IMPLICATION OF RECENT USER CHARGE LEGISLATION FOR BARGE TRANSPORTATION OF AGRICULTURAL COMMODITIES

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The view that the navigable waters of the United States should be toll free originated in the colonial period of U.S. history, and became explicitly stated federal policy in the 1884 Rivers and Harbors Act (Ashton et al.). At that time public expenditures for waterway improvements were small and the freight transportation industry was dominated by railroads. Therefore, public policy promoted water transportation as an inexpensive means of encouraging competition for the railroads.

Since the early years of this century public expenditures for improvements of the waterways have risen while water, motor, air, and pipeline transportation have become effective competitors for the railroads. The conditions which justified a toll-free waterway policy changed, but the policy was not altered. Though every president since Franklin Roosevelt has recommended that Congress levy a charge on inland waterway users, legislators have been reluctant to implement such charges.

The historical pattern changed in 1978 when Congress voted to impose a fuel tax on inland waterway traffic.[1] The fuel tax would begin at 4 cents per gallon in 1980 and rise to 10 cents per gallon by 1985. The debate over the Inland Waterways Revenue Act of 1978 (P.L. 92502) was long and tortuous. Equity and efficiency arguments, familiar to most economists, were part of the debate over both the justification for and level of a user charge. Equity arguments, following the benefit principle of taxation, suggested that those who benefit from a service should bear the cost of providing it. Efficiency arguments noted that a charge policy would promote the allocation of current waterway capacity to the most valuable uses and serve as a marketlike test of the demand for new waterway investments.

Aside from the economic arguments, the most persuasive argument in the congressional debate was that a waterway user charge might have undesirable consequences for the barge industry and its customers. Consequently, supporters of the user charge reached a compromise with the opponents in return for the opponents' support of the bill. This compromise is reflected in Section 205(c)(4)(A) of the Act which requires that the effects of waterway user taxes on the diversion of traffic from the inland waterways be evaluated. Implicit in the compromise was the agreement that if the user charge is shown to have "undesirable" consequences for the barge industry and other groups, Congress may choose to reevaluate its imposition. Therefore, although a user charge has become a reality, the effect of this charge must be assessed in the near future. Our study results can contribute to this necessary assessment.

STUDY FOCUS

One of the sectors of the economy most likely to be affected by user charges is the agricultural sector. In terms of tonnage, grains and soybeans comprise the third most important commodity carried by barge, and total barge movements of grains have been increasing much faster than movements of any other commodity (Shabman). Grain moves via barge from producing areas to processing plants at river points (with some inland shipments for processing and livestock use) and to ports for export. Transport of grain for export accounts for most barge movements, and, with the growth in international trade, has been increasing significantly.

The implications of current user charge policy for barge shipments of wheat, corn, and soybeans on the Mississippi River and its major tributaries were analyzed. Some research on user charge impacts has examined movements of all commodities shipped by barge but the commodities were aggregated into large heterogeneous groupings (CACI; Fedler et al.). Other studies have focused on

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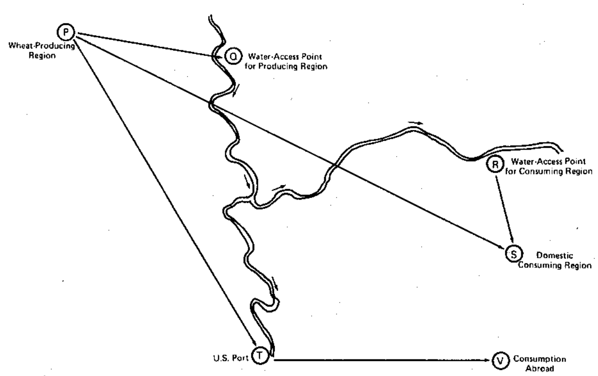
[1]We use the terms "tax" and "user charge" synonymously.

movements of specific grains from small geographic areas and thus their conclusions cannot be extrapolated to the more general question of impacts of user charges on grain movements on the total Mississippi River system (Bunker; Casavant and Thayer).[2]

RESEARCH APPROACH

Barge transportation is a link in the marketing chain that moves grains from producing areas to consuming points domestically and abroad. The barge mode depends on rail and truck to serve as feeder modes to carry agricultural products to river points and, to a lesser extent, from river points to domestic consuming areas. Ports serve as linkages between barge and ocean vessel for export movements. Barge competes directly with rail, which, although a higher cost mode, can generally provide direct service from producing to consuming points or to ports. Thus, the barge mode is intertwined with the entire grain transport network and the relationship is characterized by much complementarity and substitutability, as illustrated in Figure 1.

FIGURE 1. TYPICAL MODEL MOVEMENTS



Grain moving from the producing area at P to consuming region S or port T can move either directly by rail or indirectly via barge, which requires transportation to and perhaps from river points by rail or truck. The closer consuming areas are to river points, the greater will be any advantages of barge over rail.

Clearly the barge mode cannot be studied in isolation. Hence, we employed a technique that models the types of movements shown in Figure 1. The transshipment linear programming technique is well suited to this purpose. In general, this transshipment method can be formulated to permit movement through any number of intermediate (transshipment) points. The model used in the analysis allows for movements through two or fewer transshipment points, where modal switching could occur. Thus, any of the types of movements in Figure 1 could be selected by the model. Movements were allocated from producing to consuming areas among the available transportation modes so that transfer costs were minimized. A least cost solution for the model was found by using transfer costs for each mode without a user charge policy. The resulting allocation of movements among modes was termed the "base solution." Then barge costs were raised by the amount of a user charge and the resulting change in barge shipments was noted. Separate models were run for hard red winter wheat, hard red spring wheat, soft red winter wheat (all hereafter referred to as wheat), corn, and soybeans.[3]

No handling capacity constraints were imposed at transshipment points or on any transportation mode. We had two reasons for not using constraints. First, the imposition of capacity constraints would presolve the problem. For example, the share of grain currently moved by barge and rail may be affected by barge and rail capacity limitations. User charges may not affect such a movement, not because user charges are of no consequence, but rather because of the capacity problem. The elimination of capacity constraints from the analysis thus ensured that user charges could serve as "binding constraints," and that the model's allocation of shipment among modes would have maximum sensitivity to rate changes induced by the user charge. A second reason was the desire to give the analysis a long-run focus and not constrain the results by the nature of the present waterway transportation system.

MODEL COMPONENTS AND DATA

Regions

Different regional delineations were used in each of the models — 134 domestic regions in the wheat model, 164 regions in the corn model, and 161 regions in the soybean model.

[2]Because barge shipments on the Mississippi River system account for the largest share of all barge grain and soybean shipments, the focus of the study on this river system is justified (Shabman).

[3]In using separate models for each commodity we presume no capacity constraints at transshipment points or for any transportation model. This point is discussed hereafter.

FIGURE 2. WHEAT REGIONS

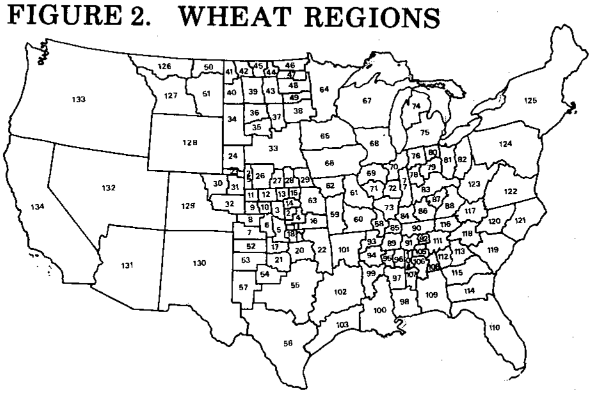
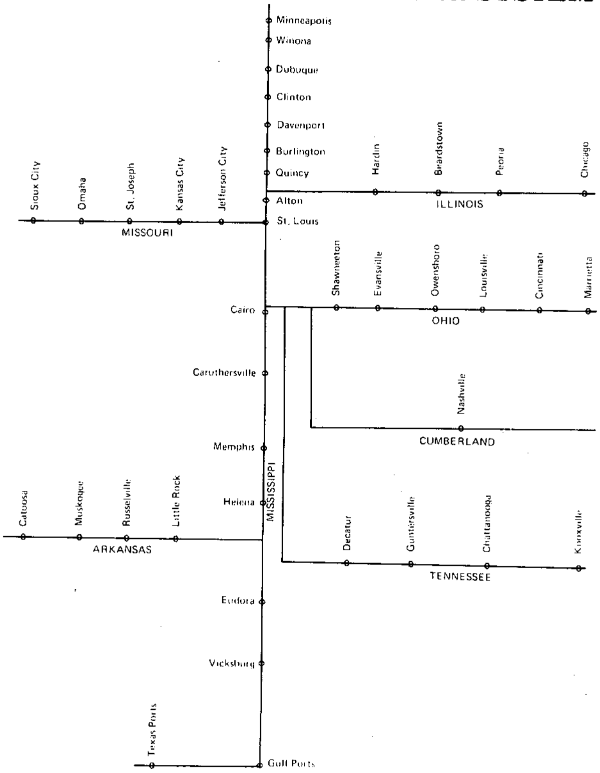


Figure 2 illustrates the wheat regions used in the study. All regions were aggregates of counties, crop reporting districts, or states; in some cases individual cities with large grain processing facilities were identified as separate regions. Twelve world regions were selected by aggregating countries with approximately equal access to ocean vessels from U.S. ports.

Transshipment Points

The models included transshipment points for domestic barge movements along the Mississippi River system and included U.S. ports

FIGURE 3. RIVER TRANSSHIPMENT POINTS SCHEMATIC FOR MISSISSIPPI RIVER SYSTEM



as transshipment points for foreign export. River transshipment points used in any of the models in the analysis are illustrated in Figure 3, a schematic map of the Mississippi River system. Many regions have access to several points. The model selected a transshipment point for each region which minimized that region's cost of barge shipments. The ports used in the analysis were Gulf ports (including Texas ports), Duluth, Chicago, California ports, East Coast ports (Norfolk, Baltimore, Philadelphia), and Northwest ports (Seattle and Portland).

Production and Consumption

Processing use estimates for all grains and soybeans were available only for 1971. Therefore 1971 production and consumption estimates were developed for each region in each model. County-level data on production for 1971, supplied by state crop reporting services, were aggregated for each region. The exportable surplus for each region (negative in the case of consuming regions) was calculated by subtracting consumption for seed, livestock, and regional processing from production. Seed and livestock use was based on published and unpublished U.S. Department of Agriculture data. Processing capacity and location data for soybean-crushing plants and for corn wet-milling plants were obtained from industry sources; wheat processing data were available from USDA sources. Exports to the 12 world regions were obtained from USDA reports (USDA *Fats and Oils Situation, FATUS, Wheat Situation*).

Transfer Costs

Five types of transfer costs for the year 1975 were included in the models—barge rates, rail rates, truck costs, ocean shipping rates, and loading and unloading costs for each of the modes.[4] For the barge mode, published rates from industry tariffs were used in the analysis. As those were not available after 1975, that year's competitive rate structure was used in the model. To account for the fact that barge carriage of grain is for the most part unregulated and hence not subject to quoted rates, U.S. Department of Transportation estimates of the deviation of actual rates from published rates were used as adjustment factors for the 1975 rates.

For the rail mode hundreds of rates from producing region centers to intermediate

[4]In the analysis we used 1975 rates actually paid by rail and barge shippers rather than synthesized transport cost estimates as was done in other studies (Anderson and Scheussler; CACI; Fedler). Costs for 1975 rather than rates were used for truck. However, our analysis on rail-barge modal split should not be significantly affected by any divergence between truck rates and costs. Also, recent changes in energy prices are not expected to alter significantly the relative rates of barge and rail.

transfer points and from intermediate points to points of consumption were collected. Through-rates were obtained by using a separate computer search procedure which identified all paths between two points, summed the component rates, and then selected the lowest cost route. Grain trucking costs were estimated by a procedure developed by Baumel et al. Ocean freight rates for grain were obtained from daily ship charters published in the *Journal of Commerce.* The fifth transport cost component used was handling costs. USDA publishes estimates of these costs by mode and region (Schienbien).[5]

User Charges

User charge policies initially designed to recover public operation and maintenance costs for the waterway system by a fuel tax will become effective in 1980 at 4 cents per gallon and rise to 10 cents per gallon by 1985. The U.S. Department of Treasury has estimated that a 6 cent tax would recover 33.4 percent of 1975-1976 operation and maintenance expenditures (Barloon). On the basis of this estimate a 10 cent fuel tax would recover approximately 50 percent of 1975 operation and maintenance costs. For the number of ton-miles of barge transportation recorded in 1975, this cost would add .00843 cents per ton-mile to barge costs (Anderson and Scheussler). To put this charge level in perspective, Table 1 compares

TABLE 1. BARGE RATES WITH AND WITHOUT USER CHARGE (CENTS PER HUNDREDWEIGHT)

Origins and Destinations	1975 Rate (No Charge)	Rate with Fuel Tax for 50 Percent of Operation and Management (New Policy)	
		Rate	Percent Increase
Minneapolis-New Orleans	27.42	30.34	11
Kansas City-New Orleans	28.71	31.73	11
Sioux City-Knoxville	48.50	51.92	7
St. Louis-Chicago	12.58	13.35	6
Minneapolis-Evansville	21.44	23.64	10
Catoosa-New Orleans	24.99	26.96	8

Source: Computed from data in Waterways Freight Bureau and U.S. Department of Transportation.

barge rates that would prevail (full shifting of the tax from barge firms to barge customers is assumed) with and without the charge for selected movements. A fuel tax covering 50 percent of operation and maintenance costs raises rates by 6 to 11 percent.

For any point-to-point movement, total user charges were based on river miles traversed. The user charge for that movement was obtained by multiplying the charge per ton-mile times the miles involved for that movement. The burden of the charge within the model was shifted fully to barge customers. Therefore, barge rates were increased in the model in the exact amount of the charge. As a result, relative rates between the barge mode and its most direct competitor, the railroads, are assumed to diverge by the amount of the user charge. The implications of this approach for model interpretation are discussed hereafter.

RESULTS

The model results for total movements of wheat, corn, and soybeans are reported in Tables 2, 3 and 4. Movements are shown by

TABLE 2. BARGE MOVEMENTS IN WHEAT MODEL BY RIVER SEGMENT (000'S OF TONS)

Points of Origin-Destination (by River Segment)	Base Solution	Movement With Fuel Tax
Missouri-Tennessee/Cumberland	347	347
Missouri-Ohio	142	130[a]
Missouri-Upper Mississippi	189	189
Missouri-Chicago	104	104
Missouri-Gulf	29	0[a]
Upper Mississippi-Tennessee/Cumberland	63	63
Upper Mississippi-Ohio	29	29
Upper Mississippi-Lower Mississippi	58	58
Upper Mississippi-Gulf	2794	2791[a]
Illinois-Chicago	117	117
Lower Mississippi-Gulf	467	467
Arkansas-Gulf	357	290[a]
TOTAL	4696	4585

[a]Change from base solution.

river segment. For each river segment the results are the aggregation of the net exports from each transshipment point on that river segment used in the model. These points are shown in Figure 3. In Tables 2, 3 and 4 the base solution is shown with the solution after imposition of the current fuel tax on barge transportation. The current user charge policy has little significant impact on the share of

[5]The data base available for this analysis dictated that 1971 production and consumption data be used with 1975 transfer cost data. This difference in years creates no problem for interpretation of the model results. Because the analysis is of shares of each mode and not absolute levels of shipments, changes in total production or consumption would not affect model results unless there were also significant changes in the location of production and consumption. There is no evidence that such location changes did occur. Also, use of more current data would alter results only if relative barge-rail rates have changed and there is no evidence of such changes.

TABLE 3. BARGE MOVEMENTS IN SOYBEAN MODEL BY RIVER SEGMENT (000'S OF TONS)

Points of Origin-Destination (by River Segment)	Base Solution	Movement With Fuel Tax
Missouri-Arkansas	273	273
Missouri-Gulf	626	457[a]
Upper Mississippi-Lower Mississippi	124	124
Upper Mississippi-Gulf	5555	5555
Ohio-Arkansas	310	310
Ohio-Gulf	1181	1181
Tennessee/Cumberland-Tennessee/Cumberland	6	6
Tennessee/Cumberland-Arkansas	310	310
Arkansas-Gulf	23	23
Illinois-Arkansas	498	498
Lower Mississippi-Gulf	1271	1204[a]
TOTAL	10177	9941

[a]Change from base solution.

TABLE 4. BARGE MOVEMENTS IN CORN MODEL BY RIVER SEGMENT (000'S OF TONS)

Points of Origin-Destination (by River Segment)	Base Solution	Movement With Fuel Tax
Upper Mississippi-Arkansas	538	0[a]
Upper Mississippi-Lower Mississippi	0	534[a]
Upper Mississippi-Gulf	7799	7803[a]
Ohio-Gulf	264	240[a]
Illinois-Tennessee/Cumberland	809	809
Illinois-Arkansas	1121	1728[a]
Illinois-Lower Mississippi	684	79[a]
Illinois-Gulf	3029	3029
TOTAL	14244	14222

[a]Change from base solution.

traffic moved by barge. For wheat the relatively small loss in traffic occurs partly from tonnage originating in the Missouri River segment and terminating at points along the Ohio and at Gulf ports for export. The rest of the loss is from shipments originating along the Arkansas River and moving through Gulf ports for export. Soybean shipment losses are for tonnage originating along the Missouri River and terminating at Gulf ports for export. Total movements within the corn model are only minimally affected, with reductions in shipments from Ohio River origins to Gulf ports for export. However, the model solution with the charge causes barge shipment to Lower Mississippi points to shift from Illinois to Upper Mississippi origins; in turn, Upper Mississippi origins shift to Arkansas River points. In the aggregate, total waterway shipment reductions from the base solution are 2 percent for wheat and soybeans, and essentially no change occurs for corn.

The sensitivity of barge movements to a user charge was tested further by doubling the charge level. The loss of barge tonnage is more significant in this case. Total barge wheat shipments in the model solution fall by 12 percent from 4744 thousand tons without the charge to 4174 thousand tons with the charge. Missouri River origins are the most significantly affected. Arkansas River wheat shipments to Gulf ports are also affected. Soybean shipments at the higher charge level fall by 9 percent from 10,177 thousand tons to 9254 thousand tons. Missouri River, Upper Mississippi River, and Arkansas River shipments to Gulf ports for export account for this traffic loss. Corn movements at the higher charge level fall by 7 percent from 14,244 thousand tons to 13,268 thousand tons. The most significant traffic loss is on movements from Upper Mississippi River origins and Illinois River origins to Gulf ports for export. This charge also induces some switching of origins and destinations within the model.

The results suggest that current charge levels apparently have little impact on movements. Some sensitivity of movements to charge levels is found at twice the current policy rate, although the proportion of diverted tonnage is not large.

CONCLUSIONS

The model results suggest that the barge industry's share of total grain movements will not be affected significantly by a user charge policy, although diversions from the Missouri and Arkansas Rivers may occur.[6] However, even these limited impacts within the model are likely to be greater than would actually occur. This conclusion is based on an assumption implicit in the model construction which has the effect of giving "worst case" impact results. Specifically, we assumed for model construction that the user charge policy would reduce the divergence between rail and barge rates by the exact amount of the user charge. This phenomenon may not occur.

First, rail rates may rise in response to increasing barge rates. Historically railroads facing water competition have been forced to lower their rates to retain traffic. Such rate reductions have been allowed by the ICC (Harbeson) and have been implemented for

[6]Because the Arkansas River transportation system is still developing, the results of these models suggest that a charge policy would inhibit future traffic growth rather than cause diversion of current traffic.

virtually all commodities, including grains. For example, Federal Barge Lines, Inc., estimated that for whole grain and soybean rail shipment to southern points the water-competitive rates were $6.29 per ton and the noncompetitive rates were $21.20 per ton (Fanchi). Clearly, the factors other than water competition that influence rate differentials are many. The key point, however, is that if barge rates were to rise because of a user charge, rail rates could be expected to rise also. Though the extent of the rail rate rise must be speculative, any rise will reduce the divergence between rail and barge rates after a user charge has been imposed.

A second implicit assumption is that the entire user charge will be shifted forward to shippers. However, the barge industry is currently undergoing significant technological and structural change (Shabman). Some barge firms, especially the larger ones, can substitute inputs in their production process to reduce average costs of shipments. Smaller firms are now merging or expanding to take advantage of economies of size. These changes in the barge industry structure will place downward pressure on barge costs and rates at the same time that a user charge is acting to raise them. Consequently, the degree to which the user charge will close the divergence between rail and barge rates could be mitigated.

As a practical matter the negligible impact reflected by the model of the current policy, considered in the context of the model assumptions, suggests that barge transport of grains will be affected little by the present policy and would be relatively insensitive to even higher charge levels.[7] Thus, the only significant impact on the agricultural sector is likely to be a loss in farm income (if full pass-through by barge firms and grain marketers is assumed). For example, the data in Table 1 suggest a maximum reduction in price received for barge-transported grain from the Upper Midwest (Minneapolis) to the Gulf of approximately 3 cents a hundredweight (1975), the actual effect depending on the relevant demand and supply elasticities. However, the full magnitude of such effects will depend on responses by railroads. If barge-competitive rail rates are raised, the losses in farm income will, of course, be larger.

[7]Possibly the charge would induce shifts in location of grain and soybean consumption which would affect use of the waterway by grain shippers. A recent study of the broiler chicken industry, a significant consumer of transported grains and soybeans, suggests that such shifts in consumption regions are not likely to occur (Spilka et al.).

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