traffic control, two main options are available. Existing taxes could be increased proportionately for each class of users. Alternatively, a combination of new fees that correspond to additional costs caused by users and existing aviation taxes could also make the air traffic control system self-financed. Neither of these options is as efficient as charging aviation users the marginal costs they impose on the air traffic control system.

Chapter Four

Inland Waterways

In 1990, the federal government spent $776 million to build, operate, and maintain the nation's inland waterway system for navigation purposes.[1] The inland waterway system is used primarily by commercial barges, although recreational and commercial passenger boats are common in some sections. Like users of the highway and aviation systems, commercial waterway users pay fuel taxes that are intended to cover some of the system's costs. But revenues from fuel taxes yielded only $63 million in 1990, or about 8 percent of the amount spent in support of the inland waterway system. Since no other charges or taxes are imposed for using inland waterways, the general fund of the federal government paid the rest of the expenses.

Some rivers would be navigable even without investment by the Army Corps of Engineers. But such work as dredging, removing obstacles, and widening and straightening channels can enhance their value by accommodating larger barge tows and enabling the vessels to move faster. Without locks and dams to regulate the flow of water, some river segments would be too shallow, rapid, dangerous, or unpredictable to accommodate the reasonably regular or predictable flow of traffic that is essential to efficient scheduling of the flow of commerce. Spending to improve the waterways, then, enhances the productivity of the users of the waterway system. It is an investment in infrastructure that, like other investments, can be evaluated on the basis of its returns.

Charging users in keeping with the costs of providing the waterway system significantly affects the efficiency and productivity of the nation's transportation resources. If users pay less than their share of the cost, they tend to overuse the system, sometimes to the detriment of competing modes, such as rail and truck. Moreover, users who do not pay their share of costs may demand excessive additional investment in the waterway system.

There may be an economic rationale for not charging users of navigable waterways the full cost of the system. If the waterway system promotes economic development or national defense capabilities, economic equity might justify having the general public pay for those external benefits. The substantial imbalance between costs and user taxes, however, suggests that it is desirable to explore ways of placing a larger share of the burden on the users.

Background

The inland waterways of the United States are a major component of the nation's transportation system. They are especially important in the transportation of heavy, low-value, bulk commodities such as coal, petroleum, chemicals, construction materials, and grain.

1. The data presented in this chapter are the most recent available for comparative purposes. In general, aggregate budget data are available for 1991, disaggregated spending data for 1990, and data on traffic for 1989.

In calendar year 1989, inland waterway traffic consisted of 606 million tons of freight carried an average of 450 miles to yield a total of 272 billion ton-miles.[2] This amount was about 10 percent of the nation's freight and 2 percent of the freight bill. About 55 percent of the tonnage carried on inland waterways is crude petroleum, petroleum products, and coal. Inland waterway transportation plays an important role in export trade; about one-half of U.S. grain exports and one-fifth of U.S. coal exports are carried on the inland waterways.

Description of Waterways and Their Users

Barges are an efficient method of moving bulk commodities that have a low value-to-weight ratio. Water transportation is especially energy-efficient in transporting large loads over long distances. Barges carrying grain, coal, and similar dry bulk commodities on the Mississippi River-Gulf Coast system are typically 195 feet long, 35 feet wide, and have a draft of nine feet. Barges have an average capacity of about 1,500 tons. Tank barges carrying liquid cargo--petroleum, petroleum products, fertilizers, and industrial chemicals--are nearly 300 feet long and can carry 1 million gallons. A tow consists of a towboat pushing a number of barges, typically eight to 17, three abreast, on large and medium-size waterways with locks. The number of barges in a tow on the lower Mississippi River is usually 30 to 40. The magnitude of these tows accounts for their efficiency.

About 1,800 companies are involved in the barge, towing, and related support businesses in the United States. Some firms own only one or two towboats, while others own fleets. Together, these organizations operate some 5,000 towboats, 27,000 dry cargo barges, and 4,000 tank barges.

The shallow-draft inland waterway system consists of about 11,000 miles of navigable channels and is maintained by the U.S. Army Corps of Engineers as part of its civil works program. (The Army's civil works program is included in budget function 300, water resources.) Most inland waterways are less than 14 feet deep, and commercial vessels traveling on them are subject to a fuel tax. The waterways subject to a fuel tax are specified in the Inland Waterways Revenue Act of 1978 and the Water Resources Development Act of 1986 and are listed in Table 14. (See Figure 4 for a map of the waterways with a fuel tax.) Traffic in deep-draft channels and ports is generally subject to the Harbor Maintenance Tax, a tax on the value of cargo. The system includes 167 lock sites, with 216 lock chambers. Where there is more than one chamber at a site, one main chamber handles most of the traffic, and an auxiliary chamber--typically smaller than the main one--is used for recreational boats and small amounts of commercial traffic at peak times or when the main chamber is undergoing maintenance or repair. The oldest locks still in use were built in 1839, and the newest was opened to traffic in 1991. The median age is about 35 years.

Cost Elements

In addition to the tow operators' private costs of labor, fuel, facilities, and equipment, waterway navigation imposes numerous resource costs, many of which are borne by the federal government. Making waterways navigable entails building and renovating locks and dams, and dredging, widening and straightening channels. These activities may impose environmental as well as direct construction costs. Operating and maintaining locks and dams and ensuring a smooth flow of traffic along the waterways also consume considerable resources. Tow operators impose and incur delay costs when waterways become congested and traffic must wait to go through locks. At the few locks and dams where

2. Army Corps of Engineers, *1990 Inland Waterway Review* (draft). The total includes some traffic on nontaxed portions of the inland waterways. Traffic on the fuel-tax waterways was 250 billion ton-miles in calendar 1989, the most recent year for which data are available.

Table 14.
Operation and Maintenance (O&M) Costs and Traffic by Waterway, 1989

Waterway	Ton-Miles (Thousands)	O&M Costs (Thousands of dollars)	O&M Costs per Ton-Mile (Cents)
Mississippi (Ohio River - Baton Rouge)	112,908,248	52,486	0.047
Ohio	51,595,916	52,184	0.101
Gulf Intracoastal Waterway	22,202,858	28,387	0.128
Mississippi (Missouri-Ohio Rivers)	17,515,644	22,414	0.128
Black Warrior-Tombigbee	4,862,584	12,213	0.251
Tennessee	6,512,433	17,383	0.267
Green-Barren	476,515	1,297	0.272
Illinois Waterway	7,870,314	24,746	0.314
Atchafalaya-Old	475,783	1,683	0.354
Kanawha	1,269,365	4,973	0.392
Mississippi (Minneapolis-Missouri River)	15,760,281	82,361	0.523
Columbia-Snake	1,437,536	9,134	0.635
Red	546,594	3,597	0.658
Monongahela	1,523,674	11,911	0.782
Missouri	796,735	7,373	0.925
Cumberland	1,215,034	11,573	0.953
Arkansas System (McClellan-Kerr)	1,788,528	26,569	1.486
Kaskaskia	97,896	1,817	1.856
Tennessee-Tombigbee Waterway	791,309	18,040	2.280
Atlantic Intracoastal Waterway	461,104	13,507	2.929
Ouachita-Black	123,884	4,315	3.483
White	58,628	2,294	3.913
Willamette	12,711	619	4.870
Alabama-Coosa	181,909	9,710	5.338
Apalachicola-Chattahoochee-Flint	93,059	7,795	8.376
Kentucky	14,695	1,480	10.072
Allegheny	52,168	7,304	14.001
Pearl	a	866	a
Total	250,645,405	438,031	0.175

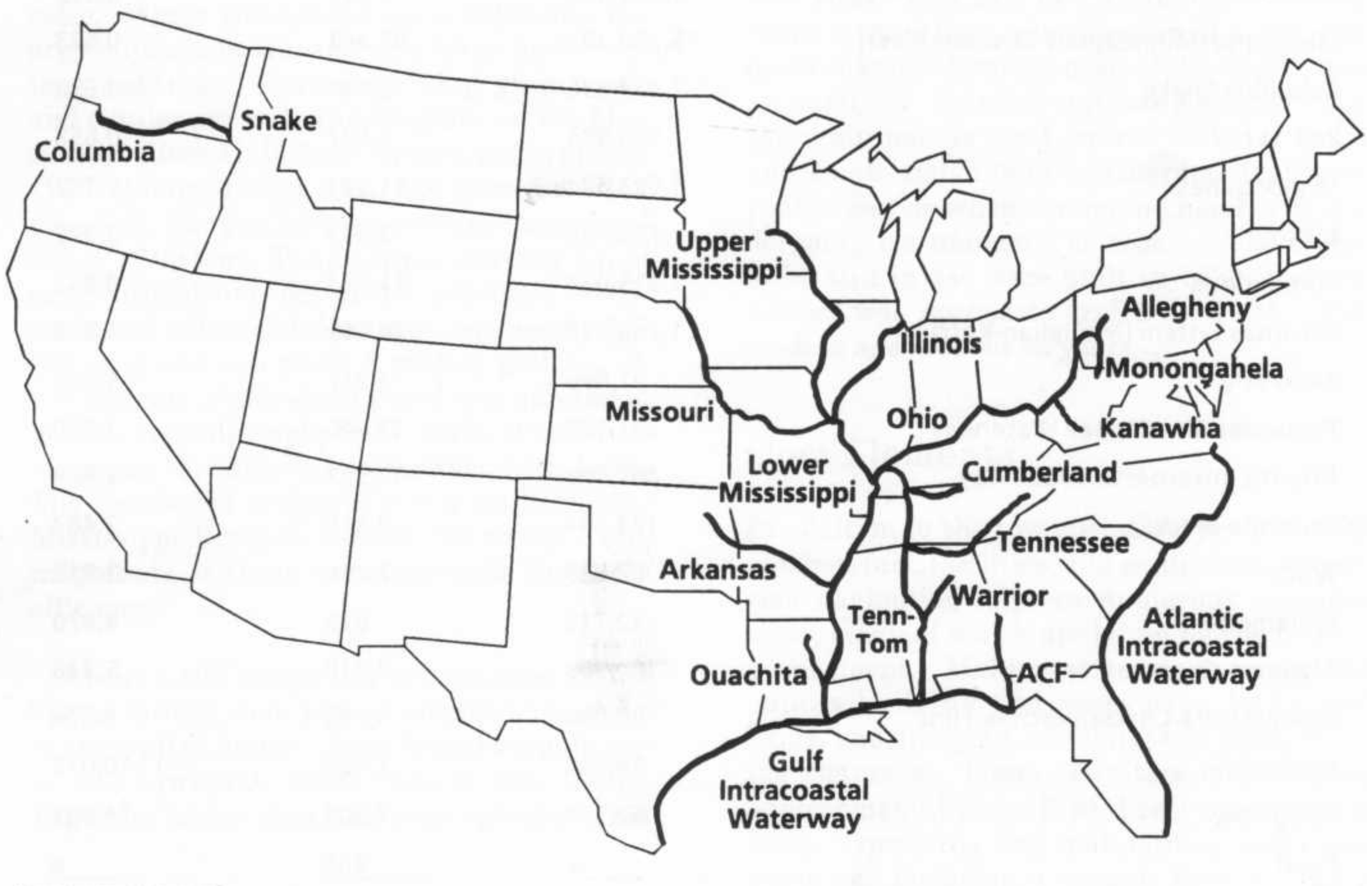
SOURCE: Army Corps of Engineers.

a. The Pearl River had no traffic in 1989.

hydroelectric power is generated, each movement may cause a small loss in generating capacity--still another resource cost.

This study is concerned primarily with costs associated with navigation, but navigation projects sometimes have other purposes, such as flood control, recreation, and generation of power. When this is the case, it is difficult to determine how much of the costs to attribute to each of the different uses or purposes. Often, much of the cost is joint: a given expenditure serves more than one purpose, such as building a levee that aids navigation and controls flooding. By definition, joint costs cannot be attributed to individual users or categories of users. Still, a system for recovering joint costs from users may be desirable. One accepted principle is to allocate costs according to the benefits received by each user or class of users. The Corps of Engineers has adopted cost-allocation regulations that describe procedures for assigning joint costs to project purposes. The corps has also extensively studied alternative methods of allocating costs that could serve as a basis for setting user charges. This study uses the corps's existing allocation system. Although serving adequately for current purposes, however, this system could be refined, based on

Figure 4.
Fuel-Tax Waterway System



SOURCE: Army Corps of Engineers.

NOTE: Tenn-Tom = Tennessee-Tombigbee; ACF = Apalachicola-Chattahoochee-Flint.

work already completed by the corps, to provide better information for imposing charges on waterway users.[3]

Federal Spending on Waterways

The Army Corps of Engineers, under the Army's civil works budget, carries out most of the federal government's spending on inland waterways. In 1990, the corps spent $384 million to operate and maintain the fuel-taxed waterway system and $392 million on construction.[4]

Spending for Operation and Maintenance

Funds for operation and maintenance (O&M) are used for dredging channels; operating locks; repairing locks, dams, revetments, and other structures; removing channel obstructions; and similar activities. Among the factors that affect the costs of operating and maintaining navigation channels are water flow, weather, and the passage of time. Some rivers need to be dredged more often than others to maintain a certain depth. In years of drought, the corps may have to do extra dredging throughout the system to maintain navigable depths. Critical to the problem of charging users of waterways is whether and how the passage of tows affects O&M costs on a waterway. The corps's data suggest that traffic is not an important determinant of O&M costs on a waterway.

Data on O&M costs and traffic on each waterway subject to the fuel tax for 1989 are presented in Table 14. The corps uses the amount of ton-miles carried on a waterway as the measure of output. Alternative measures, such as the number of tows or barges, could also be used and might be more useful in showing the effects of traffic on costs. The various measures are likely to be highly correlated for barges carrying loads. The main difference is that the ton-mile measure does not reflect the flow of tows containing empty barges.

In 1989, the systemwide average O&M cost per ton-mile was 0.17 cents. There was wide variation among waterways: O&M costs per ton-mile ranged from less than 0.05 cents on the lower Mississippi River between the Ohio River and Baton Rouge to 14 cents on the Allegheny River.[5] Because costs and traffic fluctuate somewhat from year to year, it is also useful to look at an average of several years. Over the 1977-1988 period, average O&M costs per ton-mile ranged from 0.04 cents on the lower Mississippi to 12.6 cents on the Kentucky.[6] The cost per ton-mile tends to be low on those waterways with a large amount of traffic and on those with few or no locks.

Average costs are one important factor in determining efficient investment and pricing levels, and marginal costs are another. Marginal costs--the costs of one additional unit of traffic--are difficult to determine using available data. But CBO ran a linear regression relating O&M costs to ton-miles and water-

3. See, for example, Office of the Chief of Engineers, Directorate of Civil Works, Office of Policy, U.S. Army Corps of Engineers, *Navigation Cost Allocation Study--A Feasibility Case Study* (October 5, 1980).

4. These are preliminary estimates of spending on the shallow-draft segments subject to the fuel tax. Including spending on nontaxed waterway segments and on deep-draft channels and harbors on which traffic is generally subject to the harbor maintenance tax would yield total outlays of $718 million for operation and maintenance and $534 million for construction in 1990.

5. The corps spent $866,000 in 1989 on the Pearl River, but reported no traffic. The last year for which traffic was reported on the Pearl was 1985, when the cost per ton-mile was 95 cents.

6. These averages are based on nominal dollars for each year. No attempt was made to adjust for inflation, since the purpose was to make comparisons among waterways rather than to understand trends over time. The average O&M cost per ton-mile on the Pearl River for 1977-1988 was 34.9 cents.

way length and found that one additional ton-mile would raise O&M costs by less than 0.04 cents.[7] This low marginal cost, which is less than the average cost on even the lowest-cost waterway, suggests that most O&M costs can be regarded as fixed and do not vary with output. The marginal-cost estimate applied systemwide.

It is important to note that availability of data limited this analysis. A more thorough analysis would include all relevant factors, such as the number of tows, number of lockages, and variables reflecting unusual weather conditions or other characteristics that might affect costs, and would test alternative specifications of the relationships among the variables. The limited objective here was to see whether there was any statistically significant relationship between costs and use, and if so to estimate an approximate marginal cost.

It may be easier to associate costs with use for lock operations than for dredging or other channel maintenance. Each operation involves wear and tear on the lock. Moreover, each lockage entails labor, although if an operator must be on duty (and paid) regardless of whether any tows pass through the lock during that operator's shift, the cost would not depend on the number of operations. Another type of cost, for the few locks and dams at which hydroelectric power is generated, occurs because each lock operation reduces the water flow and thus diminishes generating capacity slightly.

Congestion at locks also imposes costs. Because the costs of these delays are borne by tow operators rather than the federal government, they raise somewhat different issues about imposing user charges to improve efficiency and productivity. (See the discussion below on alternative mechanisms for charging users.)

Spending on Construction

The Army Corps of Engineers spent $392 million on construction and major rehabilitation projects on the inland waterway system in 1990. Since these projects typically take many years to complete, the spending in any single year consists of partial payment for a number of projects. A list of construction and major rehabilitation projects under way or proposed in the fiscal year 1991 budget is contained in Table 15.

Waterway construction projects are generally undertaken in response to a traffic impediment, such as when a lock and dam have become congested because of increases in traffic or breakdowns resulting from age. Replacing the lock, and perhaps expanding it, may substantially benefit barge operators. Dredging a channel deeper to allow transit by more heavily loaded barges, or widening channels, or turns in channels, to facilitate transit by more and larger tows, are other examples of improving waterways.[8]

Construction projects generally have long lives. Locks and dams are designed to last 50 years or more. The largest recent lock and dam construction project is the $950 million Melvin Price Locks and Dam (Locks and Dam 26) on the Mississippi River above St. Louis. Its 1,200-foot-long and 110-foot-wide main chamber should help alleviate congestion at the smaller (600-foot long) lock and dam it has replaced. The new main lock was opened to traffic in 1990. A 600-foot by 110-foot auxiliary lock is under construction. Another recent project is the Oliver Lock and Dam on the Black Warrior River, which was completed in 1992 and cost $120 million.

7. Both factors were statistically significant. The coefficient on the ton-mile variable, which indicates by how much O&M costs increase as a result of one additional ton-mile of traffic, was less than 0.0004. Regressions of O&M costs by waterway against ton-miles and length of waterway were run using data from 1985, 1988, and the 1977-1988 average. The number of lock sites in each segment was also included as a variable. All of the regressions gave similar results.

8. A distinction should be made between dredging to deepen a channel, which is an investment aimed at increasing capacity, and dredging to maintain a given depth, which is properly classified as O&M.

The largest channel construction project completed in recent years is the 234-mile Tennessee-Tombigbee waterway, which was built to link the Tennessee and Tombigbee rivers in Mississippi and Alabama. The channel is nine to 12 feet deep and 300 feet wide in most places, and there are 10 locks and five dams. Completed in 1985, the Tennessee-Tombigbee took 13 years to build and cost the federal government $1.8 billion. With regular maintenance, this addition to the waterway system is expected to last at least 50 years and probably longer.

Investment decisions are guided by benefit-cost analyses, which estimate the expected benefits and costs over the life of the investment. Estimating the benefits of a project can be difficult, however, especially if market prices do not reveal the value of a project to its potential beneficiaries. A system of charging users could help illuminate which investment

Table 15.
Construction and Major Rehabilitation Projects (Costs in millions of dollars as of October 1991)

Waterway/Project	Completion	Total Cost
Upper Mississippi River Locks and Dams		
Melvin Price, 1st lock	1997	737
Melvin Price, 2nd lock[a]	1993	213
No. 3, 5A-9 (6 sites)	1999	50
Upper and Middle Mississippi		
System environmental management program[b]	2002	259
Middle Mississippi River		
Regulating works	2000	215
Lower Mississippi River		
Channel improvement	2010	3,622
Atchafalaya River	2010	1,648
Arkansas River System	2000	646
Red River, mouth to Shreveport, Louisiana	c	1,847
Ohio River System Locks and Dams		
Ohio River, Gallipolis[a]	1999	384
Ohio River, Olmsted[a]	2006	1,110
Monongahela River, Grays Landing[a]	1995	174
Monongahela River, Point Marion[a]	1994	99
Kanawha River, Winfield[a]	1997	236
Gulf Intracoastal Waterway		
Mississippi River-Gulf Outlet, Inner Harbor Lock[a]	c	500
Mobile River and Tributaries		
Black Warrior River, Oliver Lock and Dam[a]	1992	120
Columbia-Snake Waterway		
Columbia River, Bonneville Lock and Dam[a]	1994	331

SOURCE: U.S. Army Corps of Engineers, *1991 Inland Waterway Review* (draft), Tables 6-3, 6-4, and 6-5.

a. Funded in part by the Inland Waterways Trust Fund.

b. Except recreation.

c. Completion date is indefinite.

projects were likely to generate the greatest increases in productivity and efficiency.

Current Financing Policy

All of the federal government's spending for operation and maintenance and part of its spending for construction on the inland waterway system is financed by general tax revenues. Revenues from a tax on fuel used by commercial vessels on the waterways cover a share of new construction spending. (See Box 5 for a description of financing by the Inland Waterways Trust Fund.) The Inland Waterways Revenue Act (IWRA) of 1978 as amended by the Water Resources Development Act (WRDA) of 1986 imposed the fuel tax as a way of shifting some of the costs from the general taxpayers to users of the waterway system. The fuel tax does not apply to deep-draft (more than 12 feet) oceangoing ships, passenger boats, recreational craft, or government vessels.[9] The schedule for phasing in the fuel tax, which began at a rate of 4 cents a gallon in 1980 and will rise to 20 cents a gallon in 1995, is shown in Table 16. Under current law, it will remain at that level.

Section 206 of the 1978 IWRA designated 26 waterways on which traffic would be subject to the fuel tax. The 1986 WRDA (Section 1404 (b)) added the newly completed Tennessee-Tombigbee Waterway to the list. The fuel tax is uniform on the 11,000 miles of shallow-draft waterways on which it applies.[10]

9. Inland Waterways Revenue Act of 1978, Section 202, codified at 26 U.S.C. Section 4042(c)(1).

10. Shallow-draft waterways other than the 27 designated, shallow-draft harbors and channels, and deep-draft harbors and channels are excluded from the fuel tax. Their traffic is subject to the harbor maintenance tax, established to pay 100 percent of their O&M costs. Local sponsors of improvements to these projects must pay a share of construction costs.

Table 16.
Phase-In Schedule of Fuel Tax Rates

Time Period	Fuel Tax (Cents per gallon)
October 1, 1980, to September 30, 1981	4
October 1, 1981, to September 30, 1983	6
October 1, 1983, to September 30, 1985	8
October 1, 1985, to December 31, 1989	10
January 1, 1990, to December 31, 1990	11
January 1, 1991, to December 31, 1991	13
January 1, 1992, to December 31, 1992	15
January 1, 1993, to December 31, 1993	17
January 1, 1994, to December 31, 1994	19
January 1, 1995, and Beyond	20

SOURCE: Internal Revenue Code, 26 USC 4042(b).

Revenues from the Fuel Tax

The fuel tax generated $60 million in 1991 and is expected to yield $460 million during the 1992-1996 period. Increases in tax rates and traffic are expected to raise revenues each year. But the higher tax rates may not yield proportional increases in revenues. Many tow operators are using fuel more efficiently. They have been running at slower, fuel-conserving speeds since excess capacity in the industry has diminished the need to deliver a load quickly and return for another. Replacing older towboats with new ones that have more fuel-efficient engines also reduces fuel consumption.

Effects of Fuel Taxes on Efficient Use of Resources

Fuel taxes--and other user taxes or charges--should be judged not only on the amount of revenue they raise but also on the incentives or disincentives they provide for efficient use of resources. The question raised in this section is what effect (if any) the fuel tax has on the use of waterways by tow operators.

Short-Run Efficiency: Does Price Equal Marginal Cost? From the standpoint of a tow operator, the fuel tax is only one component of tow operating costs. Because the tax rate is expressed in terms of cents per gallon of fuel, the amount of the tax varies directly with the amount of fuel used. The industry reports achieving an average of 500 ton-miles per gallon of fuel, although the actual amount of fuel used varies with such factors as weight, speed,

Box 5.
The Spending Side of the Current System: The Trust Fund Mechanism

The Inland Waterways Revenue Act of 1978 established the Inland Waterways Trust Fund, into which the Congress appropriates amounts equivalent to the revenues received in the Treasury from the tax on fuel used by commercial vessels. Section 1405 of the Water Resources Development Act of 1986 authorizes appropriations from the trust fund for construction and rehabilitation projects on those waterways that are subject to the fuel tax. In general, the trust fund and the general fund of the U.S. Treasury have split the costs of such projects evenly.[1] The same legislation specifies that operation and maintenance (O&M) costs are to be paid entirely from the Treasury's general fund.

The unspent balance of the trust fund earns interest. Interest payments made a relatively large contribution to total trust fund receipts in the fund's early years, when tax revenues were accumulating but outlays were not being made, because the Congress did not authorize expenditures from the fund until fiscal year 1985. Interest accounted for $32 million in 1990 and is projected to decline somewhat as balances are drawn down to pay for new projects.

The anticipation that one-half of the costs of construction will come from the trust fund imposes a constraint on new construction projects. The fuel tax does not provide enough revenue to fund half the costs of all the projects that users have been seeking. As a result, there is a need to set priorities and to fund only projects that have the greatest support. If this translates into funding only those projects for which the net benefits are greatest--and only those for which net benefits are greater than zero when an appropriate discount rate is used--the result will be increased efficiency in investment. Efficiency is maximized when all projects with positive net benefits at an appropriate rate of interest are undertaken. Budget constraints may make this impossible, however.

The requirement that the trust fund can be used only for construction and major rehabilitation, but not for operating and maintenance costs, has several implications. First, it means that the general taxpayer subsidizes waterway users. If users do not have to pay for benefits received, they are likely to demand more services. That is, they would tend to demand more spending on O&M--for example, a higher quality of service--than if they were paying for it themselves. Second, if users pay a share of construction costs, but not O&M, there may be a skewing of demands from the most efficient mix of construction and O&M spending.

The 1986 Water Resources Development Act established the Inland Waterways Users Board to advise on spending from the trust fund. Experience suggests that the board may have a beneficial effect on efficiency in the selection of projects, since it serves as a forum for users to express their needs and advise on their priorities. The board seeks to ensure that the taxes paid by users into the trust fund are spent wisely. Without direct user fees, this mechanism is quite useful in shaping investment decisions. But with price signals as well to serve as a guide, resources could be allocated even more efficiently.

The trust fund serves the accounting function of showing receipts and outlays related to inland waterway spending. If user charges or taxes in addition to the fuel tax were enacted, depositing them in the trust fund would help maintain that accounting function. Receipts and outlays do not necessarily have to be equal. If waterways provide benefits other than to direct users, then users should not bear the full cost. Moreover, all prospective spending projects should be evaluated and only those yielding net benefits should be undertaken, regardless of the size of the trust fund balance.

1. The 1986 act does not specify the split between general and trust fund financing; it is covered in the authorization of each project. To date, the split has been 50-50, but the law does not require this.

strength of current, whether or not the tow is moving upstream or downstream, congestion and delay time at locks, the amount of maneuvering needed to get through locks and other narrow passages, and the size of the tow. At the 1992 tax rate of 15 cents a gallon, the tax adds about 0.03 cents per ton-mile to operating costs. For an eight-barge tow traveling an average distance of 450 miles and getting 500 ton-miles per gallon of fuel, the tax would be about $1,600. A 17-barge tow traveling the same distance would incur fuel taxes of about $3,400. A large 40-barge tow--commonly found on the open lower Mississippi River--traveling 450 miles would incur about $8,100 in taxes. A profit-maximizing tow operator takes these factors into account, trading off fuel use with other operating considerations, such as crew costs and prompt service.

How do fuel taxes relate to the government's cost of providing waterways? The analysis of the Army Corps of Engineers' O&M costs reported in the previous section suggested that the marginal cost to the government of one additional unit of traffic along a waterway is small. The O&M costs of one additional ton-mile are estimated to be slightly less than 0.04 cents. This amount can be compared with the estimated fuel tax of 0.03 cents per ton-mile. These numbers should be treated with caution, since they are based on a number of simplifying assumptions and aggregate data. But if the estimates are reasonably accurate, they indicate that the price (based on the 1992 fuel tax rate of 15 cents a gallon) is slightly less than the marginal cost of O&M, a condition that would lead to some uneconomic use of the system.

In light of the simplifying assumptions under which the marginal-cost estimates were made, a more reliable conclusion is that the fuel tax paid by tow operators and the marginal cost to the federal government of operating and maintaining the waterways are of essentially the same order of magnitude.[11] If this is so, the fuel tax may not distort tow operators' incentives for efficient use of the waterways in the short run, at least on a systemwide basis. If marginal costs vary across waterways as average costs do, however, there would be greater divergence between the fuel tax and marginal cost and consequently less efficiency. Fuel could be taxed at different rates on different waterways, but this might cause administrative and enforcement problems.

The foregoing discussion assumes that the fuel tax is intended to cover only the costs of using the waterway system's physical plant. If all or part of the fuel tax is intended as an environmental protection or energy conservation measure, the issue becomes more complicated. As with highways and airways, the marginal costs of pollution and energy consumption would have to be estimated and added to the marginal cost of waterway use to arrive at a price for inducing efficiency.

Long-Run Implications for Corps Spending Decisions. In the private sector of the economy, if a firm cannot cover its total costs, including replacement of capital, over the long run, it goes out of business. The failure is a signal in the market that users are unwilling or unable to pay the cost of resources used to produce a specific good or service and that those resources would be more highly valued elsewhere.

In 1990, the fuel tax raised less than one-sixth of the revenues needed to cover construction spending; the U.S. taxpayers paid the remaining construction costs and all of the costs of operating and maintenance.[12] Since waterway users are not being asked to cover the full cost, the Corps of Engineers receives insufficient economic information about users' priorities for alternative corps projects, despite the corps's claim that it gets ample in-

11. The 20-cent per gallon fuel tax rate scheduled for 1995 and beyond would be equivalent to 0.04 cents per ton-mile, slightly higher than the estimated marginal cost to the government of O&M. The marginal cost may also rise, however.

12. Fuel tax revenues pay for one-half the cost of construction projects authorized under the Water Resources Development Act of 1986. General funds pay the other half, plus all the costs of construction projects authorized before the 1986 act.

formation from users about their priorities and preferences.

Fairness Considerations and Benefits Received. Fuel taxes may act as a proxy for the benefits received by tow operators, since they are correlated with use of the waterway system. This should be considered in comparing the fairness of the fuel tax with alternative ways of charging users of waterways. The correlation between fuel taxes paid and benefits received on the waterway system is diminished by a number of factors, however. The fuel used by a towboat is taxed at the same rate throughout the waterway system. But the federal government's spending varies considerably from waterway to waterway. Thus, under a uniform tax, users of high-cost waterways enjoy much higher subsidies than users of low-cost waterways.

When the marginal cost of an additional tow is very small, a user charge based on marginal cost would recover only a small portion of total costs.

Alternative Financing Options

A fuel tax may lead to greater efficiency--and equity--in waterway investment than no taxes at all because it presents a way of compelling all waterway users to bear some of the costs of the system. It sends only weak signals, however, about the desirability of specific investments.

General Principles and Criteria for Assessing Alternative Charges

The prescription for efficiency, as set forth in Chapter 1, is to charge users a price equal to the marginal social cost. The preceding discussion suggests that waterways are characterized by economies of scale, however, meaning that marginal-cost pricing will not cover total costs. There are, of course, alternative ways of dealing with the trade-off between economic efficiency and cost recovery.

Systemwide Charges Versus Charges Based on Factors Specific to Each Waterway

The various ways of charging users could be imposed on a systemwide basis or vary by waterway. Charges based on factors specific to each waterway, referred to here as waterway-specific charges, have some advantages since, as shown in Table 14, operation and maintenance costs per ton-mile vary tremendously among waterways. Users of waterways whose costs per ton-mile are relatively low would not be forced to subsidize users of waterways whose costs per ton-mile are high, as they would under a plan imposing a systemwide average charge. Some shipments for which barge transportation would be economic under a charge equal to the O&M cost on a low-cost waterway would not be economic at a higher charge, based on the systemwide O&M cost per ton-mile. Under a systemwide fee, these shipments might go by another mode (rail, pipeline, or truck) or might not be shipped at all. For this reason, charges tailored to specific waterways could lead to greater efficiency than a systemwide approach.

The waterways most likely to be affected by a waterway-specific charge are those with relatively little traffic. Any decline in traffic would necessitate raising fees because fixed O&M costs would be spread over fewer users. Such an increase could cause further declines in traffic, possibly to the point of no traffic at all on a high-cost waterway. This would be inefficient in the short run, because once the O&M costs are incurred, there is no reason to discourage traffic as long as it covers its marginal cost. The result could be economically efficient, however, if plans were made to cope with it; that is, if in advance of incurring O&M costs on a waterway, the corps determined that doing so would yield an insufficient return. Such a waterway probably would not fall into disuse immediately; more likely, operating adjustments would be made in the short run, such as running less heavily loaded barges on waterways that, without dredging, became shallower.

Pricing each waterway on the basis of its cost and traffic would help highlight the fact that some waterways are much more costly than others to maintain in relation to the number of ton-miles they serve. If levying a relatively high fee--but one that accurately reflects the costs of maintaining a particular waterway--causes users to find it no longer economic to use that waterway, its disuse would suggest that the waterway is not worth the expenditures for operation and maintenance. Reallocating expenditures to other waterways could benefit users. But the fact that users of high-cost waterways also use lower-cost waterways complicates the assessment. Closing high-cost waterways would probably reduce traffic on lower-cost waterways as well.

Charging fees on a systemwide basis has some advantages over charging on a waterway-specific basis. First, O&M costs and traffic tend to fluctuate from year to year, and the fluctuations are more pronounced for individual waterways than they are for the system as a whole. Without a good estimate of charges they might incur, it would be difficult for operators to plan how much use they would make of the waterways. Second, it would be easier administratively to base charges on a systemwide flat rate than to keep track of each waterway's use.

Charging to Recover Operation and Maintenance Costs

Set Price Equal to Marginal Cost. The regression discussed above (see pp. 57-58) estimated the marginal cost of operation and maintenance associated with an additional ton-mile to be about 0.04 cents.[13] If multiplied by the 250 billion ton-miles of traffic in 1989 (the last year for which data are available), the result is $100 million compared with total operation and maintenance costs that year of $438 million for fuel-tax waterways. When the marginal cost of an additional tow (or other unit of output, such as a ton-mile) is very small, a user charge based on marginal cost, although efficient in the short run, would recover only a small portion of total costs. Therefore, the Corps of Engineers would learn little about how much total spending on O&M would be efficient. In addition, the marginal cost-based charge does not distinguish between high-cost and low-cost waterways.

Impose an Annual License Fee. One way to cover the fixed component of O&M costs is to impose an annual license fee equal to the cost divided by the number of towboats or barges using a waterway in a given year.[14] The advantage of this approach is that once the annual fee is paid, it does not affect incentives for use. As a result, resources would be allocated

13. As noted, this regression made use of available data to produce illustrative results, but more thorough analysis including variables expressing output in tows or tow-miles and other factors affecting total costs would be needed to provide the statistical confidence about the marginal-cost relationship to base user charges on it.

14. Alternatively, a more sophisticated system based on cargo capacity or horsepower could be used.

efficiently at the margin. One disadvantage is that a license fee for barges might lead operators to use fewer barges than would be most efficient (and likewise with a license fee for towboats). The same traffic might be carried by using barges more intensively, at some additional cost in terms of speed or fuel consumption, or traffic might be cut. Another drawback is the difficulty of estimating O&M costs and user demand, especially on a prospective basis. A reasonable approximation might be reached, however, using an average of several recent years, perhaps combined with information about trends in costs and usage.

An annual fee could be imposed on either a systemwide or waterway-specific basis. Systemwide, the total amount of fixed O&M costs would be divided by the number of vessels using any part of the system. Under a waterway-specific plan, users of each waterway would share the costs on that waterway. A user of more than one waterway would pay a share of the costs of each waterway used. A drawback to a license fee specific to each waterway is that it is complex, since most vessels operate on more than one waterway. If a systemwide fee had been in effect in 1990, the charge per towboat would have been about $115,000; alternatively, the charge per barge would have been about $13,000.[15] The approach can be varied by giving users a choice between paying an annual fee or a charge per use that would be set so as not to deter occasional use.

Impose a Charge Equal to the Operation and Maintenance Cost per Ton-Mile. A proposal that has received attention in recent years is to establish a charge equal to the total O&M costs divided by the number of ton-miles transported. As discussed in Chapter 1, average-cost pricing will cover total costs, but with a loss in efficiency from marginal-cost pricing. Trips for which marginal benefits exceed the marginal cost but fall short of average cost will not be made.

If O&M costs remain roughly constant regardless of the amount of traffic, O&M costs per ton-mile depend solely on the number of ton-miles. Charging a price per ton-mile that exceeds the marginal cost would be likely to cause traffic to decline further and could set off an upward spiral of costs per ton-mile.

A charge equal to O&M costs per ton-mile could be made on either a systemwide basis--using total O&M costs divided by the total ton-miles of inland waterway traffic--or a waterway-specific basis--using the O&M costs and traffic on each waterway.

Impose a Per-Lockage Charge. Using lock operations as the basis for a user charge is another option.[16] For each lockage, the operator is charged an annual amount equal to the total O&M cost for the waterway divided by the total number of lockages handled on it.

Like the O&M charge for cost per ton-mile, a lockage fee structured in this way would represent a kind of average cost. It would reflect the expenses of operating and maintaining channels, such as dredging costs, and those of operating and maintaining locks and dams. In order to assess the efficiency of this or any other lockage-related charge, one would need to know the marginal and average costs of operating and maintaining each lock. An additional factor to consider in determining an efficient lockage fee is whether there is congestion and what the costs of congestion delays are. Congestion pricing is discussed in a later section.

Charging by lock operation would be relatively easy to administer. Lock operators would simply keep track of lock use. A lockage charge exceeding the marginal cost,

15. This estimate is based on the fleet for the heavily traveled Mississippi River and the Gulf Intracoastal Waterway region, which includes most of the fuel-taxed waterways.

16. See Rusidan Lubis, Michael V. Martin, and B. Starr McMullen, "The Impacts of Waterway User Fees on Grain Transportation on the Snake-Columbia River," *Water Resources Bulletin*, vol. 23, no. 4 (August 1987), pp. 673-680.

however, might reduce efficiency by inducing tow operators to use less efficient ports that avoided lockages or tow configurations that minimized lockages while raising other costs.

CBO calculated examples of this kind of charge for three waterways, using 1989 data for O&M costs and numbers of lockages. The costs per lockage were about $215 on the Monongahela River, $555 on the Illinois Waterway, and $1,285 on the Red River. If recreational lockages are excluded, the costs rise to $250, $780, and $1,515, respectively. These estimates are based on total O&M costs for each waterway. For greater efficiency, it would be preferable to charge according to the cost of operating each lock and dam individually.

Increase the Fuel Tax to Cover All O&M Costs. Some analysts have suggested raising the fuel tax high enough to generate enough revenue to cover the federal government's waterway costs. The administrative mechanisms to collect and enforce it are already in place. To cover O&M costs, however, the fuel tax rate would have to rise substantially, to about 85 cents a gallon, assuming that tow operators did not respond to a tax increase by cutting back on their use of fuel. At 85 cents a gallon, the rate would be 65 cents a gallon higher than the level the fuel tax is scheduled, under existing law, to reach in 1995. In the more likely event that demand for fuel would decline with an increase in the tax, the tax rate would have to rise still higher to generate enough revenue to cover costs.

On a waterway-specific basis, fuel tax rates would range from about 24 cents a gallon on the lower Mississippi River to $69 a gallon on the Allegheny River.[17] A tax greater than $5 a gallon would be required on a dozen waterways if O&M costs were to be covered. The high numbers reflect the small amount of traffic on these waterways.

Raising the fuel tax rate would undermine efficiency if the tax rate exceeded the marginal cost to the government. Analysis based on limited data available suggests that the present tax rate closely reflects the marginal cost. At a much higher rate, tow operators would face a price greater than the marginal cost and would thereby be discouraged from making trips.

Charges Based on Demand Factors. All of the types of charges discussed above are applied uniformly. In other words, all users would face the same charge per ton-mile, per gallon, per towboat, or per barge. This type of charge might affect different barge operations in quite different ways. Some commodity shipments may be more sensitive to increased prices than others, since some shippers have more alternative forms of transportation at their disposal. Even a small increase in barge rates could lead some shippers to use railroads or pipelines instead of barges. Their shift would raise the average cost for remaining users of waterways. To minimize uneconomic diversion of traffic, charges could be set lower for those who have more alternatives available and higher for those with fewer alternatives.[18]

This approach, called Ramsey pricing, is discussed in Chapter 1. It calls for charging each user according to the sensitivity of demand to the price.[19] Ramsey pricing is efficient because each use is charged a price that is as close as possible to the marginal cost of supply.[20] Ramsey pricing allows total costs to be covered while meeting the efficiency cri-

17. Similar calculations using 1985 data produced results ranging from 24 cents a gallon on the lower Mississippi to $62 a gallon on the Kentucky and $475 a gallon on the Pearl River. By 1988, there was no traffic reported on the Pearl.

18. Diversion of traffic is an economic problem only if it entails moving to a mode for which resource costs are higher.

19. Frank Ramsey, "A Contribution to the Theory of Taxation," *Economic Journal*, vol. 37 (March 1927), pp. 47-61. See also William J. Baumol and David F. Bradford, "Optimal Departures from Marginal Cost Pricing," *American Economic Review*, vol. 60 (June 1970), pp. 265-283.

20. For exposition, it is easier to refer to a user than a unit of use, which is the more precise term. A single user--for example, a barge company--might value some uses, such as when transporting a shipment on which it can charge high rates, more highly than others.

terion of setting the price equal to the cost of the marginal unit.

This approach causes two practical problems. First, it requires information that is not readily available, in particular the sensitivity of different demands to different prices. This problem is not insurmountable--the barge companies themselves must have a good grasp of what rates they can charge for carrying different commodities at different locations, and Ramsey pricing could be applied using a percentage markup over the rates charged.

The second practical problem is the acceptability of this scheme. The idea of charging higher prices to those with fewer alternatives may seem inherently unfair. Indeed, the railroad industry has for many years been criticized for charging different rates for different commodities, and for charging higher rates where there is no alternative rail or barge transportation. There are benefits to such pricing schemes, however, not only to shippers who enjoy lower rates but also to those facing higher rates. As long as the lower-rate shipments pay even a small amount more than their marginal cost, they contribute to the coverage of fixed costs that otherwise would have to be borne by higher-rate shipments. Thus, they also benefit higher-rate shippers.

Use Combination Tolls. There also have been proposals for combining the existing systemwide fuel tax and a waterway-specific ton-mile charge.[21] The objective of these proposals seems to be to increase efficiency by taking advantage of the vast difference in costs among waterways while retaining the revenue-raising capability of the nationwide fuel tax.

The fuel tax component of the combination toll could serve as a rough proxy for marginal cost, as discussed above. As described previously, there are potential problems associated with using a ton-mile charge to recover fixed costs. The most serious practical problem would be the short-run effect of driving traffic away from waterways with high costs per ton-mile. Still, this kind of policy provides gains over the long run from shifting O&M spending from little-used waterways to those that carry large volumes of traffic.

Charge for Congestion at Locks and Dams. Delays at locks and dams are costly to users. Some delays are caused by mechanical or other operating problems; others result from too many tows waiting to use the locks at the same time. In any case, tow operators, not the federal government, bear the costs of delay, such as higher labor and fuel costs associated with extra operating time. With congestion, each tow not only incurs a cost of delay but also imposes such a cost on other tows.

Pricing to alleviate congestion follows the same principle described in the previous chapters: set the price equal to the marginal social cost, so that users bear the cost of delays they impose on others. The social costs will be recognized and factored into tow operators' decisions about using the waterway system only if charges are imposed to reflect the costs. Such charges would give users an incentive to use waterway resources more economically.

At present, lock operators generally deal with congestion by accommodating tows on a first-come, first-served basis.[22] This approach is not necessarily the most efficient solution from the standpoint of resource use. Efficiency would dictate giving priority in use to the tows willing and able to pay the highest price for it. Tows for which the costs of delay are lower would fall back in the queue.

21. See Department of Transportation and Department of Commerce, *Inland Waterway User Taxes and Charges*, a report of the Secretary of Transportation to the U.S. Congress pursuant to Section 205, Public Law 95-502, the Inland Waterway Revenue Act of 1978 (February 1982), p. 36.

22. There are some exceptions. For instance, if two small tows can fit together in a lock chamber, the second, smaller one may be allowed to move ahead of the larger. Also, if tows are waiting in both the upbound and downbound directions, the lock operator may allow several to pass in one direction before processing several in the other direction, since this reduces total transit time.

Congestion at locks and dams is somewhat different from congestion on highways and at airports. Highways and airports typically are congested at certain times of day--generally at the beginning and end of the workday--when people are most likely to take trips. By contrast, once a trip is under way, a tow generally keeps operating, with crew members on duty 24 hours a day. Congestion at a lock occurs when several tows arrive at about the same time, although that time could as easily be 5:00 a.m. as 5:00 p.m. It is possible, then, that simply scheduling lockages, or providing traffic information to tow operators, could reduce delays caused by congestion. If this is so, tow operators might be willing to pay a relatively small fee to cover the cost of administering a reservation system. If two or more tows arrived at a lock at the same time, the one with the reservation would be given priority. Under this system, tow operators might choose not to make a reservation and to take their chances of a delay when traffic is light to moderate, but to pay for a reservation to avoid delay at peak times.

There may be times, for instance if an unusually large harvest results in a sizable increase in the number of grain-carrying barges, when the lock capacity is insufficient to handle all the traffic. Under such circumstances, efficiency and productivity are enhanced if there is a way of allocating the scarce capacity to the tows that place the highest value on it. That result could be achieved by selling time slots to the highest bidder. By contrast with the normal situation, when a reservation would cost a nominal fee to cover administration costs, the peak-period reservation would carry a premium charge to reflect the scarcity of capacity. The existence of a premium would help signal the demand for additional capacity.

Under any kind of reservation system, efficiency could be gained by allowing tow operators holding reservations to sell them to others who want to go through the locks first.

The key to economic efficiency is that the benefits of a prospective project equal or exceed the costs.

Commercial barge traffic constitutes the predominant flow at most locks, but some serve a large number of recreational craft as well. Currently, lockmasters usually follow the first-come, first-served rule, although they have discretion in setting the order and pattern of lockage transits. If, for example, a recreational boat can fit in a lock chamber with other recreational boats or with a small commercial tow, the lockmaster may allow it to move ahead of a larger tow in the queue. In some areas, recreational use has been steadily increasing and could cause delays for commercial traffic. Under a reservation system, the same rules could apply to all users.

Other External Costs. Use of locks and dams may entail other social costs. Where hydroelectric power is generated, each lock operation may reduce the water flow and slightly diminish generating capacity. Efficient pricing would place the burden of this loss on boat operators using the facilities.

Charging to Recover Capital Costs of Specific Projects

For generations, economists have struggled with the problem of finding an efficient way to cover the cost of major capital investments.[23] Once a canal or a lock and dam has been built, the marginal cost of one additional tow is minimal. If users were charged the marginal cost, revenues would be insufficient to cover total costs. But the revenue shortfall could be made up through the types of pricing mechanisms discussed above.[24]

The key to economic efficiency is that the benefits of a prospective project equal or exceed the costs.[25] The construction cost generally is incurred in one or a few years--depending on the size of the project--but the project is expected to provide services over a much longer period--50 years or longer for a lock and dam. Requiring users to pay for the project as soon as costs are incurred would be undesirable because the investment will continue to provide returns over many years. Instead, project costs can be annualized, like a mortgage, on the basis of the initial cost, the number of years the project is expected to provide benefits, and an interest rate that reflects the time value of money. This expresses the cost as if money for the investment were borrowed to finance it and then paid back over a period of time.

Impose an Annual Fee Based on Annualized Capital Costs Divided Equally Among Users. Annualized capital costs could be divided by the number of users or the number of units of use. For example, tow operators could be required to purchase annual permits entitling them to operate on the waterways. A permit's price in any year could equal the annualized total capital outlays divided by the number of users. Alternatively, the unit on which charging could be based might be the towboat (possibly with gradations according to horsepower) or the barge. As discussed above, a fixed fee would minimize negative effects on economic efficiency because once paid it would not affect incentives for additional use.

Capital costs could be charged solely to users of new construction (or major rehabilitation) projects, to all users of the waterway system, or to all users of the major waterway on which the investment is located.

The way a charge is imposed has implications for distribution as well as for efficiency. Charging the same fee to big and small companies would place a greater burden on the small ones. Charging per towboat or barge would alleviate this problem to some extent. But this might create incentives to reduce the number of towboats or barges operated, perhaps to an inefficiently low number.

Impose a Per-Use Charge. Alternatively, a charge could be based on the amount of use. Suppose, for instance, that the charge was calculated by dividing capital costs by the number of tows, with each tow being charged the average annualized cost. This method might induce operators to increase the size of each tow--for instance, doubling the number of barges in each tow, so as to cut in half the number of tows and thus the tow charge. Of course, the tow charge would be just one of many cost factors--labor, fuel, and possibly other charges such as for lockages--and the tow operator also would need to take into account such demand factors as whether shippers would tolerate delays caused by assembling more barges for each tow. In any event, because it would affect operations in ways not related to costs, this form of charge is likely to be less efficient than a fixed annual fee unrelated to operations.

---

23. See Jules Dupuit, "On the Measurement of the Utility of Public Works," written in 1844 and reprinted in D. Mundy, ed. ,*Transport* (London: Penguin Books, 1968), pp. 19-57; Ramsey, "A Contribution to the Theory of Taxation"; Baumol and Bradford, "Optimal Departures from Marginal Cost Pricing"; and Clifford Winston, "Conceptual Developments in the Economics of Transportation: An Interpretive Survey," *Journal of Economic Literature*, vol. XXIII (March 1985), pp. 57-94.

24. Besides the loss in allocative efficiency from charging fees to recover the costs of past investments, there is the risk of still more inefficiency if the past investment was larger and costlier than optimal.

25. The Corps of Engineers uses shipper surveys and data on traffic trends and congestion to estimate the benefits of waterway investments. Charging users (or announcing plans to charge) and observing their willingness to pay for new projects can provide additional useful information in setting investment priorities.

Charges Based on Demand Factors. Capital costs could be covered by Ramsey pricing, as discussed above in the section on covering O&M costs. The same considerations apply.

Without pricing considerations as a guide, some investments have been criticized as being larger and more expensive than the benefits would warrant. This problem is currently being addressed in part by the Inland Waterways Users Board, which advises the federal government on investment priorities. The Users Board has an incentive to support investments with high returns and to oppose less worthwhile investments. Its recommendations are merely advisory, however.[26]

Because past investments are sunk--that is, the resources needed to build them have already been spent--and because some may have been inefficiently large, imposing charges to cover the historical costs would not improve the efficiency of resource allocation. From an equity standpoint, however, there might be justification for attempting to recover at least a portion of these costs.

Examples of Capital Cost Recovery

The two largest projects in recent years are the Tennessee-Tombigbee Waterway and the Melvin Price Locks and Dam.

Tennessee-Tombigbee Waterway. The Tennessee-Tombigbee Waterway, completed in 1985, cost $1.79 billion.[27] (See Table 17 for a comparison of the annualized payments under alternative assumptions about the appropriate discount rate and the expected lifetime.) At a discount rate of 3 percent and expected life of 100 years, the annual payment would be $57 million; at a discount rate of 10 percent, the annual payment over 100 years would be $179 million. Divided by the 1.8 billion ton-miles carried on the Tenn-Tom in 1988, these costs amount to 3 cents to 10 cents per ton-mile, at discount rates of 3 percent and 10 percent respectively.

Table 17.
Payments Needed to Recover the $1.79 Billion Investment in the Tennessee-Tombigbee Waterway Under Alternative Assumptions

Discount Rate (Percent)	Life (Years)	Annual Payment (Millions of dollars)	Payment per Ton-Mile (Cents)
3	50	69.6	3.8
3	100	56.6	3.1
7	50	129.7	7.2
7	100	125.4	6.9
10	50	180.5	9.9
10	100	179.0	9.9

SOURCE: Congressional Budget Office calculations.

Melvin Price Locks and Dam. The new main chamber of the Melvin Price Locks and Dam was opened to traffic in 1990, replacing the old Locks and Dam 26 on the Mississippi River above St. Louis. The main chamber is 1,200 feet long and 110 feet wide, and cost $737 million.[28] An auxiliary chamber, 600 feet long and 110 feet wide, is under construction and scheduled to open in 1993 at a cost of $213 million. If these costs are combined and amortized over periods of 50 years to 100 years at discount rates of 3 percent to 10 percent, the annual payment would range from $30.1 million to $95.8 million.[29] At traffic levels reported at the lock site in 1989,

26. See Section 302 of the 1986 Water Resources Development Act.

27. These are nominal dollars spanning the 13-year construction period from 1972 to 1985. It would be preferable to convert the spending each year into constant dollars for the year 1985.

28. U.S. Army Corps of Engineers, *Justification for Appropriation Estimate, FY 1993*, Book 2, Lower Mississippi Valley, pp. 38-43.

29. As with the Tennessee-Tombigbee example, this assumes that all costs were incurred in the same year and that there is no inflation. The numbers are intended merely to give a very rough idea of the implications of alternative cost recovery schemes. More accurate estimates would require refinement of the calculation.

these costs translate into a range of $2,020 to $6,440 per lockage, or 44 cents to $1.40 per ton, as shown in Table 18.

Table 18.
Annual Payments Needed to Recover the $950 Million Investment in the Melvin Price Locks and Dam, Under Alternative Assumptions

Discount Rate (Percent)	Life (Years)	Annual Payment (Millions of dollars)	Payment (Dollars per lockage)	Payment (Dollars per ton)
3	50	36.9	2,480	0.54
3	100	30.1	2,020	0.44
7	50	68.8	4,630	1.01
7	100	66.6	4,480	0.97
10	50	95.8	6,440	1.40
10	100	95.0	6,390	1.39

SOURCE: Congressional Budget Office calculations, based on 1989 traffic.

Conclusion

Existing taxes imposed on users of the inland waterways do not raise enough revenue to cover operation and maintenance costs, let alone the costs of new construction. Economic theory suggests efficient ways of charging waterway users to reduce the demands on the Treasury's general fund. Developing a schedule of efficient charges would require more information than is currently available about the specific factors influencing waterway costs. If operation and maintenance costs are unaffected by an additional tow, then O&M costs should be treated as fixed costs, and any user charge should not vary with use. If costs do vary with use--at a congested lock and dam, for instance--then efficiency would require users to be charged the marginal cost.

Appendix

"Top-Down" Cost Allocation Studies of Pavement Costs

The *Final Report on the Federal Highway Cost Allocation Study (HCAS)*, published in 1982, is the most comprehensive effort to allocate pavement costs to classes of highway users and compare the costs and revenue of each class.[1] Because several changes have been made since 1982 in federal taxes on highway users, the findings are out of date. Still, the study provides a general picture of various user groups' costs and revenues and the cross-subsidies between them. More recently, the *Heavy Vehicle Cost Responsibility Study (HVCRS)* focused on shares of pavement costs and revenues by vehicles with gross weights of 80,000 pounds or more.[2] Together, these studies shed light on the question of which users are paying more than their share of pavement costs and which are paying less.

***HCAS* Findings.** The *HCAS* found that certain classes of vehicles were paying more than their share of pavement costs and some were paying less. Single-unit trucks paid 30 percent to 75 percent more than their share of costs in 1977, but combination vehicles--power units pulling one or more trailers or semi-trailers--paid 15 percent to 55 percent less

Table A-1.
Comparison of Pavement Cost Responsibility and User Taxes Paid, by Class of Vehicle

Vehicle Class	Ratio of User Taxes Paid to Cost Responsibility[a] 1977	1985[b]
Passenger Vehicles	1.11	0.98
Autos	1.10	0.97
Large	1.21	1.16
Small	0.70	0.71
Motorcycles	0.46	0.58
Pick-ups and vans	1.23	1.08
Buses	0.51	0.03
Intercity	1.16	0.15
Other[c]	0.33	0.00
Trucks	0.79	1.03
Single unit	1.51	1.99
Under 26,000 pounds	1.31	1.71
Over 26,000 pounds	1.74	2.21
Combinations	0.59	0.80
Under 50,000 pounds	0.84	1.23
50,000 to 70,000 pounds	0.85	1.25
70,000 to 75,000 pounds	0.60	0.78
Over 75,000 pounds	0.45	0.59
All vehicles	1.00	1.00

SOURCE: Department of Transportation, Federal Highway Administration, *Final Report on the Federal Highway Cost Allocation Study* (May 1982), Tables VI-10, p. VI-33, and VI-13, p. VI-36.

a. Ratio of user charge payments to cost responsibilities under the approach recommended by the Federal Highway Administration. A ratio of less than 1.0 indicates underpayment.

b. Projections for 1985, assuming the 1982 tax structure.

c. Transit and school buses are exempt from most user taxes.

1. Department of Transportation, Federal Highway Administration, *Final Report on the Federal Highway Cost Allocation Study*, Report of the Secretary of Transportation to the United States Congress Pursuant to Public Law 95-599, Surface Transportation Assistance Act of 1978 (May 1982).

2. Department of Transportation, *Heavy Vehicle Cost Responsibility Study*, Report of the Secretary of Transportation to the United States Congress Pursuant to Section 931 of the Deficit Reduction Act of 1984 (November 1988).

than their share (see Table A-1). Large automobiles paid about 20 percent more and small automobiles about 30 percent less than their shares, with this difference reflecting variations in fuel tax revenues arising from differences in fuel-efficiency between large and small cars, though their costs were about the same.

The *HCAS* made a similar comparison for 1985 using projections based on the 1977 tax rates but taking into account such factors as expected changes in the fuel economy of various vehicles and effects of inflation on revenues from various taxes. Taxes based on value, such as the excise taxes on vehicles and tires, were projected to bring in rising revenues because of inflation. The fuel taxes, which are based on physical units, were not expected to rise. The ratios of revenues to costs are shown in Table A-1.[3]

***HVCRS* Findings.** *HCAS's* findings that heavy trucks generally paid less than their share of costs led to demands for more detailed information about variations in shares among different weights and configurations of heavy trucks. In the Deficit Reduction Act of 1984, the Congress directed that the Secretary of Transportation "conduct a study of whether highway motor vehicles with taxable gross weights of 80,000 pounds or more bear their fair share of the cost of the highway system."[4] The resulting *Heavy Vehicle Cost Responsibility Study* found sizable differences among weight groups in the ratio of revenue shares from user taxes to cost shares, as shown in Table A-2. Note that the shares presented are shares of costs and revenues of trucks weighing more than 50,000 pounds rather than shares of costs and revenues of all highway users.

Table A-2.
Ratio of Shares of User Tax Contributions to Shares of Highway Costs Caused by Trucks Over 50,000 Pounds Gross Weight

Operating Weight Group (Thousands of pounds)	Ratio of User Tax Shares to Cost Shares
50 to 70	1.32
70 to 80	0.81
80 to 90	0.49
90 to 100	0.37
100 to 110	0.50
110 to 120	0.59
Greater than 120	0.94

SOURCE: Department of Transportation, *Heavy Vehicle Cost Responsibility Study* (November 1988), Table IV-7, p. IV-17.

There are several differences between the *HCAS* and the *HVCRS*. The *HCAS* grouped vehicles by registered weight, but the *HVCRS* grouped them by operating weight. Revenues estimated in the *HVCRS* were based on the taxes in effect at the time of the study, which differed from those in the earlier *HCAS*.[5] Still, the methodology for cost allocation was essentially the same, and both the *HCAS* and the *HVCRS* show that heavy vehicles impose disproportionate costs on the highway system.

There are even greater differences between the studies on cost allocation and studies of marginal costs. The approaches differ in both techniques and objectives. The top-down ap-

3. A recent review of cost allocation methodologies is contained in *Rationalization of Procedures for Highway Cost Allocation Studies*, prepared by the Urban Institute and Sydec, Inc., for the Trucking Research Institute, ATA Foundation, Inc. (October 1990).

4. Section 931 of the Deficit Reduction Act of 1984 (98 Stat. 494).

5. The tax changes included a 5-cents-a-gallon increase in fuel taxes, plus an additional 6 cents for diesel fuel (the so-called "diesel differential"), to make diesel fuel taxed at 15 cents a gallon and gasoline at 9 cents; repeal of taxes on motor oil, tread rubber, inner tubes, and truck parts; an increase in the heavy vehicle use tax; and a change in the structure of the excise taxes on trucks and tires.

proach is motivated by questions of equity, whereas the marginal-cost approach is motivated by questions of efficiency. This is not to say that there is no element of efficiency in the top-down approach, nor that equity is ignored in the marginal-cost approach. Indeed, the concept of equity adopted in the *HCAS*--at the behest of the Congress--is cost-based: users should pay according to the costs they cause.

The top-down approach allocates all costs, including joint costs associated with any and all users, whereas the marginal-cost approach does not. Another difference is that the top-down studies allocated only the costs to the government, but the marginal-cost studies also included external costs of congestion, pollution, and noise. Because the marginal-cost estimates are particularly important from the standpoint of economic efficiency, they are the focus of Chapter 2.

ISBN 0-16-037937-7
90000
9 780160 379376

RELATED CBO STUDIES

The Status of the Airport and Airway Trust Fund, December 1988.

Federal Policies for Infrastructure Management, June 1986.

Toll Financing of U.S. Highways, December 1985.

Financing U.S. Airports in the 1980s, April 1984.

Public Works Infrastructure: Policy Considerations for the 1980s, April 1983.

The Interstate Highway System: Issues and Options, June 1982.

Transportation Finance: Choices in a Period of Change, March 1978.

Financing Waterway Development: The User Charge Debate, July 1977.

Copies of the studies may be obtained by calling CBO's Publications Office at (202) 226-2809. The Office of Intergovernmental Relations is CBO's Congressional liaison office and can be reached at 226-2600.

CONGRESSIONAL
BUDGET OFFICE
Second and D Streets, S.W.
Washington, D.C. 20515