losses caused by business interruption is not large. The calculations involved in an application are quite simple and cheap to use and make use of specific software developed for this study. Finally, the use of the SIC code allows a reasonably refined and classified set of secondary losses to be estimated.

CONCLUSIONS

The results of the development and case study application of the methodology that were carried out in this research support several relevant conclusions and define further research needs. Estimation of nonphysical damage losses caused by flood conditions is a multifaceted and complex problem. It requires knowledge of the transportation function of commercial and industrial firms as well as the composition of the transportation network itself. In addition, knowledge of public- and private-sector accounting and real estate appraisal is required. The methodology developed here synthesizes these various components into a technique that requires some collection of field data and the use of previously compiled financial relations and network travel data. With some additional refinement, the technique could also take into account the effect of the documented losses on the rest of the economy of a region. This could be accomplished by using basic-nonbasic multipliers or typical regional input-output types of economic linkages. This is an appropriate subject for further research and expansion of computational capability.

The results provide the means for developing reasonably quick estimates of the losses that result from flood conditions. Application of the approach to other sites can be carried out by using the existing technique and existing financial and accounting information inputs. The computer software and user-related materials provide a capability for generalization and ease of use at other sites.

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Waterway User Charges: Some Likely Impacts in the Tennessee Area

Kenneth J. Burns and George D. Mickle, Memphis State University, Memphis, Tennessee

Research whose purpose was to assess potential waterway user charges and their impacts and to provide the basis for the establishment of a state position is reported. The research was intended to serve the function of an informational report and not to provide hard recommendations either for or against a user charge. Most of the information was gathered through secondary sources published by water carrier associations and various federal agencies. Data were also collected, by means of survey and sampling techniques, from such primary sources as waterway carriers and industrial shippers. An analysis of the financial profile of the towing industry suggests that any user charge levied on towing firms will ultimately be passed on to the consumer. Smaller firms will probably suffer most since they operate with smaller margins and high turnover. Reduction in overall industry market share of national commodity transports will remove some of the economies associated with large-volume movements and eventually affect the profitability of larger towing firms. A segment toll represents the greater impact in terms of towing industry operating costs, shipping rates, state waterway traffic volume, employment, and electrical consumer utility costs. A $0.01/L ($0.04/gal) fuel tax represents the smallest impact. In light of the lack of complete empirical evidence, any cost-recovery scheme should be phased in on a gradual basis so as to allow for a cautious monitoring of both positive and negative impacts.

The state of Tennessee, with its access to three of the nation's major navigable waterways, has found its river systems to be a great asset in attracting basic industries Recently, developments in government policy have focused attention on the "free use" of U.S. inland waterways, and this has culuminated in various proposals for imposing a user charge on the nation's towing industry. The immediate concern of the state of Tennessee is that such a development may reduce the inherent advantages of a river transport system and thus destroy some of the economic vitality and job opportunities provided by the state's river system.

USER CHARGE OPTIONS

The four likely forms of user charge are (a) fuel taxes, (b) lockage fees, (c) segment tolls, and (d) licensing of floating equipment. Fuel tax cost-recovery schemes are analyzed at various levels that range approximately from $0.01 to $0.11/L ($0.04 to $0.40/gal). The magnitude of the lockage-fee method of collection was derived for each specific lock-and-dam facility based on the determination of an "imputed" value that commercial operators place on lockages by taking into consideration

costs of delays and congestion. Segment-toll analysis is based on fees levied per commercial ton kilometer, and the toll is set for each river segment to recover the costs of that segment. The license-fee cost-recovery alternative is approached on the basis of power for towboats and tonnage capacity for barges.

Certain aspects of the waterway user charge issue are relevant to any of the alternatives under consideration. The first of these aspects deals with an assessment of congressional intent in relation to the distinction between commercial and recreational use of waterways. If legislative action results in the exemption of recreational vessels, the benefits that could be gained from any form of user charge would be substantially reduced.

Another aspect of importance relevant to all methods of collection deals primarily with the proper definition of the U.S. inland waterway system. Much discussion by policy makers and researchers has centered on the cross subsidization of various river segments in an attempt to establish a user charge program that would be equitable for all sections of the nation. The interdependence of the various subsystems and the commercial intercourse between the various segments are such that each subsystem becomes an integral and economically justifiable component of the entire national river system. The implication of this idea for the analyst is that no one subsystem can be completely separated from the total system without distorting the true values of potential impacts. Any loss of traffic on the Tennessee river system would ultimately be felt on other river segments and vice versa. The impact measures in this paper deal only with potential initial-round adjustments that can be directly associated with a specific river system. They do not take into consideration any loss of traffic that occurs as a result of secondary influences ultimately felt in the long chain of economic adjustments. The immediate question becomes, How will industry in general, and the towing industry in particular, respond to a waterway user tax?

OPERATING AND PERFORMANCE CHARACTERISTICS OF THE TOWING INDUSTRY

Any likely economic impacts of a waterway user charge on the economy of Tennessee will probably be conditioned by how the towing industry responds to the tax. This response in turn may be expected to be related to the operating and performance characteristics of the industry, which will in turn have economic implications for industry in general and its use of river transportation.

Some general guidelines on the financial status of waterway towing firms are published by Robert Morris Associates (1). These data represent good approximations to the financial nature of the industry.

The asset structure of towing firms is dominated by fixed assets where about 66 percent of total investment is accounted for. Smaller firms ($1 to 10 million in revenue) tend to be characterized by slightly more investment in current assets than do larger firms—about 26 percent compared with about 24 percent of total assets. A category of other noncurrent assets, which is not readily definable, balances out the asset structure for these firms. Thus, in terms of asset structure, the firms appear to be quite similar; there appear to be only small differences in current assets between large firms and small firms.

Table 1. Analysis of return on assets and equity.

Size of Firm	Turnover[a]	Margin[b] (%)	Return on Assets[c] (%)	Return on Equity[d] (%)
Small	1.0	8.0	8.0	19.1
Large	0.64	12.8	8.2	23.0
All	0.74	11.2	8.3	21.3

[a]Sales/total assets. [b]Income/sales. [c]Income/assets. [d]Equation 1.

The towing industry depends on a great deal of debt financing in its total financial structure. Short-term financing constitutes 20.7 percent of the total. In general, the average towing firm uses 43.5 percent long-term debt. In terms of total debt, firms in the industry could be considered highly leveraged: Total debt represents 57.9 percent of the financial structure for smaller firms and 65.0 percent for larger firms. Thus, net worth or owner financing represents about 42 percent of total financing for smaller firms and 35.0 percent for larger firms. The major significance of these debt ratios is that, if income were to fall significantly for some reason, the return to the owners in this industry would be subject to an abrupt decline.

Expenses or operating costs, when compared with the revenue dollar, differ significantly between small firms and large firms. For small firms, profit before tax represents 8 percent of the revenue dollar; for larger firms, it represents 12.8 percent. For whatever reasons, the smaller firms display less efficiency in converting the revenue dollar into income.

The observations on the industry's financial structure have already indicated the highly leveraged position of the industry. The median ratio for smaller firms is 1.3 times whereas that for larger firms is 2.2 times. This high proportion of debt relative to net worth indicates a good deal of potential debt pressure in the industry. As the high ratios suggest, firms in the industry tend to owe more to creditors than their ownership can cover.

The ultimate value of interest for the owners is the amount of total return generated by all assets. For all firms in the sample, the before-tax return on equity was 20.6 percent. It should be emphasized at this point that the return on equity is related to the turnover of all assets and the profit margin on revenue given the amount of debt used in the financial structure. Return on investment expresses income before taxes as a percentage of the total assets of the firm, whether financed by owners or creditors. The relation of return on assets (investment) to returns on equity may be stated as

$$\text{Return on equity} = \text{return on assets}/[1 - (\text{debt}/\text{total assets})] \quad (1)$$

It is obvious that the amount of debt influences the size of the denominator in the equation and high amounts of debt will translate into higher percentage returns on equity, other things being equal. However, if the return on investment declines because of poor use of assets or poor profit margin and if the debt ratio remains constant, the return to the owner will decrease. The relation between turnover of assets, profit margin, return on assets (investment), debt ratio, and return on equity is given in Table 1.

Although the preceding comments relate to the general operating and financing profile of waterway towing firms, there are major differences that are related to type and volume of specific kinds of shipping by the towing firm. Thus, conclusions that are reached with respect to likely impact must be viewed as being based on industry averages and allow for considerable differences from these averages on an individual basis.

One of the proposed user charge alternatives is the fuel tax. Given current fuel costs, it is imperative to know what portion of a towing firm's total operating expenses is represented by fuel. Among the Tennessee

firms surveyed for this study, fuel averaged 31.2 percent of operating costs.

Other studies have shown that tow-related costs are dominated by fuel and depreciation whereas most of the remaining costs in the crew category are dominated by wages and fringe benefits (2). In these studies, it was found that fuel costs currently represent about one-third of total operating costs.

Another important aspect is the towing industry's cost of hauling compared with alternative modes (2). The cost of barge line-haul service to shippers is about 2.1 mills/t·km (3 mills/ton-mile) compared with about 9.6 and 14.4 mills/t·km (14 and 21 mills/ton-mile) for rail and truck, respectively. It is important to note that these rates apply only to line-haul and not to the total cost of moving an item from one point to the ultimate point of use.

When handling costs are included with line-haul costs, the barge advantage declines and in some cases may be eliminated (2). Another important consideration for shippers is the value of the commodity being shipped. Since the water mode lags behind both rail and truck in terms of flexibility and speed, long transit times for high-value commodities result in larger inventory investment for the shipper. Clearly, the waterway industry will be less capable of passing user charges on to the shipper when the cost differential between water and other modes, particularly rail, is not as great as it appears at first glance to be.

An overall profile emerges in which the most important factor in modal choice is the distance between origin and destination: The longer the distance is, the more likely is the movement by water. The cost and time of barge loading and unloading require a reasonably long haul to make the water mode attractive. Increasing value per ton has a depressing effect over long hauls because of the slower speed of the water mode and its effect on inventory costs. The bulk versus nonbulk nature of commodities also has its effect since bulk commodities are more likely to move by water. The economies associated with long hauls and the costs of handling for certain commodities suggest that the basic traffic patterns in terms of distance and handling will have to be maintained in the industry. It would be difficult to avoid the effects of segment tolls or lockage fees without losing the economies of long haul and handling advantages.

TENNESSEE TOWING INDUSTRY

In terms of annual gross revenues, the majority of Tennessee's towing firms are in the $1 million-$10 million category. About 52 percent of total traffic is accounted for by activity on the Mississippi River, about 20 percent by activity on the Tennessee River, about 5 percent by activity on the Cumberland River, and the remainder by activity on other river systems. The revenue profile given below is based on a sample of 13 firms that represent about 48 percent of Tennessee-based towing firms in class 1 (regulated carriers) and class 2 (exempt, for-hire carriers):

Size of Firm ($000 000s)	Number of Firms
<1	1
1-10	10
11-50	2

Data on the assets of the surveyed firms, taken from a Memphis State University survey of Tennessee industrial waterway users, are given below:

Size of Firm ($000 000s)	Number of Firms
<1	2
1-10	7
11-50	3
>51	1

It can be seen that total assets exceed total revenues, which suggests an asset turnover of something less than one.

If midpoints for both revenues and assets are used for estimating purposes, and if the ≥$51 million category is treated as near $50 million, revenue can be estimated to be near $100 million and assets near $175 million. This combination of figures produces a sample asset turnover of slightly less than 0.60, which appears to be somewhat low compared with the estimates provided by the Robert Morris Associates survey (1).

Other evidence from the sample suggests that the asset estimate is too high. Since total assets for the sample can be estimated from a review of the value of towboats and equipment submitted by the respondents, an alternative estimate of assets is available for purposes of comparison. By using these estimates and allowing for depreciation, a book value for tows in the sample can be determined at approximately $23 million. A barge value of approximately $64 million can be determined by using estimated purchase prices of equipment and allowing for depreciation.

Since it was previously shown that fixed assets represent 66 percent of total assets for the industry, $131 million of total assets can be estimated for the sample. By comparing the $131 million in total assets with the revenue estimate of $100 million, an asset turnover ratio of 0.76 is generated. The ratio for all firms generated by Robert Morris Associates (1) was 0.74, which shows that assets for the sample are reasonably representative of suggested norms and are of average size.

Another important consideration at this point is whether the industry is capable of raising its asset turnover to offset any possible decline in profit margin that could result from the industry's need to absorb part of any waterway user charge that might be levied. The largest-powered tow in the sample was 2610 kW (3500 hp); the most common size was 1342 kW (1800 hp). In all likelihood, the industry has already determined the most efficient power for their tows given the characteristics of the river systems on which they must operate. It is unlikely that the efficiencies that relate to larger tow sizes and speeds are available to the system. Thus, on the surface it appears that the industry will have difficulty improving utilization of assets or enhancing profit margins to offet user charges. This suggests that user charges levied on the industry will ultimately be passed on to the river-using firm. The extent to which they will be passed on to the consumer will depend on competitive conditions under which these firms sell in the national markets.

User Charge Effects

The obvious question at this stage is, What effect will all this have on the volume of commerce hauled on the Tennessee waterway system? If the towing industry does have difficulty finding new efficiencies to offset the user charge, the charge will be passed on to the waterway shipper. To the extent that cheaper transportation alternatives are available, the amount of traffic on the system will likely decline. Smaller firms will probably suffer most since they already operate with smaller margins and higher turnovers. Any reduction in traffic

will reduce both turnover and margin and result in the increased possibility of early failure for these firms. Larger firms are probably in a better position to absorb the user charge because of the higher margins they currently enjoy.

Furthermore, reductions in market share could possibly remove some of the economies of scale associated with large-volume traffic movements. This will eventually affect larger firms in terms of profitability but, more important, it will have an adverse effect on their ability to service the large outstanding debt.

Industry Reaction

How will the waterway shippers react to any attempt by the towing industry to pass along user charges? Of course, conclusions here must be related to the proposed level of the user charge and the relative size of the current barge cost advantage compared with alternative shipping modes.

The operating characteristics of the towing industry are such that fuel represents about one-third of its operating costs. This means that about a 100 percent increase in fuel cost would result in approximately a 33 percent increase in waterway freight rates. These figures need to be viewed in the context of how the respondent reacted to the survey question about specified rate changes: If the implementation of a waterway user charge results in higher water freight rates, at what cost increase would you abandon waterway shipping entirely? Responses to this question are given in the table below (3):

Rate Increase (%)	Number Who Would Abandon Waterway Shipping
10	5
11-24	8
25-49	4
50-99	3
100-199	3
≥200	0
None of the above	9

It is apparent from these responses that the advantage of shipping by barge is not overwhelming for at least 13 of the respondents. Reasonably modest rate increases would result in their abandoning waterways altogether. The effect on the towing industry is obvious: It would suffer a loss in traffic volume. But it should be emphasized that a 10 percent rate increase is associated with a 30 percent increase in fuel prices. Chances are that a $0.01/L ($0.04/gal) tax would result in no firms abandoning the water mode since the rate increase would be in the neighborhood of 3.5 percent. As the tax rate was raised, the effects would be more pronounced. It is important that about one-third of the sample would abandon waterways when the tax on fuel reaches about $0.066-$0.069/L ($0.25-$0.26/gal). The latter amount would be associated with about a 75 percent increase in fuel prices.

In addition, a user charge may have a significant moderating influence on the cost of shipping some commodities. Because handling costs for some commodities are quite high, the line-haul cost to which the user charge would be applied represents only a portion of the costs that face the shipper. If the line-haul on a commodity costs approximately $5.51/t ($5/ton) and handling costs $5.51/t, the total cost to the shipper is $11.02/t ($10/ton). However, when line-haul costs increase by 50 percent to $8.27/t ($7.50/ton), the total cost to the shipper increases to $13.78/t ($12.50/ton) or by 25 percent. To the extent that some efficiencies in handling can be realized in the future, part of the impact of a user charge may be offset. As previously noted, the towing industry already operates at a disadvantage in handling certain types of commodities whereas in the handling of others the marine mode is found to be cheaper. For those commodity groups for which shipping by water involves a handling disadvantage, handling costs considerably offset the line-haul cost advantage enjoyed by the towing industry, and this makes it more difficult for waterways to remain competitive in certain commodity areas. It thus appears that the impact of a user charge will not be felt evenly over all commodity areas in the industry.

The extent to which industrial firms currently depend on water for their incoming and outgoing shipments is another important consideration. In a survey sample of 32 firms that operate in Tennessee with access to water, 20 firms responded that water accounts for 56 percent of their incoming shipments and 15 firms responded that water accounts for about 40 percent of their outgoing shipments. As expected, water is more important for incoming shipments.

Firms in the sample were asked to estimate what percentage of incoming and outgoing freight they would ship by water given specified rate increases. Their responses are indicated in the table below:

Incoming Freight (%)	Rate Increase (%)	Outgoing Freight (%)
34	1-10	17
17	11-24	15
14	25-49	11
9	50-99	9
7	100-199	3
7	200+	2

At a 1 to 10 percent rate increase, the firms in the sample indicated that they would continue to ship about 34 percent of their incoming freight by water. The percentage abruptly drops, however, to 17 percent as the rates rise to the 11-24 percent category. Because of the nature of their operations, some firms would remain with the water mode even at very high rate increases. Although outgoing shipments do not lend themselves so readily to the water mode, rate increases appear to have a significant impact on the volume of shipments. These data suggest that the impact of a user tax on the water mode may be more severe than that indicated when one simply looks at the number of firms that would abandon the mode as a result of rate increases.

The locational characteristics of the firms surveyed also have some bearing on their willingness to change modes. Rail access is available to about 91 percent of the firms, whereas highway access is available to all. One other consideration is likely to result in more long-term consequences for industry in Tennessee. About 97 percent of the firms surveyed indicated that water transportation was an important factor in their decision to locate at their present site of operation. The apparent readiness of firms to change modes as a result of rate increases suggests that any advantages the water mode might have offered to some of these firms in the past will no longer exist. In time, some of these firms may relocate, but it is more important that the region will be less attractive to firms that are considering relocating in the Tennessee area for the first time.

One other important factor is the effect that transportation mode has on a firm's investment in inventory. The long shipping times involved in water transportation will tend to discourage the shipment of high-value

items on the river systems. Twenty-three of the firms in the sample indicated that the method of transportation did influence their inventory investment; 15 of these firms indicated that water transportation results in higher average inventories. To the extent that this is a cost implicit in shipping by water, the line-haul cost advantage associated with large shipments is reduced to a degree that is related to the value of the cargo hauled and the time involved in shipping. Thus, for shipments of high-value commodities that are costly to handle, the line-haul cost advantage may be offset by higher handling cost and implicit inventory costs.

Cost-Recovery Alternatives

Although current legislation ensures a fuel tax as a means of collecting tax revenues, all likely forms of user charge alternatives were examined and are briefly reviewed here.

Fuel Tax

The consequences for Tennessee waterway operators of a fuel tax cost-recovery collection program can be seen in the data given below (1 L = 0.264 gal):

Measure	Mean	Standard Deviation
Price of fuel (¢/L)	9.67	0.54
Fuel cost ÷ operating cost (%)	31.2	13
Percentage increase in price of fuel resulting from tax of		
2.11 cents/L	21.9	1.3
6.34 cents/L	65.8	4.04
10.57 cents/L	109.5	6.37
Percentage increase in operating costs resulting from tax of		
2.11 cents/L	7.3	2.88
6.34 cents/L	22.3	8.7
10.57 cents/L	36.4	14.83

Based on the responses from towing firms, extrapolations were made to determine the effect of three fuel tax rates—2.11, 6.34, and 10.57 cents/L (8, 25, and 40 cents/gal)—on both fuel and operating costs. The estimates reflect no adjustment for possible fuel conservation measures. These data show that a 10.57 cents/L (40 cents/gal) fuel tax, or a 109.5 percent increase in fuel prices, would increase operating costs by an average of 36.4 percent, and a 2.11 cents/L (8 cents/gal) tax rate would increase operating costs by 7.3 percent. The significant point to note is that operating costs increase by about one-third the increase in fuel costs; the result is that towing firms are likely to increase shipping rates by the same amount if they can be passed on to the users of water transportation.

The relation between fuel costs and operating costs provides a meaningful basis on which to analyze how shippers are likely to react to any attempt by the towing industry to pass along these cost increases. In an attempt to measure the elasticity of demand by Tennessee industrial shippers, the survey responses of 32 shipping firms were analyzed:

Increase in Shipping Rate (%)	Number Who Would Abandon Waterway Shipping	Percentage of Sample	Elasticity of Demand
1-10	5	15.63	-10.00
11-24	8	25.00	-4.00
25-49	4	12.50	-2.00
50-99	3	9.38	-1.00
100-199	3	9.38	-0.50
≥ 200	0	0.00	-0.25

Nine shippers, or 28 percent of the sample, indicated that they would never abandon the water mode. Thirteen shippers, or 41 percent of the respondents, reported that they would shift from water transportation if waterway rates increased by 25 percent. Since a 10.57 cents/L (40 cents/gal) fuel tax is estimated to result in a 36 percent increase in operating costs, increases of this amount in shipping rates would result in sharp reductions in Tennessee's total waterway traffic. Shippers who can shift to other modes with relative ease will do so. The cost increases that will be borne by these firms will vary according to the current rate differential between the rail and truck modes and the towing industry, assuming that the rail and truck modes do not increase their present rate structure.

Segment-Specific Fuel Tax

Another possible form of user charge would be a fuel tax levied on a segment-specific basis although the necessary record-keeping and administrative costs would tend to discourage it. Cost recovery could be achieved with a segment-specific fuel tax of approximately 1 cent/L (4 cents/gal) on the lower Mississippi River, 6.9 cents/L (26 cents/gal) on the Tennessee River, and 21.1 cents/L (80 cents/gal) on the Cumberland River. Given recent fuel costs of 9.67 cents/L (36.6 cents/gal), this cost-recovery scheme on the Cumberland would result in more than a 200 percent increase in fuel costs and prohibitive increases in freight rates on that river. River transportation could not survive on the Cumberland.

Lockage Fees and Congestion Tolls

The philosophy behind the imposition of lockage fees is that the expenditure of federal funds for lock-and-dam maintenance and operations should be financed through the collection of fees from commercial tows and possibly recreational vessels. The major advantage of lockage fees is that the tax would be imposed on vessels at the moment of lockage, which would make possible service-specific user charges. It is argued that, if waterway users are not willing to pay the price necessary to cover the cost of waterway services, then the particular lock or dam, or perhaps the entire river segment, does not "meet the market test" and the facility should be closed.

In situations where dams and locks are constructed in advance of regional economic development, a dilemma arises for policy makers. Such development requires, at least in the beginning, freedom from any user charge program that would restrict the development and generation of river traffic.

From an economist's point of view, a lockage fee depends on determination of some market price for lockages, or an "optimal congestion toll". The calculation of such tolls for the Tennessee river systems can be demonstrated by using computerized data from the Corp of Engineers performance monitoring system. A series of 12 regression equations were estimated for nine locks on the Tennessee River and three locks on the Cumberland River. Delay time—the dependent variable—was regressed against seven independent variables. The results of these 12 regression equations provide insight into the present operations of locks and dams on the Tennessee and Cumberland Rivers. As expected, average delay time was found to vary greatly between the various locks:

River System	Lock	Average Delay Time (min)
Cumberland	Barkley	87.2
	Cheatham	8.4
	Old Hickory	6.8
Tennessee	Kentucky	316.6
	Pickwick	43.6
	Wilson	17.7
	Wheeler	8.4
	Guntersville	10.8
	Nickajack	10.8
	Chickamauga	11.9
	Watts Bar	9.1
	Fort Loudoun	17.3

It was possible to calculate the cost of delay per unit of congestion for each of the locks tested by extracting the coefficient for congestion from each fitted regression equation. This coefficient represents the delay time, in minutes, that is created for the last vessel in a queue by each preceding vessel. By using a figure of $200/h as the average cost of delay (3), the implicit cost of delay or the cost of congestion can then be determined for each unit of congestion.

Calculation of the congestion toll, based on the observed behavior of commercial vessels, produces a fee that represents the transformation of the implicit cost commercial tows are already experiencing under the present rationing mechanism into an explicit charge for priority lockage. Based on observed behavior, the basic congestion cost represents the "imputed value" that commercial operators place on lockages since such costs are currently incurred each time a vessel must wait to receive lockage services. These lockage tolls range from a high of $948.52 for an average toll for the Kentucky Lock to a low of $28.13 for the Old Hickory Lock (3). These average tolls for priority lockages on each dam would become the minimum lockage fee for all vessels. The revenue that could be generated from imposition of such a lockage fee depends on the mix of vessels that pay the basic fee and the priority-lockage surcharge.

To the extent that queuing represents the "revealed value" of lockages to commercial tows, the Tennessee River data imply that a large portion of federal costs for maintaining that river system could be recovered from a system of lockage fees, provided commercial tow operators were willing to pay such fees. This, of course, depends on the recognition by waterway operators that the cost of a lockage fee is, in fact, equal to the average cost of delay that they experience under current conditions. Recovery of operating and maintenance costs for the Cumberland River is more doubtful under such a revenue-raising scheme. Congestion costs on the Cumberland are low because total river traffic, both commercial and recreational, is relatively light.

Segment Toll

The segment toll calls for a fee per ton kilometer of commercial traffic, the toll being set for each river segment to recover the cost of that segment. Proposed segment tolls for the three river systems of interest to Tennessee (4) are given below (1 t·km = 0.685 ton-mile):

River System	Estimated Segment Toll (mills/t·km)	Resulting Increase in Operating Costs (%)
Lower Mississippi	3.7	4.0
Tennessee	17.4	28.5
Cumberland	38.3	81.0

A segment toll would be similar in cost impact to a differential fuel tax of 1.6 cents/L (6 cents/gal) on the lower Mississippi, 6.9 cents/L (26 cents/gal) on the Tennessee, and 21.1 cents/L (80 cents/gal) on the Cumberland. Administration of the segment toll, which would require constant monitoring of all traffic movements over specific segments of a given waterway, may be complicated and expensive. Specific problems are related to the disposition of empty tows, congestion problems, high-bulk items of low value and heavy weight, and lightly used waterways. Such tolls would likely be resisted as inefficient, inequitable, and potentially fatal to some commerce on Tennessee rivers, especially the Cumberland.

License Fee

The license-fee proposal calls for license fees to be levied on the basis of power capability for towboats and tonnage capacity for barges. One proposal calls for a tax rate of $24.67/rated kW ($18.41/hp) for towboats and $3.45/t ($3.13/ton) of capacity for barges. If levied in such a manner, the fee actually amounts to a capital tax of quite high proportion on capital equipment over its productive life. As a result, producers or shippers may attempt to substitute less expensive and lower-cost tows or barges, which may result in a loss of some economies of scale and increases in shipping costs, terminal costs, and shipping times.

It is quite possible that license fees could be levied for specific river systems. Based on a figure of 385 commercial vessels operating on the Tennessee River in 1976, a license fee of $9960/vessel would have been necessary to fully fund the Tennessee River segment. Based on a figure of only 194 vessels operating on the Cumberland River, a license fee of $19 766 would be necessary for commercial operators on that system. Because of an overlap of 105 vessels on the two rivers, a decision might be made to treat the two rivers as one system and set a license fee of $15 413/vessel to apply to both systems based on system costs. In general, the inefficiencies and delays encouraged by such a program would tend to make the licensing option an unattractive method for financing waterway costs and improvements.

OTHER ECONOMIC CONSIDERATIONS

Summary of Impact of User Charge Alternatives

Prediction of the ultimate impact of waterway user charges on the Tennessee economy depends on which form and what level of user charge are imposed.

The fuel tax appears to be the more popular alternative, but it is likely to face some difficulties if levied at a level high enough to recover all costs for monitoring and operating the river systems. For example, when taxes reach a level at which operating costs increase by about 25 percent, a substantial number of shippers will abandon the waterway system in the short run and may eventually relocate in the long run. This carries obvious implications for employment and ex-

Table 2. Likely economic impact of selected waterway user charges on the Tennessee river system.

User Charge Alternative	Increase in Operating Costs (%)	Increase in Shipping Rates (%)	Decrease in Waterway Tonnage (%)
Systemwide fuel tax			
1 cent/L	3.70	3.30	5.16
2.11 cents/L	7.30	6.60	10.32
6.34 cents/L	22.30	20.10	32.46
26 cents/L	36.40	32.80	44.53
Segment-specific fuel tax			
Tennessee River (6.9 cents/L)	23.70	21.33	34.51
Cumberland River (21.1 cents/L)	72.90	65.60	56.06
Mississippi River (1.6 cents/L)	5.50	5.00	7.82
Lockage fee (all vessels paying)			
Tennessee River	6.80	6.10	9.53
Cumberland River	28.00	25.20	40.73
Lockage fee (recreational vessels exempt)			
Tennessee River	28.00	25.20	40.73
Cumberland River	63.00	56.70	54.39
Segment toll			
Tennessee River	28.50	25.70	40.98
Cumberland River	81.00	72.90	57.43
Mississippi River	4.00	3.60	5.63

Note: 1 L = 0.264 gal.

penditures on new plant and equipment.

Although a lockage fee may reduce congestion on the Tennessee River and thus reduce commercial delay times, it would fall far short of collecting most operation and maintenance costs on the Cumberland River. Because these toll levels must be so high on some river systems to recover costs, not much confidence can be placed in the effectiveness of a lockage toll.

Under the segment-toll option, a user charge would increase operating costs on the Cumberland River by 81 percent and require about a 72.9 percent increase in shipping rates. Alternatively, a segment-specific fuel tax set at a level necessary to recover operation and maintenance costs would increase operating costs by 72.9 percent and increase shipping rates by about 65.5 percent. Setting the fee at a level necessary to recover all federal expenditures would probably result in the large-scale abandonment of the Cumberland River by commercial operators.

Table 2 (4) gives the best estimate (in light of the problems of adequate data accessibility) of the likely impact of each user charge option on waterway shipping on Tennessee rivers. The smallest impact occurs with a 1 cent/L (4 cents/gal) fuel tax; the segment toll represents the greater impact in terms of towing-industry operating costs, increases in shipping rates, and potential loss in the volume of state waterway traffic.

Impact on Employment

The severity of the impact of a user charge for the various waterway systems in Tennessee depends on both the method of collection that is ultimately selected and the ultimate level of cost revovery. In 1973, it was estimated that 65 273 jobs were associated with river-related industry (5). This figure may be converted into approximately 6019 direct and indirect jobs on the Mississippi River, 45 242 jobs on the Tennessee, and 14 013 jobs on the Cumberland.

If economic feasibility is considered and it is assumed that percentage decreases in direct employment have some relation to percentage reductions in waterway shipping, the worst impact on employment would result from the implementation of a segment toll. In contrast, the imposition of the least-impact alternative—the 1 cent/L (4 cents/gal) fuel tax—would result in the smallest decreases in employment.

Indirect employment, or the employment provided by industrial firms that have located in Tennessee as a result of the state's river systems, must also be considered. Loss of employment in these industries will, however, be mitigated by the ability of industrial shippers to switch to other modes of transport. Although the effects of user charges may influence the future expansion or relocation decisions of these firms, it is unlikely that the disappearance of these jobs will occur over the short run given the sunken capital investments of river-related industry. Job losses will likely be a longer-term proposition. It is difficult to measure accurately the potential long-term loss of industry plant locations completely new to the state, given the many uncertainties of industry relocation decisions.

Information is available from Tennessee Valley Authority sources regarding the amount of capital investment in industrial plants along the Tennessee River over the past 20 years or so. The data suggest that these outlays have been growing at approximately a 9 percent compound rate annually. Given these past trends, estimates for future expenditures can be arrived at, assuming no waterway user charge. It is significant, however, that 96.9 percent of the survey respondents indicated that the waterways were important to their decision to locate in the Tennessee area. The estimated loss of such capital investments could be determined for each possible level of a fuel tax by using the amount of decrease in waterway traffic volume as a proxy for the possible loss in new plant expenditures and expansions. The expenditure losses could then be converted to employment losses based on ratios of capital to labor. Depending on the rate levels imposed, employment-related consequences for the state can be described as ranging from moderate to devastating, especially when one considers that these estimates do not include the possible job losses on the other two river systems or the secondary effects that would ultimately be felt throughout the state's economy. When the possible loss of existing jobs is considered, the implications for Tennessee become even more critical.

SOCIAL IMPLICATIONS

The ultimate objective of a waterway user charge is to shift the burden of navigational improvements from general tax revenues, or the taxpayer in general, to the direct users of navigable rivers. The implicit consequence for the public would be a change of roles in the financial support for waterway projects; that is, the citizen would benefit as a taxpayer by getting some relief from the pressures of an expanding tax liability but would ultimately face higher prices for certain consumer goods.

The user charge program will probably distribute the costs of navigational improvements among a larger number of citizens, thereby reducing the relative cost share of some individuals, particularly middle-income persons. But identifying the specific individuals who are to be added to the rolls of those who financially support navigational improvements may cause some uneasiness, especially among policy makers.

Only Congress can decide on the desirability of such a redistribution of the financial burden. However, because not enough is known about the complex interactions that could be initiated by implementation of a user charge program or about the final outcome, it would be sensible to phase in any cost-recovery scheme gradually and thus allow for cautious monitoring and analysis of

both positive and negative impacts.

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