magnesite	2.00	2.00	1.50	1.50	1.50	0.50
Manganese Ores	2.00	2.00	1.50	1.50	1.50	0.50
Marine Shell	1.00	1.25	1.00	1.25	1.00	0.50
Melamine Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Metal Containers	6.25	6.25	5.25	5.25	5.25	5.25
Methanol (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Mineral Sand	1.25	1.25	1.35	1.25	1.25	0.50
Misc Food Pds (Grain Mill Pds)	1.75	3.00	1.25	1.25	1.35	1.35
Molasses (Liq)	1.50	1.50	1.50	1.50	1.50	1.50
Motor Vehicles	8.25	8.25	8.25	8.25	8.25	8.25
Muriatic Acid Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Naptha (Liq)	0.75	0.75	1.00	1.25	1.00	1.25
Napthenic Acid (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Newsprint Paper	5.00	5.00	5.00	5.00	5.00	5.00
Nitrogen Fertilizer	1.25	2.00	1.25	2.00	1.25	0.50
Oats	1.88	1.88	1.88	1.88	0.20	0.50
Olivine	1.25	1.25	1.25	1.25	1.25	0.50
Ore (Non Ferrous)	2.25	2.25	2.25	2.25	2.25	2.25
Orthoxylene (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Paper and Paperboard	3.50	3.50	3.50	3.50	3.50	3.50
Paraxylene	1.50	1.60	1.50	1.60	1.50	1.60
Petroleum Coke	1.75	1.75	1.75	1.75	1.75	0.50
Petroleum Products (Liq)	0.75	0.75	1.00	1.25	1.00	1.25
Phenylamine (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Phosphatic Chem Fertz (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Pig Iron	2.50	2.50	2.50	2.50	2.50	2.50
Plastic, Synthetic (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Polyethylene	1.50	1.60	1.50	1.60	1.50	1.60
Polystyrene	1.50	1.60	1.50	1.60	1.50	1.60
Polystrene Acetone	1.50	1.60	1.50	1.60	1.50	1.60
Potassic Chem Fertz (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Propylamine (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Propylene Glycol	1.50	1.60	1.50	1.60	1.50	1.60
Pulpwood	2.50	2.50	2.50	2.50	2.50	2.50
Residual Fuel Oil (Liq)	0.75	0.75	1.00	1.25	1.00	1.25
Rice	1.25	1.25	1.25	1.25	0.20	0.50
Rock Asphalt (Dry)	1.25	1.25	1.25	1.25	1.25	0.50
Rosin (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Rye	1.50	1.50	1.50	1.50	1.50	0.50
Salt	1.00	2.00	1.00	2.00	1.00	0.50
Salt Cake	1.00	2.00	1.00	2.00	1.00	2.00
Sand and Gravel	1.25	1.25	1.25	1.25	1.25	0.50
Shale	1.25	1.25	1.25	1.25	1.25	0.50
Ships and Boats	14.25	14.25	12.50	12.50	--	--
Slag	1.25	1.25	1.25	1.25	1.25	0.50
Soap Detergents (Liq)	1.50	1.60	1.50	1.60	1.50	1.60

Sodium Acetate Residue	1.50	1.60	1.50	1.60	1.50	1.60
Sodium Chloride (Liq)	0.57	0.57	0.61	0.61	0.61	0.61
Sodium Hydroxide (Liq)	0.75	0.75	1.00	1.25	1.00	1.25
Sorghum Grains	1.50	1.50	1.50	1.50	1.50	0.50
Soybeans	1.00	1.00	1.00	1.00	0.20	0.50
Structural Clay Products	1.25	2.25	1.25	2.25	1.25	0.50
Styrene	1.50	1.60	1.50	1.60	1.50	1.60
Sugar	0.75	1.00	0.75	1.00	0.75	1.00
Sulphur (Dry)	1.25	1.25	1.25	1.25	1.25	1.25
Sulphur (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Sulphuric Acid (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Synthetic Rubber	1.50	1.60	1.50	1.60	1.50	1.60
Textile Products	2.00	2.00	2.00	2.00	2.00	2.00
Toluene	0.75	0.75	1.00	1.25	1.00	1.25
Vegetable Oils (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Veneer	6.75	6.75	4.50	4.50	4.50	4.50
Vinyl Chloride (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Waste, Municipal Solid	1.50	2.00	1.50	2.00	1.00	0.50
Water	1.00	1.10	1.00	1.10	1.00	1.10
Waterway Improvement Material	1.25	1.25	1.50	3.00	1.25	0.75
Weed Killing Acid (Liq)	1.50	1.60	1.50	1.60	1.50	1.60
Wheat	1.00	1.00	1.00	1.00	0.20	0.50
Wheat Flour	2.00	2.25	2.00	2.00	2.00	2.00
Woodpulp	5.00	5.00	5.00	5.00	5.00	5.00
Xylene	0.75	0.75	1.00	1.25	1.00	1.25
Zinc Concentrates	1.25	1.25	1.25	1.25	1.25	0.50

Exceptions/Notes:

Clay, Sand, and Gravel - Bulk Dry - Truck-to-Rail, Rail-to-Truck, $1.75
Salt - Barge to Truck, $2.75
Riprap - Truck-to-Rail, Rail-to-Truck, $3.00
Coal - Truck-to-Rail, Rail-to-Truck, $1.50
Conveyer - $0.20 to load, $0.25 per ton per mile, $0.50 to load barge

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APPENDIX A-3
Metholdogical Summary: Water-Compelled Rail Rates

A number of the variables used to estimate railroad pricing behavior are obtained directly from the Carload Waybill Sample and appear in the specified model without manipulation. However, a number of the relevant variables are constructed from the waybill data and/or other data sources. A precise and detailed discussion of this latter group of variable is provided below.

Distance-To-Water Measure

Obviously, the most important variable within the context of this analysis is the shipment distance to water measure(s) included in the estimated models. From a purely theoretical vantage, both distance of a shipment's origin to the nearest navigation resource and distance to water at the destination should impact the desirability of the barge alternative. In practice, however, the relative importance of the distance to water at the origin and the distance to water at the destination is an empirical matter. In some cases, most or all origins may be at or near a navigation resource, so that it is the destination distance to water which is the most important determinant of railroad pricing. It is equally possible to encounter situations in which the terminal distance to water is unimportant relative to the origin distance to the nearest waterway.

As the text indicates, the relationship between distance to water and observed rates is discontinuous over the full range of shipment distances. Specifically, at some critical distance from the water, available navigation ceases to have any effect on rail rates. For estimation purposes, this critical distance is reflected by two dummy variables, $OCDUM_i$ and $TCDUM_i$. The value of the former variable is equal to one if the origin distance to water is less than the critical distance beyond which water has no impact and zero otherwise. Similarly, $TCDUM_i$ takes on a value of one if the destination distance to water is less than the appropriate critical distance and zero otherwise. In order to account for a full range of possibilities, the estimation process for each commodity began with the same specification which is summarized by Equation A1 below:

(A1) $RTM_i = d_1 + d_2(OD2W_i) \times (OCDUM_i) + d_3(TD2W_i) \times (TCDUM_i) + d_4(OCDUM_i) + d_5(TCDUM_i) + ßX + e_I$

where RTM_i is the revenue per ton-mile, $OD2W_i$ is the origin distance to water, $TD2W_i$ is the destination distance to water, ß is a vector of regression coefficients, and X is a vector of other independent variables. This specification allows for either or both of the relevant distances to water to affect the observed railroad rate. If either combination of dummy variable and interaction term is jointly insignificant at the ten percent level, that combination was dropped from the model specification and the model was re-estimated. If available water transportation has the assumed dampening impact on railroad rates, the signs for the two interaction terms are positive and the signs of the two dummy variables are negative.

In order to determine the appropriate critical distance, the model described by Equation (A1) was estimated iteratively. At each iteration, the value defining each dummy variable was incremented by five miles. When the joint probability that an interaction term and its associated dummy variable are both different from zero was maximized, that particular distance was fixed while the routine continued to increment the definition of the remaining dummy variable until the joint probability for that interaction/dummy pair was also maximized. At that point, the first pair to converge was re-estimated to verify its stability and the process was continued until a stable pair of probability maximizing distances was obtained.

The actual distances are calculated as straight-line distances from the most active business location in the county of origin/termination to a major general commodities port.[1] Finally, because trans-shipment imposes fixed costs which must be averaged over the entire shipment distance, all distance to water measures were weighted by the total shipment distance.

Railroad Market Concentration

In past investigations, we have used a number of different measures to capture the importance of intramodal railroad competition as a determinant of observed rates.[2] In this investigation, the richness of the waybill data allowed us to construct a new measure which seems to improve our ability to account for this competition. In the analysis $RRCON_{ij}$ is defined as the product of the originating carrier's market share at origin ***i*** with the delivering carrier's market share at destination ***j***. This specification treats the multi-line production of railroad transportation as a vertical relationship and, as with any such vertical relationship, market power at any stage in the process is sufficient to generate higher prices.

Route Density.

In the absence of truly reliable route information, it is nearly impossible to fully account for the effects of traffic density on railroad costs (and rates). For the purposes of this analysis, a density is calculated for each carrier or combination of carriers serving a particular state-to-state origin-destination pair. The value of this calculation is equal to the sum of transported tons across all commodities divided by the mean distance for the carrier(s)' movements over the particular origin and destination pair. The data support the construction of an analogous measure over smaller geographic units (either BEA areas or counties), but the route structures of most carriers seem to indicate that the state-to-state measure is preferable.

Car Ownership

Unlike past efforts, these estimations explicitly account for whether the equipment used in a particular movement is owned by a railroad or by the customer (or some third party). Table A2 contains the list of railroads reporting marks used to determine whether or not a particular car is a system car.

Table A2
Railroad Reporting Marks

ALS	AM	AKMD	ALM	ATSF	SFRC	BAR	BM	BN	BNFE
CBQ	CS	FWD	GN	NP	BBN	RBBQ	RBCS	RBW	SLSF
SFE	WHI	CN	BCNE	CAN	CNIS	CVC	DWC	NAR	CV
CGW	CMO	FDDM	LM	MSTL	CC	CAGY	CR	BA	BCK
CNJ	CLW	EL	ERIE	MGA	NH	NYC	PAE	PC	PRR
RDG	RR	TDC	CP	CPAA	CPI	CPT	DA	NJ	THB
CSXT	ACL	AWP	BO	CO	CRR	GA	LN	MON	NC
RFP	SAL	SBD	SCL	WA	WM	DME	DH	DHNY	DRGW
EJE	ELS	FEC	GVSR	GTW	DTI	DTS	IC	CIW	GMO
ICG	IHB	IAS	KCS	CTIE	GNA	MSRC	KYLE	MSDR	MP
ARDP	ARMH	ARNW	BKTY	CHTT	DKS	MI	MKT	MKTT	OKKT
TP	MRL	NS	NW	PWV	SA	SOU	TAG	VGN	NOKL
PAL	PPU	SRN	SLR	SSW	SOO	MILW	MNS	SP	SPFE
GMSR	SR	UP	SI	TNM	SPFE	WP	WPMW	WE	WC

Carrier Dummy Variables

In addition to the other right-hand-side variables, each estimation contained a set of zero/one dummy variables designed to indicate a specific carriers participation in the shipment. Each of these variables assumes a value of one if the particular carrier originated or terminated the shipment and zero otherwise.[3]

Appendix A-3 Footnotes

[1]The most active business location within each county is defined as that city or town with the greatest number of business addresses.
[2]Previous measures included the number of carriers offering service between a particular origin-destination pair and a Herfindahl-Hirschmann type statistic calculated over a particular market.
[3]This method fails to represent the participation of a bridge carrier which neither originates nor terminates the shipment. However, given that the mean number of carriers is significantly less than two for each of the commodities and that bridge carriers have a diminished influence over price, we do not feel this is inappropriate.

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