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Private-Sector Involvement and Toll Road Financing in the Provision of Highways

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PREFACE

Would you tell me, please which way
I ought to go from here? asked Alice.
That depends a good deal on where
you want to go, said the Cat.

Lewis Carroll

As the reader examines the contents of this Record in which are presented major portions of the discourse from the International Conference on the Role of the Private Sector and Market Processes in the Financing and Provisions of Roads, it is appropriate to recall these lines from Lewis Carroll's *Alice In Wonderland.* The conference, sponsored by the Committee on the Application of Economics to Transportation Problems and held in Baltimore July 6–9, 1986, was truly international in scope; it attracted 120 participants, 25 percent of whom were from countries other than the United States. This Record provides an opportunity for the transportation community worldwide to determine where it "ought to go from here" in the financing and provision of roads.

There is much to be learned from the marketplace—in terms of both what it can provide efficiently and what it cannot. It was the intent of the conference to serve as a forum for exchanging new ideas and for challenging old ones. For those who attended, this intent was met. Now, the challenge to transportation officials, as well as the reader, is to determine, like Alice, which way they want to go in terms of the role of the private sector and the market in the financing and provision of roads.

Because private turnpikes and toll roads existed before the creation of national highway systems, some of the papers are about the history and evolution of private involvement in roads and what can be learned from the past. The economics of roadway privatization, impact fees, public-private partnerships, and nontoll approaches to funding public roads are considered, and the prospects for privatization and the use of market forces in the financing and provision of roads are assessed.

Special thanks are due to those who planned and executed this conference. Without the help of Gabriel Roth, Ralph Erickson, Antoine Hobeika, Mike Walton, and Ken Cook, it would never have come to fruition. To them and to those who participated, a hearty thanks.

Gary Allen
Chairman, Committee on Application of Economic Analysis to Transportation Problems

Transportation Research Record 1107

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Opening Remarks

ALAN WALTERS

During the last 7 years, there has occurred one of the most momentous changes in the history of the world, the consequences of which will shape the future of our planet: the privatization of Chinese agriculture that began in 1979. This change was little noted and even less understood in the early years. Certainly there was no full-scale transfer of all property rights to the private farmer, but it was privatization nevertheless. The farmer was given the right, inter alia, to sell his output and keep a substantial fraction of the proceeds. In only 5 years output approximately doubled. China, who had been in fear of famine, has become a net exporter of food. Penniless peasants have become wealthy farmers. This revolution—and for once the term is justified—has occurred in the biggest industry in the largest country in the world. Never has so much been achieved in so short a time.

In addition to the inherent importance of the Chinese reform, it is interesting because it was widely thought that it could not be done and, were it to be done, the result would be chaos. But China managed to use privatization to solve problems older than history.

After Chinese agriculture, the next largest privatization was that of British Telecom. Apart from the sheer difference in size, these two privatizations differ sharply in technological sophistication, capital intensity, organizational form, and countless other ways. Yet British Telecom was just as ripe a candidate for privatization.

The essence of private provision lies in the twin principles of providing incentives to create, rather than destroy, wealth and of allowing the cooperation and coordination of people in this process through the anonymity of the free-market price system. The incentive of private reward assures that there is ceaseless exploration of new ways of doing things, and products of new technologies are enlisted in these efforts. No tier of coordinating committees is needed. No echelons of bureaucrats are required. No regulations, controls, or quotas are applied. The free-enterprise arrangement harmonizes and directs all efforts to the production of wealth.

Privatization, compared with public-sector provision, is particularly advantageous when there is very rapid technical progress in an industry. Private incentives and profit and loss statements, more quickly and effectively than any committee of scientists and technocrats, will sort out the good technologies from the bad. In both agriculture and telecommunications there have been rapid technological advances—from the "green revolution" to optical fibers and digital switching.

Private provision clearly scores high marks when there is great heterogeneity in the conditions of production or in the product. Again agriculture demonstrates this nicely. Each plot of land is somehow unique and needs different treatment. Similarly the weather cannot be ordered to conform to any plan, and no central planner can tell which are the best crops to grow. All these decisions are best left to the individual—with the right incentives of course. In the case of British Telecom, the hallmark should be the enormous variety of information services. Just as we do not all want a black Ford motor car, so we will not rest content with the restricted telephone wire services of yesteryear. What we do want can only be revealed by the free market.

It has been shown that private provision and freedom from restrictive regulation relieve industry of the stranglehold of various interest groups, such as a trade union or political party. There is no need to labor this point to this audience.

Finally, privatization will be most efficacious in those industries or firms which, under public ownership and management, waste resources either by plain inefficiency or by misallocation. Of course waste also occurs in the private sector, but the wastrel, not the taxpaper, pays the penalty. Privatization polices the profligate.

How does all of this apply to highways? The first and superficial answer, at least for the first three points, must be "tenuously." Let us go through the points in turn. First, it is not at all obvious that the technology of road provision is changing rapidly, and even if it is argued that there has been a revolution in methods of road construction, public provision by contracting through the private sector has effectively absorbed and capitalized on such technical change. The public road authorities usually specify the sort of road required and the private comptetitive contractors have a considerable incentive to find the most efficient ways of supplying the highways to specification.

Second, variations in the nature of production processes and in the quality and form of output are hardly the obvious characteristics one thinks about first in the highway industry. To the untutored eye a road is a road is a road. No doubt it is conceivable that a private road authority will be able to design different forms of highway "output" with different signaling systems and more efficient traffic-sorting arrangements, but I suspect that such improvements are probably not be a breakthrough. Third, despite the Davis Bacon Act or its analogue in other countries, trade unions or other monopolistic powers do not contribute to making the road business abysmally inefficient with bloated payrolls and low-quality output. (Note, however, that this will be unlikely to be true in those countries in which much of the maintenance or construction is done through force account. There the strictures are likely to apply.)

It is on the fourth blessing of privatization that our hopes principally must rest. Even the most casual observer of highways and their use must be struck by the enormous disparities. In the United States we see wonderful Interstate highways in

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rural areas, particularly in the West and parts of the South, that are hardly used and certainly never come anywhere near capacity use. On the other hand, urban highways—particularly the urban parts of the Interstate highways such as I-66 in Washington, D.C., or I-95 in Baltimore—are highly congested. It is difficult to avoid the conclusion that the rural Interstates were much overdone and that the urban Interstates (and for that matter urban highways generally) are much underdone. Scholarly analysis has confirmed this common-sense view *(1)*.

It is important to note that the waste is not merely on the negative side—the overbuilding of rural highways—but also on the positive side in the failure to build more urban road capacity. Jammed urban highways on which vehicles travel at snail-paced speeds are testimony to highway users' willingness to pay for additional road space.

Of course economists have long professed to be able to measure, to an acceptable degree of accuracy, the willingness to pay for highways. And such is the sophistry of my profession that it has been acclaimed that "rubber pays for the roads" in the United States. Expenditure on highways (or at least federal roads) came from the highway trust fund that was financed mainly by taxes on gasoline and tires. This is no test of willingness to pay for a particular road, any more than payment of taxes means willingness to pay for a B-1 bomber. An individual can decide whether to travel the road, but he can hardly decide whether to contract out or in to the defense umbrella. In the language of economics, road services are private goods, whereas defense is a public good.

It would have been sensible for governments to base decisions to build or not build roads on calculations, however fallible, of willingness to pay. But manifestly they have not. This is a classic case of "the prisoners dilemma." The waste of resources is not the only loss. As is so often the case in economic policy, the more serious effects are indirect—on incentives and behavior. Instead of seeking more efficient methods of production, people engage in political maneuvering. Instead of making a better mousetrap, one seeks a pliant politican. Instead of producing goods and services, the system produces rules and regulations. Economic life becomes politicized.

In other countries similar phenomena can be observed. India, the second largest country in the world, has a most inadequate road system. For many years road transport has been throttled by mixtures of high tariffs, high taxes, and regulatory red tape. Neither consumers nor producers have been free to express their preferences. With a privatized road system, it is highly likely that the Indian road system would have been considerably more extensive than the present one, and with the restrictions and discrimination against road transport eliminated, it is plausible to infer that India would have had a road system comparable to that of Brazil in the 1970s. Similarly, China, after many decades of socialism, suffers from a road system that is a major bottleneck on growth of trade and income. Such are the changes of attitude, however, that China has been exploring the possibilities of private toll roads as one way of easing this serious constraint.

Privatization offers a better way. It is very likely that, were the roads to be constructed by private capital and owned by private enterprise, there would be little waste of resources. When it is one's own money, rather than the resources of the taxpayer, wits are greatly sharpened. It is not possible, indeed it would be undesirable, to have no waste. There is bound to be some, as people explore new and untried techniques and methods. But the private purse is as good a watchdog as man has ever found.

Would privatization have prevented the overbuilding of the Interstate system? It is clear that, were they not subsidized, a large fraction of the Interstates in rural areas could never raise enough in (primarily toll) revenue to give a modest rate of return on capital. It is conjecture that even if the rural Interstates were given a dollar-for-dollar matching revenue grant, more than half the rural Interstates would still not be attractive to a private investor. This does not mean that no new road capacity would have been forthcoming. Undoubtedly there would have been some sort of road that would pass the acid test, but few of the dual carriageway or divided four-lane highways would have been built.

What about the positive side—would additional highways in the great congested urban areas have been developed? Here one is much less certain. Notwithstanding the high profitability of such urban roads, the political problems of eminent domain, environmental objections, and the distribution of the indirect benefits and costs are matters over which the political authorities would hardly concede any substantial freedom to the private road corporation. The most formidable objections to privatization are those that arise in the context of urban highways. Alas I have no solution, but the agenda of this conference suggests that many ideas are in the air, and I wish them well.

In many respects, however, technological conditions have changed so dramatically during the past two or three decades that hitherto impossible ideas have become not merely practical but efficient. For example, more than 30 years ago when I wrote my first paper *(2)* on the efficient pricing of highway services, the administrative and practical problems of introducing a much more efficient pricing (or toll) system were obvious and severe. I was driven to suggest special "stickers" or, in its most sophisticated form, some sort of taxi meter. By the end of the 1970s it was clear that electronics and information technology generally had largely solved the administrative and technical problems of road pricing. The political problems remain.

Looking back some two or three decades, it is remarkable how ideas have changed. In the 1960s we saw the start of the rapid growth of government that went on unchecked for a quarter of a century. In those days it was unfashionable, even jejune, to promote privatization. Statism, subsidies, and new federal agencies blossomed (if that is the right word) to deal with the old problem of poverty and the new problems of environment, civil rights, equality, and the like. In the late 1970s and 1980s opinion changed, not only because of disappointment with the performance of state programs, but at least in part because of the astonishing performance of the private sector.

There is good reason to believe that the new ideas about the appropriate role of the state are here to stay—perhaps for a decade or two. Experience shows that opinions change slowly and that they tend to hang around long after the rationalization for them has disappeared. Yet ideas dominate policy. As Keynes concluded in the *General Theory:* "But, soon or late, it is ideas, not vested interests, which are dangerous for good or evil."

In the United Kingdom we have observed the potency of these ideas of privatization sweep policy along at a pace that few would have thought possible. And I suspect that, were Keynes to have lived until his 100th birthday, his judgment would have been good.

REFERENCES

1. A. F. Friedlander. *The Interstate Highway System: A Study in Public Investment*. North-Holland, Amsterdam, 1965.
2. A. Walters. Track Costs and Motor Taxation. *Journal of Industrial Economics*, 1954.

Private-Sector Involvement in Virginia's Nineteenth-Century Transportation Improvement Program

HOWARD NEWLON, JR.

This paper is a discussion of the financing of roads, and to a lesser extent other modes of transportation, in Virginia between 1816 and 1860, a period of major expansion during which a mixed system of private- and public-sector financing was used. The intent was to maximize the benefits and minimize the disadvantages of both systems. The perceived and real costs and benefits of this system are described, and parallels with the present situation are pointed out.

The history of transportation in Virginia during the 19th century is yet to be written. Although published works on transportation per se are few, a number of dissertations and theses, fortunately, have addressed elements of the major issues during limited time periods. Three of the dissertations are most important and have provided the information on which this paper is based. In 1948 Phillip Morrison Rice completed, at the University of North Carolina, a Ph.D. dissertation entitled *Internal Improvements in Virginia, 1775–1860*, which followed his M.A. thesis, *The Virginia Board of Public Works, 1816–1842*, completed the previous year. This dissertation is the best available overview of the policy and political issues involving canals, roads, and railroads before the Civil War. In 1950 Edward G. Roberts completed a Ph.D. dissertation, *The Roads of Virginia 1607–1840*, at the University of Virginia. This was a cartographic study, with supporting text, of the evolution of the roads from settlement through the early years of the 19th century. In 1957 Robert F. Hunter completed a Ph.D. dissertation, *The Turnpike Movement in Virginia, 1816–1860*, at Columbia University. This work was concerned with the turnpikes constructed by stock companies under the General Turnpike Law of 1817. Other relevant works are Wayland Dunaway's *History of the James River and Kanawha Company*, published by Columbia University Press in 1922, that provides extensive treatment of Virginia's major canal effort and Carter Goodrich's "The Virginia System of Mixed Enterprise: A Study of State Planning of Internal Improvements," published in the *Political Science Quarterly* in September 1949, in which are discussed the funding, policy, and planning aspects of Virginia's internal improvement program. All of these works, as well as many others on specific improvements, draw heavily on the primary source, the records of the Virginia Board of Public Works, which include not only the records of the board but many of the records from the various canal, railroad, and road companies under its jurisdiction. These records, held by the Virginia State Library in Richmond, were made much more accessible than theretofore by the publication in 1978 of the *Board of Public Works Inventory* by John S. Salmon of the Virginia State Library.

No comprehensive thesis on Virginia's railroads has been published, but a number of histories of individual railroads have been, and there also is a Ph.D. dissertation entitled *The Virginia Railroads, 1828–1860* that was completed by Charles W. Turner at the University of Minnesota in 1946.

Further study of the issues would begin with these resources that are rich in detail and information.

INTRODUCTION

Since the first permanent English settlement in America nearly 380 years ago at Jamestown, the Commonwealth of Virginia

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has faced the need to construct, maintain, and finance transportation facilities. For almost two centuries, in addition to its present boundaries, Virginia included the areas in six of the present states ceded to the United States in the Northwest Territory in 1784, including all or parts of Ohio, Illinois, Indiana, Michigan, Wisconsin, and Minnesota, as well as Kentucky and West Virginia. From the formation of Kentucky in 1792 until 1863, the period on which this paper is focused, Virginia included the present states of Virginia and West Virginia. This land area was not only large, it also was extremely diverse in topography, materials, climate, density of population, and fiscal resources.

The purpose of this paper is to review the financing of roads, and to a lesser extent other modes of transportation, during the period 1816–1860, for it was during this period of major expansion that Virginia continuously used what Carter Goodrich *(1)* has designated a "mixed enterprise" funding system of private- and public-sector financing intended to maximize the advantages and minimize the disadvantages of both. During the 19th century Virginia's internal improvements program was directed toward three modes of transportation: canals, turnpikes, and railroads. The canal era covered the years 1785–1880, the railroads 1828– , and the turnpikes 1785–1854.

Reference, both historically and currently, usually is made to four physiographic regions defined by two north-south axes: the fall line in the east, connecting Alexandria, Richmond, and Petersburg and the Blue Ridge Mountains. The fall line is where the eastward-flowing rivers are interrupted by falls. These major provinces are further subdivided by the James River that runs west to east. The region east of the fall line, including the Eastern Shore and the Chesapeake Bay, is designated "Tidewater." The "Piedmont" is the area between the fall line on the east and the Blue Ridge Mountains to the west. Piedmont usually refers to the portion north of the James River, and the designation "Southside" is used for the area to the south. The "Valley" runs generally southwestward between the Blue Ridge and the Alleghenies, with the portion south of the James referred to as "Southwestern" Virginia or simply "Southwest." Extending west of the Alleghenies to the Ohio River is what was once called the "trans-Allegheny" section that is now West Virginia.

Although these regions represent significantly variable demands with regard to construction, materials, and so forth, the focus of this paper is on the methods of financing; the engineering aspects of meeting these demands will be discussed only to the extent that they influenced the funding needs.

EARLY HISTORY

For almost 200 years the provision of funding was not a major consideration because the need was for labor to clear and construct rudimentary roads. This labor was enlisted under the English Road Law of 1515, which the colony adopted and which required that each "laboring male tithable" (males 16 and older, slave or free) annually provide work on the road for a specified period, usually 5 or 6 days. From the initial settlement in 1607 until 1657 the roads were under the jurisdiction of the Anglican Church Vestry. In 1657 jurisdiction was transferred to the Gentlemen Justices of the County Court, who were for the most part the same individuals. In both cases the work was under the supervision of the "overseer of roads" or the "surveyor of highways," who was responsible for laying out, constructing, and maintaining the roads, primarily with donated materials and rights-of-way. The limited funds required were provided from local revenues.

The first statewide levy for road construction was authorized by the Virginia General Assembly in 1748. This levy of tobacco was for constructing a road from Pignut Mountain in the Piedmont (present Loudoun County) to the Blue Ridge.

By the time of the American Revolution, it was recognized that the county court system and the use of compulsory labor were not meeting the increasing needs. Following the revolution, a number of recommended modifications were placed before the governor and the general assembly. These included the financing of road repairs through tolls and increases in county taxes, the use of general state tax revenues for road work, lotteries, and the very innovative, if foolhardy, proposal in 1805 for a tax of 1 percent to be levied on all debts (i.e., bad debts) registered at the county courts to raise revenue for road construction.

There was not widespread support for any of these proposals for a variety of reasons. Chief among these was that improving river navigation was viewed as having much greater commercial significance and was given much higher priority by Jefferson, Madison, Washington, and Henry. There was little support for routes that did not not lie near the taxpayer's residence, and a powerful group in Virginia, including Jefferson, believed that state control of transportation meant poor management and waste of public money.

Thus, for approximately 200 years, the financing of road construction was essentially a function of local government, with the general assembly authorizing a few projects for roads and canals, but the period of expansion was dawning and other experimental efforts came into being. In 1785 the general assembly enacted legislation enabling creation of the Little River Turnpike Company as a private venture on the assumption that the receipts from tolls would provide an attractive opportunity for private investment. This apparently was the first private toll road authorized in the United States, and apparently its attractiveness to private investors was not as great as had been thought because funding was not forthcoming. The Little River Company was rechartered in 1795 but again was not successful in attracting funds. Finally, in 1802, chartered for the third time, the company was successful in attracting investment and successfully completed 33 ¾ mi of road from the port of Alexandria westward toward the Blue Ridge (currently US-50). This road operated into the early years of the 20th century.

Between 1802 and 1816, 10 turnpike companies were successful in building and operating a total of 222 ¾ mi of roads. Seven were in the Northern Piedmont and connected Alexandria and the Valley. One was between Fredericksburg and Orange, the first step in connecting the Rappahannock River with the Valley, and another was between Manchester (South Richmond) and Petersburg and connected the falls of the James with the falls of the Appomattox. The remaining road was in what is now West Virginia.

The significant characteristics of these turnpikes are sum-

TABLE 1 TURNPIKES SUCCESSFULLY OPENED BEFORE 1817

Name	Date Chartered	Date Opened	Length (mi)	Authorized Capitalization ($)	State's Proportion of Total Subscription ($)	Income, Repair Costs, and Dividends Through 1848			
						Average Tolls per Mile per Year ($)	Average Repair Costs per Mile per Year ($)	Dividends	
								Years Paid	Average Yield (%)
Little River	1802[a]	1806	33¾	150,000	8	425	180	27	2.02
Faquier and Alexandria	1808	1819[b]	28½	100,000	30	66	59	None	
Ashby's Gap	1809	1827	20½	133,050	11	217	147	17	1.23
Leesburg	1809	1820	14	84,000	40	129	77	6	0.314
Snicker's Gap	1810	1823	33¾	85,275	23	41	22	None	
Swift Run Gap	1810	1813	36½	119,800	39	100	42	23	1.24
Fairfax	1813	–[b]	3	13,750	40	–[c]	–[d]	None	
Falls Bridge	1813	1823	13	80,521	40	20	57	None	
Shepherdstown and Smithfield, W.Va.	1816	1826	13¾	46,687	40	40	10	None	
Manchester and Petersburg	1816	1824	20	75,900	11	154	79	None	

[a]Chartered but unsuccessful in 1785 and 1795.
[b]Data not certain.
[c]Receipts given to toll collector (apparently to cover his costs).
[d]Unknown.

marized in Table 1, and several interesting observations can be made about these data. First, the delay between authorization by the general assembly and the opening of a facility as reflected by the initial collection of tolls generally was about 10 years; the Little River and Swift Run facilities were exceptions. It should be noted, however, that the Little River Turnpike had been authorized twice previously.

Perhaps most significant is that major support from state revenues in the form of stock subscriptions was required for all but four of the turnpikes. As would be expected, the four were in the major corridors and, as is the case today, were most attractive to private investors. The Little River, Ashby's Gap, and Snicker's Gap routes connected the port at Alexandria with the Valley of Virginia, and the Manchester and Petersburg connected two of Virginia's major industrial and commercial centers. (Significantly, the section of Interstate 95 between Richmond and Petersburg was built and has operated as a toll facility since its construction in the 1950s.) The legislation authorizing these facilities recognized that state support would be needed, and this was provided in the form of authorization to purchase stock on behalf of the commonwealth, up to a specified maximum, in the event that private subscription did not provide the required funding. These individual authorizations formed the basis on which the creation of the Internal Improvement Fund was established in 1816.

The final point to be made is that the turnpike companies did not prove to be very productive investments. Other available investment opportunities—land, agriculture, slaves, iron—along with a greater emphasis on water transportation in Virginia and nationwide simply made private investment hard to come by.

The final break with England at the end of the War of 1812 increased the recognition that the survival of the nation lay with developing its westward resources. The greater distances between the navigable rivers to the west, compared with those in the Tidewater, along with increasing westward migration demanded more roads and canal connections. This was addressed by the general assembly in 1816 and 1817 by passage of legislation under which these demands would be addressed for the remainder of the 19th century.

Virginia, of course, was not the only state facing funding problems, and these were also the focus of considerable debate at the federal level. Although Virginia had patterned its road-building efforts after British antecedents, it did not adopt the "turnpike trust" approach used in England. Under this system, a committee of citizens in each of the towns and cities was authorized to borrow money, have turnpikes constructed, and collect tolls for their maintenance and for the amortization of the debt. When the debt was paid, the committee was supposed to cease and desist from the collection of tolls and to surrender the road to the public. This system did not work well in practice, and Parliament was often forced to intervene in what became vested interests and to deal with trustees who pocketed the proceeds as if these were indeed private enterprises.

In New England the principle of user support through tolls was adopted, but the companies were chartered as strictly private enterprises with no state participation. Ironically, because the private enterprise system in New England returned virtually no profits, the roads, such as they were, reverted to the public within a few decades thus unintentionally achieving the goal of the British system.

Even as transportation was being addressed at the state level the role of the federal government was being debated. In 1808 Albert Gallatin presented his landmark report on roads and canals to the U.S. Senate. He noted that in some countries roads and canals could be built by private enterprise. He did not think that this could be done in the United States because *(a)* capital was relatively scarce and *(b)* the needs were in a vast expanse of thinly populated territory. Gallatin further stated that "some works already executed are unprofitable; many more remain unattempted, because their ultimate productiveness depends on other improvements, too expensive or too distant to be embraced by the same individual."

Gallatin was convinced that the federal government was the

only agency competent to accomplish the task, and he proposed a comprehensive system of roads and canals linking the population and commercial centers of the eastern United States with Detroit, St. Louis, and New Orleans, as well as improvements to connections between Lakes Erie, Ontario, and Champlain. He also recommended the expenditure of federal money on local projects that were not directly benefited by the larger system. His estimate for accomplishing his 10-year plan was $20 million, which he proposed to fund without additional taxation by using existing revenues and those from the sale of public lands. He suggested establishing a revolving fund; there would be continuous sale of the facilities to private entrepreneurs as they became profitable (the exact reverse of the British trust principle) and the proceeds would be applied to fund new projects. Although the War of 1812 caused the abandonment of any attempts to address transportation needs, it dramatically emphasized that a poor transportation system was a handicap to the country's military establishment. After the war congressional leaders supported something like the Gallatin plan but on a much more modest scale. The most visible of these efforts was the Calhoun Bonus Bill of 1817, which called for accomplishing internal improvements with funds to accrue to the federal government from a bonus declared by the banks. As ultimately passed, the bill required that the funds be distributed to the states on the basis of population. President Madison vetoed the bill on the ground that it was in excess of federal powers.

When Virginia committed itself to a coordinated statewide transportation effort, it found itself confronted with the necessity of choosing among a variety of theories and practices concerning the type of financial aid to be given, the agent for the distribution of that aid, and the method for raising the funds. In the first case, the question revolved around whether state funds should be used for stock subscriptions to private companies or be expended for actual construction controlled and supervised by the state. On the second point, the differing opinions centered on whether the capital should come from federal or state sources, from a combination of both, from private sources, or from a combination of private and state sources. On the third point, the question was the source of the supporting funds; that is, whether they should be tax monies, income derived from dividends and bank bonuses, or revenue gained from borrowing against the credit of the state. Obviously, these are the same questions that are faced today.

BOARD OF PUBLIC WORKS

Virginia's response to these questions was embodied in two legislative enactments of the general assembly. These two acts guided Virginia's turnpike, canal, and railroad efforts throughout the remainder of the 19th century. The first, passed on February 5, 1816, was titled "An Act to Create a Fund for Internal Improvement." It also created the Board of Public Works. The board included the governor as president. He was assisted by directors who were the treasurer, the attorney general, and 10 other citizens to be chosen annually by joint ballot of the senate and the house of delegates. Of these 10 citizens, the act stated that "three shall reside westward of the Allegheny mountain; two between the Allegheny and the Blue Ridge; three between the Blue Ridge and the great post road (along the fall line) . . . and the residue, between that road and the coast." This distribution reflected the four physiographic regions previously described.

A majority of the board (seven members) were required to do business and the members received the same pay and allowances as the members of the legislature. The board was responsible for funding by subscribing to stock, overseeing, and providing technical assistance to private companies chartered by the legislature. Technical assistance associated with the location, design, and construction of the transportation facilities would come from the Office of the Principal Engineer. During the period 1816–1843 four individuals filled this office: Laommi Baldwin, Jr., Thomas Moore, Isaac Briggs, and Claud Crozet. Baldwin and Crozet were of international stature, and Moore and Briggs performed significant engineering assignments in the United States. It was intended that the board be reimbursed for engineering services, but such was seldom the case.

Of most significance for the present discussion is the Internal Improvement Fund itself and the way it was intended to be used. The fund was created by transfer to it of shares held by the state in the stock of the Little River Turnpike Company, the Dismal Swamp, Appomattox, Potomac, and James River canal companies, the Bank of Virginia, and the Farmer's Bank of Virginia.

The inclusion of the bank stocks deserves some explanation. In 1816 banks had existed in Virginia for only a few years and demands for more were increasingly heard. Bank dividends and bonuses were seen (and proved for several years) to be significant sources of revenues, as would be fees collected and put into the fund when new banks were established. Calhoun's Bonus Bill, previously discussed, was based on the same rationale. In this connection it is of interest to note that during this period the state of Tennessee created a fund supported by bank stock, stipulating that the proceeds were to be used for internal improvements and education.

The initial value of Virginia's fund was between $1.2 million and $1.3 million. The exact figure varies depending on which source is consulted, because of differences between par and market values. Because data compiled by Goodrich *(1)* will be used later in this paper, his figure of $1,251,761 will be used for consistency. It was envisioned and intended that the fund be self-perpetuating, and although the income from the fund, about $100,000, would be less than needed, the anticipated increasing income from bank stocks and the "profits" from the initial projects would soon provide sufficient monies to meet the needs.

Reduced to its essentials, use of the fund was based on four principles: first, financial aid for actual improvements was to be granted only in the form of stock subscriptions to companies duly incorporated by the legislature; second, only those works that could not be undertaken completely by private capital were to receive such aid; third, the state's stock subscriptions were designed primarily to place particular companies on a sound financial footing and were to be withdrawn when profits enabled the company to become self-sustaining; and, fourth, the revenue for improvements was to be derived from the profits accruing to the state in the form of dividends and bonuses and not from taxes and loans. Modifications occurred

apart from administration of the fund, but these principles remained essentially intact between 1816 and 1831.

Subscription was limited to two-fifths (40 percent) of the stock and could be made only after presentation to the board of documentation that the remaining three-fifths had been subscribed by private sources and that 20 percent of the private portion had actually been paid for. All turnpike stock was offered in small denominations compared with the stock of companies in New England, which often sold for $1,000 a share. For instance, the costs for individual shares in Virginia were small, from $25 to $50, apparently in hopes of making the stock attractive to many small investors. Issues were common stock; no preferred stock or bonds were used. The board designated an individual to represent and vote its interest on the boards of the specific companies. It should be noted that the creation of the fund and the board occurred during a time of prosperity, but unfortunately depressed economic conditions were soon to follow.

Before the results of this legislation are presented, brief mention should be made of the law designed to guide the Board of Public Works in dealing with the turnpike companies. This law, passed February 7, 1817, was lengthy and detailed. Although it survived throughout the 19th century with only minor modifications, interpretations of its provisions varied from time to time and its provisions were sometimes ignored with relative impunity. The law required that companies apply to the legislature for a charter that included the amount of capital stock authorized and the denominations to be issued. It specified that after one-half of the authorized stock had been subscribed (but not necessarily paid for) a president and five directors should be elected. The law set forth widths of turnpikes, their surfacing, the construction of "summer roads," the erection of tollgates, the weight of loads and width of wheels, rates of tolls, remedies against nonpayers, and persons exempted. It, in effect, granted the company the state's power of eminent domain and the right to use materials adjacent to the road with provisions for settling disputes and assessing damages in the county court with the aid of five "discreet, intelligent, disinterested and impartial freeholders." It is of some interest to note that this law prohibited the cutting, without the owner's consent, of any "fruit tree, preserved in any field or lot, for shade or ornament . . ." or the taking of any material constituting a fence or building.

An important provision of the law was the portion that dealt with procedures relating to roads "out-of-repair." When a complaint was presented to a justice of the peace, three "discreet and disinterested freeholders" would be directed to inspect the road. If they found that the road was indeed "out-of-repair," the judge was empowered to suspend the collection of tolls until the road met the approval of the court. This was known as "throwing open the gates," and was rather commonly cited in reports submitted to the board. Obviously, failure to maintain the road made it less attractive to users willing to pay, and in many cases the lack of maintenance reflected the fact that there were not sufficient people using the road to generate the funds necessary for maintenance and operation—conditions similar to those faced by public transit today.

It would be gratifying if it were possible to conclude that the Board of Public Works was able to meet the needs with the self-sustaining fund that appeared so logical and sound. Such success was not to be. Only the briefest summary of results can be presented here and the bottom-line figures would label this experiment a failure. In 1851 the board reported that the state possessed 872 mi of "the most capacious and substantially constructed canals in the Union" and about 3,000 mi of turnpikes. The effect of obsolescence had been heavy, and the subsequent emergence of the railroads was destined to magnify this situation. The board calculated the return on the state's investment as 7/1000 of 1 percent. They cited the Snicker's Gap Turnpike Company as "having a good road but not much used" since the traffic had been diverted to canals and railroads serving the same area.

Despite their lack of economic success, the transportation facilities were in place. There is evidence that the continued commitment to the mixed enterprise system reflected the fact that the motivation for internal improvement was not entirely economic and that no other system was deemed to be better. More likely, the commitment was based more on sentiments such as that expressed by the board in its 1839 annual report:

> The enlarged results of roads and canals can no more be confined to these whose toil, enterprise and capital first opened them, than the blessings of freedom and good government be restricted to the patriotic band who risked their lives and properties in its establishment.

Although the bottom line, narrowly viewed in terms of direct economic return to the state and other stock holders, was disastrous, many of the roads that were built during this period continue to serve the commonwealth in upgraded form, and at least one of the bridges built in the 1820s still carries a primary route. It is against this background that the performance of the Internal Improvement Fund and the mixed enterprise approach for 45 years (1816–1860) will be discussed.

According to Rice *(2)*, before the creation of the fund in 1816, the state had made separate cash payments for the construction of western roads. Of the $204,147.01 expended from the fund by the state on all internal improvements, $154,933.33 (76 percent) was in the form of stock subscription and the balance in irredeemable expenditures for surveys and construction not connected with private companies.

The state's investment and turnpike mileage between 1805 and 1860 as presented by Hunter *(3)* are summarized in Table 2.

TABLE 2 STATE INVESTMENT AND TURNPIKE MILEAGE

Year	State's Investment ($)	Total Turnpike Mileage
1805	12,550	34
1310	168,100	173
1815	205,500	189
1820	278,475	321
1825	305,546	371
1830	386,331	541
1835	958,718	1,203
1840	1,824,166	2,148
1845	1,824,166	2,148
1850	4,066,493	4,827
1855	4,640,077	6,379
1860	4,643,077	6,390

As the data in this table indicate, the accretion of investment in turnpikes between 1805 and 1840 was slow but steady. Between 1840 and 1845, the worst years of depression, investment ceased. Then followed a period of spectacular increase and another period of no growth. No new companies were subscribed to between 1840 and 1845 and after 1854 only one 10-mi road was supported. Tables 3 and 4 are taken from Goodrich *(1)*. As indicated in the notes, there are some slight discrepancies between the figures in the two tables, and these figures are not directly comparable with those in Table 2 because Tables 3 and 4 relate to all improvements and Table 2 is limited to turnpikes.

As the data in Table 3 indicate, between 1816 and 1824 the fund operated as anticipated. The total net revenue from all investments was $706,771, of which $62,385 (88 percent) came from "profits" of the companies. For the same period, as given in Table 4, the value of the bank holdings increased to $1,337,200, which added to the holdings in improvements of $608,661 provided a net worth of $1,945,861, an increase of 55 percent during the 8-year period.

As the data in Table 3 indicate, an item for payment of interest first appeared in 1825 and an item for state contribution in 1836. As the data in Table 4 indicate, for the remainder of the period the value of the principal that created the fund was protected, but the stock did not appreciate as anticipated. By the end of the period the net revenue from all investments was a deficit of the same order of magnitude as the interest payments. Although the entire story of these entries is extremely complex, a brief outline of some of the major causes is necessary.

As has been noted, the Internal Improvement Fund was to be applied to all modes of transportation, which at the time of its creation were roads and canals, including a few major bridge projects. The fund was created just at the time when interest in canals increased nationwide, which reinforced Virginia's resolve to canalize the Potomac and the James and their important tributaries.

In 1828 the Baltimore and Ohio Railroad began construction to connect the port of Baltimore with the Ohio River. This railroad began operation as a horse-drawn line in 1829, was converted to steam in 1831, and the entire connection was completed in 1852. Not only did the line pass through Virginia, it also portended a significant economic threat to Virginia's ports at Norfolk and Alexandria, which were dependent on the successful completion of canal projects on the James and Potomac rivers.

In addition to competing demands from canal and railroad interests, demands from the trans-Allegheny region for connections of any kind, including roads, were increasing greatly, a condition made even more complex because these facilities needed to be built in mountainous terrain and would traverse substantial distances through sparsely settled areas.

Compounding the difficulties posed by the greatly expanded needs were diminished resources reflecting the recession of 1819, which greatly decreased the productivity of the bank investments and available capital.

In 1820, in response to dissatisfaction with progress of the James River Company on its canal, legislation was passed under which the state assumed the responsibility of improving the waterway and management of the project. Under this transfer, stockholders in the original corporation were guaranteed an

TABLE 3 CURRENT REVENUE, EXPENDITURES, AND INVESTMENTS—VIRGINIA FUND FOR INTERNAL IMPROVEMENTS, 1816–1861

Year	Revenue from Bank Investments	Gross Revenue from Improvement Investments	Interest Payments	Net Revenue from Improvement Investments	Net Revenue from All Investments	State Contribution	Board Expenses	Investment from Current Revenue	Investment from Loan Proceeds	Investment from other Sources	Disinvestment	Net Investment
1816	32,429	.....	.....	.....	32,429	.....	3,721	.....	.....	1,251,761[h]	.....	1,251,761
1817	74,987	8,000	.....	8,000	82,987	.....	6,572	51,605	.....	.....	.....	51,605
1818	111,810	7,000	.....	7,000	118,810	.....	8,508	158,679	.....	112,500	.....	271,179
1819	65,529	4,914	.....	4,914	70,443	.....	24,656	45,750	.....	.....	6,500	39,250
1820	81,579	3,408	.....	3,408	84,987	.....	23,199	46,650	.....	.....	.....	46,650
1821	64,354	11,997	.....	11,997	76,352	.....	15,783	67,650	.....	4,700	.....	72,350
1822	77,984	11,878	.....	11,878	89,862	.....	16,056	72,070	.....	.....	23,370	48,699
1823	68,984[b]	7,318	.....	7,318	76,302	.....	8,936	77,400	.....	.....	.....	77,400
1824	71,729[b]	7,870	.....	7,870	78,599	.....	13,199	49,280	.....	.....	.....	49,280
1825	77,173	38,345	45,558	- 7,212	69,960	.....	15,957	47,280	.....	.....	.....	47,280
1826	79,005	32,505	62,450	- 29,934	49,070	.....	8,868	43,225	.....	.....	.....	43,225
1827	71,274	40,895	70,370	- 29,474	41,799	.....	9,656	35,383	.....	.....	40,300[k]	-4,917
1828	69,215	47,611	71,673	- 24,061	45,153	.....	8,738	38,077	.....	.....	.....	38,077
1829	76,080	45,624	71,673	- 26,049	50,031	.....	6,669	31,064	.....	.....	.....	31,064
1830	76,178	62,484	71,898	- 9,414	66,764	.....	10,945	15,866	.....	.....	.....	15,866
1831	72,160	59,410	72,376	- 12,965	59,195	.....	13,528	18,641	.....	.....	.....	18,641
1832	80,163	58,898	74,883	- 15,984	64,178	.....	8,994	81,140	80,000	.....	.....	161,140
1833	87,099	72,245	80,361	- 8,116	78,983	.....	13,009	35,112	65,000	.....	22,000	78,112
1834	105,218	43,384	80,630	- 37,245	67,972	.....	18,419	47,753	395,000	.....	.....	442,753
1835	125,930[b]	67,732	94,445	- 26,713	99,216	.....	15,267	25,459[e]	253,800	.....	15,173	274,086
1836	131,959[b]	62,459	99,769	- 35,310	96,649	.....	13,012	75,681[e]	118,008	1,000,000[h]	11,700[l]	1,181,981
1837	119,715[b]	61,191	101,337	- 40,146	79,569	9,962	26,771	137,428[e]	965,969	.....	123,996[l]	979,409
1838	92,748[b]	62,711	184,693	- 121,981	- 29,233	100,052	26,364	10,550[e]	1,298,834	.....	.....	1,309,384
1839	144,305[b]	87,198	265,092	- 177,893	- 33,588	85,000	21,259	19,097[e]	948,574	.....	.....	967,671
1840	92,002[b]	69,446	356,292	- 286,846	- 194,843	201,200	16,412	20,000[e]	203,792	.....	.....	223,792
1841	79,072[b]	48,738	338,771	- 290,032	- 210,960	239,600	10,231	20,900[e]	229,282	.....	.....	250,182
1842	72,779[b]	21,695	325,024	- 303,328	- 230,549	238,500	9,226	13,100[e]	366,124	.....	.....	379,224
1843	107,852[b]	22,619	368,136	- 345,516	- 237,664	241,000	6,028	.....	42,820	.....	10,100[m]	32,720
1844	123,773[b]	67,826	372,418	- 304,592	- 180,819	186,000	3,070	8,000[e]	8,808	105,540[l]	.....	122,348

TABLE 3 *continued*

Year	Revenue from Bank Investments	Gross Revenue from Improvement Investments	Interest Payments	Net Revenue from Improvement Investments	Net Revenue from All Investments	State Contribution	Board Expenses	Investment from Current Revenue	Investment from Loan Proceeds	Investment from other Sources	Disinvestment	Net Investment
1845	118,400[b]	72,414	386,489	- 314,074	- 195,673	190,080	3,750	4,000[e]	16,469	.....	.....	20,469
1846	119,202[b]	97,107	353,426	- 256,318	- 137,115	195,676	3,810	3,500[e]	23,358	.....[l]	697,592[m]	-670,734
1847	126,943	97,775	346,407	- 248,631	- 131,688	150,000	6,471	5,102[f]	530,446[f]	27,520[l]	260,000[k]	303,069
1848	128,006	106,126	409,092	- 309,965	- 176,959	200,000	6,985	19,430[f]	454,527[f]	52,308[l]	.....	526,266
1849	126,370	150,251	406,691	- 256,440	- 130,070	175,000	7,709	6,430[f]	724,742[f]	4,000[l]	338,100[n]	397,072
1850	130,114	133,738	477,858	- 344,120	- 214,005	197,000	8,016	25,922	1,664,527	698,971[h]	187,266[m]	2,202,155
1851	139,442	151,772	570,662	- 418,889	- 279,447	245,000[d]	17,061	2,410	2,118,639	339,131[j]	31,001[o]	2,429,179
1852	139,373	183,744	737,521	- 553,777	- 414,403	145,305[d]	21,554	256,688	2,616,070	.....	1,500	2,871,258
1853	145,520	121,503	748,156[c]	- 626,652	- 481,132	832,715	6,007	150,000	3,849,552	.....	43,524	3,956,028
1854	152,211	320,615	1,842,855	-1,522,239	-1,370,028	1,351,880	5,069	389,131	3,997,946	.....	100,000	4,287,077
1855	155,860	97,582	1,798,304	-1,700,721	-1,544,861	1,600,027	5,449	140,000	1,654,010	.....	64,600[p]	1,729,409
1856	157,349	140,348	1,986,947	-1,846,599	-1,689,250	1,655,895	6,564	.....	2,194,599	.....	4,000	2,190,599
1857	148,380	98,922	2,328,090	-2,229,168	-2,808,788	2,098,737	6,093	.....	1,041,596	.....	143,996[q]	897,600
1858	150,139	135,616	2,632,515	-2,496,898	-2,346,759	2,353,998	11,772	.....	1,568,951	.....	.....	1,568,951
1859	162,954	319,648	2,934,797	-2,615,148	-2,452,193	2,451,842	6,387	.....	1,589,343	300,000	.....	1,889,313
1860	166,971	341,463	2,703,748	-2,362,285	-2,195,314	2,200,019	10,475	.....	6,394,447[g]	.....	.....	6,394,447
1861	154,505	174,521	2,478,266	-2,303,744	-2,149,239	2,158,191	8,163	.....	1,297,205	.....	.....	1,297,205
Total[a]	4,942,845	3,878,565	26,347,691	-22,468,817	-17,526,268	19,502,599	574,390	2,295,453	36,712,438	3,896,431	2,114,718	40,789,596

Notes to Table 3

This and the following table have been prepared by Naomi Waxman from the Reports of the Second Auditor on the State of the Fund for Internal Improvements.

[a] The totals will show a slight discrepancy since the cents columns have been omitted in printing.

[b] Includes bank bonus.

[c] From this point on, payments made by the Board and the state to the sinking fund for interest and redemption are included as well as interest payments made directly by the Board.

[d] Reduced by $150,000 loan from Board to treasury.

[e] Includes bank bonus paid in stock.

[f] Part of this was for state works not at the time listed as assets of the Fund: $37,958 in 1848; $192,788 in 1849.

[g] Of this, $5,052,000 represents acquisition of $7,400,000 stock in James River and Kanawha Company in return for a subscription of $200,000, the conversion of a loan of $2,386,000, and the assumption by the state of the company's guaranteed bonds and of the annuity to the stock of the old James River Company.

[h] Transfer of state's interest to Board.

[i] Conversion of debt for interest or current dividends into company bonds or stock.

[j] Of this, $85,200 represents revaluation of old James River Company stock; $43,950 represents conversion of company debt into bonds or stock; $210,000 represents excess of book value over cash paid for improvement sold to Board by city of Petersburg.

[k] No receipts to Fund. Proceeds appear to have gone to state treasury or sinking fund.

[l] $5,600 represents loss on sale of assets.

[m] Assets written off or written down.

[n] $323,500 represents the value of the state holdings in the Petersburg Railroad which were transferred to the city of Petersburg; $10,600 represents sale of assets for which no receipts to the Fund are shown.

[o] $11,413 represents loss involved in sale of improvement to city of Petersburg.

[p] $50,000 represents assets written off.

[q] $40,000 sale of bank stock; $103,000 assets written off; no receipts to Fund.

annual return of 12 percent on their investment for the first 12 years and 15 percent thereafter. Significantly, the company was not placed under the Board of Public Works but rather under a state corporation of which the governor was president. The company was authorized to borrow $200,000 a year to complete the project, with the state guaranteeing the interest. Fortunately, if there was a deficit, no more than $18,000 could come from the Internal Improvement Fund. As Goodrich and others have observed, this was the beginning of reduced authority of the board to plan and optimize its commitment of resources, but it increasingly faced the problem of responding to the dictates of powerful forces in the general assembly committed to the canal even after its obsolescence was recognized. Improvements did accelerate, but between 1820 and 1823 the costs of the work exceeded by almost three times those estimated. Obviously, the use of $18,000, which did not entirely pay the interest, was not popular with those demanding improvements in other areas. The situation worsened. According to Rice *(2)*, between 1823 and 1831 work on the canal progressed slowly but payment of interest on the loans required

TABLE 4 CAPITAL ACCOUNT—VIRGINIA FUND FOR INTERNAL IMPROVEMENTS, 1816–1861

Year	Bank Holdings	Holdings in State Works	Holdings in Other Improvements	Total Holdings in Improvements	Total Holdings[b]	Debt Outstanding	Net Worth
1816	1,128,000	.....	123,661	123,661	1,251,761	.....	1,251,761
1817	1,164,300	.....	139,161	139,161	1,303,461	.....	1,303,461
1818	1,364,100	.....	173,461	173,461	1,537,561	.....	1,537,561
1819	1,357,600	.....	219,211	219,211	1,576,811	.....	1,576,811
1820	1,357,600	.....	265,861	265,861	1,623,461	.....	1,623,461
1821	1,358,200	.....	337,611	337,611	1,696,811	.....	1,696,811
1822	1,337,200	.....	433,051	433,051	1,770,251	.....	1,770,251
1823	1,337,200	.....	509,381	509,381	1,846,581	.....	1,846,581
1824	1,337,200	.....	608,661	608,661	1,945,861	.....	1,945,861
1825	1,337,200	.....	655,941	655,941	1,993,141	.....	1,993,141
1826	1,337,220	.....	699,166	699,166	2,036,366	.....	2,036,366
1827	1,337,200	.....	694,249	694,249	2,031,449	.....	2,031,449
1828	1,337,200	.....	732,326	732,326	2,060,526	.....	2,060,526
1829	1,337,200	.....	763,391	763,391	2,100,591	.....	2,100,591
1830	1,337,200	.....	779,257	799,257	2,116,457	.....	2,116,457
1831	1,337,200	.....	797,899	797,899	2,135,099	.....	2,135,099
1832	1,371,600	.....	920,923	920,923	2,292,523	50,000	2,242,523
1833	1,396,473	.....	994,035	994,035	2,390,508	80,000	2,310,508
1834	1,396,473	.....	1,436,789	1,436,789	2,833,262	135,000	2,698,262
1835	1,391,300	.....	1,716,049	1,716,049	3,117,349	440,000	2,677,349
1836	1,392,500	.....	2,898,813	2,898,813	4,291,313	521,500	3,769,813
1837	1,345,800	6,469	3,889,919	3,896,389	5,242,189	1,735,900	3,490,289
1838	1,349,800	19,520	5,186,040	5,205,561	6,555,360	2,695,400	3,859,960
1839	1,363,700	44,492	6,114,839	6,159,332	7,453,031	3,672,113	3,780,917
1840	1,383,700	63,754	6,299,364	6,363,119	7,746,824	3,802,680	3,944,143
1841	1,404,600	103,982	6,472,442	6,576,424	7,981,024	4,026,969	3,954,107
1842	1,417,700	190,385	6,751,756	6,942,141	8,359,824	4,377,376	3,982,448
1843	1,417,700	226,385	6,747,752	6,974,137	8,391,837	4,414,917	3,976,920
1844	1,388,200	230,522	6,910,153	7,140,676	8,528,876	4,660,671	3,982,448
1845	1,392,200	244,008	6,841,701	7,085,710	8,467,910	4,394,660	4,073,250
1846	1,143,850	187,213	6,478,998	6,666,211	7,810,061	4,288,585	3,521,476
1847	1,143,850	187,358	6,850,123	7,037,481	8,181,331	4,885,735	3,295,596
1848	1,143,850	194,136	7,331,653	7,525,790	8,669,640	5,359,559	3,310,080
1849	1,143,850	235,409	7,518,402	7,753,811	8,897,661	5,985,432	2,912,229
1850	1,143,850	1,193,676	8,747,290	9,940,967	11,099,817	8,063,039	3,036,777
1851	1,143,850	1,554,595	10,939,560	12,494,156	13,638,006	10,139,630	3,498,376
1852	1,143,850	1,975,901	13,373,334	15,350,236	16,494,086	13,679,447[c]	2,814,639
1853	1,143,850	2,363,673	16,781,939	19,145,612	20,289,462	17,591,668	2,697,794
1843-55[a]	1,143,850	3,688,984	21,457,068	25,146,053	26,289,903	24,255,372	2,034,530
1856-57[a]	1,103,850	4,390,129	23,893,169	28,283,299	29,387,159	27,032,808	2,354,915
1858-59[a]	1,103,850	5,285,346	26,456,528	31,741,874	32,845,724	29,740,209	3,105,515
1860-61[a]	1,103,850	6,530,531	32,813,277	39,343,808	40,452,292	34,359,418[d]	6,092,873

[a] Biennial reports only.
[b] Year-to-year changes in this column correspond substantially with the figures of Net Investment in Table 3, but the nature of the data and changes in the accounting methods of the Fund cause minor discrepancies.
[c] From this point on, the figure represents all improvement debt outstanding in the hands of the public and therefore may overstate the Fund's obligation by including debt for improvement projects not listed as assets of the Fund.
[d] Does not include obligation to pay annuity on old James River stock.

20.8 percent of the total disbursements from the fund in 1823, 54.0 percent in 1826, and 68.9 percent in 1831. Obviously, this created a major political controversy during the entire period. According to even the most conservative estimates made in 1816, the value of public works that should have been constructed by the beginning of 1830 was more than $5.7 million. The actual value amounted to just over $500,000 in stock subscriptions, $190,000 in loans to companies, and $50,000 in the form of the state's purchase of James River stock.

In 1831 the board was reorganized to divest the administrative body of its 10 elective members and place their duties in the hands of ex officio directors (the governor, the lieutenant-governor, the treasurer, and the second auditor). This legislation also reduced the salary of the principal engineer, Claud Crozet, and the following year his job was abolished. At least part of the dissatisfaction with Crozet was due to his advocacy of abandonment of the proposed extension of the canal across the mountains in favor of building a rail connection to the Ohio River.

Crozet's recognition of the impact of the railroad was

obviously prophetic of the other major impact on the "self-perpetuating" fund. The first state subscription to railroads from the fund apparently occurred in 1831. Although most of the railroads before 1850 were local in nature, after 1850 the Board of Public Works exercised a major influence in integrating the east-west routes into a compatible system, often over the opposition of the canal interests. The ultimate effect of the addition of railroad needs to those of canals and roads was that, during the period 1785–1860, approximately $37 million was appropriated for public works, approximately two-thirds of which went to railroad projects, and most of that after 1847.

The Civil War and massive floods in 1870 and 1877, coupled with the ascension of the railroads, ended Virginia's canal system. In 1880 the Richmond & Alleghany Railroad Company purchased the assets of the James River Company and constructed its James River line on the towpath on which it runs today. This line became a part of the Chesapeake & Ohio Railway Company in 1888.

In addition to the reorganization of the board and the initial subscription to railroad stock in 1831, the state at the same time responded to the trans-Allegheny needs by chartering companies in which the state was the major, if not sole, stockholder to construct the turnpikes of great length that represented Virginia's reach for the westward trade. Four of these were the Kanawha, the Northwestern, the Staunton and Parkersburg, and the Southwestern. The roads were 208, 237, 234, and 175 mi long and required state subscriptions of $249,393, $425,280, $368,278, and $562,100. Facilities of this length through sparsely settled country were of little interest to private investors but today remain as primary routes in upgraded form. Their construction covered the period 1825–1846, largely a period of nationwide economic depression.

During the period 1802–1861, the legislature chartered 647 toll roads of which only 190 (29 percent) became operating enterprises. Of the 37 chartered between 1802 and 1848, only 14 paid any dividends to the shareholders. Statistical information on the 190 companies is presented in the Appendix in which the companies are arranged by physiographic regions.

SUMMARY

Extrapolation of 19th-century experience to current issues obviously must be done with significant reservations. There are, however, certain lessons to be learned and certain general factors that should at least be recognized when considering the funding needs and sources necessary to protect the investment in America's transportation infrastructure and expand it to meet projected needs.

The most obvious lesson is that current issues differ from those of the 19th century more in degree than in kind. The provision of a balanced and integrated statewide, multimodal transportation system must take into account complex technical, economic, and political factors as well as needs that usually exceed the available resources even when subsidized by public funds.

The major questions addressed during the formulation of Virginia's improvement efforts in the early part of the 19th century were *(a)* whether state funds should be used for stock subscriptions to private companies or be expended for actual construction by the state; *(b)* whether the capital should come from federal or state funds or from a combination of both; and *(c)* whether the funds should come from taxation, general revenues, or borrowing. Obviously, these continue to be important questions.

In addition to the obsolescence of a major element (canals) and the emergence of an unanticipated mode (railroads), Virginia's 19th-century experience illustrates that a comparatively small portion of the overall transportation system carries its own cost and, in effect, subsidizes the remainder, particularly when a significant portion of the system serves the needs of areas with low population densities. Involvement of the private sector in only those facilities that return a profit would make the remainder of the system even more dependent on public funding.

Viewed strictly in economic terms and as a closed system, Virginia's "mixed enterprise" approach to funding internal improvements was a failure. Viewed from a broader perspective of benefits to the citizens and commercial enterprises of the commonwealth, it provided the basis of the current road system, which is the third largest state system in the nation.

REFERENCES

1. C. Goodrich. The Virginia System of Mixed Enterprise: A Study of Planning of Internal Improvements. *Political Science Quarterly,* Sept. 1949.
2. P. M. Rice. *Internal Improvements in Virginia, 1775–1860.* Ph.D. dissertation. University of North Carolina, Chapel Hill, 1948.
3. R. F. Hunter. *The Turnpike Movement in Virginia, 1816–1860.* Ph.D. dissertation. Columbia University, New York, 1957.

APPENDIX: DATA ON EARLY VIRGINIA TURNPIKES

TABLE A-1 INTERREGIONAL ROUTES BY REGION

Name	Date Chartered	Date Opened	Length, Miles	Authorized Capitalization	State's Proportion of Total Subscription	Income, Repair Costs, and Dividends Through 1848: Average Tolls, Mile/Year	Average Repair Costs, Mile/Year	Dividends: Years Paid	Dividends: Average Yield
TIDEWATER, PIEDMONT & SOUTHSIDE									
Little River	1802[a]	1806	33 3/4	$150,000	8%	$425	$180	27	2.02%
Fauquier & Alexandria	1808	1819?	28 1/2	100,000	30%	66	59	none	--
Leesburg	1809	1820 (1859)	14 20	84,000	40%	129	77	6	0.314%
Swift Run Gap	1810	1813	36 1/2	119,800	39%	100	42	23	1.24%
Fairfax	1813	(b)	3	13,750	40%	(c)	(b)	--	(b)
Falls Bridge	1813	1823	13	80,521	40%	20	57	none	--
Manchester & Petersburg	1816	1824	20	75,900	11%	154	79	none	--
Middle	1818	1832	16 1/2	60,000	40%	41	22	none	--
Leesburg & Summer's Gap	1831	1834	10	50,000	40%	83	144	none	--
Pittsylvania & Lynchburg	1834	1837	25 3/4	17,500	40%	60	79	none[d]	--
Lynchburg & Buffalo Springs	1837	1839?	41 3/4	25,000	40%	28	10	none	--
THE VALLEY									
Shepherdstown & Smithfield	1816	1826	13 3/4	46,687	40%	$40	10	none	--
Jackson's River	1829	1833	26	20,000	40%	50	34	7	(b)
Lexington & Covington	1829	1833	41 1/4	36,000	40%	24	25	none	--
Berryville	1830	1833	15 1/2	16,700	38%	46	9	11	(b)
Smithfield, Charleston & Harper's Ferry	1830	1832	14	35,750	39%	99	44	none	--
Warm Springs & Harrisonburg	1830	1833	59 3/4	30,000	40%	31	16	6	(b)
Natural Bridge	1836	1839	35	16,000	40%	6	7	none	--
Valley	1838	1840	92	400,000	60%	140	108	none	(e)
SOUTHWEST VIRGINIA									
Lafayette & English Ferry	1838	1843	24	15,000	40%	472	20	9	2.43%
Salem Pepper's Ferry	1838	1842	36	17,540	35%	475	23	9	none
TRANS-ALLEGHENY									
Wellsburg & Washington	1822	1835?	6	18,783	27%	$127	$67	2	0.364%
White & Salt Sulphur Springs	1831	1837	20 1/2	10,000	40%	44	19	10	5.12%
Lewisburg & Blue Sulphur Springs	1834	1838	15 1/4	12,500	40%	41	6	none	--
Charleston & Point Pleasant	1835	1839	56	52,800	40%	17	9	none	--
Red & Blue Sulphur Springs	1836	1839	32 3/4	12,500	40%	6	5	none	--
Capapon & North Branch	1838	1846?	45	30,000	40%	12	4	none	--
Holiday's Cove	1838	1840	6	12,250	39%	47	53	2	0.274%

Source: Hunter, R. F., "The Turnpike Movement in Virginia, 1816-1860," Unpublished Ph.D. dissertation, Columbia University, 1957.

[a] Unsuccessfully chartered in 1785 and 1795.
[b] Unknown.
[c] Receipts given to toll collector (apparently to cover his costs).
[d] Paid $5,425 in dividends by 1860.
[e] Paid $34,000 in dividends by 1860.

TABLE A-2 INTERREGIONAL ROUTES BY CORRIDOR

Name	Date Chartered	Date Opened	Length	Authorized Capitalization	State's Proportion of Total Subscription	Income, Repair Costs, and Dividends Through 1848: Average Tolls Mile/ Year	Average Repair Costs Mile/ Year	Dividends: Years Paid	Dividends: Average Yield
VALLEY -- PIEDMONT									
Ashby's Gap	1809	1827	20 1/2	133,050	11%	$217	$147	17	1.23%
Snicker's Gap	1810	1823	33 3/4	85,275	23%	41	22	none	--
Tye River & Blue Ridge	1819	1827	22 1/4	6,000	40	5	6	none	--
Staunton & James River	1824	1827	43 1/2	50,000[a]	40	89	56	14	(b)
SOUTHWEST -- SOUTHEAST									
Lynchburg & Salem	1818	1824	59 1/2	103,700	29	102	24	24	2.27%
Fincastle & Blue Ridge	1830	1834	14	8,000	40	40	17	13	(b)
Pittsylvania, Franklin & Botetourt	1830	1841	93	27,825	40	8 (to 1843)	(b)	none	--
TRANS-ALLEGHENY -- VALLEY									
Huntersville & Warm Springs	1832	1837	27	16,000	40	$5	$17	none	--
TRANS-ALLEGHENY -- SOUTHWEST									
Giles, Fayette & Kanawha	1837	(b)	118	42,600	35	(b)	(b)	none	--

Source: Hunter, R. F., "The Turnpike Movement in Virginia, 1816-1860," Unpublished Ph.D. dissertation, Columbia University, 1957.

[a] Increased by $120,000 in 1859.

An Economic Argument for Privatization of Highway Ownership

DAVID GELTNER AND FRED MOAVENZADEH

There are four potential economic justifications for privatizing highways: greater revenues without increased taxes, improved highway use efficiency, production efficiency of maintenance, and quality of highway services. However, because of market imperfections of laissez-faire private provision of highways, the economic feasibility and desirability of privatization depend on regulatory structures to efficiently control and mitigate potential problems of excess tolls and inadequate maintenance. Possible types of regulatory structures are discussed.

Throughout history, and in virtually all lands, most highways have been built, owned, and maintained by governments. There have been some important exceptions to this rule, perhaps most notably the case of Great Britain during the Industrial Revolution before the advent of the railroads. But for the most part, highways have been part of the government sector. There are no doubt several reasons for this, including military and political concerns, especially in previous times or other countries, but one of the most fundamental reasons why government ownership of highways is so widespread is that it may often be more economically efficient for the government to provide highways than to leave this task to the private sector.

The reason for this is that highways are subject to various types of "market failure," or market "imperfections," in economic jargon. Because of this, the private highway market could not be expected to behave according to the classical model of "perfect competition" in which rational private agents are guided "as by an invisible hand" to an efficient (i.e., welfare-maximizing) outcome in equilibrium without any centralized control. As a result, even though profit maximization might lead private owners to be efficient with regard to the internal cost of highway production, the overall highway market would not be efficient in the "allocative" sense. That is, the efficient quantity or quality of highways would not be provided by the private sector, or the highways that were provided would not be used efficiently, or both. In other words, society's allocation of its production and consumption capabilities between highways and other goods would not be efficient.

There are a number of reasons for market failure in the case of highway production: *(a)* Some highways (namely, nontoll roads) are "nonexcludable" goods (i.e., nontoll roads are like "public goods" in that consumers cannot be excluded from "consuming" whatever level of highway quality is provided). *(b)* Highway supply cannot be perfectly competitive because, even though there would be some competition between parallel highways or alternative routes between two points, no two highways would be perfect substitutes due to geographic uniqueness (thus, private highways would have "market power," like monopolies or cartels, and it would be found feasible and advantageous to charge tolls that were too high and to provide too little quantity or quality of road, from a social perspective). *(c)* Related to the preceding two points are "externalities" associated with highway production (i.e., costs or benefits of producing highways that cannot be traded in any market, such that the highway producer cannot "experience" these costs or benefits and take them into account in his production decision). Another source of market failure sometimes mentioned regarding highways is economies of scale or "lumpy" capacity in highway production, but this is just a technical reason underlying *(b)*.

These sources of "imperfection" represent the basic theoretical justification for government provision of highways, and no doubt they underlie the historical fact that most highways have been provided by the government, not only in this country but in all other countries as well.

It is important to realize that although these imperfections make it necessary in the interest of economic efficiency for the government to play some role in the highway market, they do not necessarily imply that the government should own the highways. Indeed, imperfections exist in many markets in which the government does not own the productive assets. For example, national defense is the classical example of the nonexcludable commodity, yet the government, though it provides the national defense, does not itself own all of the assets that produce the national defense. For example, the factories that produce fighters, missiles, and tanks are all privately owned. Electric power distribution exhibits scale economies and natural monoply that prevent perfect competition, but the government, at least in this country, does not own most electrical distribution systems. Many industries cause pollution, which is an "external" cost of production, but that does not compel the government to nationalize all polluting industries.

RATIONALE FOR PRIVATIZATION OF EXISTING HIGHWAYS

In this section the concept of privatization of highway ownership is examined from the perspective of economic efficiency. The focus is primarily on existing highways, although much of what is said would also be applicable to building new highway capacity.

Highway privatization is an appealing concept during these times because of the combination of growing need for infrastructure maintenance and strong political pressures for fiscal austerity and reduced taxes. The attractiveness of the privatization concept may be attributed to four reasons:

1. Revenues might be raised without increasing taxes,
2. Efficiency of highway usage might be improved,

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3. Production efficiency of highway maintenance might be improved, and
4. Quality of highway services might be improved.

Highway privatization could certainly raise additional revenues for existing highways without recourse to tax increases if the privatization were accomplished by converting previously nontoll roads to toll roads or if it resulted in increasing the tolls charged on existing toll roads, or both. Of course, this could be done without privatization, but it might be easier, for political or administrative reasons, to accomplish this type of tolling in connection with a program of privatization.

(It should be noted that private development of new highway capacity, to provide access to a private real estate development, for example, could raise highway construction revenue without the road necessarily being tolled, if the real estate development provides enough excess profit to pay for the road. In this paper, however, attention is focused on existing highway capacity.)

Two questions that beg to be seriously considered when the revenue-raising argument for privatization is invoked are *(a)* are more revenues really needed for highways and *(b)* what would be the economic efficiency impact of converting nontoll roads to toll facilities or raising tolls on existing toll roads? There is a substantial body of evidence, beginning with the Choate and Walter study *(1)* and continuing through the Joint Economic Committee's report *(2)* and more recent studies *(3, 4)*, to the effect that the answer to the first question is yes; more revenues, perhaps quite a bit more revenues than are currently being collected, are needed to maintain existing highways and provide necessary new capacity. The second question relates to the second reason listed previously as a justification for highway privatization.

When the toll or price charged for highway usage is changed, the quantity and pattern of highway usage is also changed because of the user demand function that relates highway usage demand to highway price. If the highway usage price was previously too low, then an increase in tolls could well improve the economic efficiency of highway usage, at least as long as the tolls are not increased too much. Thus the second reason that potentially justifies the privatization of existing highways only applies to privatization by means of toll roads, and the key question is whether private toll roads would charge an efficient toll (or at least a more efficient one than the status quo). Again, privatization is not necessarily required because the government could in theory institute efficient tolls on publicly owned highways. Nevertheless, political or administrative expediency might argue for a policy of efficient tolling coupled with a policy of privatization.

The evidence is that current highway prices (usage-sensitive excise taxes and user fees plus tolls, if any) are far below the economic efficient level on congested highways, such as most urban expressways during daytime hours. Tolling such roads would be efficient from the perspective of overall social welfare, though all the parties directly affected (those who continue using the highway and pay the tolls, those who switch to alternate routes to avoid the tolls, and those already using the alternate routes) would be made worse off one way or another unless they were compensated by receiving some of the toll revenues. Uncongested roads are probably not underpriced in general, at the existing prices.

This leads to the third reason in the list of potential economic justifications for highway privatization, to improve highway maintenance production efficiency. Normally, private companies have profit-maximization incentives to minimize production costs. This implies that, unless government regulation distorts the normal incentives, private highway companies would be at least as efficient as the government in providing highway maintenance in the sense that, for any given physical maintenance operation, a private highway owner would incur costs less than or equal to those incurred by a government owner. Or, equivalently, for any given level of expenditure on highway maintenance, a private highway owner could provide at least as much physical highway maintenance as could a government owner.

The "at least" in this point is important. Many would argue that private owners would be significantly more efficient than government owners in maintaining highways, especially over the long run. This argument is perhaps more sociological or cultural than economic, because there is nothing in economic theory that explains why the government could not minimize maintenance production costs. Nevertheless, perhaps because of the different types of incentives that operate within a bureaucratic-political organization as opposed to a private for-profit organization, or perhaps because of the various administrative regulations and restrictions that constrain management flexibility in government organizations, it could be argued that it is quite likely that private highway owners would be significantly more efficient than public highway owners. This is a proposition that is difficult to test now because there are almost no privately owned highways to compare with government-owned ones.

It should be noted in this regard that highways could be privatized in a manner that would almost guarantee that maintenance would be produced more efficiently on them by their new private owners than would be possible for the government. This could be accomplished simply by the government refusing to accept any bids for highway purchases that did not include some capitalization of maintenance production efficiency improvement over what the government estimates it could do. Or, equivalently, government highway departments could be allowed to compete on an equal footing with private bidders in the process of auctioning off the highways. In this way, any highways that were sold to private bidders would necessarily be sold to buyers who at least believed (and were willing to put their money where their beliefs were) that they could maintain the highways more efficiently than the government. Furthermore, the public would obtain, through the highway sale price, the capitalization of this maintenance production efficiency improvement.

The cost of national highway maintenance is so huge (easily $30 billion per year just to maintain existing highway and bridge capacity, including necessary rehabilitation and reconstruction) that even a small percentage improvement in the efficiency of this maintenance would yield large absolute savings. For example, a 5 percent improvement in highway maintenance efficiency would be like getting at least $1.5 billion more per year in revenue for highways. Though there would probably be substantial administrative costs associated with highway privatization in the form, for example, of needed regulatory oversight of the private highways for safety and economic efficiency purposes (discussed in the next section),

these administrative costs might well be much smaller than the highway maintenance production efficiency gains.

Furthermore, the same technique described earlier for ensuring that privatized highways bring production efficiency improvements could also be used to ensure that these efficiency improvements are large enough to more than offset any administrative costs. The government would simply have to estimate the administrative costs required to regulate the highway being offered for sale and then announce a minimum qualifying bid price that would include enough capitalization of maintenance production efficiency improvements to cover the expected capitalized administrative costs, or highway owners could be assessed fees to support their own regulation, as is typically done by state utility commissions to the companies they regulate.

It should also be noted that the production efficiency argument for highway privatization applies to private nontoll roads as well as to private toll roads, at least potentially. For example, the government could sell a nontoll road to a private owner and pay the private owner an annual public access fee, say, per vehicle using the road. In this way the road could be privatized without being converted to a toll facility. The maintenance production efficiency incentive would be preserved as long as the fee per vehicle paid by the government for public use rights was not some "cost-plus" type of fee based on maintenance expenditures by the owner.

For all of these reasons, the third of the justifications for highway privatization, to improve maintenance production efficiency, may well be the most general and powerful economic reason for privatization of highway ownership at least for existing highways.

The fourth and final reason listed at the beginning of this section as a possible economic justification for privatization of highway ownership is to improve the quality of highway services. It might be expected that private highway owners would bring a more vigorous and innovative approach to managing traffic flow and servicing their traveling "customers." Private highway companies would not be in perfect competition with each other or with competing government-owned roads in the same travel markets, but there would be some competition. And highway company revenues would be directly proportional to usage of the roads, whether the privatization were accomplished by toll roads or by private nontoll roads as described previously (with public access fees paid by the government per vehicle using the road). So private highway companies might have more of an incentive than the government does to provide services and amentities and to manage traffic flow in a manner that pleases their users, the traveling public. With the present "monoculture" of nothing but government-owned highways it is hard to test this hypothesis.

POLICY CHALLENGE: EFFICIENT GOVERNMENT REGULATION OF PRIVATELY OWNED HIGHWAYS

As was argued in the preceding section, highway privatization can potentially bring important production efficiency and revenue-generation benefits, but, unless private roads can be regulated or controlled efficiently, these benefits will probably not materialize or not be worth the likely loss in allocative efficiency associated with excessive tolls and suboptimal highway quality, which private highway owners would provide, due to the highway market "imperfections" described in the first section. Therefore the economic feasibility and desirability of highway privatization depend critically on whether the effects of such market imperfections can be efficiently controlled and mitigated without negating the potential benefits. If the prospects for such efficient regulation appear good, then the overall argument to at least experiment with some highway privatization would appear to be quite strong.

Laissez-Faire Result: How Bad Could It Be?

How "bad" would things be if privatization were undertaken without any government intervention? There would be two basic problems, price and quality.

If privatization occurred with no government intervention, the private roads would virtually all have to be toll roads because the highway owners would have little other source of revenues. So the first question to ask is "When should existing highways be tolled?"

Viewed purely from the perspective of overall economic efficiency, this question is rather easy to answer. It is efficient to toll a previously untolled road only if

$$ACC < \frac{T^2 \varepsilon}{2P}$$

where

ACC = average cost of collection of tolls per vehicle mile traveled (VMT),
ε = absolute value of the elasticity of demand for travel on the highway with respect to average total user cost (P),
T = efficient toll per VMT, and
P = average total user cost per VMT including value of time and inconvenience and money cost including wear and tear on vehicles.

In this formula, the efficient toll (T) represents the so-called "Pigouvian tax," which would induce efficient usage of the highway. The efficient toll is equal to the difference between the marginal social cost of highway usage (including the marginal effect on congestion) and the average private cost of highway usage actually experienced by the user, both taken at the efficient usage level on the highway. The efficient usage level is that at which the marginal social value of usage equals the marginal social cost of usage.

On uncongested existing highways, the efficient toll would typically be only about a cent or two per VMT, perhaps quite a bit less for light vehicles. The efficient toll consists essentially only of the additional maintenance cost caused by marginal highway usage. In effect, this efficient toll for uncongested roads is already being paid in the form of gasoline taxes and other usage-sensitive highway user fees. On congested urban expressways the efficient toll might typically be 10 or 20 cents per VMT, even for light vehicles, because of the marginal congestion cost of traffic.

To get some idea of the practical implications of the formula,

some "ball park" numbers can be plugged in for the relevant variables. A typical value for P would be 40 cents per VMT, and a reasonable guess for ε would be 0.75. ACC consists of tollbooth delay time costs for the highway users plus monetary (administrative) costs for the toll-collecting agency. Suppose the value of time for the average vehicle using the highway is \$5.00/hr, a figure consistent with econometric findings in studies of travel demand. And suppose the average vehicle stops at toll gates for 10 sec per trip on the highway. Then, in cents, the time cost is $1.4/L$, where L is the average vehicle trip length on the highway (in miles). Suppose 24 person-hours per day are required for toll-taker wages for each 5,000 vehicles per day using the highway and toll-taker wages are \$10.00/hr including fringe benefits. Then the monetary collection costs are $4.8/L$. Thus $ACC = 6.2/L$, and the formula expressed in terms of L becomes

$$T > 25.7/L^{1/2}$$

Thus, if L is 10 mi, the efficient toll must exceed 8.1 cents per VMT; if L is 100 mi, T must exceed 2.6 cents per VMT; and if L is 500 mi, T must exceed 1.15 cents per VMT. Otherwise, the losses from the cost of toll collection will exceed the gains in highway usage efficiency. It therefore appears to be clear, considering that users already pay a gasoline tax, that the only existing nontoll highways that could be efficiently tolled, using existing toll collection technology, are roads that suffer from significant traffic congestion.

As a result of this, if potential changes are limited to the toll road model of highway privatization (as would be implied by a pure laissez-faire approach), then the number of miles of existing highway that are candidates for privatization are greatly reduced, at least assuming existing toll collection technology.

But what of that relatively small portion of the total highway mileage but important fraction of the total highway usage, consisting primarily of the major urban freeways and beltways, that is congested? Here, the economic efficiency problem from the pure laissez-faire approach to privatization would not be that the roads would be tolled but that they would be tolled at too high a level. The profit-maximizing toll would greatly exceed the efficient toll, even under conditions of congestion. Table 1 gives a comparison of the efficient toll with the profit-maximizing toll assuming that the zero-toll demand is 80 or 95 percent of the facility capacity and demand elasticity is either one-half or one (conditions currently typical in urban areas in the daytime). Although the profit-maximizing toll might be closer to the socially optimal toll than the current zero-toll under relatively high congestion (95 percent saturation) with unit elasticity, it is nevertheless clearly above the socially optimal toll. With relatively low congestion or inelastic demand, the profit-maximizing toll greatly exceeds the social optimum and would be worse even than the currently typical zero-toll. If constant elasticity were assumed instead of linear demand, the profit-maximizing tolls would diverge even further from the efficient level.

TABLE 1 COMPARISON OF OPTIMAL AND PROFIT-MAXIMIZING TOLLS ON CONGESTED URBAN EXPRESSWAYS (cents per VMT)

	Zero-Toll Demand as Percentage of Capacity	
	80%	95%
Elasticity = 1/2		
Profit-maximizing toll	38.0	46.0
Optimal toll	7.5	17.7
Elasticity = 1		
Profit-maximizing toll	23.0	28.5
Optimal toll	7.5	17.7

NOTE: Linear demand is assumed over the range. Elasticities are point elasticities at the zero-toll price, where price is defined as total user cost (value of time and inconvenience as well as monetary outlays).

Now consider the problem of highway quality, or maintenance policy, under laissez-faire privatization. It can be shown that the profit-maximizing maintenance policy will differ from the efficient policy whenever the marginal social benefit (MSB) of highway quality differs from the marginal private benefit (MPB) of highway quality to the owner. Furthermore, if MPB is less than MSB, the profit-maximizing maintenance policy will provide too little highway quality over the long run. MSB is here defined as the gross value society obtains from a marginal unit of highway quality at any given time. MPB is defined with reference to the private highway owner, and it equals the additional usage revenue obtained by the private highway owner from one more unit of highway quality at any given time. It can furthermore be shown that, no matter what level the toll is set at, the result will be that MPB will be less than MSB [see Geltner *(3)* for details]. Thus the laissez-faire highway will not only charge too high a toll but it will provide too little maintenance of the highway.

Efficient Solutions to the Excess Toll Problem

The excess toll problem described in the previous subsection can be dealt with, at least in theory, by appropriate government privatization policy. There are two main alternative policy approaches that could control or avoid this problem.

The first possibility is simply not to privatize via tolling but rather to privatize highways according to the "nontoll private highway" model, previously mentioned. This approach does require some continuing government involvement in the highway business, but as a "customer" rather than as the owner or producer. Private nontoll roads would receive their revenues from public access fees paid by the government per unit of usage (e.g., VMT) of the road. Usage would have to be monitored, much as television network rating agencies monitor television viewing, and the billing might be on a monthly or an annual basis. The formula defining the fee per VMT would be specified by the government before sale of the highway.

This form of privatization would be appropriate wherever the government did not want to toll a previously untolled facility, either because it would be economically inefficient to do so (e.g., uncongested roads) or because it would be socially undesirable (or politically impossible) to convert a freeway into a tollway.

Now consider the second approach to controlling the excess toll problem: government regulation of the toll. This is the method that would apply in the case in which the government did wish to privatize via the toll road model, either because the road is already tolled or because the government desires to

institute tolling on a previously free facility (for revenue generation or usage efficiency purposes, or both).

The traditional method of economic regulation of public utilities and transportation companies in this country would regulate the tolls on the basis of "fair rate of return" on (typically historical or "book") value of investment, or "operating ratio." The allowable return or ratio is calculated net of maintenance expenditures, thereby destroying the normal profit-maximization incentive to minimize production costs. Another problem results because the absolute profits allowed may be a direct function of the amount of capital invested in the highway by the owners.

In the long run this method of regulation distorts production and removes the incentives for production efficiency. It is also complicated and expensive to administer and subject to industry "capture" of the regulators and other abuses. Its justification is that, presumably, these losses in production efficiency are more than compensated by gains in overall allocative efficiency compared with what would occur in the absence of regulation (assuming laissez-faire private ownership). Applied to the private toll road problem, for example, this form of regulation would probably result in both lower tolls and better maintained roads than would occur without any regulation. Thus traditional regulation deals simultaneously with both of the problems that result from laissez-faire private ownership, though with no guarantee of an economically efficient result overall.

Therefore economic regulation as typically practiced in this country is an admittedly imperfect instrument from the economic efficiency perspective. However, that the government is currently the owner of the highway assets might make it politically and legally easier to improve on this traditional type of regulation in the case of highway privatization.

A formula for the maximum allowable toll could be prespecified and fixed as part of the terms of sale of the highway, known by all bidders in advance of the bidding. This formula could be based on such things as the highway traffic volume and speed flow, broad-based price indices such as the Consumer Price Index or the Producer Price Index, and determinants of average user value of time such as regional per capita income. The formula for the maximum allowable toll could be based on the efficient Pigouvian toll formula, including congestion costs, as described earlier.

This efficient toll is effectively independent of the absolute level of highway maintenance expenditures, which is why the profit-maximization incentive to minimize internal highway maintenance costs would be preserved under this regulatory system. The efficient toll depends on the marginal cost of highway quality maintenance with respect to usage volume, but this marginal cost is a technical or engineering-based parameter that could be estimated by an independent agent, such as an engineering firm or panel of highway engineering experts. Unlike the absolute level of maintenance expenditure, the marginal maintenance cost with respect to traffic volume is not a parameter that is subject to direct manipulation by the highway owner.

Because the toll formula as well as any highway maintenance requirements would be known by all bidders in advance of bidding for the highway, no highway owner could subsequently claim that the toll and maintenance requirements constitute a "taking" of private property without compensation by the government (which is the legal basis of "fair rate of return"–based regulation). As long as the government cannot unilaterally change the toll formula and maintenance requirements subsequent to sale of the highway, financial difficulty on the part of the highway company would not be related to any government "taking." Similarly, lower maintenance production costs leading to high profits for the owner would not give the government any legal basis to force the highway owner to reduce the tolls, and the incentive for the highway owner to minimize costs would thereby be preserved.

Thus the proposal to divorce the allowable toll from any direct link to rate of return or to maintenance expenditure would appear to solve the excessive toll problem without introducing the incentives for inefficient production usually found in traditional forms of government regulation of privately owned utilities.

Efficient Solutions to the Maintenance Problem

There are two basic approaches that the government could take to cause the privatized highway (toll or nontoll) to provide the desirable (i.e., efficient) level of highway quality over time without destroying the private owner's normal incentive to minimize the cost of producing highway maintenance. These two approaches are not mutually exclusive and indeed may well be viewed as complements of one another.

The first method, the "legalistic" approach, is simply for the government to require in the terms of sale of the highway that it be maintained to a certain level of physical quality. Various legal mechanisms exist to structure such a requirement, and they are not without precedent in major capital asset transactions. For example, the highway could be sold subject to an asset maintenance covenant, with the government holding a lien on the highway. (This would be not unlike the type of legal covenant often found in corporate bonds and debentures to protect the bondholders.) Or the government could retain the highway right-of-way and "sell" the highway by means of a perpetual lease, one of the terms of which could be asset maintenance.

These methods tend to be legalistic and adversarial, however, and they could be difficult and costly to enforce by themselves. For this reason it might make sense to supplement these legalistic mechanisms with a marketlike mechanism that gives the private highway owner a profit incentive to provide the correct maintenance.

The second basic approach is for the terms of sale of the highway to prespecify the formula of a Pigouvian subsidy or incentive fee to be provided by the government to the highway owner. In the case of a nontoll road, this incentive payment would simply be included in the definition of the public access fee to be paid by the government per VMT of usage of the road. In the case of a toll road, the incentive payment would be made by the government to the highway owner, per VMT of usage, over and above the revenues the owner collected from tolls. Such an incentive payment system would be defined and would work in the following manner.

The unregulated private highway company would voluntarily provide the economically efficient level of maintenance

(in order to maximize its own profits) if the MPB equalled the MSB. The basic idea of the incentive payment is to define this payment according to a formula that will cause the MPB to equal the MSB. For example, if the incentive payment per VMT is defined independent of the current level of highway quality, then the appropriate formula is

$$S = t + \frac{P}{\varepsilon} \tag{1}$$

where

- t = usage-sensitive highway user fees or taxes per VMT apart from tolls (e.g., gasoline taxes),
- P = total average user cost,
- ε = elasticity of demand for highway usage with respect to P, and
- S = payment per VMT by the government to the highway owner.

If highways were perfectly competitive then ε would be infinite and the second term in Equation 1 would vanish. But highways are not perfect substitutes for one another, and the ε perceived by the typical highway owner is likely to be around unity, perhaps even less. Thus, because P is typically on the order of 40 cents per VMT and highway user fees are currently only 1 or 2 cents per VMT, S is likely to be some 40 times the current level of government highway funding.

Providing such a large public access fee or subsidy would not transfer wealth to the highway company from the government (i.e., from the rest of society) because the bids for the purchase of the highway would be based on the knowledge of the level of S, capitalizing and thereby transferring to the government the huge profits implied by S. If the government invested the proceeds of the sale of the highways in a sort of "highway endowment fund," most or all of the annual access fees could, on average, be paid out of the earnings from this endowment, forever.

However, if the government does not wish to offer such a large public access fee as S, a slightly more complicated formula, which defines the incentive payment as a dynamic function of the cumulative changes in observed highway quality, could be used. This dynamic formula requires knowledge of the highway quality and of the elasticity of average total user cost (P) with respect to highway quality, but it would allow the incentive payment per VMT to be at a level near that of current government expenditures on highways.

It may be objected that the incentive payment approach would be difficult to implement because it requires that the government know or estimate the value of some unknown parameters, such as P or ε. In reality, the government must estimate these parameters anyway in order to follow an efficient maintenance policy, even if it owns the highway itself. Although governments may not currently explicitly estimate these parameters, their maintenance policy decisions imply implicit estimates of these parameters or the maintenance policy cannot be argued to be based on maximization of economic welfare. Forcing this process to be more explicit cannot harm the efficiency of the result.

CONCLUSION AND SUMMARY

In the first section were described the market "imperfections," which cause laissez-faire private highway provision to fail and which no doubt underlie much of the theoretical rationale and historical fact of government ownership of most highways throughout the world. The main dangers in this regard would be charging of excess tolls (in the case of unregulated private toll roads) and providing too little highway maintenance (in the case of both private nontoll roads and private toll roads).

In the second section the basic economic argument for privatization of ownership of existing highways in this country was presented. Noted were several reasons that might make a carefully executed program of highway privatization advantageous on economic efficiency grounds, provided the government could prevent various types of inefficient behavior that profit-maximizing private highway companies could be expected to display under a laissez-fare regime because of the imperfections described in the first section.

In the third section were described some perhaps novel but quite possibly workable ideas for highway privatization (either toll or nontoll) so that the main potential advantages of highway privatization might be preserved while preventing the problems of excessive tolling or suboptimal maintenance of highway quality that would otherwise stem from the imperfections of the highway market. This proposed type of governmental intervention would not destroy the normal private-sector incentive for production efficiency.

Finally, although this paper has been focused on privatization of existing highway capacity, the techniques and policies described in the third section could also be applied to privatization of the provision of new or additional highway capacity. For example, the government could specify how much new capacity is to be built and where it is to be built. The government could then auction off the rights to build and own that specified capacity, much as it auctions off petroleum leases. If the terms of sale are prespecified as described, the result should be efficient construction and maintenance of the new highway capacity.

In summary, it appears that the economic argument in favor of privatizing some highways in one way or another (toll or nontoll) can be encapsulated in three main points. First, it appears at least plausible that privatization could lead directly or indirectly to some highway maintenance production efficiency improvements (for both private nontoll roads and toll roads) and to some additional revenue generation and usage efficiency improvements (where the privatization is accompanied by tolling). Second, it is really impossible to either prove or disprove these assertions in the abstract; some real-world privatization experiments must be carried out to learn whether privatization can demonstrate more efficient or effective maintenance techniques and roadway pricing. Third, there would appear to be little downside risk from a policy of careful and selective privatization. The main dangers, that excessive tolls would be charged or that the roads would not be maintained to high enough standards of quality, should be avoidable by using the techniques described in the third section. If privatization does not appear to work well, it should be possible to modify or abandon the experiment with little or no irreparable damage, at least in the case of nontoll roads, because roads do

not wear out overnight, and it would be obvious if they were not being well maintained.

REFERENCES

1. P. Choate and S. Walter. *America In Ruins.* Council of State Planning Agencies, Washington, D.C., 1981.
2. *Hard Choices.* U.S. Joint Economic Committee, Washington, D.C., 1984.
3. D. Geltner. *Highway Privatization.* MIT/CCRE Working Paper. Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, 1986.
4. F. Moavenzadeh. *Private Highways: A Proposal To Help Resolve the Highway Infrastructure Crisis.* Presented at MIT Center for Transportation Forum, 1986.

Some Financial, Economic, and Social Policy Issues Associated with Toll Finance

GARY L. GITTINGS

Financial pressures are forcing state departments of transportation to consider alternative funding strategies, including an expanded roll for toll financing as a supplemental source of revenue to complement current user charges. It is timely and appropriate, therefore, to examine some important financial, economic, and social policy issues associated with tolls. The discussion is primarily directed toward the use of tolls for major reconstruction on federal-aid highways. Among the findings are that, despite the relative inefficiency of toll finance as a highway revenue mechanism, there are circumstances in which tolls may be economically justified. One example is when there are insufficient revenues from traditional highway user imposts and toll financing is used to make needed highway improvements many years in advance of when they otherwise could be made. However, federal policy, which mandates full repayment of all prior federal aid used on a potential toll facility, severely limits the usefulness of the toll mechanism for purposes of resurfacing, restoring, rehabilitating, and reconstructing highways. This policy has no economic justification. From a social equity perspective, toll financing has a potential advantage over current user taxes and fees because of the ability to more closely align the user charge with the benefit received or with the direct use made of the highway facility. The choices made about toll collection system design have significant implications for the capital and operating costs of toll collection. However, toll collection design decisions cannot rest on cost criteria alone, for the design will have implications for user access, traffic route choice, toll revenue, safety, and highway financing equity that also must be recognized.

During the last decade numerous state departments of transportation have come under extreme financial pressure because of the magnitude of the funds required to maintain and rehabilitate the existing highway network at a satisfactory level of service. In addition, new highway investments, although perhaps not demanded to the same degree as in past eras, nonetheless remain an important and necessary part of most states' highway programs. The states have responded to the fiscal pressures with a variety of strategies including shifting priorities, adopting new management techniques, increasing the rates of current revenue sources, and searching for new revenue sources. New priorities have caused a shift away from the long-range network expansion programs prevalent in the 1960s to programs that emphasize system preservation through maintenance, rehabilitation, and improved management of existing resources. New management techniques have been adopted in such diverse areas as pavement maintenance, construction, quality assurance, and fiscal planning and programming. In a number of states, the means by which highway needs traditionally were defined have changed to reflect more accurately the benefits that are achievable through a given improvement. Overall, emphasis has been placed on improving the management and cost-effectiveness of highway programs.

The Surface Transportation Assistance Act (STAA) of 1982 increased and modified the structure of highway user taxes to provide for a 50 percent increase in funding for the federal-aid highway program. To match the federal aid, many states implemented user tax and fee increases of their own, but, because funding demand continues to exceed supply, states have also been looking to new sources of funding, including an expanded role for toll financing of highway improvements. Wisconsin, for example, initiated a study before passage of the STAA on toll financing for Interstate "4R" (resurfacing, restoration, rehabilitation, and reconstruction) needs *(1)*. Although the 4R

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funding provided by the STAA reduced Wisconsin's immediate need for toll financing, other states continue to study toll financing for new construction as well as for major reconstruction. Pennsylvania sponsored two toll-financing feasibility studies for this purpose *(2, 3)*. Arizona, Colorado, Maryland, Michigan, and Virginia are all reported to have recently finished toll feasibility studies *(4)*.

The renewed interest in tolls has prompted recommendations for changes in current federal statutes that limit the use of toll financing. Proposals have been made by such diverse groups as the Heritage Foundation, the American Association of State Highway and Transportation Officials, and the Reagan administration, as well as by individual states *(5–7)*. Numerous bills related to toll financing have also been introduced in the Congress. In most cases, the interest in tolls is as a supplemental revenue source to complement, not replace, existing user charges.

Given the current interest in toll financing, it is appropriate and timely to examine some of the important financial, economic, and social policy issues associated with the toll pricing mechanism. Such is the purpose of this paper. The discussion is directed principally to the use of toll financing for 4R-type improvements to existing highway facilities, although most of the issues pertain to toll financing of new construction as well.

IMPLICATIONS OF FEDERAL-AID PAYBACK POLICY FOR TOLL FINANCING

It has long been recognized that toll financing is a relatively expensive means of raising revenue for highway improvements and imposes additional costs on the economy that are not incurred from the use of more conventional means, such as motor fuel taxes or vehicle registration fees. The most commonly recognized additional costs are

1. Direct costs of toll collection, including the capital costs to construct toll collection facilities and purchase collection equipment and the operating costs to collect tolls and maintain the toll facilities;
2. Direct costs on toll facility users from stops at toll collection plazas; these costs include higher vehicle operating costs, increased travel time, and potentially decreased highway safety;
3. Direct costs to users diverted to alternative routes who otherwise would have used the toll facility if it were toll free; and
4. Indirect costs, imposed by diverted traffic, to users of alternative routes.

These costs can be significant; they have an important bearing on the economic justification of toll financing. The most critical determinants of the financial viability of toll road projects are the magnitude of capital construction costs, the prevailing bond coupon rates and coverage ratios, the type of toll collection system, the toll rate structure, and the volume and vehicle mix of traffic. However, for financing the reconstruction of existing federal-aid highways or bridges, another factor, federal policy on the payback of federal aid previously expended on the facility, is in most instances the most important variable determining the magnitude of total costs and the ultimate financial viability of toll financing *(2)*.

Federal policy on payback of federal aid is founded on the doctrines of 20th-century, federal highway funding policy. Commencing with the passage of the Federal-Aid Road Act in 1916 and reinforced in the Federal-Aid Highway Act of 1921, U.S. government highway funding policy has encouraged funding sources supported by general user taxes and discouraged direct user charges or toll financing *(8, 9)*. Indeed, the early federal acts explicitly prohibited the use of federal aid to build toll roads. However, through the years modifications in federal policy have gradually relaxed the strict restrictions preventing the mix of federal aid and toll facilities, although a general policy favoring toll-free roads is still maintained. In most cases, a condition of these modifications has been that tolls be removed from the facility when the construction debt has been retired.

The exceptions permitting the mix of federal-aid and toll financing have arisen from recognition of the benefits of an integrated, well-maintained highway network whether or not it is completely toll free *(2)*. The first type of exception, granted in 1927, resulted from congressional awareness that its prohibition on tolls was leading to a fragmented highway network. State and local governments were building toll facilities but not connecting them with federal-aid roads. Congress modified its toll policy to permit federal funding of toll bridges and their approaches on the federal-aid highway system.

The second and third exceptions, contained in the Federal-Aid Highway Act of 1956, permitted the use of federal aid to construct approaches to toll roads on the Interstate system and incorporated approximately 2,500 mi of existing toll roads into the proposed 40,000-mi Interstate system. In the latter case, Congress acknowledged the impropriety and wastefulness that would result from building high-class free roads parallel to and in competition with existing turnpikes *(8)*.

The fourth exception also pertains to turnpikes on the Interstate system. Section 105 of the Surface Transportation Assistance Act of 1978 authorized the use of federal Interstate 4R funds on Interstate system toll roads. However, as with the first and second exception categories, pledges must be made to remove the tolls when the bonded debt is retired. Three states, Connecticut, Kansas, and New York, have signed Section 105 agreements *(10)*.

Instances of Federal-Aid Payback to Permit Tolls

In addition to these four exception classes, Congress has periodically allowed states to repay federal aid expended to build or partly build a highway so that tolls may be imposed. There have been at least five such cases, and in each instance the passage of the legislation necessary to permit the repayment of federal funds has not appeared to be politically difficult *(11)*. However, in each case the facility was less than 50 mi long; it is not clear that congressional approval would be as readily forthcoming for the conversion of a longer, federal-aid route or a portion of the Interstate system to toll road.

That, in each of the five cases, Congress required the full payback of all federal aid has significant implications for the

financial feasibility of converting any existing limited-access highway to toll collection. For example, Rao and Gittings determined that the full payback of $385.7 million of federal aid expended on Interstate 80 in Pennsylvania as of December 31, 1979, would account for approximately 42 percent of the required bond issue for capital costs to convert the road to toll collection *(2)* (Table 1). The expense of payback exceeded the estimated reconstruction cost of the highway at that time and was nearly 20 times the cost of constructing the toll collection barriers. Without the payback requirement, the required bond issue was estimated to be 53 percent lower, as the data in Table 1 indicate.

This increase in the bond issue occasioned by a full payback requirement also dramatically raised the toll rates needed to make I-80 a self-sufficient (including a satisfactory debt service coverage ratio) toll road. The estimated necessary toll rate for automobiles ranged from $1.68 to $3.22 at each of the five barriers along the route if full payback were mandated. The range results from alternative assumptions about the amount of traffic diverted by tolls *(2)*. Assuming no payback, the estimated necessary automobile toll rate dropped to a range of from $0.66 to $1.77. Assuming an automobile traveling the full 318-mi length of I-80 in Pennsylvania, the per mile toll rate would range from 2.7 to 5.2 cents with full payback and from 1.1 to 2.8 cents without payback. The latter is comparable to toll rates on existing, older, major nonurban toll roads in the United States.

The impact of federal payback policy on the financial feasibility of converting any given Interstate route to a toll road is even stronger today than it was just a few years ago because of the recent major federal expenditures for Interstate 4R. For example, from January 1979 to January 1986, approximately $210 million was spent on I-80 4R projects in Pennsylvania. A payback requirement including the 4R outlay would certainly preclude the feasibility of I-80 as a self-sufficient toll road and might even jeopardize a breakeven operation, in which annual revenues just cover annual expenses including debt service, at reasonable toll rates.

Similar findings were also estimated for toll financing of the rehabilitation of a short 46-mi stretch of I-90 through northwestern Pennsylvania just south of the city of Erie *(2)*. Full federal-aid payback consisted of $81.6 million, which amounted to 54 percent of the required bond issue to convert the route to a toll road. This percentage was higher than on I-80 because the 4R requirements were not proportionately high. The required bond issue was estimated to be three times lower without payback than with full payback. The impact of the payback requirement on the required toll rates was similar to that for I-80.

The findings from the I-80 and I-90 case studies in Pennsylvania led to the conclusion that the principal costs of converting most existing limited-access, federal-aid highways to toll roads would be the payback of prior federal-aid expenditures. There may be a few facilities for which existing reconstruction costs might exceed the cost of previous federal aid, but the number of such facilities is likely to be low given the recent federal emphasis on restoration *(2)*.

An additional conclusion from the case studies was that most limited-access highways of at least moderate traffic levels (probably 10,000 or more vehicles per day and an average traffic mix between trucks and automobiles) would generate sufficient revenues from tolls set at prevailing rates to cover all financial costs of toll collection, including amortized debt service on toll collection facilities plus annual roadway maintenance expense and the annual debt service on major reconstruction. However, few routes carry sufficient traffic volumes to cover the total costs of toll road conversion and operation if full federal-aid payback is required *(2)*. It is should be noted that Rao and Gittings did not explicitly consider the potential loss of Interstate 4R funds in their case study calculations.

Evaluation of and Recommendation on Payback Policy

Given the importance of a federal policy requiring full federal-aid payback to the financial viability of using toll financing to rehabilitate existing major routes, is there an economic rationale that would justify such a policy? When a highway facility has been constructed, the federal aid expended for construction is a historical or sunk coat. Unless the remaining physical resources in the highway facility have alternative uses, and the federal government can lay claim to these resources on

TABLE 1 CAPITAL COSTS OF CONVERTING INTERSTATE 80 TO A TOLL HIGHWAY IN PENNSYLVANIA

	Federal-Aid Payback		No Federal-Aid Payback	
Capital Cost Component	Cost ($ million)	Percentage	Cost ($ million)	Percentage
Construction of toll barriers, plazas, and buildings and purchase of collection equipment	20.2	2.2	20.2	4.7
Payback of federal aid	385.7	42.0		
Reconstruction (4R) of highway	315.4	34.3	315.4	73.8
Interest and bond issue costs	197.6	21.5	92.0	21.5
Total required bond issue	918.9	100.0	427.6	100.0

NOTE: Principal assumptions are that all figures are in 1980 dollars; there is a 30-year, 9 percent coupon bond issue; federal aid is used through December 31, 1979, for both original construction and improvement; there is an open, main-line barrier, toll collection system; and interest costs are for bondholder payments during construction.

the basis of its prior investment, requiring the payback of federal aid as a condition of toll financing has no economic justification. Because the value of the remaining physical resources in the case of deteriorated highways appears to be quite limited, if not nonexistent, a federal policy mandating full payback incorrectly imposes a financial cost on the state for physical resources that no longer have economic value. Such a policy distorts state decision making away from what potentially might be a prudent, economically justified course of action—toll financing.

A federal policy mandating full payback would also require the charging of higher tolls that would divert more traffic and misallocate more resources than otherwise is the case with toll financing. That is, because toll rates set high enough to cover full payback of federal aid include charges that are not occasioned by highway use, they result in a greater misallocation of traffic between the toll road and toll-free roads than would be the case if full payback were not mandated. This traffic misallocation also imposes additional economic costs on users of alternative toll-free roads.

Further, from an equity viewpoint, full payback is highly unjust. In effect, payback is forcing users of the new (reconstructed) facility to pay for the cost of the old (original) investment, even though they are not the principal beneficiaries of that investment. The majority of the benefit of the original investment accrued to its users, who presumably, through user taxes, have already paid for the cost of the original facility.

Nonetheless, the obligation of federal aid to the states is legally viewed as a contractual arrangement, stipulating that federally aided facilities shall be free of tolls. It may be politically difficult to pass legislation to break the provisions of the contract despite the economic and social equity rationale. Therefore, it is likely that federal payback will be required. However, if payback is required, it should be related to the remaining value of the highway facility and not the full cost of the original investment. Payback should not be required on that portion of the original value that has been consumed through use or natural deterioration. It follows that the logical way to measure the remaining value for payback is to depreciate the federal-aid portion of the original investment that has deteriorated, allowing for a suitable residual or salvage value of the highway elements not fully depreciated.

Depreciation is a complex issue, however. A highway facility contains many physical components with vastly different service lives. For example, pavements generally deteriorate in 10 to 20 years, depending on usage, whereas structures may last more than 50 years and rights-of-way may not deteriorate for thousands of years. Consequently, there are legitimate arguments for using different service lives for each highway component; this complicates the depreciation calculation. Additional complexities include estimating a market salvage value for each component and establishing the appropriate method of depreciation. Traditional private-sector depreciation methods, such as straight-line or various accelerated alternatives, may not be indicative of the rate at and manner in which highway components depreciate.

Regardless of the complexities that depreciation may introduce, they are not significant enough to invalidate the concept nor the practicality of relating federal-aid payback to the remaining value of the highway facility. For example, if the highway pavement, including subbase, is badly deteriorated, the federal share of the original pavement cost should be fully depreciated with no salvage value. None of the pavement cost should be included in the payback requirement. Because other highway elements, such as earthwork and structures, have longer service lives than pavements, they should be depreciated only partly, and the remaining value should be included in the federal payback. The full value of the federal share of the right-of-way and engineering costs should also be included in the payback. The straight-line method of depreciation is the simplest and most straightforward to use, and it probably provides a reasonably accurate estimate. Although further refinement of this suggested approach could be made, it probably would not add significantly to the accuracy of the estimate of the proper depreciated value for federal payback purposes.

The consequence of a federal payback policy with depreciation for the financial viability of using toll financing can again be demonstrated by the two Pennsylvania case studies. Table 2 gives the impact on the total required bond issue (A), annual debt service requirement (B), total annual costs (E), and annual revenue goal (F) from the variation in payback policy for both I-80 and I-90. In both instances, substantial savings result from a policy that allows depreciation. These savings improve the financial viability of both projects, moving them from a situation in which they fall short of breakeven to one in which they nearly meet the annual revenue goal (Figures 1 and 2).

CONSEQUENCES OF ALTERNATIVE TOLL COLLECTION SYSTEMS

Because toll financing occasions additional economic and financial costs not incurred with traditional user charges, it is important that these additional costs be minimized to mitigate the adverse impacts of tolls. One potential for significant cost savings lies in the design of the toll collection system. This design involves choices about the type of toll system, the number of collection points, the location of collection points, and the degree of automation in the system. The choice made about each of the items will have significant implications for the capital and operating costs of toll collection. However, toll collection design decisions cannot rest on cost criteria alone, for the design will have implications for user access, traffic route choice, toll revenue, safety, and highway financing equity that also must be recognized.

The complexity of the design decisions varies with the type of highway facility. For bridges, the design choices are relatively straightforward. The choices are primarily concerned with two questions: whether to collect tolls in one or both directions and at which end or ends of the bridge to locate toll barriers. The most favorable circumstances for collecting tolls in only one direction are situations in which a high percentage of the trips use the same route in both directions, such as work trips, where there is not a good alternative route. In these situations tolls can be doubled and collected in only one direction without arousing strong political objections. If tolls are to be collected in both directions, an additional choice must be made between using one or two barriers.

TABLE 2 IMPACT OF ALTERNATIVE PAYBACK POLICIES ON THE TOTAL FINANCIAL COSTS OF CONVERTING PENNSYLVANIA ROUTES TO TOLL ROADS ($ millions)

	I-80			I-90		
	Federal Payback Without Depreciation	Federal Payback With Depreciation	No Federal Payback	Federal Payback Without Depreciation	Federal Payback With Depreciation	No Federal Payback
Capital costs						
Construction of toll barriers and interchanges	20.2	20.2	20.2	9.8	9.8	9.8
Payback of earlier federal aid	385.7	159.4		81.6	32.7	
Construction or reconstruction of highway	315.4	315.4	315.4	27.2	27.2	27.2
Interest, bond issue costs	197.6	135.6	92.0	32.5	19.1	10.1
Total required bond issue (A)	918.9	630.6	427.6	151.1	88.8	47.1
Annual debt service requirement (B)	90.8	62.3	42.3	14.9	8.7	4.6
Debt coverage at 150 percent (B × 1.5) (C)	136.3	93.5	63.4	22.4	13.1	7.0
Total operation and maintenance expense (D)	25.4	25.4	25.4	6.4	6.4	6.4
Total annual costs (B + D) (E)	116.2	87.7	67.7	21.3	15.1	11.0
Annual revenue goal (C + D) (F)	161.7	118.9	88.8	28.8	19.5	13.4

NOTE: Principal assumptions are that all figures are in 1980 dollars; there is a 30-year, 9 percent coupon bond issue; federal aid is used through December 31, 1979, for both original construction and improvement; there is an open, main-line barrier, toll collection system; and interest costs are for bondholder payments during construction.

Policy Decisions on Highways

Determining the physical configuration of the toll collection system is more complex for highways than for bridges. Two major policy decisions must be made. One concerns the traffic that is to pay tolls—through traffic only, through and some local traffic, or all users. The second is a choice about the number of interchanges. Both policy decisions should be made interactively for they deal with the same broad issue of facility access and require an assessment of trade-offs on facility costs, traffic impacts, and community reactions.

The decision about the traffic that is to pay tolls dictates the type of toll collection system employed and thus is made with consideration of the accessibility and cost characteristics of alternative collection systems. There are three basic variations: closed (ticket) systems, open (main-line barrier) systems, and hybrid (barrier-ramp) systems. The closed toll collection system limits access to toll-paying motorists. Tollbooths are

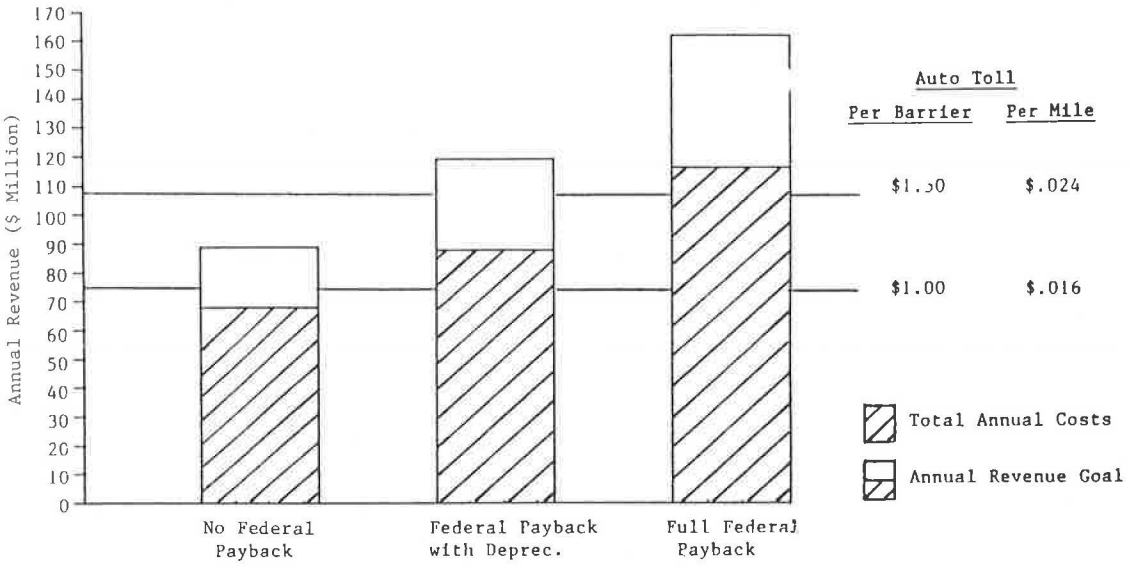

FIGURE 1 Implications of alternative federal payback policies, open main-line barrier system, I-80 in Pennsylvania.

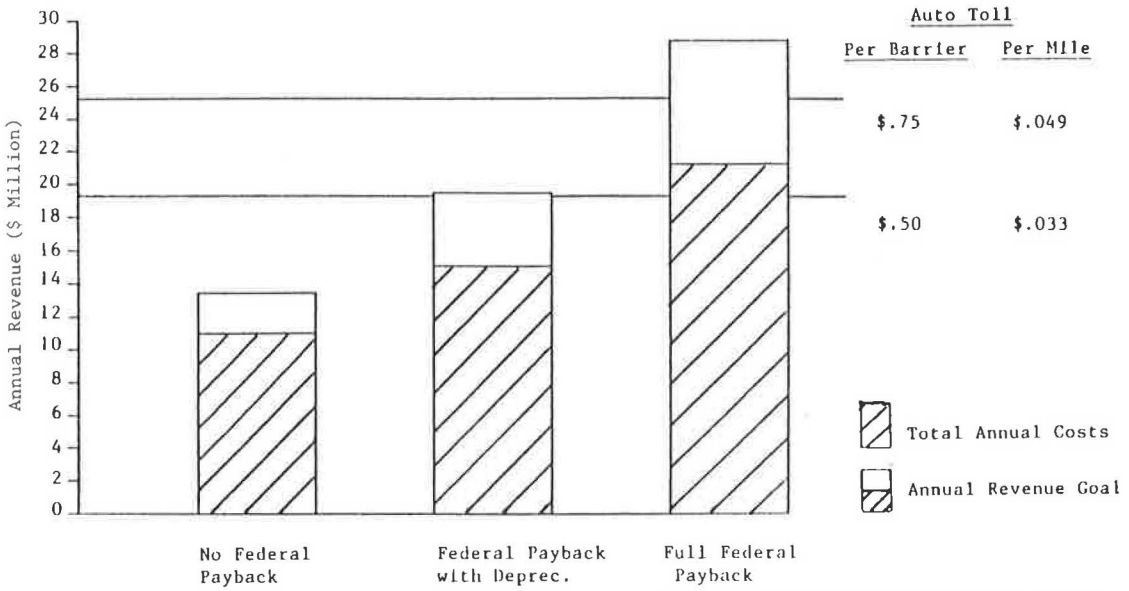

FIGURE 2 Implications of alternative federal payback policies, open main-line barrier system, I-90 in Pennsylvania.

located at each point of entry and exit, and main-line barriers span the roadway at each end of the toll route. Typical examples of closed, ticket system toll roads are the New Jersey, Ohio, and Pennsylvania turnpikes.

A second toll collection alternative, the barrier system, allows local, short-distance traffic to use the facility without paying tolls. Barriers are located intermittently along the main line of the road; no tollbooths are placed on the interchange ramps. All traffic must stop at the barriers to pay the toll; however, local traffic may avoid paying tolls if there is no barrier between entry and exit points. The percentage of trips allowed to move toll free depends on the number and location of the main-line barriers. The Connecticut Turnpike and the Bee Line Expressway in Florida are examples of barrier system toll roads.

A third alternative design, the barrier-ramp system, is a hybrid of the other two systems. It may be designed either as a closed or an open system and is often found on toll roads that pass through both urban and rural areas. If designed as a closed system, toll barriers are located at intervals along the main line. In addition, most interchange ramps also contain toll booths so that no segment of the road may be used without payment of a toll. A good example of the closed barrier-ramp system is the Illinois Tollway System.

Open barrier-ramp systems allow the flow of some toll-free traffic. They may be designed with main-line toll barriers and tollbooths on selected high-revenue interchange ramps and yet allow toll-free passage between certain contiguous interchanges. An example of this type of design is the Garden State Parkway in New Jersey, which has three toll-free sections near the towns of Elizabeth, Toms River, and Cape May.

The open hybrid system also may be designed to separate completely the open and closed portions of the toll road. The main line of the New York Thruway is a closed ticket system, although spurs of the thruway serving Buffalo and New York City are open and use main-line barriers for the collection of tolls.

Generalizing on the (financial) cost differential between barrier and closed toll collection systems requires assumptions about many variables. Most important for closed-system costs is the number of interchanges retained. The choice of number of interchanges involves a trade-off between total costs and user accessibility, both of which vary directly with the number of interchanges. Existing nontoll limited-access highways have a higher density of interchanges and are more accessible than typical, closed-system toll roads. For example, the 318-mi I-80 through Pennsylvania has 62 interchanges. In contrast, there are only 28 interchanges along the 358-mi, east-west main line of the Pennsylvania Turnpike. Similarly, on 225 mi of I-70 through Ohio there are approximately 70 interchanges, but on the 241-mi Ohio Turnpike there are only 19 interchanges, including the 2 end terminal tollgates. The high density of interchanges coupled with the need for collection facilities at each entry and exit point makes the cost of converting existing nontoll, limited-access highways to closed-system toll roads extremely expensive, both in terms of the capital costs to adapt each interchange to facilitate toll collection and in terms of operating and maintaining the many toll collection points. Costs can be decreased by closing some interchanges; however, this action may also reduce toll revenue and will decrease accessibility.

Even though the financial implications of closing an interchange can be assessed analytically given knowledge of motorists' behavior with respect to tolls, the decision on closing may be primarily political because of the complex social impacts involved. Closing an interchange can impose significant changes in travel patterns and social interactions. Objections are likely to arise from motorists who are frequent users of the interchange, from nearby business and commercial establishments, and from the community in general if there is a perception that the change in accessibility is a threat to community safety. On the other hand, homeowners in close proximity to the interchange may applaud its closing. However, for the most part, closing an interchange takes something away from tax-

payers without giving them much in return. Such actions by government are rare and are likely to be resisted in the political arena.

Barrier systems have the potential of maintaining accessibility while minimizing the cost of toll collection by concentrating the toll collection function in a few locations. By not collecting tolls on low-volume interchanges, barrier systems avoid points where collection expenses per revenue dollar are high. However, this cost advantage of barrier systems is offset to a degree by the need for more toll collection lanes per collection point due to the higher traffic volumes found on the main line. Furthermore, construction costs for each main-line barrier lane are higher than for closed-system collection lanes because of the need for longer and wider approaches to each collection point.

Because of the offsetting costs, barrier systems are not inherently less costly than closed toll collection systems even though, in practice, toll collection is less expensive on main-line barrier toll roads. Only by limiting toll collection to a few locations do barrier systems realize major cost savings over closed toll systems. It is the potential to reduce costs provided by the inherent flexibility in the number of collection points that is the principal advantage of barrier systems.

This advantage may be put to full use in minimizing the costs of converting existing limited-access highways to toll routes. For example, the capital costs for a closed toll collection system that maintains all present interchanges on I-80 in Pennsylvania were estimated to be $508 million in 1980 dollars *(2)*. These costs included construction of tollbooths, support buildings, and plaza areas; interchange area reconstruction; and purchase and installation of toll collection equipment. Nearly 50 percent of the total cost was for reconstructing interchanges to make them suitable for toll collection. In contrast, the total cost to construct a main-line barrier system consisting of five barriers over the 318 mi of I-80 was estimated at $20.2 million. The variation in operating expense was equally dramatic, with annual fare collection expenses estimated at $48.8 million for the closed system versus $6.7 million for the barrier system *(2)*.

Toll Collection System Safety

Although barrier toll collection systems have potential cost advantages, there are some disadvantages relative to closed systems. Barriers along the main line raise the potential for accidents because motorists approaching the barrier must come to a complete stop from high speeds while concurrently jockeying for the shortest queue and searching for the required toll. Closed ticket systems, where vehicle deceleration occurs primarily on the exit ramps before the toll collection area, may thus be safer than barrier systems.

User Reaction to Alternative Tollbooth and Barrier Configurations

Another item to consider when choosing a toll collection arrangement is user reaction to the arrangement and the resulting impact on the distribution of traffic between toll and alternative toll-free routes and on toll revenue. User reaction is likely to vary between toll collection systems primarily as a function of trip length. This is most apparent for trips on short segments of the potential toll route. Motorists who use short segments of a currently free road would not change their travel patterns if those segments remained open or free under a barrier or open barrier-ramp toll system. Should a closed system be implemented, however, some marginal short trips would not be made, or at least some of them would be diverted to alternative free routes. These marginal trips include nonessential trips, trip purposes for which travel time is not highly valued, trips for which the toll route offers only a small savings in time, or trips made by people with low incomes.

The impact of the toll collection configuration on longer trips is primarily a function of total toll charge and barrier density. There is nothing inherent in any of the configurations that would cause toll rates to be higher on one alternative than on another. Given equal total toll charges, barrier and open hybrid systems, however, may divert a proportionally higher number of long trips than closed systems because the higher number of barriers encountered on these systems increases travel time. An open system with three or more barriers becomes less attractive relative to closed systems. Although travel delays at toll barriers may be short relative to trip times, such irritating delays are perceived as being longer than they actually are. This perception may cause more longer trips to be diverted from barrier and open hybrid configurations than from closed systems.

Because user reaction varies with trip length, it is difficult to generalize about which toll collection system is likely to divert more traffic without knowledge of the trip length distribution. Of course, the more trips diverted by tolls from uncongested highway facilities, the higher the adverse impact of tolls from the misallocation of traffic between toll and nontoll routes. And, the more traffic diverted, the lower the toll revenue.

Variations in the Equity of the Toll Collection System

The basic theme in highway finance has been that the highway user should pay for the highway system. This theme is viewed by the general population and its political leaders as an equitable means of providing the nation with a good highway system. Two principles for charging users are most popular: The "benefit principle" is that users should pay for roads in proportion to the benefits received. The "incremental cost principle" is that users should pay according to the highway construction costs required for their type of vehicle *(12)*.

On the basis of the benefit principle, the closed system is the potentially more equitable toll collection design because each user must pay a toll for using the facility; if the benefit from making the trip were known, each user could be charged a toll equal to the benefit received in accordance with the tenets of the benefit principle. On open toll systems, some users are allowed to move toll free; hence they can never be charged for the benefits of making the trip. However, given that the benefits of trip making are most often not known, there is no sound basis for drawing conclusions about the equity of one toll collection system versus another, at least in terms of the benefit principle. It cannot be argued that either toll collection alterna-

tive more or less closely aligns the toll charge to the benefits received from trip making.

In terms of the incremental cost principle, closed systems are inherently more equitable because their charges are based on each increment of road service consumed. Open system charges are much more lumpy; some users pay high costs per unit of service while other users pay no toll.

ECONOMIC EFFICIENCY OF TOLL FINANCING

There is little argument that toll financing is a more expensive method of financing highway improvements than traditional user charge methods. Some of these additional expenses are direct economic costs, such as the capital and operating costs for toll collection and the costs incurred by toll facility users from additional stops to pay tolls. Some additional costs are indirect economic costs, such as the additional costs imposed on users of alternative toll-free routes by toll-diverted traffic. And, as previously discussed, expenses such as federal-aid payback are not economic but financial costs. To the extent that these financial costs make toll rates higher than costs occasioned by toll facility use and thus divert traffic that would use the toll facility if toll rates were lower, toll financing involves an economic misallocation of traffic between toll and nontoll highway facilities.

Capital Costs of Toll Collection

Probably the most visible and frequently discussed of the additional expenses associated with toll financing are the capital and operating costs for toll collection. The capital construction costs incurred to install toll collection facilities, including tollbooths, buildings, plaza areas, collection equipment, and, if necessary, interchange reconstruction, may be relatively minor, or they may be significant enough to dictate the financial feasibility of the toll conversion project. The most important factors determining the absolute magnitude of these capital costs are the type of toll system; the number of toll collection points; the level, composition, and peaking characteristics of the traffic stream; and the size and location of the toll conversion project. The impact that these factors have on the magnitude of capital costs and the design of the toll collection system was discussed in more detail earlier as well as in other sources *(2, 11)*. As a general rule, the capital costs for toll collection, although potentially significant, can be held to less than 10 percent of total capital costs, including federal-aid payback, assuming that a cost-efficient toll collection system is used.

Operating Costs of Toll Collection

Toll collection is an expensive way of raising highway revenues. As traditionally practiced in the United States, toll collection is labor intensive with labor costs accounting for as much as 80 percent of total collection expenses on closed ticket systems *(13)*. Technological improvements as well as better management techniques have sought to trim the labor intensity of collection. For example, the use of main-line toll barriers has reduced the need for manning each point of access and egress. The substitution of automatic machines for human toll collectors has further reduced the necessary manpower. So has the practice on the Garden State Parkway of using senior citizens as part-time employees to meet peak-period demands. Other innovations include collecting tolls in only one direction with a doubling of the toll rate and limiting the collection hours to avoid low-volume periods *(14)*.

Despite the improvements, toll collection costs remain relatively high, particularly on closed ticket systems. In 1985 Pennsylvania Turnpike toll collection costs as a percentage of toll collection revenue were 14.8 percent *(15)*. New York State Thruway and New Jersey Turnpike collection costs were 16 and 19 percent of total toll revenues, respectively, in 1985 *(16, 17)*. These percentages are a few points higher on all three toll facilities than they were in 1980. These percentages also do not include toll collection area maintenance expenses, costs that are not incurred with traditional, highway user imposts.

The collection costs for the traditional user imposts are lower than for tolls. The costs for motor vehicle registration and license fee collection as a percentage of fee receipts for all U.S. states ran approximately 13 percent in 1984. The collection costs for motor fuel taxes averaged less than 1 percent of tax receipts in 1984 *(18)*. Because motor fuel service companies serve as the collection agents, motor fuel taxes are a highly efficient means of raising highway revenue. Neither registration and license fee collection costs nor motor fuel tax collection costs as a percentage of receipts have changed significantly since 1980. It is apparent that toll collection, in comparison with traditional highway user taxes and fees, is an inefficient means of raising highway revenue.

RATIONALE FOR TOLLS DESPITE ADDITIONAL COSTS

Even though toll financing is generally an economically inefficient means of collecting highway user revenue, are there, nonetheless, special circumstances in which toll financing might be economically justified? One of the often cited advantages of tolls is that they provide a means of levying congestion prices on heavily traveled urban routes. The additional costs of such toll financing may be more than offset by the ability to price road users in accordance with the costs occasioned by use, including the high external or social costs imposed by road use during peak travel periods. Including these social costs in the toll internalizes the social costs in the road use pricing system, thereby encouraging road users to make more efficient route or mode choices. If congestion pricing sufficiently mitigates peak-hour demand, there may be an additional benefit from the postponement or avoidance of the need for additional road capacity. The rationale for congestion tolls has been developed extensively *(12, 19–21)*. Its use on U.S. toll facilities is, however, quite limited.

Toll financing might also be justified under special financial conditions. Rao and Gittings concluded that toll financing can be a useful and justified way of supplementing general highway user tax and fee revenue, particularly if the toll revenues are dedicated to building, maintaining, or improving facilities that, in the absence of toll financing, are not likely to be built,

maintained, or improved to first-class standards *(2)*. For example, in the case of an existing highway facility, if funds from traditional revenue sources are not available to make needed improvements in a timely fashion, the level of service deteriorates, and the cost of using the deteriorating facility correspondingly increases. On the other hand, if toll financing expedites the required improvements, users may benefit from lower vehicle operating, travel time, and accident costs despite the higher highway user charges associated with tolls. The primary question, then, is whether the increase in user benefits made possible by toll financing is sufficient to justify the additional costs associated with toll collection. If benefits exceed costs, then toll financing may be economically acceptable within the constraints imposed by society on other means of financing.

However, this primary question is difficult to answer because it involves speculation on the level of service if the needed improvements are not made. Hypothetically, in the worst case, the road is allowed to deteriorate and is closed for safety reasons. For the highway's users, the closing of the road means increases in travel times, accidents, and possibly operating costs as they divert to alternative routes with lower levels of service. In some cases fewer trips may be made. These additional user costs can be viewed as the maximum user benefits of toll financing for those travelers who would have used the road as a toll facility. If the deteriorated road is rehabilitated as a toll road, benefits accrue to users of alternative routes who would otherwise experience increased congestion and more rapidly deteriorating highway facilities occasioned by the diverted traffic.

A more likely scenario than the worst case is that the road is maintained at a lower level of service with a lower posted speed limit, and a minimum amount of surface maintenance is performed to maintain the integrity of the pavement. In this situation, the benefits to users of having a more immediate toll-financed reconstruction of the highway would be the difference in accident, travel time, and vehicle-operating costs between a higher level of service toll road and a lower level of service free road. These benefits must be measured over the period from when a reconstructed highway could be completed with toll financing to when it could be completed with conventional financing. The length of this period of time will, in most circumstances, be a governing factor in whether or not the benefits of toll financing exceed the additional economic costs.

Recent analysis by the Congressional Budget Office (CBO) estimated that toll-financing benefits may exceed the additional costs if a needed highway facility can be built 4 or more years sooner than under conventional pay-as-you-go tax financing *(10)*. However, if toll financing produces a facility only 2 or fewer years sooner, the use of toll financing is probably not worth the additional costs. The CBO indicates that the time advantage needed to make toll financing beneficial is sensitive to the overall level of benefits provided by the road, the prevailing bond interest rates, and the amount of traffic diversion caused by tolls.

Social Equity

Thus far the discussion has examined the economic implications of using toll financing to rehabilitate existing federal-aid routes. From an economic viewpoint, it is clearly inefficient to impose user charges via the toll mechanism. However, in addition to economic efficiency, there are a number of other commonly accepted goals of pricing or tax mechanisms designed to raise funds for public action. Toll financing also should be judged in light of these other goals.

The most politically popular of the other goals is an equitable distribution of the tax burden *(22)*. In highway finance, this equity goal has been translated into the policy that the highway user should pay for the full cost of the highway system *(12)*. This policy arose in part because it was viewed as the fairest and most proper way of paying for highways. However, although the basic policy is commonly accepted, there has not always been agreement about what constitutes an equitable distribution of the financial burden among highway users. One of the most often accepted guidelines today is the benefit principle, whereby users pay for roads in proportion to the benefits received *(12)*. In the early 1960s Mohring and Harwitz (*23*, p. 88) used the benefit principle, expressed in terms of equating either benefit tax ratios or net benefits for all population classes, to analyze the equity of alternative tax systems for raising highway revenues; their conclusion was that

> primary reliance on levies such as tolls or gasoline taxes that are directly related to highway use would provide a more nearly equitable allocation of the highway financing burden than would reliance on the general tax revenues of the federal government.

The governing criterion that led to this conclusion was the relative freedom of choice, afforded by each tax alternative, to consume highway services. This freedom was seen as critical to the potential of each tax system to equate benefit-to-tax ratios. The further the choice of paying for each highway service is removed from the actual consumption of each service, the greater the likelihood that an inequitable burden is placed on the individual consumer. By imposing a charge only for each use of highway service, the highway authority is giving the consumer the freedom to choose whether the direct benefits received from a given trip exceed the direct costs, including the use charge. The greater the freedom of choice, the authors argued, the higher the potential to equate benefit-to-tax ratios for all population classes.

Mohring and Harwitz did not express an opinion on whether tolls or gasoline taxes were more equitable on the basis of the benefit principle. However, using their freedom of choice criterion, it would appear that tolls levied for the rehabilitation of a given facility are more equitable than a general gasoline tax increase for the same purpose, because the tolls more closely align payments to the use of the facility. With the gasoline tax increase, payments are made by highway users whether or not they travel on the rehabilitated facility. Consequently, these users do not have the option of making payments only if they use the facility; they pay whether or not they receive any benefits from the facility. On the other hand, with tolls, only those who benefit from use of the toll road pay the toll. Therefore, it would appear that tolls offer a more complete freedom of choice and thus a greater potential for equating benefit-to-tax ratios or net benefits.

CONCLUSION

For many decades, the U.S. highway road user charge policy has steered a path clear of toll financing and generally discouraged the use of tolls as a highway revenue mechanism. Yet the present financial status of the U.S. highway program, relative to the financial needs of that program, may no longer ignore toll financing, particularly in light of the existing political climate that favors governmental fiscal austerity and balanced budgets. In this climate, toll financing can be a viable supplemental source of important revenues for needed highway improvements that otherwise would be postponed or forgone. Toll financing should be viewed as one more component of a package of financing mechanisms to be judiciously employed in funding the level of highway service desired.

In this paper some of the financial, economic, and social policy issues associated with imposing user charges via the toll mechanism have been examined. Particular attention has been given to the use of tolls to rehabilitate existing federal-aid routes. From an economic viewpoint, toll financing is a relatively inefficient means of raising highway user revenue. Toll financing incurs additional economic costs over and above those costs incurred by other funding mechanisms. These additional costs include higher costs of collection and capital costs for the construction of toll collection facilities. Furthermore, highway users incur increased travel time, vehicle-operating, and possibly accident costs because of the necessity of stopping at toll collection facilities.

Nevertheless, there are circumstances in which toll financing may result in a more efficient use of highway facilities or may permit additional user benefits that exceed the economic cost disadvantage of tolls; in such situations, tolls can be economically justified. One example is when tolls are appropriately levied to reflect congestion costs. Another example is when there are insufficient revenues from traditional highway user imposts and toll financing is used to make needed highway improvements many years before they could otherwise be made.

However, one of the barriers to the use of toll financing in the latter instance is federal policy that mandates the full repayment of all prior federal aid used on a given highway facility before toll financing may be used to rehabilitate that facility. This policy severely limits the number of highway facilities that would be self-supporting or even break-even toll facilities at reasonable toll rates, thus reducing the usefulness of the toll mechanism for highway 4R purposes.

A major policy recommendation made in this paper is that full federal-aid payback not be required to convert an existing federal-aid facility to tolls. There is no economic justification for requiring any payback, and from an equity viewpoint full payback is highly unjust. However, it is also recognized that the obligation of federal aid to the states is legally viewed as a contractual arrangement, stipulating that federally aided facilities shall be free of tolls. It may be politically difficult to pass legislation to break the provisions of the contract despite the economic and social equity rationale. Therefore, it is likely that some payback will be required. In light of these circumstances, it is recommended that payback be related to the depreciated value of the federal-aid portion of the original investment and not the full cost. This policy is based on sound business principles and may satisfy the political concerns.

From a social equity perspective, toll financing has a potential advantage over current user taxes and fees. This potential advantage stems from the ability to align more closely the user charge with the benefit received or with the direct use made of the highway facility.

Decisions on toll collection system design also have economic and social consequences. The design decisions involve choices about the degree of user access and about the traffic that is to pay tolls. If a relatively high level of access is desired, the inherent flexibility of the main-line barrier system design provides important capital and operating cost savings and allows some toll-free local traffic movement on the toll facility.

However, allowing some traffic to move toll free may raise some objections on equity grounds and will reduce gross toll receipts. If a policy limiting toll road use only to toll-paying motorists is desired, then a closed-system design must be constructed. This type of design, however, may be prohibitively expensive for converting existing, limited-access highways to toll roads because of existing high interchange density. Some low-volume interchanges could be closed; however, this may be politically impractical.

REFERENCES

1. *Feasibility of Converting Wisconsin's Interstate to a Toll Road.* Summary Report. Wilbur Smith and Associates and Howard, Needles, Tammen and Bergendoff, New Haven, Conn., Aug. 1983.
2. K. Rao and G. Gittings. *Feasibility Study of Supplemental Toll Financing in Pennsylvania.* Final Report. Pennsylvania Transportation Institute, Pennsylvania State University, University Park, March 1983.
3. Vollmer Associates et al. *Pennsylvania Toll Roads Feasibility Study.* Final Report. Governor's Toll Roads Task Force, Harrisburg, Pa., Dec. 1983.
4. *Newsletter.* Transportation Infrastructure Advisory Group, Washington, D.C., No. 3, March 1986.
5. S. M. Butler, M. Sanera, and W. B. Weinrod. *Mandate for Leadership II: Continuing the Conservative Revolution.* The Heritage Foundation, Washington, D.C., 1984.
6. *A New Focus for America's Highways: Recommendations on the Federal-Aid Highway Program.* AASHTO, Washington, D.C., April 1985.
7. T. M. Strah. Funding Bill Would Change Law, Allow U.S. Toll Roads. *Transport Topics,* No. 2635, Feb. 17, 1986, pp. 1–38.
8. *Special Report 83: Law of Turnpike and Toll Bridges: An Analysis.* HRB, National Research Council, Washington, D.C., 1964.
9. W. A. Rusch. *NCHRP Synthesis of Highway Practice 117: Toll Highway Financing.* TRB, National Research Council, Washington, D.C., Dec. 1984.
10. *Toll Financing of U.S. Highways.* Congressional Budget Office, Washington, D.C., Dec. 1985.
11. G. L. Gittings. *A Methodology for Assessing the Feasibility of Toll Financed Highway Facilities.* M.S. thesis. Northwestern University, Evanston, Ill., Aug. 1982.
12. A. A. Walters. *The Economics of Road User Charges.* World Bank Staff Occasional Paper 5. The World Bank, Washington, D.C., 1968.
13. Applied Economics, Inc. *An Economic Evaluation of Toll Financing for Highways.* International Bank for Reconstruction and Development, Washington, D.C., 1972.
14. M. Wohl and C. Hendrickson. *Transportation Investment and Pricing Principles.* John Wiley and Sons, Inc., New York, 1984.

15. *Annual Report.* Pennsylvania Turnpike Commission, Harrisburg, Pa., May 31, 1985.
16. *Annual Report 1985.* New York State Thruway Authority, Albany, N.Y., 1986.
17. *Annual Report 1985.* New Jersey Turnpike Authority, New Brunswick, N.J., 1986.
18. *Highway Statistics 1984.* FHWA, U.S. Department of Transportation, 1984.
19. F. H. Knight. Some Fallacies in the Interpretation of Social Costs. *The Quarterly Journal of Economics,* No. 38, 1924, pp. 582–606.
20. R. M. Zettel and R. R. Carll. The Basic Theory of Efficiency Tolls: The Tolled, The Tolled-Off, and the Un-Tolled. In *Highway Research Record 47,* HRB, National Research Council, Washington, D.C., 1964, pp. 46–65.
21. P. A. Viton. Equilibrium Short-Run-Marginal-Cost Pricing of a Transport Facility. *Journal of Transport Economics and Policy,* Vol. 14, No. 2, May 1980, pp. 185–203.
22. R. A. Musgrave and P. B. Musgrave. *Public Finance in Theory and Practice.* McGraw-Hill, New York, 1973.
23. H. Mohring and M. Harwitz. *Highway Benefits—An Analytical Framework.* Northwestern University Press, Evanston, Ill., 1962.

Financing, Private-Sector Involvement, and Market Processes in the Provision of National Roads in South Africa

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In this paper is described the changing basis of the provision of rural roads in South Africa that led to the introduction of toll roads and, in the process, to an increasing degree of privatization in the provision of roads. The background financial and administrative arrangements for the provision of rural roads is discussed and national policy that influences the financing of roads is described. With the increasing shortage of funds for roads during the past decade, the need for better economic justification of specific road projects and the search for new sources of funds combined with the policy of user charging and of supporting the free market system has had a significant effect on the development of the rural road system. Before 1980 the private sector was involved in road provision to a varying extent through contracting, construction work, and consulting services. Following a decision in 1982 to implement toll roads on a limited basis on the national road system, private-sector involvement expanded to include financing and management of revenue collection activities. Greater attention was paid to the economic and financial justification of road projects. After the policy of toll financing of roads was established, the Department of Transport was approached by private-sector companies requesting the grant of concessions to finance, design, construct, maintain, and operate certain national roads and to collect tolls to defray the costs. These proposals, which would constitute further privatization in the road sector in South Africa, are currently under consideration.

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South Africa covers an area roughly equal to 12 percent of the United States or 3.7 percent of the area of the whole of Africa. Its road system at present consists of approximately 3000 km of freeways, 50 000 km of rural two-lane blacktop roads, and 135 000 km of gravel roads. There are a total of more than 230 000 km of roads and streets.

The purpose of this paper is to describe the changing basis of the provision of rural roads in South Africa that led to the introduction of toll roads and, in the process, to an increasing degree of privatization of road provision. The limited introduction of certain market forces into the provision of roads in South Africa is described as is the increasing involvement of the private sector.

Until the end of the 1970s planning of the national road system in South Africa was based on the concept that the major cities of South Africa should be connected by a system of freeways. The road standards used were basically similar to U.S. standards modified to take into account the South Arican rule of the road (i.e., drive on the left) and climatological conditions. However, funds available for roads decreased dramatically in the mid-1970s, and it soon became apparent that expenditures on roads had to be better justified than previously and that new sources of revenue had to be explored. At about the same time, the government gave impetus to its policies of promoting the free market system and charging the user for services provided by government.

The need for better economic justification of roads and the search for new sources of funds for roads, combined with the

policies of promoting the free market system as well as user charging, had a significant effect on the development of the rural road system. Potential national road projects became subjected to economic analysis and only projects with an acceptable rate of return, based on user benefits and road costs, were considered for implementation. The possibility of implementing toll roads was also investigated and found to be feasible on a limited scale. The implementation of toll finncing of suitable projects was based on the traditional combination of using loans for the financing of roads and tolls for repayment of the loans. The floating of lloans on the capital market brought about a significant increase in funds available for roads at the time. Furthermore, the need for financial discipline in establishing toll roads brought about a closer scrutiny of proposed road projects. Because users are prepared to pay for only a portion of the benefit used in the economic analysis, the financial feasibility of a project was found to be a more stringent criterion than the economic analysis. A strategy was developed whereby economic and financial criteria were combined to arrive at a decision on the selection and scope of projects. Through this mechanism, the market forces of the users' willingness to pay and the prevailing interest rates and effects of inflation were brought into the project selection process.

Unitl 1982 the private esector was involved in road provision primarily through contracting for construction work and through consulting work. National roads are designed and constructed almost exclusively by the private sector, and the provision of provincial and local authority roads is divided almost equally between the private sector and in-house departmental forces. During 1984 when the economy was in a severe downturn and contractors were having difficulties obtaining adequate work, the Department of Transport was approached by major construction companies that wished to obtain concessions to finanace, design, construct, maintain, and operate certain roads and to collect tolls to defray the costs. The decision was made by the Department of Transport to investigate and negotiate the award of concessions to consortia of private entities including construction companies, banks, consulting engineers, and toll operators. A strategy was sought to ensure that the effectiveness and efficiency of the private sector were used and, at the same time, to ensure accountability in the use of public funds.

BACKGROUND FINANCIAL ENVIRONMENT

In the 18th century Adam Smith in *Wealth of Nations* outlined the essential functions of the state that are the determinants of the level of public expenditure: first, protection against external attack; second, protection against internal assault, injustice or oppression; and, third, the provision of public works and services "which it can never be for the interest of any individual . . . to erect and maintain, because the profit could never repay the expense to [the] individual . . ., though it may frequently do much more than repay it to a great society."

Today the issue of the scope and degree of public expenditure on those public goods to which Smith refers is a notoriously controversial one. Public-sector expenditure as a proportion of the national product has shown a rising secular trend in industrialized countries since World War II—so much so that it has sometimes been referred to as the "fiscal revolution." Such expenditure springs from enlarged perceptions of Smith's third category because the public, in western countries in particular, has come to demand as of right a myriad of so-called entitlements guaranteeing minimum standards of income, job availability, public transport, health care, and other elements that make up that elusive entity the "quality of life."

The International Monetary Fund speaks of a "revolution of rising expectations regarding what a government can and should do" and singles out the following elements:

- Stabilization of the economy,
- Promotion of economic growth,
- Redistribution of income,
- Guaranteed employment and levels of income,
- Aid for sick industries,
- Subsidies for specific goods and services, and
- Regulation or control of certain activities.

This broader perception of the state's responsibilities has inevitably placed escalating pressure on the expenditure side of the budget, which has been reflected in higher taxation that, in turn, has acted to inhibit growth. This situation calls for still higher taxation as long as the entitlements are regarded—as they invariably are—as sacrosanct.

The situation that confronts economists, financiers, and politicians in South Africa reflects the true nature of the country—a mixture of First and Third Worlds, or a more modern and spophisticated exchange sector that exists alongside a far less developed one. The elimination of the glaring disparities between the two is one of government's highest priorities and is one that is bound to cost a great deal of money.

Many development functions reside in the public sector because there has been a lack of entrepreneurial interest due mainly to inadequate rates of return on capital investment in certain developmental spheres. The government has thus been required to provide necessary facilities through the public sector. Government spending and employment in South Africa as a proportion of the gross domestic product, after a gratifying fall in the late 1970s has been rising during the 1980s. State employment today represents approximately 30 percent of the total economy, and it has been estimated that the disposal to the private sector of five major state corporations responsible for the production of electricity, steel and iron, air travel, rail travel, and postal services would allow 80 percent of the national debt to be retired immediately.

Because the reduction of the disparities between the First and Third Worlds in South Africa is likely to cost a good deal of money, government has been increasingly looking at the privatization of certain public-sector assets as a means of reducing the problem of public-sector funding.

SOME THOUGHTS ON PRIVATIZATION OF ROADS

If, after all that is possible has been done to reduce public-sector spending, it is found that the sector is still taking too large a helping from the natural resources pool, then (leaving aside Herculean cuts and retrenchments) the options open to government include privatization on the one hand and extended

user charging on the other. These issues have been particularly pertinent and have aroused interest in roads in South Africa during recent years.

The main thrust of privatization involves what may be termed the return or transfer of productive resources to the private sector, where, ex hypothesi, they can often be more efficiently used than when they fall under the broadly defined public sector. No fingers are pointed at the public sector, but there are undeniably certain activities currently found under its umbrella—on all three tiers of government in South Africa—that could more rationally fit into the private sector. No doubt each and every activity could originally be justified on the grounds that the private sector was unwilling or slow to get involved, but government should be constantly alert to changing circumstances and demands rather than fixed on the probably quite different circumstances of the past.

It is not suggested that there are not services that in the nature of things must unquestionably be kept in public rather than private hands on grounds of socioeconomic or even political considerations, but government should be fearless in looking for suitable candidates for privatization at all levels and tiers and in all fields of public enterprise including the provision of roads. It is, after all, preeminently the private sector that creates wealth and thereby raises living standards, so the more resources channeled to the private sector, the greater the welath generated.

The effects of privatization on the public sector should also be traced. There could well be, as is frequently argued, a multiplier effect in public-sector productivity as the work force in that sector shrinks. And this in turn, if coupled with an application of the user charge principle to which the South African government is committed, will mean a reduction of the pbulic sector's share of gross domestic expenditure with all of the concomitant benefits for the taxpayer and thus for the economy at large.

Privatization can of course take various forms such as deregulation to liberalize competition and thus prevent monopolies, transfer of ownership of state assets (or the long-term leasing thereof), or encouragement of private-sector provision of collective services. In the provision of roads the second option, transfer or leasing of state assets (roads), and the third option are the most relevant.

A cardinal point that has been strongly emphasized in the South African context is the need to prevent the creation of natural monopolies and the consequent elimination of competition in the provision of roads. This problem can range from construction activities to the need to prevent captive road traffic markets due to the nonavailability of acceptable alternative routes. It would be ill-advised to exchange state monopolies for private ones, and competitive policy should be a major factor in evaluating potential procedures. The whole idea of privatization is to allow natural market forces to determine the price and volume of services such as roads so that in the long term such public goods will be provided at the lowest possible price.

The whole question of privatization is presently being considered in South Africa by a State President's Committee on Privatisation under the chairmanship of the Minister for Administration and Economic Advisory Services.

DEVELOPMENT AND CURRENT STATUS OF THE SOUTH AFRICAN RURAL ROAD NETWORK

The earliest reference to road building in South Africa is to be found in the diary of Jan van Riebeeck, the leader of the original settlers. On August 4, 1653, he wrote "The bookkeeper Verburgh was [today] sent to the forest with 13 men, to make a good road for the wagon to transport wood."

Indeed, no road was built; Verburg and his 13 men merely mared out a route, thus setting the pattern for the following 150 years. The oxwagons of the time followed footpaths and game trails over the mountains. It was only with the coming of the British at the beginning of the 19th century, as a result of the Napoleonic wars, that road building was undertaken in earnest. By 1825 the first engineered pass (the Fransch Hoek Pass) over the mountains encircling Cape Town had been built. In 1828 Governer Sir Lowry Cole wrote "Because [the farmers] are cut off from a market for their produce there is no stimulus for industry and the inhabitants will continue in their present state of poverty for ever." He acted to some effect after writing this because Sir Lowry's Pass over the Hottentots Holland mountains was opened in 1830. This pass had been built by Major Charles Mitchell at the then cost of £3000 in the intervening 2 years. This route, much improved in the interim, is still in use today.

In 1843 John Montagu was appointed Colonial Secretary and he set about a further program of road building. He appointed a Central Road Board of three officials and three nominees to help him. The Road Board received a property rate of 1 penny on the pound (0.4 percent), which was supplemented by tolls collected at tollgates, bridges, and ferries. The first 40 km of hardened road was completed by 1845 at a cost of £40 000. It was calculated at the time that the savings in transport costs would be £20 000 per year, an early example of economic analysis.

At this point two great names in South African road-building history enter the scene, the Bains, father and son. Under their supervision a large mileage of roadway, with many mountain passes, was completed. Much of this work remains in use. The tollgates that helped to pay for it can still be seen in many locations, the Montagu and Garcia passes for example, and some of the Bains' bridges have been declared national monuments.

With the discovery of diamonds, and subsequently gold, in the interior, railways were rapidly extended, and roads were relegated to a feeder role. At Union in 1910 roads were made a provincial responsibility, but not much progress was made. By 1925 the longest continuous stretch of bituminous road was the 75 km between Cape Town and Wellington at the foot of Bain's Kloof.

The motor vehicle was by this time making its presence felt, and after investigation a National Roads Board was set up in 1935 with the object of providing a network of national roads linking provinces and main centers. This board adopted a program with a total length of 8600 km, which it proposed to build in 5 years. Funds for this program were provided by a levy of 3 pennies per gallon of imported fuel, a percentage rate of about 20 percent. The program not surprisingly was too

ambitious and by 1946 (World War II also delayed matters) only 5900 km had been completed. By 1970 the approved program had expanded to 13 000 km, most of which was complete.

In 1971 the National Transport Commission, which supersceded the National Roads Board in 1948, decided to reduce the national road network to its essentials and to rebuild these essentials in the form of freeways. It gradually became apparent that this was an error and that sundry sections of the old system, which had been ceded to the provinces, should have been retained. It was patently impossible to redevelop all of the roads to freeway standards and many of them did not justify such a step in any case.

A reassessment of what routes should be national routes was thus undertaken in 1984, and it was acknowledged that the roads in this system might be of different standards according to the needs of the route. This new system includes approximately 10 000 km of road, about 3000 km less than the 1971 system of 13 000 km, and represents 5.4 percent of all rural roads and 20 percent of all paved rural roads in the republic. It is proposed to redeclare this entire system a national road network as and when funds become available for the purpose.

Average traffic figures on the South African road system are fairly light. In Cape Province much of the system has average daily traffic (ADT) of around 1,000 vehicles per day (vpd) as a result of the sparse development in desirt and semidesert country. In the Transvaal figures of around 3,000 vpd are common and it is in this province that most difficulty is expected in accommodating traffic growth. In Natal traffic is chiefly confined to the erstwhile national road system and can be rather high in places, ranging up to 16,000 vpd on single-carriageway roads during holiday periods. Of course much higher figures are common around the cities. ADTs of from 40,000 to 120,000 can be expected in these areas, and at these levels freeways are of course required.

The system of divided control of road building between the National Road Authority and the provinces does not encourage a logical or rational division of road funding, with funds going to the most economic or most deserving cases. In the future it could well be that all road-building funds in the country will be combined in one fund and that the distribution will then be determined in a logical manner based on economic prioritization and actual needs instead by the fairly subjective method used at present. The total budget for rural road construction and maintenance is currently of the order of R1,500 million per year.

FINANCING OF ROADS IN SOUTH AFRICA

In South Africa, as in most countries throughout the world, concern is being expressed about the trend of declining revenue for road financing that, together with severe inflation in road construction costs, is leading to a cost-revenue squeeze. The problem is related to four basic factors:

- A decreasing rate of revenue growth,
- A diminishing effectiveness of revenue because of the effects of inflation on construction costs,

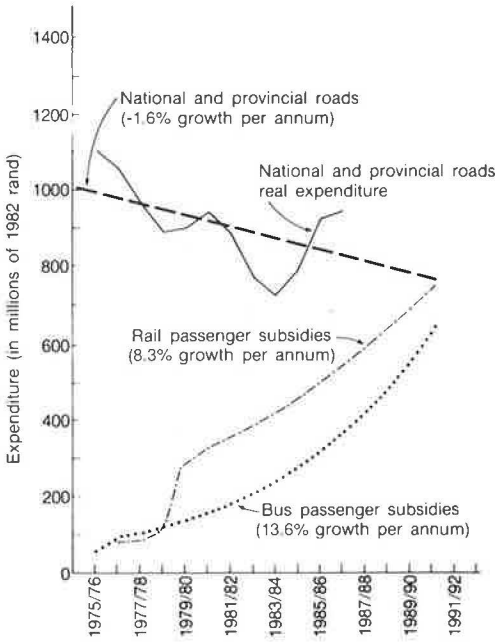

FIGURE 1 Projections of expenditures for selected transport-related items based on historical growth rates.

- A trend toward the siphoning off of a portion of the revneue generated by the road user into multimodal general transportation funds to subsidize uneconomical transportation forms such as suburban railway services (Figure 1), and
- Increasing maintenance and operating costs on the more highly trafficked facilities.

Continually increasing demands are being made on road user taxes, especially the fuel tax. In addition, the percentage of the fuel tax allocated to road construction has diminished considerably in recent times. As an example of this tendency, the National Road Fund at its creation received 17 percent of the total cost of fuel for road construction; currently this figure stands at 8 percent.

Figure 2 shows the trend in road financing that has prompted road authorities to seek additional sources of income for the provision of road facilities.

The Department of Transport (DOT) administers the

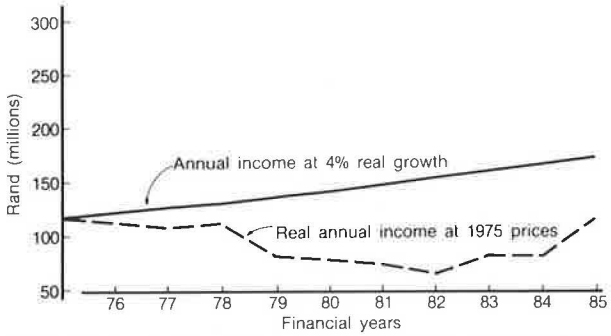

FIGURE 2 National Road Fund: revenue from levies on fuel sales.

National Road Fund (NRF) on behalf of the National Transport Commission (NTC) and is responsible for the national road system as well as for certain other road facilities such as roads in national parks.

The NRF is a statutorily dedicated fund that is financed solely from a levy on petrol and diesel sales. At present (April 1986) this levy is 7c and 8c per liter on petrol and diesel sales, respectively. Income from the fuel levy accrues directly to the fund via the oil companies who remit payments on a monthly basis. Capital expenditure on road projects is directly controlled by the NTC and is administered by personnel from the DOT. The financial structure of the NRF is based strictly on cash flow without any capitalization of expenditure or accrual of income and expenditure. This suits the nature and objective of the NRF (i.e., to expand the national road network using funds as and when they become available). Recourse to the capital market to fund deficits in the NRF is the exception rather than the rule and occurs only when warranted by urgent capital expenditure.

Provincial administrations, through their roads departments, are responsible for the construction, maintenance, and operation of provincial roads of various classes. The provincial administrations derive their incomes mainly from the Treasury; small additional sources of income are vehicle and other licences and permits, provincial taxes and levies, and the NRF (a 70 percent subsidy on special roads). The magnitude of the annual budget of each province is determined by the central Treasury using a formula that takes account of, inter alia, land area; length of road system; car, tractor, and truck population; and traffic volumes as well as indices of construction and maintenance prices. The Treasury allocates to each province the difference between the formula amount and the province's own income. Although part of the allocation to each province is earmarked for roads, the provinces are not bound to spend exactly this amount on roads. The greatest part of the provinces' road budgets are spent on their provincial road systems, and small contributions are made to municipal roads.

In an effort to identify appropriate levels of road expenditure, and also as an aid to the rational allocation of funds to various projects, the DOT in 1980 initiated a countrywide road needs study. This study has confirmed, and continues to confirm, the inadequacy of funds for road construction to meet the country's road traffic demands.

INTRODUCTION OF TOLL ROADS IN SOUTH AFRICA

In the light of the steadily decreasing real value of funds for the construction of national roads in South Africa during the 1970s, officials from the DOT, following an overseas visit in 1980 to countries in which toll roads formed part of the road system, reported that "the toll system of financing roads proejcts was technically feasible in South Africa and could make a modest contribution to road revneue" (Principles and Policies for Possible Toll Financing of Roads in South Africa, unpublished DOT document, Sept. 1981).

A parliamentary select committee considered a proposal to introduce toll roads in South Africa and, after hearing all of the offered opinion, including a report from the DOT, recommended in its report in JUne 1982 that toll financing of roads on a limited scale be introduced.

In June 1983 the National Roads Act was amended to facilitate the levying of tolls on national roads. In the terms of the act, a toll road project has to be a portion of a national road, the toll road has to be described in detail, and the toll tariffs must be published in the Government Gazette. A number of potential toll projects have been analyzed and evaluated, and during 1984 the first of nine current toll projects was opened to road traffic.

FINANCIAL STRUCTURE OF TOLL ROADS

The very nature of toll road financing as opposed to fuel levy funding necessitated a different financial structure for the National Roads Toll Fund (NRTF), though it ultimately has the same end as that of levy financing. Rigorous financial management is an essential requirement for toll financing because this form of financing is expensive and is exposed to the vagaries of fluctuating interest rates, the capital and money markets, and the like.

The requirements of a financial structure for toll roads are to provide systems for

- Identifying potential projects;
- Evaluating projects using accepted economic and financial analysis (e.g., rate of return, cost-benefit analysis);
- Setting the financial parameters within which the project is to operate (e.g., finance period, interst rate, rate of capital expenditure);
- Actually financing projets (e.g., capital market borrowing, other borrowing, grants);
- Operating the toll road (financial and traffic management including recording and control of operating income and expenditure);
- Accounting financially for each individual toll road and the NRTF as a whole;
- Servicing of all loans; and
- Establishing redemption funds and repaying the loans.

Of the nine identified toll roads in South Africa, possibly only one could be considered completely self-financing as a toll project and this one only marginally so. This has led to a mixed financing strategy, namely toll financing and "soft" loans from the NRF. The degree of toll financing is established by determining that portion of the total project costs that can be supported from net toll income. It is believed that this portion should be at least on the order of 50 percent of the total project costs including the cost of the toll facility itself. The balance is financed from the NRF. The calculation of the load supportable by revenue for a toll project implies that if a loan equal to this present worth is taken out, interest commitments will be paid or repaid (if capitalized) during the analysis period (provided that the same interest rate is used). In this way toll financing makes a substantial contribution to the project cost, thereby releasing levy funds to other less viable projects and to maintenance of the whole road network. Thus there exists a toll- and a fuel-levy–financed portion of the total project cost for each toll road. The toll-financed portion is provided by the capital mar-

ket in the form of short-, medium-, and long-term loans, all of which are repayable within the financing period determined for that project (usually 20 years). The levy-financed portion is provided by the NRF in the form of a long-term loan. The terms of this loan set a moratorium on interest and capital repayments for as long as it takes to repay the capital market loans for each individual toll project (usually 20 years). The interest rate is based on a construction index so that the NRF is repaid in real terms. Theoretically when the capital market and the NRF loans have been repaid for a particular toll project, tolls will be abolished on that project.

The different character of the two forms of funding (viz toll and fuel levy funding) lends itself to applying each form of funding in a different manner. The levy funding is easily obtainable from the NRF, simply by the transfer of funds from one account to another. In practice it is simpler still because all capital and current expenditures (whether toll or fuel levy funded) must be routed through the NRF, which is later refunded that portion of the expenditure that should have been toll funded.

Toll funding is more formal than fuel levy funding and requires planning for the placement of loans on the market, which may often result in under- or oversubscription. The combination of toll and levy funding therefore provides an attractive financing mix from the point of view of budgeting (i.e., one is a flexible, informal funding and the other a more structured and formal funding). The levy funds are also used for funding deficits on current expenditure, but here the term of the loan is short (usually on the order of a few months). Thus the fuel levy funds are used for both capital and current expenditure, and the current expenditure is repaid as a priority after external current loans are repaid.

The fuel levy fund will pay interest on capital market loans during the project construction period and contribute to interest payments during the initial project years when net toll revenue will be inadequate to service the loans. To guard against an overcommitment of the levy funds available to the NRF, a limit of 15 percent was placed on interest payments as a percentage of total levy income.

ANALYSIS OF POTENTIAL TOLL PROJECTS

The methodology used to analyze toll projects in South Africa addresses three separate areas *(1)*:

- Traffic analysis,
- Economic anslysis, and
- Financial analysis.

Traffic Analysis

In view of the extreme sensitivity of the results of economic and financial analysis to base year traffic volumes and the sensitivity of toll revenue estimates to vehicle fleet composition, emphasis is placed on accurate traffic aalysis. To this end, extensive use was made of the so-called Traffic Engineering Logger developed at the National Institute for Transport and Road Research.

The following methodologies are employed to determine toll-eligible traffic (i.e., that part of the corridor traffic for which the toll road would be a "minimum travel cost" option depending on the degree of complexity of the road network).

- In the case of a proposed new road with one or a few alternative routes, an origin-destination survey is undertaken to determine the percentage of corridor road users with interim and final origins and destinations such that the toll road would constitute the minimum travel cost route. In some instances, several different major traffic streams, each with its own relationship of toll-eligible traffic to total traffic, are identified and a weighted average toll-eligible traffic percentage is determined for the total corridor traffic stream.
- In the case of a potential toll road that would form part of an urban road network, the toll-eligible traffic volumes on the potential toll road are determined by applying a computerized urban transport planning package, such as DELTRAN.

The perceived road user benefit with respect to a vehicle in a specific vehicle class is defiend, for the purpose of the toll road studies, as savings in fuel and time costs for a vehicle in that vehicle class if the potential toll road were used instead of an alternative route. The methodologies employed to determine the savings in time and fuel cost include the RODES II computer program for rural roads and for urban roads the DELTRAN computer program. Comparisons of travel time and fuel consumption at the expected average speeds during the peak and off-peak periods on the toll road and the alternative routes, respectively, are also made.

The outcome of the traffic analysis has two major applications: *(a)* it serves as a basic input to the economic and financial analyses, as described later, and *(b)* it is used in the design of toll plazas.

Economic Analysis

The second major area investigated for potential toll roads is their potential economic benefits. Indices of the economic worth of a road project (benefit-to-cost ratios, net present values, and internal rates of return) are developed for the before- and after-toll cases. In the "after-toll" case the following negative effects on the economic performance of a project that result from tolling the project are taken into consideration:

- The reduction in road user benefits that results from some road users being tolled "off" the new facility and
- The introduction of toll-related capital and operating costs.

The values of these indices for the project, if tolled, are then compared with those values of the indices that are considered the threshold values for economic feasibility to determine whether that specific project, if tolled, will comply with the threshold values.

Where present worth is determined, the minimum acceptable rate of return is used as the discount rate (currently 6 percent per annum is prescribed by the Department of Finance). To provide more information, the exercise is, of course, also per-

formed at other discount rates and sensitivity analyses are carried out.

In the "before-toll" analysis, the present worths of the new road right-of-way, construction, maintenance, and future rehabilitation cost are determined. In the after-toll analysis, the present worth of toll-related capital cost (including road widening at the toll plaza, control building, electrical works, tollbooths, and electronic equipment) and toll-related operating and maintenance costs are added to the before-toll analysis figures.

In relation to benefits, the present worth of savings in time, fuel, oil, tires, vehicle depreciation, vehicle maintenance, and accidents as well as the present worth of the residual value of the project is determined. For the after-toll case, the present worth of project benefits is reduced as a result of reduced traffic volumes on the new tolled facility.

By including in the total package of economically viable road projects those projects that, if tolled, would still have acceptable indices of economic worth, more economically viable road projects can be implemented with the combination of toll financing and the other sources of income than would otherwise have been the case. Figure 3 graphically shows the economic analysis with respect to a particular project.

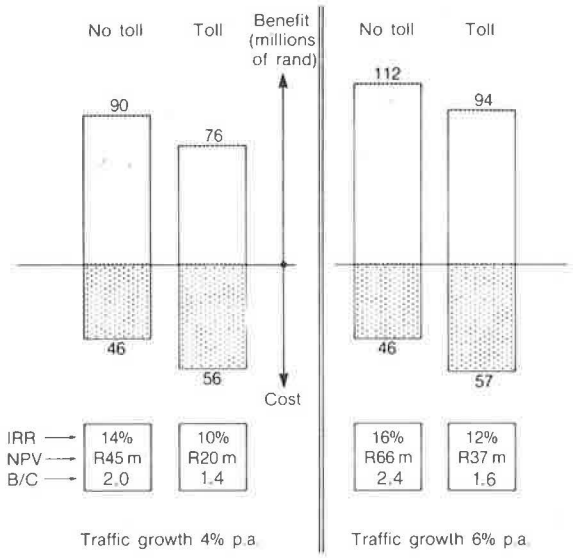

FIGURE 3 Typical results of economic analysis.

Financial Analysis

The basic premise in the conceptual framework of the financial analysis of potential toll projects holds that even though the project is economically viable after being tolled, it is not a prerequisite for the financial feasibility of the project that the toll revenue should repay the toll costs associated with the project. The objective of the financial analysis of potential toll projects is, therefore, to determine whether toll revenue can make an acceptable financial contribution to the repayment of the construction cost after meeting operating and maintenance cost. Acceptability in this sense is determined by the decision maker who must carefully consider the cost at which this financial contribution is obtained.

The loan supportable by revenue (LSR) is the most important single indication of the financial potential of a toll project compared with the present value of project capital cost.

LSR is determined by first calculating the net toll revenue for each year of the analysis period by deducting from the gross toll revneue in each year *(a)* toll plaza and head office operating expenditure, *(b)* toll plaza and toll equipment maintenance expenditure, *(c)* road maintenance expenditure, and *(d)* road rehabilitation expenditure.

The loan supportable by future toll revenue is then determined by discounting the net toll revenue in each future project year to its present worth, using the expected real interest rate as a discount rate, and summing the future year net toll revenues.

The toll road financial analysis strategy, which is employed for state toll projects and for which finanical parameters have to be quantified, includes the following phases:

Phase 1: construction period
- Procurement of capital market loans to the extent that the future net toll revneue can support these loans,
- Procurement of the remainder of the construction cost from the fuel levy income of the NRF, and
- Payment of interest on the capital market loans during the road construction period from the NRF.

Phase 2: initial years of the project
- Payment of interest on the loan from net toll revenue (after provision for toll operating and maintenance expenditure) and the fuel levy income of the NRF and
- Short-term capital market loans that can be "rolled over."

Phase 3: rest of project life
- Payment of interest on capital market loans from net toll revenue;
- Establishment of redemption or other special funds and the buying back of NTC stock in the secondary capital market;
- Repayment of medium- and short-term capital market loans from net toll revenue and the partial roll over of loans;
- Payment of rehabilitation cost from one or a combination of the following sources: *(a)* the fuel levy income of the NRF, *(b)* current net toll revenue, and *(c)* the redemption fund;
- Repayment of the long-term or, particularly, rolled-over short- and medium-term capital market loans when due; and
- Repayment of the NRF for its contribution to interest payments and to construction cost (to the extent that the latter is possible).

PROPOSALS FOR ROAD CONCESSIONS

At present (April 1986) toll road projects in South Africa are constructed and operated by the DOT using a small task force within the National Roads Division, termed "Tollplan." As has been described, the financial planning and control of the toll projects are exercised through a National Toll Road Fund.

Recently the department received a proposal from a private-sector consortium made up of road contractors, consulting engineers, and financial institutions for the complete financing,

construction, and operation of certain toll road projects over a period of from 25 to 30 years, with the facilities to revert to government control after expiration of the particular contract or franchise.

To ensure public accountability and also to provide any other interested parties with the opportunity to partake in a possible concession system for portions of the road infrastructure, the Minister of Transport Affairs publicly requested interested bodies to submit proposals for such concessions to the department.

Seven separate groups responded and, on the basis of their potential abilities and financial standing, for groups were chosen by the department to partake in the privatization scheme. These four groups, by mutual arrangement, amalgamated to form two separate potential concessionaires.

The two consortia involved in the offers are so large that they in effect control approximately 80 percent of the country's total private road-building strength. Their proposals could virtually involve the creation of two separate monopolies—one for the Johannesburg region and another for rural toll road construction on the country's two major routes—with the resulting control problems involved in monopolistic situations.

The offers are still under consideration because certain financial guarantees were required by the consortia. From the early negotiations it appears likely that some form of statutory body for the control of toll roads is likely to emerge and that ownership will remain under significant government control until the stage at which full private ownership of the facilities can be considered is reached.

Privatization has a number of advantages and in the department's case the main advantages are that the department is placed in a position to undertake necessary construction projects sooner with earlier resulting benefits to road users and the NRF moneys are freed for other necessary work that cannot be carried out on a fully self-supporting basis.

There are naturally a number of disadvantages or difficulties in the approach. Private enterprise is essentially based on self-interest, and caveat emptor has become part of existence. Progress runs on profit, but there is also the need for optimization in the use of resources and, as explained in the initial part of this paper, for a reduction of public-sector involvement in the provision of basic infrastructural needs. The role of government tends to become that of an arbitrator between private and public interests but with the handicap that decision making has to be based on information supplied by a well-informed interested party to the action. In this light various measures for achieving a workable solution that is fair to all have to be considered. Time will tell whether the approach is practical or not. It is understandable that under such circumstances the government's approach has to be on the cautious side because constraints can always be lifted or relaxed but are not easily imposed later.

The basic aim behind road concessions allied to toll financing is to obtain funds from the private sector at a reasonable cost and on a regular and long-term basis. From the entrepreneur's point of view the aim appears to be to limit equity during the earlier stages of a project and then, as returns improve, to expand the loans. The negative factors involved in the approach are that the loans involved are large; that overseas experience with toll roads has indicated a degree of risk, particularly during periods when high interest rates prevail; that long payback periods are unavoidable; and that the facilities revert to the government at the end of the concession period. This leads to a situation in which there has to be some balance between risk and reward. In the basence of adequate guarantees and given the undertaking involved in this relatively new kind of venture in South Africa, the required return on investment could be fairly high. To overcome the political and other problems that could result from possible excess profits at some future stage, an approach suggested is to limit profits to an agreed real rate of return and to syphon off the excess into a road-related fund that could be used for expansion of the toll road system. As an alternative, a portion of the fund could be turned into equity for public participation in the operation.

Because of the risk factors involved, and because private-sector entrepreneurs cannot realistically be expected to be concerned with socioeconomic interests at the expense of profits for their shareholders, only roads with potentially high traffic volumes can be considered in the privatization move unless some risk sharing is introduced into the agreement. Other factors such as possible government interaction through the provision of alternative high-quality facilities, the possible creation and control of private-sector monopolies, and the need to ensure free competition in road construction work so that market forces prevail require detailed examination.

At this stage investigations and negotiations concerning the relative merits of two alternative approaches are being carried out. The two alternatives are

- Granting of concessions to individual consortia for portions of the national road network and
- Creation of a statutory toll road authority constituted in such a way that private-sector ownership would eventually result; this body would carry out toll road functions on a tender basis.

To enable the proposed enterprise to be successful two conditions must be met:

- Government must be in a position to ensure and to demonstrate that adequate road facilities for the development of the country are provided in an accountable manner and
- Private-sector institutions undertaking the provision of certain public facilities through privatization must be able to access sufficient funds at a cost that will ensure that in the long term to enterprise will yield adequate profits.

Unless these conditions are met, any attempt to privatize roads will fail.

CONCLUSIONS

Because of other pressing demands, the allocation of public funds to the road sector in South Africa has been diminishing during the last decade and has been insufficient to meet the needs of road traffic.

In an environment in which government has adopted a policy of reducing public expenditure and encouraging private-sector involvement in the provision of public goods, two new direc-

tions in road financing have been considered during the past 5 years.

Tolling of roads, partly financed by loans taken out on the capital market by the state, has been implemented and, viewed in broad terms, has proved successful. Although the cost of toll collection has been higher than other methods of collection of funds, more efficient use has been made of resources and higher expenditure on roads has resulted.

The granting of concessions to private companies to finance, design, construct, maintain, and operate national roads and to collect tolls is also being considered. Although this will result in greater use of private-sector resources, there is a danger that the public may be exploited or alternatively that the private-sector companies may experience difficulties in the long run. The creation of a statutory body, with a large involvement by the private sector, to provide certain needed and justified toll roads might well be a better solution to guard against possible exploitation of the public.

ACKNOWLEDGMENT

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REFERENCE

1. W. J. Pienaar. Methodologies Employed in the Traffic, Economic and Financial Analysis of Toll Roads. *Proc., Annual Transport Convention*, Pretoria, Republic of South Africa, 1985.

New Thinking on Private-Sector Toll Roads in India: Rationale and Issues

D. P. PENDSE

India's effort to involve the private sector in the provision of tolled roadways is outlined in this paper. Relevant provisions of the Seventh Five-Year Plan (1985–1990) and concerns of the private sector are discussed, and questions that remain to be resolved are summarized.

India has the fourth longest road network (1.7 million km) in the world (Table 1), about 0.8 million km of which are paved, but the unfinished tasks are stupendous: merely to connect by road all villages of 500 or more people by the year 2001 and to raise road density to 0.82 km/km^2 from the present 0.46 km/km^2, the length of the road network would have to be increased to 2.7 million km.

RATIONALE

Some of the many weaknesses of India's road system have been well summed up in the Seventh Five-Year Plan (1985–1990):

> As much as 65 percent of the villages in the country are without an all-weather road. Only 47 percent of the road length in the country is provided with a proper surface. Besides, the pavement width of most of the road length is only single-lane. Even in respect of National Highways, 30 percent of the length has a single-lane road pavement. The grid as a whole suffers from serious deficiencies and there is a growing mismatch between traffic needs and available infrastructure, thus resulting in severe capacity constraints, delay, congestion, fuel wastage and higher vehicle-operating costs. It has been estimated that fuel wastage due to bad roads alone costs the country nearly Rs 5,000 million [as of October 28, 1986, the exchange rate was about U.S. $1 = Rs 12.90] a year, the loss due to extra wear and tear of tyres, spare parts and other components being many times larger.

The task ahead is tremendous because, due to an acute resources crunch, investments sanctioned for roads in successive five-year plans are falling far short of requirements. For example, 600 bridges were needed on the national highways during the sixth plan period (1980–1985), but only 60 were included in the plan, and, in the first 3 years, only 9 were actually sanctioned. Because of cost escalations, the divergence between targets and physical achievements has become even wider (Table 2), and the adverse effects of poor and inadequate roads on the economy and on fuel consumption are becoming clear.

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TABLE 1 COMPARISON OF SOME U.S. AND INDIAN STATISTICS

	Year	United States	India
Area (km^2 000s)	1984	9363	3288
Population (millions)	1984	237	736
Per capital gross national product (U.S. $)	1984	15,390	260
Road length (km millions)	1982	6.36	1.55[a]
Road density (km/km^2)	1982	0.68	0.47[b]
Motor vehicles (millions)	1983	166.2	67[c]

[a]In 1985 this value was 1.77.
[b]In 1985 this value was 0.54.
[c]In 1985 this value was 9.0.

TABLE 2 DEFICIENCIES AND SEVENTH FIVE-YEAR PLAN TARGETS

	Deficiencies as of April 1, 1985	Seventh Plan Target for March 31, 1990
Widening to two lanes (km)	5487	3500
Widening to four or six lanes (km)	1794	100
Bypasses (no.)	191	10
Major bridges (no.)	137	78
Minor bridges (no.)	1,587	600
Funds required (Rs millions)		
To clear all deficiencies		56,800
Seventh plan provision		8,920

Given the constraints on resources, it is not surprising that, as far as state-sector industrial investments are concerned, the entire Seventh Five-Year Plan is to be largely one of "consolidation." The development of infrastructure, which includes roads, is given high priority in the plan. Even so, the major thrust of the roads program during this period will be "to consolidate the gains so far achieved, properly maintain existing assets and initiate steps for upgradation and modernization of the roads system." The expansion of capacity will thus admittedly fall far short of requirements, a fortiori, because compensating for poor past maintenance will preempt significant portions of allocations.

Winds of change are now blowing over the entire spectrum of economic and industrial policies. The opening of the hitherto highly controlled Indian economy has been considerably accelerated since the new government headed by Rajiv Gandhi took office in November 1984. As a result of a significant liberalization of the industrial licensing and other related economic policies, rapid expansion and technological upgrading are expected in all automobile- and vehicle-related industries. In the past, railway interests were apprehensive about increases in the road network and the growth of road transport industries (Tables 3 and 4). However, the investment plans of the railroads are under severe financial strain; the relative importance of the road transport industry will continue to grow, and a much more modern and much larger roads system will be needed.

The government has been quick to see the implications of these trends and has taken several policy initiatives. New investments in the public sector are to be restricted to those areas "where it alone can undertake projects requiring high investments and sophisticated and frontier areas of technology," and much greater responsibility for fulfilling plan objectives will be placed on the private sector.

The private sector in India has certainly come of age and has shown remarkable technological capabilities in complex areas and equally remarkable financial performance and promise. The promise is also displayed in the ability to attract vast resources from the Indian capital market. Confidence is being placed in the private sector not a day too soon. The roads development industry, like the railways, has for years been the exclusive preserve of the state sector, but the new confidence in the private sector has led the government to accept a suggestion made by a distinguished Indian industrialist:

> It is possible that the Government sees the importance of good roads but due to constraints of resources—financial, technical and managerial—it is unable to translate all our

TABLE 3 ROAD-RAIL MODAL SHARE IN INDIA

	Passenger Kilometers (billions)			Freight Tonne Kilometers (billions)		
Year	Road	Rail	Total	Road	Rail	Total
1950–1951	23	67	90	5.5	44.1	49.6
	(26)	(74)		(11)	(89)	
1960–1961	57	78	135	35	88	123
	(42)	(58)		(28)	(72)	
1970–1971	169	118	287	66	127	193
	(59)	(41)		(34)	(66)	
1973–1974	208	136	344	67	122	189
	(60)	(40)		(35)	(65)	
1976–1977	235	164	399	76	157	233
	(59)	(41)		(33)	(67)	
1977–1978	250	177	427	77	163	240
	(59)	(41)		(32)	(68)	
1978–1979	270	193	463	81	155	236
	(59)	(42)		(34)	(66)	
1981–1982	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	(69)	(31)		(49)	(51)	
2000–2001	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
(projections)	(73)	(27)		(56)	(44)	

NOTE: Figures in parentheses are the percentage share of road and rail. N.A. = not available.

TABLE 4 GROWTH OF INDIAN ROAD NETWORK AND VEHICLE POPULATION

Road Length			Vehicle Population (000s)				
Year (1)	100 km (2)	Index (1951=100) (3)	Two Wheelers and Other (4)	Cars, Jeeps, and Taxis (5)	Trucks and Buses (6)	All Vehicles (4)+(5)+(6) (7)	Index for Total in (7) (1951=100) (8)
1951	400	100	31	159	116	306	100
1961	524	131	130	310	224	664	217
1971	918	230	746	682	436	1,865	609
1975	1215	304	1,257	766	449	2,472	808
1980	1492	373	2,847	1,054	612	4,514	1,475
1982	1546	387	3,885	1,207	751	5,844	1,910
1985[a]	1772	443	6,506	1,517	952	8,975	2,933

[a]Figures for 1985 are provisional.

dreams into action. If this be so, I wonder why the Government does not consider requesting private sector companies to supplement its own plans. Such companies could construct good roads and maintain them, if they are allowed to charge a mutually agreed toll for a specified number of years.

ISSUES

Tolls have been neither unknown nor unacceptable to the government in the past. On several bridges on the national highways, tolls have been an accepted practice for a number of years. However, the enormous need for the construction of new roads and the increasing difficulties faced in the proper maintenance of the existing road system both called for some new thinking. This is now reflected in the government's keenness to invite the private sector to participate in the road industry. The invitation is contained in a new policy statement, entitled *General Information on the National Highway System and Schemes for Private Sector Participation*, that was issued by the government of India in July 1985 after informal consultations with some concerned and experienced interests. The government has assured that necessary enabling legislation will be introduced and has even invited entrepreneurs to specify the provisions that need to be incorporated in such legislation.

Implementation of the policy is likely to bring to light quite a few issues about which decisions will have to be made to ensure concrete public response to this initiative. Some of these are

1. On what terms should land be made available by the government?
2. Should projects, such as building of roads, bypasses, tunnels, and bridges, be identified by the private-sector party, or should they be specified by the government? The government has listed some projects in the policy statement but has hastened to add that "the list is by no means exhaustive" and that "the private entrepreneur is free to identify the project, design its elements, raise funds, construct the facility, maintain the facility and collect tolls."
3. Should tolls be allowed for an unlimited period or for only a specified period, say, until investment costs are recovered?
4. Because new roads open up new geographic areas for industrial development, should the government in some way offer to underwrite the recovery of the initial costs of investment?
5. What type of private-sector entrepreneur should be permitted? Should such parties be required to be public limited companies, or could an individual entrepreneur also be given the task? If the former, should there be financial participation by the government or by the state-owned financial institutions? Should their nominees be on the board to safeguard the public interest?
6. What should be the scope for foreign collaboration or for participation of foreign firms in this industry? According to present official thinking, this "is not ruled out."
7. Should toll-financed schemes be allowed for potential monopoly routes where no alternative toll-free facility is available to the general public? The policy statement does not favor this, and in one such case in South India where there was no toll-free alternative, public reaction was sharp.
8. What principles should govern toll pricing? Experience in Europe, Japan, and the United States suggests several principles, and a study will be educational. Probably different principles will have to be applied in different cases. Apart from principles, such practical considerations as *(a)* the period for which tolls are to be allowed, *(b)* the costs of and the machinery for collections, and *(c)* allowance for inflation may also be important factors in deciding the actual toll in specific cases.

The government's initiative and invitation to the private sector to participate in the roads development industry is compelling, innovative, and timely. It deserves a constructive and generous response from the private sector. The road transport industry has been an excellent and faithful tax-gatherer for the government. Its accelerated growth in the coming decade and the awareness that this growth cannot be sustained without a matching roads network, also augurs well for the success of this initiative.

Since the announcements were made, several Indian private-sector units and their associations have held discussions among themselves and with the government to examine the ramifications and clarify their understanding; many foreign companies have also shown interest in participating.

Unfortunately, translation of the policy initiatives into action

has been slow. Firm offers from Indian parties were received for only two projects. It appears that some gaps between official and industry viewpoints have come to light. For example, prospective entrepreneurs would like their road construction projects to be treated on a par with other industrial projects that qualify for financial assistance from the state-owned financial institutions, whereas the government would like financing of road projects to be done by private entrepreneurs from their own resources or from open market borrowings and equity flotations. Other subjects under discussion include governmental participation in these projects, foreign collaborations, import of equipment, and tax concessions including accelerated depreciation. It is hoped that differences will be eventually ironed out and that this unique experiment will be a success.

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The Toll Ring in Bergen, Norway

ODD I. LARSEN

This paper is about the recently opened toll ring around Bergen, Norway. The physical characteristics of the toll ring—toll stations, methods of payment, reserved lanes, and control system—are described. The toll ring is successful because it was introduced to raise funds for badly needed major improvements to the road system not to restrain traffic.

On January 2, 1986, the city of Bergen implemented a toll ring around the central business district (CBD). The Bergen toll ring and the Area License Scheme in Singapore are the only examples known to this author of vehicles being charged a toll for entering the CBD. Similar schemes have previously been proposed and considered in several cities as a measure of traffic restraint. Implementation, however, has usually been found unfeasible, mainly because of lack of public and political support.

Using some kind of road-pricing scheme to restrain traffic in the presence of severe congestion has been advocated on the grounds that it may be a better alternative than heavy investments in road capacity or continued congestion. Economists have also pointed out that this may bring the private cost of using scarce road space more in line with the social cost. The toll ring in Bergen, however, was introduced to help finance a major program of road construction, and traffic diversion is not considered an objective.

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BACKGROUND

Bergen is situated on the western coast of Norway (Figure 1). It is the second largest town in Norway with a population of 200,000. Including the surrounding municipalities, the Bergen area has a population of 250,000.

Bergen has for centuries been a center of coastal trade, but its role as a trade center has been diminishing, in part because of better land-based communications and the declining importance of the Norwegian fishing industries. In recent years the economy of the Bergen area has gained from the northward movement of oil explorations on the Norwegian continental shelf.

The city of Bergen, a separate municipality within the county of Hordaland, is situated on a mountainous peninsula and is often called the city between the seven mountains. The topography concentrates the built-up area in certain corridors. Compared with many other cities of similar size, a large share of the population has been living in the central area, but in the last 10 to 20 years there has been a marked outward movement of population. Another consequence of the topography is that the cost of road construction is high and that vacant land that can be used for new roads is scarce in the central parts of the city.

Car ownership is below the national average, but in recent years the gap has been closing. At present car ownership in Bergen is about 320 cars per 1,000 population compared with a national average of 360.

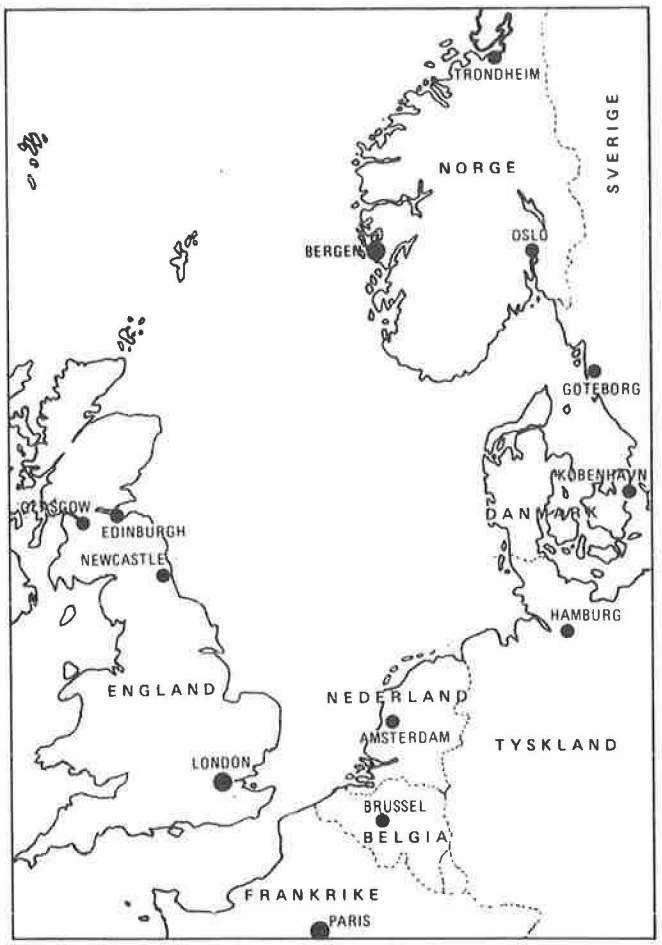

FIGURE 1 Bergen in the context of northern Europe.

THE TOLL RING

Because of the topography and the present road system, the CBD in Bergen is covered by only six toll stations, the locations of which are shown in Figure 2, on the main access roads to the CBD.

The exact location of the toll stations was dictated mainly by practical considerations. Three bridges lead to the CBD and these are natural points for toll collection. In two cases the toll station is actually located on the bridge (3 and 4 in Figure 2). On the third bridge there is one station on each of the two accesses. The reason for this is that the bridge is too narrow for the construction of a toll station.

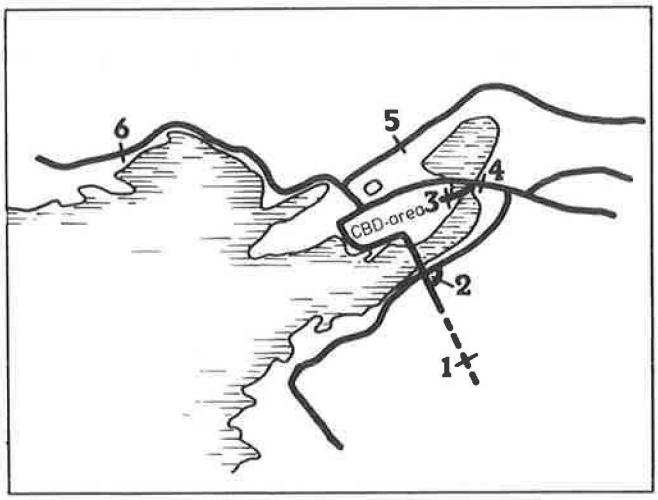

FIGURE 2 Location of toll stations.

One of the access roads is from a tunnel that was financed and built by a private company, the Bridge and Tunnel Company. The company has until now operated a toll station at this tunnel and collected tolls in both directions. This station (1 in Figure 2) has now become part of the toll ring. The ownership and the remaining outstanding debt were transferred to the government when the toll ring came into operation.

One consequence of using the existing toll station is that the toll ring is not strictly speaking a "ring." The drivers of a daily traffic flow of approximately 2,500 vehicles have to pay the toll on entering the tunnel although they are not going over the bridge to the CBD on the other side of the tunnel. If these drivers want to avoid paying the toll, they can detour by way of a steep, narrow, and badly paved road.

The two remaining toll stations (5 and 6) are on land-based access roads. These stations are located at points where there are no suitable alternative roads that vehicles going to the CBD can use. An additional toll station will become operational when the construction of a new western road link is completed. Less than 10 percent of the population in Bergen lives inside the toll ring.

Tolls are collected from all motor vehicles, except buses in regular service and light motorcycles, going toward the CBD. Tolls are collected from 6 a.m. to 10 p.m., Monday through Friday, except on public holidays.

Methods of Payment

The level of toll rates was set to satisfy a goal of 35 million NoK in net revenue for 1986 based on an estimated average daily traffic volume of 54,000 paying vehicles. The payment scheme includes

- Single tickets that are bought at the manned toll booths,
- Prepaid tickets that are bought in booklets of 20 tickets and delivered at the manned toll booths, and
- Monthly, semiannual, and annual passes that are placed on the windscreen.

The toll rates, in Norwegian Krones (NoK 1 ≈ U.S. $0.13), for 1986 are as follows.

	Light Vehicles	*Heavy Vehicles*
Single tickets	5	10
Booklet of 20 tickets	90	180
Monthly pass	100	200
Semiannual	575	1,150
Yearly	1,100	2,200

Heavy vehicles are defined as vehicles allowed to carry a payload of 3.5 metric tonnes or more.

Reserved Lanes

There are reserved lanes for vehicles with passes and such vehicles can pass through the toll stations without stopping. As a rule, the toll booths that serve the reserved lanes are unmanned part of the day.

The two toll stations with the highest traffic load have four lanes of which two are reserved for pass users. In the morning peak hour the traffic at these stations is from 1,500 to 1,600 vehicles. The remaining four stations have two lanes with one lane reserved for pass users and peak-hour traffic ranges from 1,200 to about 600.

Control System

The use of passes necessitates some kind of control system to avoid extensive cheating. In Bergen the system is based on videotape recordings of licence plates.

The licence numbers on the videotape are punched and compared with a file containing the licence numbers of vehicles that have a valid pass for the month. The licence numbers of vehicles without a valid pass can thus be sorted out and the owner found. The procedure followed to collect the fine of NoK 200 is the same as that used for parking fines.

The initial plan was to randomly select a toll station and a 4-hr period for a daily taping session. So far, however, the taping sessions have been more selective.

From this description it should be clear that the toll ring in Bergen is a rather simple construct. It is easy to imagine more sophisticated schemes for toll collection, but the system works and the time and manpower available for preparations made it impossible to explore more sophisticated systems. At present it appears that the cost of toll collection (including engineering work, equipment, and consultant fees) will amount to from 18 to 20 percent of net revenue.

WHY A TOLL RING IN BERGEN?

One of the interesting aspects of the toll ring in Bergen is that it was indeed implemented instead of remaining only a proposal. Several factors were important in this regard.

Insufficient Funds

The main roads in Bergen and in the other major cities in Norway are classified as national roads. The construction and maintenance of national roads are funded by the national treasury. Toll financing is used on a small scale and has until now been used mainly for a few bridges and tunnels outside the major cities.

Motor vehicles and road traffic are subject to heavy taxation in Norway. Taxes on import, ownership, and fuel are, however, considered part of the government's general tax base and are not earmarked for the construction and maintenance of roads. Government income from these taxes has in recent years exceeded government spending on roads by a substantial amount. More important is the strong emphasis on regional policies in allocating government funds for road construction. Less developed regions with substandard roads or missing road links are given priority even if the returns on investments are lower than in the larger cities.

A result of this policy is that problems caused by insufficient capacity on the main roads are steadily increasing in the larger cities. At present the situation is worst in Bergen and Oslo.

Toll-Financing Proposal

In each county there is a local branch of the National Roads Authority that has the administrative responsibility for planning, constructing, and maintaining national and county roads in the county.

The toll ring was first proposed in a Master Plan for National and County Roads in the Bergen area, dated October 1983. The plan was prepared by the local branch of the National Roads Authority and was to serve a twofold purpose:

- It was to be an input in the preparation of a general plan for the transport sector in the Bergen area and
- It was to be an input to a National Roads Plan for the period 1986–1989.

For the preparation of the National Roads Plan the government had issued guidelines that contained an assessment of the government funds to be allocated to each county in the planning period. The Master Plan for Roads in the Bergen area documented severe problems of congestion, traffic safety, noise, and air pollution on the existing road system. The plan also outlined projects that could provide Bergen with a satisfactory road system. The combined investment cost of these projects was calculated at NoK 2,000 million.

It would have been technically feasible to complete all of the projects in 12 years starting in 1986. However, given the government funds that could be allocated for road projects in Bergen, the construction period would have been at least 30 years.

To speed up construction, supplementary financing from the revenues from a toll ring and additional grants from the government were proposed. Before inclusion of this proposal in the plan, an informal meeting was held with representatives of the major political parties.

Collecting tolls on existing roads and using the proceeds to build new road was considered the best and possibly the only feasible solution. Several possible schemes of toll collection were considered. The recommended solution was toll collection on all weekdays from 6 a.m. to 12 p.m.

Good Marketing and Clear-Cut Alternatives

The presentation of the plan was followed by public hearings and dissemination of information. A special newspaper that described the plan was distributed to all households in the Bergen area. The emphasis in the information campaign was on the choice to be made between having good roads in 12 or 30 years, and the toll ring as the only realistic way to shorten the period of construction.

The first decision in the Bergen City Council about the Master Plan for Roads in Bergen took the form of a proposal to the central government. The municipality of Bergen would provide extra funds for roadbuilding of NoK 30 million (in 1983 Knones) per year if the government would provide the same amount as a special grant to national roads in Bergen. This proposal was made in April 1984 before any decision had been made about how Bergen's share would be financed.

Different methods of financing Bergen's own share were then discussed in a report that was presented in November 1984. The conclusion was that the only realistic solution was a toll ring as proposed in the Master Plan for Roads.

Toll Ring Not a Major Political Issue

Finally, in January 1985, the Bergen City Council decided on a toll ring with a period of collection from 6 a.m. to 10 p.m., Monday through Friday. Deciding on further details was delegated to the executive body of the city council. The decision was supported by a great majority, and all of the major parties voted for the toll ring.

Eleven months were left for preparations, engineering work, and so forth. Additional delay was caused because a decision on what agency would be responsible for toll collection was not reached until May. The outcome was that the Bridge and Tunnel Company should be responsible. The main reason for this choice was that the company had experience in toll collection.

In June 1985 the Norwegian Parliament formally approved the toll ring scheme and agreed to the proposal set forth by the Bergen City Council. Although the proposal of a toll ring scheme had political backing from the start, it was a controversial issue. If one of the major parties in Bergen had opposed the scheme, it could probably have gained may supporters.

One of the main reasons for the success of the scheme is that the proposal for a road toll was linked to the completion of specific projects. It was evident that major improvements to the road system were badly needed, and this made the benefits easy to understand. If a toll ring had been proposed as a measure of traffic restraint, it would certainly not have gained the necessary support in Bergen.

SOME REFLECTIONS ON THE TOLL RING AND TOLL FINANCING IN GENERAL

In comparison with traditional toll financing schemes, the toll ring in Bergen has several advantages:

- There is no attractive alternative route open to motorists who want to avoid paying the toll. The impacts on route choice are therefore of minor importance.
- The unfavorable impact on traffic that would occur if motorists were charged only for the use of new high-capacity roads is avoided.
- Distributional issues will not cause the same concern as they would if toll financing were used and tolls were collected on only a few road links.
- Extensive use of passes reduces the delays inflicted on motorists.

On the other hand, from an economic point of view, the solution chosen in Bergen could still be improved. The period of toll collection is 16 hr a day, which makes the cost of toll collection unnecessarily high. In the rush hours Bergen experiences rather severe congestion on the main roads, but the toll rates are probably too low to cause a significant shift in modal split and thereby relief of the congestion.

On economic grounds a strong case can therefore be made for toll collection only in the rush hours and for charging higher toll rates to meet the goal for net revenue. This could reduce the costs of both traffic congestion and toll collection.

Although several alternative periods of toll collection (including a 6 a.m. to 10 a.m. alternative) were considered, a thorough cost-benefit analysis was not carried out. The argument put forth in favor of a long period of toll collection was that all motorists would benefit from an improved road system and should accordingly share the cost equally. It was also pointed out that a shift in modal split in the rush hours would have the unwanted effect of increasing the subsidies paid to public transport.

A cost-benefit analysis of different periods of toll collection might not have changed the final decision, but it would at least have presented the Bergen City Council with an assessment of the economic trade-offs involved.

Is Toll Financing Inefficient?

Although toll financing of road construction is used in many countries, it is often regarded as a costly and rather clumsy way of financing road projects.

Taking account of the marginal cost of public funds may change this conclusion. Recent estimates by Ballard et al. *(1)* and Hansson *(2)* of the marginal cost of public funds indicate that the cost of tax financing may well exceed the cost of toll financing for many projects.

It should be pointed out that the choice between tolls and taxes can be treated as a problem of minimizing the cost of financing a project or a collection of projects. This procedure involves two steps. The first is to design toll schemes that minimize the "social cost" of collecting a given net revenue. The next step is to compare average and marginal costs of collecting different amounts of net revenue with the marginal cost of public funds.

Depending on the parameters involved, the optimal solution may be full financing by taxes, full financing by tolls, or the financing split between tolls and taxes. In the last case an optimal share will, in principle, exist.

IMPACTS AND EXPERIENCES TO DATE

It is too early for a comprehensive evaluation of the toll ring, but some conclusions are evident.

The opinion was widespread among the general public that the toll ring would lead to increased congestion. On the first day of operation this was true. On the second day, however, delays were back to normal levels during the rush hours.

In February and March there was increased congestion on the first day of the month due to motorists stopping at the toll stations to renew their monthly passes. In April this was

avoided, mainly because an advertising campaign urging renewal of passes before the first of the month was run in the newspapers. In May and June the same problem emerged.

Passes are for sale in bank offices as well as at the toll booths. Continued problems on the first day of each month indicate that additional sales outlets are needed or that some other action should be taken.

A major concern in deciding the prices for passes and tickets was to foster the use of passes. The Institute of Transport Economics acted as a consultant on this matter and their recommendations were followed. It was estimated that the recommended price structure would lead to about 18,000 pass users. The share of pass users in the total traffic stream was estimated to be approximately 60 percent on a daily basis and around 80 percent in the morning rush hour.

The estimate of the number of pass users proved to be correct. The exact share of pass users in the traffic stream has not been established so far because the vehicle detectors on the toll stations have not functioned properly. The available evidence indicates that about 55 percent of the daily traffic stream is pass users. This corresponds to higher than estimated revenue from the sale of single and prepaid tickets. The sales of tickets and passes so far indicate that gross revenue in 1986 may reach or slightly exceed NoK 50 million; estimated revenue was NoK 44 million.

The Institute of Transport Economics also recommended the control scheme used. Several alternatives were considered, but the chosen alternative appeared to be the only one that could catch both motorists without passes and motorists using forged or borrowed passes. A government agency had to approve the control scheme, and this delayed implementation until April. The results from the first taping sessions indicated that approximately 5 percent of the motorists have been cheating. This is somewhat more than expected. The percentage will certainly decrease when it becomes known that cheating is not as riskless as it had been before April.

The impacts on traffic volumes are of major interest. It was expected that the toll ring would decrease the number of passing vehicles in the period of operation by 3 percent. Due to the malfunctioning of the detectors, there has not been a continuous traffic count at the toll stations. The comparisons that have been made so far are based on ordinary traffic counts in October and November 1985 and January and February 1986. The traffic counts show a decrease of about 10 percent in the period of operation.

The results from these traffic counts, however, do not warrant any firm conclusions. First, account must be taken of the seasonal variations in traffic flows. This factor alone may account for a decrease of this magnitude. Second, that the price of gasoline decreased by nearly 20 percent between October 1985 and February 1986 must be considered. Third, in 1985 the Bergen area experienced the highest sales figures for new cars in years and these figures have also been high in the first quarter of this year. Public transport fares were increased by 7 percent on January 1.

A proper assessment of the impacts on traffic will therefore have to wait until more data are available and a thorough analysis has been carried out. The latest traffic figures, however, indicate a slightly higher diversion of traffic than expected. The greatest impact can be expected among motorists who use single or prepaid tickets. Pass users will face a marginal price of zero and can be expected to be unaffected by the toll ring.

FUTURE TOLL FINANCING IN NORWAY

As was mentioned previously, the financing of major road construction schemes is a general problem in the larger cities in Norway. At present discussions are going on in the Oslo region and in the city of Trondheim about whether to use toll financing on a major scale. In Trondheim a toll ring will certainly be considered. The Oslo City Council voted against a toll ring scheme a number of years ago and decided to use a traditional toll financing scheme for a major road project in the CBD. However, to obtain funds for additional projects and to avoid diverting traffic to other roads in the CBD, the use of a toll ring (or an area licence scheme) might be reconsidered.

The agreement reached between Bergen and the government, which guarantees Bergen a special grant of the same amount as the proceeds from the toll ring, will certainly create a precedent for similar agreements with Oslo and Trondheim. This will also make it more tempting for the local authorities to consider toll financing.

REFERENCES

1. C. L. Ballard, J. B. Shoven, and J. Whalley. General Equilibrium Computations of the Marginal Welfare Costs of Taxes in the United States. *American Economic Review,* 1985, pp. 128–138.
2. I. Hansson. Marginal Cost of Public Funds for Different Tax Instruments and Government Expenditures. *Scandinavian Journal of Economics,* 1984, pp. 115–130.

Technology and the Heavy-Vehicle Electronic License Plate Program: Potential Uses for Government and Industry

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Automatic vehicle identification (AVI) developments in Oregon and the heavy-vehicle electronic license plate project are discussed. An overview is given of some worldwide developments. Potential applications of AVI technology and its use in conjunction with other state-of-the-art techniques for vehicle weighing and classification are examined. Potential advantages associated with the implementation of large-scale AVI systems for the monitoring of vehicles are discussed. Some of the technological options for AVI are reviewed, and the major highway-based applications of AVI technology are examined.

Current methods of collecting extensive data on the nation's highway system are costly to both government and industry. Many of these data collection activities entail substantial efforts, yet the data produced over the years have such inconsistencies among states and among sources, or have such important elements missing, that much of the data are not directly useful. A solution to many of these problems may be found in new electronic technology.

Developments in data transmission, processing, and communications have increased the viability and reliability of automatic vehicle identification (AVI) equipment, and parallel developments have occurred in weigh-in-motion (WIM) and automatic vehicle classification (AVC) technology. Thus techniques for the collection of data on traffic volumes, speeds, and vehicle weights and types have now become a practical proposition as has the reliable transfer of data from remote sites. The combination of these technologies could improve the potential of AVI in a number of applications.

A total traffic-monitoring system would include components that automatically weigh, classify, measure speed, and specifically identify individual vehicles. This state-of-the-art technology provides an extraordinary opportunity to bring about a quantum jump in multiuse data collection of heavy-vehicle characteristics.

OREGON DEMONSTRATION PROJECT

Since 1983 Oregon has been involved in an individual effort to investigate how identifying and weighing vehicles in motion could be used to the advantage of both the government and the trucking industry. It was hoped that integration of AVI and WIM technology could help not only with planning and design information but also in size, weight, and speed enforcement. The Oregon Department of Transportation (ODOT) also believes that the Oregon system, when fully implemented, has the potential to improve the tracking of hazardous materials, help fleet managers monitor movement of their vehicles, and promote a reduction of thefts of vehicles equipped with AVI devices *(1)*. To reach its full potential, it is recognized that many more sites in addition to every port of entry (POE) and most weigh stations need to be equipped with AVI and WIM technology. These additional sites would provide more information to trucking firms for fleet management as well as monitor bypass routes *(2)*.

The Oregon Automatic Vehicle Identification/Weigh-in-Motion demonstration project began in February 1984 with the installation of high-speed weigh-in-motion scales in both northbound lanes of Interstate 5 near the Jefferson exit. This system is used primarily for the collection of planning data. The scales register vehicle weight, length, axle spacing, 18-kip equivalent single axle loads, speed, and time. Since these scales were installed, more than 15 million vehicles have been weighed and classified. About 20 percent of these vehicles are trucks *(3)*.

Also in February 1984, about 28 mi further north at Woodburn, a moderate-speed WIM and overheight sorting system was installed at a northbound weigh station. This WIM equipment is used to screen trucks as part of Oregon's ongoing truck weight enforcement program. Legally loaded vehicles that enter the weigh station and cross over the weigh pads at from 25 to 35 mph are automatically given a green light to return to the freeway. Approximately 90 percent of the vehicles are passed through the station with the green light. Trucks with overheight, overweight, or axle weight distribution problems are directed to the static scale. This sorting system has allowed the Weighmaster Unit to operate the station with one person rather than the three previously needed.

Although data from these two sites are still being analyzed, it is noteworthy that the high-speed Jefferson WIM scales record from 50 to 100 percent more overloads than the Woodburn sorter scale. This would appear to indicate a substantial scale bypass problem at the Woodburn weigh station.

In the spring and summer of 1984, General Railway Signal Automatic Vehicle Identification reader-activators were installed at these two sites and at the Ashland POE and the Ridgefield, Washington, POE on I-5. These reader-activators read data from precoded passive transponders, mounted on trucks. Twenty-one trucking firms are enthusiastically participating in the Oregon project and have installed 200 transponders on their vehicles. These trucks are automatically tracked as they travel I-5 from the California-Oregon border north to the Oregon-Washington border, a distance of 310 mi *(4)*.

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The information received at these five locations has been tied together with a data base management system, creating a unified, accessible AVI/WIM data base.

Another element of the Oregon project is a portable bridge weighing system (BWS) that employs strain gauges to convert a bridge into a scale, weighing trucks as they pass over it. The strain gauge data are converted to vehicle weight information by a computer housed in a van. This system is used primarily on rural highways and is useful in determining which roads are used as bypass routes by overloaded trucks. Through a federal grant to the ODOT in June 1983, Science Applications International Corporation, in cooperation with ODOT, successfully interfaced and tested, in a rural location, the portable BWS and a portable AVI system *(4–6)*.

Trucking firms participating in Oregon's demonstration project see two of the biggest advantages coming from this system as the time they save at weigh stations and the possibility of the system promoting fairer competition. There appears to be an increasing number of violators attempting to gain a competitive edge by either running trucks overloaded or evading taxes. Because of these violators, the industry as a whole suffers because the legal operators are at a competitive disadvantage and because the negative image of the violators reflects on all operators *(7)*.

Oregon is currently working on plans for automating ports of entry. The prototype will be the newest Oregon POE at Woodburn, southbound on I-5. This port is open 24 hr a day, with as many as 200 trucks per hour at peak times. AVI, WIM, and AVC will be combined with a supervisory computer and various software and hardware packages to link the technologies. In addition to the usual weighing functions, personnel at POE also fulfill regulatory and tax-collecting functions. It is estimated that 9 of the 13 manual tasks currently required of a weighmaster per truck can be eliminated. With this technology, 85 percent of the vehicles going through the POE can be automatically processed, saving time for both government and industry *(4)*.

The benefits to be derived from a system of this type are potentially immense. Oregon is planning for further expansion of its automated vehicle-monitoring program. Preliminary plans suggest the possibility of instrumenting 100 bridges for the portable BWS as well as other low-cost weigh-in-motion systems. Many of these installations will be interfaced with AVI. With the information derived from such a system, highway planning and designing would be greatly improved. The proper placement of these installations should also go a long way toward eliminating the scale bypass problem and, therefore, the vehicle overload problem *(4)*.

HEAVY-VEHICLE ELECTRONIC LICENSE PLATE PROGRAM—A MULTISTATE PROJECT

About the same time the Oregon Heavy-Vehicle Monitoring Project got under way, the Arizona Department of Transportation received a grant from the FHWA to study the feasibility of a WIM/AVI demonstration in a multistate environment. This study was completed by Castle Rock Consultants in December 1984. The report was encouraging about the technical feasibility as well as the potential benefits to both government and the private sector. This preliminary study indicated that such as program, fully implemented, could soon pay for itself *(8)*. Another, more thorough, study is to be conducted under the Heavy-Vehicle Electronic License Plate (HELP) program to either confirm or disclaim the optimism of the Castle Rock report.

Results of the Arizona feasibility study and the positive feedback from the Oregon concept demonstration project generated interest, especially in Western states, in developing a multistate program. In February 1985, a kick-off informational meeting of government officials and trucking representatives was held in Portland, Oregon, to determine the possibility of a multistate demonstration project. The meeting marked the beginning of the HELP project and resulted in the formation of a multistate organization. A decision was made that the best management approach was to have both government and trucking industry representatives work together to oversee the project.

The project was originally dubbed the Crescent Study because the states that showed the strongest initial interest formed a crescent shape from the Canadian-Washington border, through the Pacific Coast states, across to Texas. The study now includes Alaska, Arizona, California, Idaho, Iowa, Minnesota, Nevada, New Mexico, Oregon, Pennsylvania, Texas, Washington, and most recently Virginia. The participation of states outside the crescent has made it necessary to change the name of the overall study to HELP *(9)*.

The multistate HELP System Development Program is essentially a cooperative research and demonstration project to investigate the new technological tools available for gathering pertinent heavy-vehicle data. The purpose of research such as this is not to reach conclusions but to discover things that are presently unknown. What the participants hope to learn from the testing of the HELP system is what functional and practical applications there are for automated systems on the nation's highways. From the study, transportation professionals should gain insight into whether or not it is cost-effective to develop and implement a national vehicle-monitoring system that may benefit both government and industry. The multistate program has now reached the stage where a number of developmental and testing phases, which will continue for the next 2 years, are beginning *(8)*. Within this framework, the following program elements can be identified:

1. An AVI testing project has just been begun at Ford Motor Company's Yucca, Arizona, Motor Vehicle Test Track Laboratory, and field tests are soon to follow. The results of these tests will be used to develop a generic AVI system specification. The specified system will then be put through a similar testing program and any necessary fine-tuning will be carried out.
2. The WIM/AVC performance specification elements are similar efforts to address the weigh-in-motion and automatic vehicle classification components of the HELP system. A contract was just awarded to Texas Transportation Institute to conduct this study.
3. The Systems Design Study, awarded to Cimarron Software of Texas, is now under way and will define the communications and processing requirements for public- and private-sector applications. The main tasks involve communication

systems design and computer systems analyses for data processing and utilization.

4. The Motor Carrier Services Plan Study, soon to be awarded, will involve an examination, in greater detail, of how the HELP system may benefit the motor carrier industry.

5. The Satellite Reference Design System Study, soon to be awarded, will investigate the economic and technical feasibility of a satellite-based traffic-monitoring system. This will include definition of the system, costs and benefits to both government and industry, and comparison with alternative gound-based data collection systems. Ways in which satellites could be integrated with a ground-based HELP system will also be covered.

6. A Site Selection Study will involve the development of guidelines that will enable states to locate HELP stations along the planned demonstration routes. This study will determine the optimal number and location of HELP sites to meet the aims and requirements of the program. Sites will be selected so that they can also be readily incorporated into a national system if the demonstration should prove worthwhile.

7. The final phase of the HELP program is the actual deployment of a heavy-vehicle monitoring system in the Crescent states. The states of Texas, New Mexico, Arizona, California, Oregon, and Washington (and perhaps the province of British Columbia) are now planning installations of WIM and AVI stations along two major Interstate highways, I-5 and I-10. After installation, an evaluation study is scheduled to assess the practicality and usefulness of this type of technological integration. Unfortunately, a complete measure of the possible benefits to be derived from a fully developed HELP system is not possible without a more saturated implementation of sites than is provided for in this research.

8. Two closely related projects, which are being undertaken during the same time frame as HELP, are a study on the potential for a Low-Cost Automatic Weight and Classification System and the National Cooperative Highway Research Program's (NCHRP's) study of the Feasibility of a National Heavy-Vehicle Monitoring System.

Iowa, Minnesota, Washington, and Oregon are involved with research on the durability and accuracy of piezo-electric sensors for weighing trucks in motion. The output from these low-cost sensors and loops will be analyzed using microprocessor technology. The system will include off-scale detection, tire width measurement, vehicle speed, classification by axle spacing, axle and gross weights, and equivalent single axle loading calculations. In addition, NCHRP is about to award a contract for development of a low-cost bridge weigh-in-motion scale. Both of these low-cost weighing concepts are aimed at producing installed sensors for under $10,000—a price at which automation of virtually all weighing activities becomes quite attractive *(8)*.

The objective of the NCHRP research, which is being conducted by Arthur D. Little, Inc., and SYDEC, is to identify and evaluate the needs, issues, requirements, and feasibility of using AVI on a national level. This study will serve as a guidepost to national decision makers. Can it be a cost-effective, statistically sound replacement or supplement to existing heavy-vehicle data collection systems? The NCHRP study will build on the knowledge gained from the HELP program and any other related studies.

The HELP System Development Program is both ambitious and complex. The program, since October 1985, has employed a management consultant whose chief task is to manage and coordinate the technical aspects of the program. A policy consultant has just been hired to address policy issues that emerge during the course of the program and handle public relations, educational, and promotional activities. The policy and management consultant services are a direct response to the complexity of the program.

Selection of a generic AVI system under the HELP program is currently scheduled to be completed in 1988. Within a few months after this selection, the states along the crescent path are expected to have 10,000 test vehicles from about 200 trucking companies equipped with transponders. The demonstration continues through 1989. The final evaluation of the project and the report should be finished by March 1990.

To summarize, the overall aim of the HELP System Development Program is to investigate the potential benefits and costs of automatic traffic-monitoring systems to both states and the trucking industry.

OVERVIEW OF POTENTIAL APPLICATIONS OF AVI

Automatic vehicle identification systems could have applications throughout the field of highway transportation. Specific applications will be found in such areas as planning, design and operation of highway weight enforcement systems, surveillance, communications, and control. These include

- Heavy-vehicle monitoring,
- Revenue collection and road pricing,
- Traffic operations and urban transport planning, and
- Law enforcement.

Heavy-Vehicle Monitoring

AVI, coupled with state-of-the-art techniques for weighing vehicles in motion, provides a method by which truck data collection efforts may be simplified and coordinated. The technique improves productivity while reducing long-term data collection costs. In addition, AVI/WIM systems offer advantages to the operators of commercial vehicle fleets by providing a means by which fleet managers can monitor the location of vehicles and, therefore, utilize the resources at their disposal more efficiently.

Finally, AVI/WIM technology can be used in the enforcement of size and weight limits. Using a combination of automatic identification, weigh-in-motion, and vehicle classification, enforcement agencies could identify a truck and determine its size and weight and whether it is covered by a special permit exemption.

Before completion of two important studies, NCHRP's study on the Feasibility of a National Heavy-Vehicle Monitoring System and the HELP System Demonstration Project, it is impossible to be conclusive about the net benefits of heavy-vehicle monitoring systems. There may be a threshold level of deployment necessary before net benefits are achieved.

However, at this time AVI/WIM appears to offer substantial benefits in the monitoring, control, and operation of the heavy-

vehicle population. To be sure, in recent years there has been tremendous growth in the use of heavier commercial vehicles, which has resulted in an accelerated deterioration of the nation's major highway systems. Many states have attempted to limit the use of heavy vehicles to certain routes as well as conduct vigorous weight enforcement programs, but these are difficult and costly to administer.

Concern about the effectiveness of current taxation structures in ensuring that commercial vehicles contribute a proportionate payment for road costs is also of concern to many states. The influx of larger and heavier vehicles has reinforced the need for increased vehicle-weighing and vehicle-monitoring activities. Both federal and state governments have shown concern for the problem and have begun to investigate scenarios for automatically monitoring truck size and weights including the use of AVI techniques. The multistate HELP System Demonstration Project is most notable among these efforts. Oregon's own project has already demonstrated that AVI interfaced with weigh-in-motion systems has a reasonable, if not promising, chance for widespread adoption.

Revenue Collection and Road Pricing

AVI used in revenue collection applications can greatly speed operations at toll booths, car park entrances, truck ports of entry, and other facilities where a vehicle has to come to a stop to either present payment or evidence of legal weight and proper papers. The system can be operated in either a prepaid or a credit mode. In either case, the patron would receive periodic statements of usage and account records. Such a system would offer the patron convenience of payment, nonstop passage through the facility, and printed records of usage. An AVI-based revenue collection system could offer the operator significant labor savings and better information on vehicular movements through the facility *(8)*.

In revenue collection systems, where the operation is hindered by lack of capacity at the collection point, the faster passage afforded by an AVI system can substantially improve operations. A further extension of this concept is the introduction of toll charges on congested facilities using AVI for electronic road pricing. The concept of road pricing, whereby users of congested highways would pay for the use of the road on a differential basis, has been widely examined and is currently being studied in Hong Kong. All preliminary technical work has been accomplished, but actual implementation will depend largely on the attitude of the Republic of China. The study indicated that an AVI road-pricing system could be made flexible by charging differential prices by type of vehicle, occupancy rate, time of day, and traffic density of the corridor during peak hours. The conclusion was that the system was cost-effective and easily justifiable on the basis of the benefits resulting from reduced congestion and pollution.

Another form of revenue collection to which AVI may make a contribution is weight-distance taxation. A few states implement this form of heavy-vehicle taxation whereby a particular vehicle is charged on the basis of the distance traveled and registered load. An AVI system for the administration of weight-distance taxes would have several advantages over the present tax collection process. States that have weight-distance taxes could use a common data base for standardized truck taxation, which would make it possible to achieve a uniform and continuous tax program. The use of AVI technology could lead to considerable reductions in the cost of operating the revenue collection process and, in addition, lead to equally significant reductions in evasion *(1)*.

Moreover, states that have this form of taxation could make further improvements in the overall equity of their tax structures by basing the tax rate on a combination of vehicle parameters such as gross weight, axle weights, vehicle configuration, location, time, functional class of highway, and the like so as to reflect the broader impacts of transportation users on the community as a whole. It is important to keep in mind that most states do not have weight-distance taxes; fuel taxes and registration fees are preferred as the primary source of tax payment from heavy vehicles. Here too, AVI systems can offer state officials information necessary to adequately assess trucking firms' reports of fuel used within the state and the accuracy of the report of registration fees the firm has prorated among the various states in which it operates.

Traffic Operations and Urban Transport Planning

AVI offers potential for improved traffic operations, particularly where priority access systems are planned or utilized. The ability to uniquely and accurately identify vehicles by type could greatly increase the effectiveness of priority access systems. Surveillance and control systems could also benefit because AVI information, coupled with data on vehicle speeds, lengths, and types, would permit more precise definition of traffic composition and flows.

The prediction of the number of interzonal trips and their distribution by time of day, route, and mode is inherent in the transportation planning process. These predictions are based on large quantities of origin-destination data, the collection of which is expensive and time consuming. It is unlikely that an AVI system would be installed specifically to benefit the transportation planning process, but if the installation of AVI systems for other applications became a reality AVI readers at specific locations could produce automatic and accurate origin-destination data in a form that could be used efficiently by transportation planners *(8)*.

Law Enforcement

Motor vehicles are used directly or indirectly in a wide variety of criminal activities. These range from the theft of private automobiles and the hijacking of trucks to use in perpetrating a crime or fleeing from the scene of a crime. The present methods of locating these vehicles are, in large part, cumbersome and ineffective, although recent developments in automatic video scanning of conventional license plates have shown promising results.

In one application an electronic video scanning system was located at a toll plaza to the Dartford Tunnel, near London, England. As a vehicle stopped to pay the toll, its number was electronically read and compared with an on-line data base of license plate numbers of wanted vehicles. Detection of a wanted vehicle resulted in a message being relayed to a local

police control center. The development of this equipment is continuing with the adaptation of the system to read the license plates of vehicles as they move at highway speeds.

AVI, coupled with speed-monitoring techniques, has obvious applications in speed limit enforcement activities. Systems that automatically photograph a speeding vehicle's license plate are already commercially available. An AVI-based speed trap could operate unmanned to automatically record and store the identity of violators who could subsequently be warned or prosecuted.

Another law enforcement application is in the trucking industry where hijacking of vehicles is a serious problem. The location of trucks equipped with AVI transponders would be determined automatically as they moved along known routes. Knowledge that the truck had not reached a specific point within a predetermined time interval could indicate a potential problem.

A recent marketing distribution plan developed for the LoJack Corporation of Boston, Massachusetts, by Touche Ross & Company assessed the potential market for the company, which has developed and patented a vehicle theft detection system based on state-of-the-art technology. In defining the nature of the motor vehicle theft problem, the report uses as evidence costs borne by society and the trucking industry. It was estimated that annual losses through theft to the trucking industry amount to approximately $7 billion. The number of automobiles stolen each year in the United States was put at more than 1 million, at an estimated cost to society of $2.9 billion and with automobile insurance losses due to theft approximately $3 billion annually. It was also noted that drivers of stolen cars and trucks are responsible for causing more than 5,000 disabling injuries and fatalities annually. If increased deterrence through use of a traffic-monitoring system could lead to even a small reduction in these figures, the benefits to society would be substantial.

CONCLUSIONS

To reiterate, the goal of the Oregon and multistate HELP AVI projects is to investigate the potential use of AVI and WIM technology to serve both government and industry in monitoring heavy vehicles. The potential for benefits from AVI looks promising for both sectors.

Government needs a way to improve its truck safety, weight, and enforcement programs. Current methods are largely ineffective and costly. State DOTs are in desperate need of obtaining better, more reliable, and less expensive data for the planning and design of highways. Also, it should not be forgotten that government is responsible for ensuring the collection of taxes that truckers pay. AVI offers a promising alternative to the current labor-intensive tax-auditing methods.

Stopping at weigh stations and ports of entry takes away valuable trucking time, and time is money. Monitoring truck movements at critical checkpoints could induce more truckers to pay their "fair share" of road user taxes, and honest truckers would definitely benefit. The HELP program is also studying the potential of AVI to assist truckers in fleet management control and to reduce the expense and effort involved with the filing of numerous reports through automating the entire process.

Other developments that involve AVI are taking place around the world. Hong Kong is experimenting with AVI as a potential road-pricing tool to control congestion. London is investigating use of AVI for apprehending toll violators, and Boston is interested in AVI for tracking vehicle thefts. The Port of New York and New Jersey is interested in AVI for monitoring buses as are other cities around the United States.

The technology described in this paper should be just as useful in the Far East and in Europe as it is in North America. All of the AVI applications discussed are viable. The people involved in the HELP project are anxious to find out just how viable some of them are.

REFERENCES

1. L. Henion. Weigh-in-Motion, New Technology to Assist Us in Managing Our Highway Investment. Presented at National Weigh-in-Motion Conference, Denver, Colo., July 1983.
2. M. Krukar. *The Benefits of Using Automatic Vehicle Identification Tracking Devices to the State of Oregon and the Trucking Industry.* Oregon Department of Transportation, Salem, 1983.
3. M. Krukar and L. Henion. The Oregon Weigh-in-Motion Project. Presented at Eighteenth Annual Pacific Northwest Regional Economic Conference, Olympia, Wash., May 1984.
4. M. Krukar and L. Henion. The Use of Weigh-in-Motion/Automatic Vehicle Identification Data in Oregon. Presented at Second National Conference on Weigh-in-Motion Technology and Applications, Atlanta, Ga., May 1985.
5. T. L. McDaniel and J. W. Schmidt. *The Development of an AVI/WIM Data Base and the Demonstration of a Combination of Bridge WIM and Portable AVI Data.* Science Applications International Corporation, San Diego, Calif., April 1985.
6. F. Moses and M. Gohsn. *Weighing Trucks in Motion Using Instrumented Highway Bridges.* Report FHWA/OH-81/008. FHWA, U.S. Department of Transportation, Dec. 1981.
7. G. Burgess and H. S. Coulter. Managing the Highway System in an Era of Technological Change. Presented at Western Highway Institute Conference, San Francisco, Calif., July 1984.
8. P. Davies. *Heavy Vehicle Electronic License Plate (HELP) System Phase 1A Feasibility Study.* CRC Corporation, Nottingham, England, 1984.
9. L. Henion. *What is the Crescent Project?* Oregon State Highway Division, Salem, Feb. 1985.

Electronic Road Pricing in Hong Kong: An Opportunity for Road Privatization?

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The Hong Kong Government investigated the feasibility of introducing electronic road pricing (ERP) to the territory as a means of controlling congestion. By selectively charging road users at busy times and places, road pricing offers a method of restraining the usage of vehicles on the road network and is potentially more equitable and more efficient than the main alternative policy option, restraint of car ownership. To assess all aspects of the feasibility of ERP, the government engaged Transpotech to carry out a 2-year pilot project. A full subset of the road system engineering components of a road-pricing system ran successfully for more than 6 months in the central area of Hong Kong. Evaluation of the system has shown that there are no technological barriers to the introduction of ERP in Hong Kong. A major transportation study was conducted to assess the effects of road pricing in Hong Kong. The results showed that full system would be extremely efficient and cost-effective, and a number of viable schemes were presented. The accounting, administrative, and legislative aspects of ERP were fully investigated and reported on by Transpotech. These aspects present no problems. ERP was presented as a method of restraining traffic and not as a way of financing roads. Privatization issues were not explored in the studies, nor in subsequent discussions. ERP was not well received by local people and the government of Hong Kong is not proceeding with the implementation of a full ERP system.

In 1985 Transpotech completed a 2-year contract with the Hong Kong Government to demonstrate the viability of electronic road pricing (ERP) in the territory. The work was described in detail elsewhere *(1–4)*.

The contract was *(a)* for the supply of the pilot stage of a potential full system, involving a complete subset of such a system, installed and working in central Hong Kong and *(b)* for transport studies to assess the effectiveness of road pricing as a new and efficient tool for the control of traffic congestion.

Transpotech was supported by a number of subcontractors and suppliers. Plessey Controls Ltd., supplied all of the road system engineering equipment, which was developed from the company's experience with traffic control systems and automatic vehicle identification systems. The MVA Consultancy completed a major study of Hong Kong's traffic conditions up to 1991 and the effects that alternative implementations of a full road-pricing system would have. Other suppliers included GEC Avionics; Logica, who helped to provide a demonstration accounting system for the pilot stage; Logica's sister company in Hong Kong, Jardine Logica Systems; and a number of other Hong Kong–based firms.

The project progressed extremely well: all of the equipment was installed on or ahead of schedule and worked well above its performance specifications; the accounting and administration of a full system were thoroughly investigated; a detailed final system outline design was proposed; and transport studies showed that ERP offers a highly efficient and equitable method of dealing with Hong Kong's intense traffic problems.

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WHAT IS ERP?

ERP is a system for automatically assessing vehicles for road-use charges at specific locations and time periods. Unlike conventional tolls, it does not require vehicles to stop, or payments to be made, when the charges are incurred.

Figure 1 shows how the ERP system works. A small, inexpensive and extremely tough solid-state device called an electronic number plate (ENP) is attached in minutes to the underside of each vehicle. The ENP is a passive unit that contains custom-built integrated circuits and will transmit a unique identification code.

A series of charge zones, which in the Hong Kong urban area would include as many as 200 sites, is defined, and motorists are charged for each zone boundary crossed during busy times. At each site an array of loops is buried in the road surface. As a

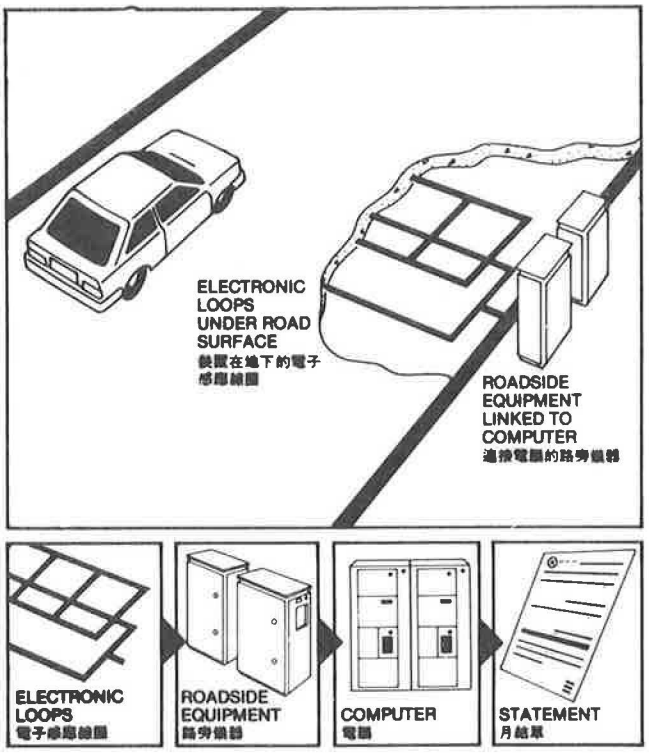


FIGURE 1 ERP system.

vehicle passes over the array, a power loop energizes its ENP, and one of a series of inductive receiver loops picks up the vehicle's transmitted coded identity.

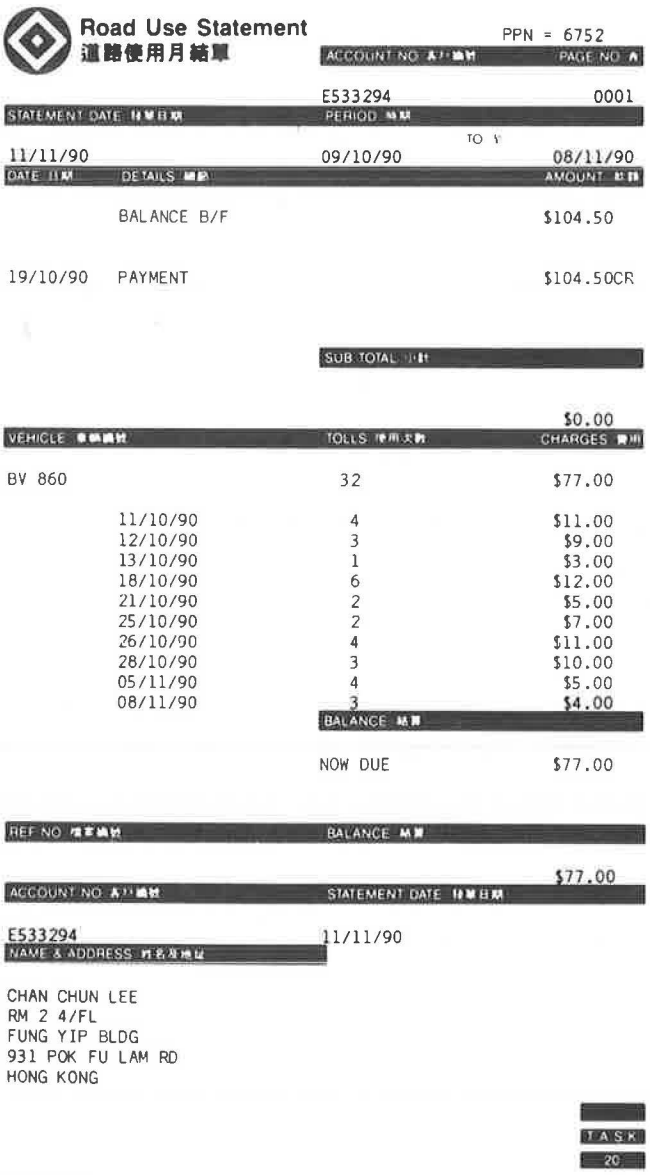
Roadside cabinets similar to those used for traffic signal control contain a number of microcomputers that handle data from the receiver loops. These contain vehicle detection logic, interrogators to decode the ENP signals, and modems for transmission of data to the control center.

At the control center vehicle data are rigorously checked and validated before being passed to the accounting system that generates regular bills for vehicle owners. The design of the control center computers makes innovative use of local area network computer technology, which means that the system can be designed in an extremely efficient modular fashion using inexpensive microcomputers and that the pilot scheme is a true subset of a full system, which does not require the use of large mainframe computers.

Validated data are accumulated during the month, and each owner is sent a statement of road-use charges at the end of the period. The bill is similar to a credit card statement, and in Hong Kong would be payable by a number of methods familiar to vehicle owners. A typical statement is shown in Figure 2.

A closed-circuit television (CCTV) system, supplied in the pilot scheme by GEC Avionics, with cameras installed at selected sites, ensures that any vehicle without an ENP—or one the owner of which is trying to cheat the system—is photographed. The pictures are transmitted to the control center where appropriate enforcement action is automatically initiated.

The system incorporates strict controls on access to the vehicle data collected and ensures that no permanent record of a vehicle's movements is kept. Although records of individual transactions are kept until after the appropriate charges are paid, there is no record of individual trip patterns or of who was driving a vehicle—the CCTV photographs are specifically designed for number plate recognition and do not include the driver of a vehicle.


Road Use Statement
道路使用月結單

PPN = 6752

ACCOUNT NO. PAGE NO.

E533294 0001

STATEMENT DATE PERIOD

TO

11/11/90 09/10/90 08/11/90

DATE	DETAILS	AMOUNT
	BALANCE B/F	$104.50
19/10/90	PAYMENT	$104.50CR
	SUB TOTAL	$0.00

VEHICLE	TOLLS	CHARGES
BV 860	32	$77.00
11/10/90	4	$11.00
12/10/90	3	$9.00
13/10/90	1	$3.00
18/10/90	6	$12.00
21/10/90	2	$5.00
25/10/90	2	$7.00
26/10/90	4	$11.00
28/10/90	3	$10.00
05/11/90	4	$5.00
08/11/90	3	$4.00
	BALANCE	
	NOW DUE	$77.00

REF NO. BALANCE

$77.00

ACCOUNT NO. STATEMENT DATE

E533294 11/11/90

NAME & ADDRESS

CHAN CHUN LEE
RM 2 4/FL
FUNG YIP BLDG
931 POK FU LAM RD
HONG KONG

TASK
20

FIGURE 2 Typical statement.

POLICY BACKGROUND OF ROAD PRICING IN HONG KONG

By 1982 Hong Kong's increasing prosperity had led to such pressure on the roads from a rapidly increasing vehicle fleet that, despite a massive road-building program, traffic problems were reaching intolerable levels in the urban areas during workdays. At that time private cars accounted for two-thirds of the total vehicle fleet and their numbers were increasing by more than 10 percent per year. The government sought to check the spread of congestion by taxes on car ownership. The actions taken to increase the cost of motoring included, for example, a trebling of the annual license fee and a doubling of the first registration tax on new vehicles entering the territory.

Car ownership actually dropped and the fiscal measures were certainly effective in taking cars off the road at congested times and places, but these fiscal measures also removed cars from uncongested roads and denied many people the choice of whether to use their cars on uncongested roads. The government recognized that ERP would be more efficient and fairer than ownership restraint.

Figure 3 shows that more than 40,000 cars have been given up since 1982 and that pressure from the fast-growing economy is expected to bring about an increase in the number of cars. Without more restraint of some form, by 1991 there will again be too much traffic competing for the heavily congested road network. If the restraint were to take the form of continued increases in car ownership taxation, annual license fees equivalent to U.S. $2,500 could be the order of the day.

PILOT-STAGE TECHNOLOGY

Introduction

In the Central district of Hong Kong Island, 18 on-street sites were successfully installed for the pilot stage (two off-street sites were used for commissioning and testing). The sites defined a "watertight" zone through which any vehicle entering Central had to pass, and the test sites within the zone

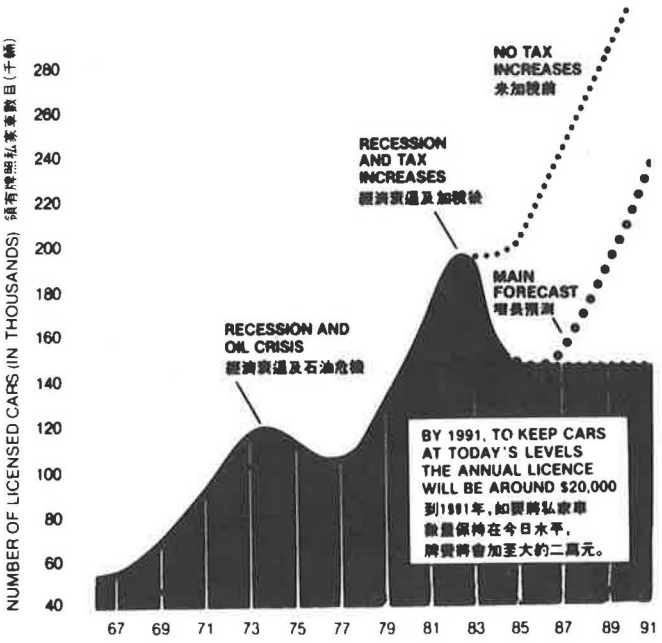


FIGURE 3 Car ownership.

ensured that most movements through the system generated three or more transactions.

More than 2,500 vehicles were fitted with ENOs for the pilot stage. About 1,200 of these were government vehicles, 700 or so were buses, and the remainder belonged to volunteers—companies and individuals—who regularly used the area. A wide range of vehicle types was included, and there were no difficulties in fitting the ENP quickly and simply (average fitting time was around 5 min).

All of the control center computers were installed on or ahead of schedule and successfully handled the large amount of data (about 30,000 transactions per day) generated by the vehicle fleet as it crossed the Central sites.

The pilot-stage data-capture equipment was a complete subset of a potential full system. Because of the modular nature of the control center computers, the design and implementation of each part of the pilot-stage system were also appropriate to a full system.

Electronic Number Plate

Each vehicle was fitted with an electronic number plate, which transmits a string of data on a phase-modulated signal to a roadside interrogator at each outstation. The data included a securely coded serial number that uniquely identified the vehicle. The standard ENP requires no electrical connection and, once fitted, requires no manual intervention and is maintenance free.

Outstation

The roadside outstation is housed in a cabinet identical to those used for traffic signal controllers. It is made up of an interrogator connected to a number of loops of cable buried in the road, a processor, a transmission unit, and a number of interfaces to local equipment. The interrogator demodulates the signals from each road loop and passes the identity data to the processor, which implements message assembly and transmission to the central office.

The outstation has a number of interfaces with external equipment:

- Closed-circuit television interface. Some outstations are fitted with camera equipment to capture photographs of vehicles that have not been satisfactorily identified and transmit these photographs to the central office. The outstation computer passes information (such as registration mark) to the camera equipment for automatic imprinting on photographs and controls requests for the transmission of photographs.
- Police terminal. A portable terminal or handset may be plugged into any outstation to provide information for purposes of police enforcement. The display can indicate the status of each vehicle and show whether its ENP identity has been received by the outstation or whether it appears to be an "unfitted" vehicle.
- Maintenance handset. A maintenance handset may be plugged into any outstation to enable the operation of the outstation to be checked and to obtain a readout of the fault log.
- Toll display unit. Each outstation is designed to drive a toll display unit. The display would show the toll rates as specified by the operating authority. The toll display unit would be controlled by its own microprocessor so that rates displayed could be confirmed, operational faults reported, and default to a null or zero charge display enforced.

Control Center

Vehicle identity data are transmitted from the outstations to a control center via telephone lines. Processing within the control center is distributed among

- A set of communication controllers to handle communications with a fixed set of outstations;
- A set of data validators, each responsible for a subset of all available ENPs; and
- The supervisory processor that supervises the system as a whole and performs "anomaly" processing.

All processors are interconnected via the Ethernet Local Area Network (LAN) because each one may need to communicate with any other and the system must be capable of handling a large amount of data in real time.

ACCOUNTING AND ADMINISTRATION

The pilot scheme included a demonstration accounting system that provided most of the functions of a full system, including the production of simulated statements similar to those that would be sent to vehicle owners (Figure 2). Interfacing with the Hong Kong computerized vehicle-licensing system was most encouraging and Transpotech successfully integrated the accounting system into the control center.

Part of Transpotech's project brief was to report on all aspects of implementing and running a full ERP system, and the legislative and administrative requirements were fully investigated. The lessons drawn from the development of the demonstration accounting system, together with the definition of a full system's administrative requirements, led to the outline specification of a joint accounting and administrative system. Some of the more detailed work was undertaken by the Hong Kong–based systems house, Jardine Logica Systems.

The specification of the administrative requirements included a thorough assessment of debt collection procedures. Similarly, the use of automatic enforcement procedures was fully specified. These procedures were based on the CCTV system, a small team of enforcement officers, and a system of vehicle "call-in" notices that would operate if there was the suspicion of a faulty ENP.

OTHER POTENTIAL USES OF THE SYSTEM AND THE TECHNOLOGY

Automatic vehicle identification (AVI) offers a large number of exciting possibilities beyond the direct application to road pricing. Some of these have been investigated in the course of the Hong Kong pilot-stage project, others are still ideas.

One of the major side benefits of an ERP scheme would be its potential for automatic traffic data collection. For various purposes, data are needed by traffic authorities on traffic counts, trip matrices, journey items, routes, and axle counts. An ERP system could fulfill all of these requirements, automatically and at a fraction of the cost of the extensive special surveys that are currently conducted.

The benefits of real-time traffic information from an ERP system would be substantial. The police, motoring organizations, and local radio stations all need up-to-the-minute information about traffic conditions and incidents.

One of the major potential applications of AVI technology is in automatic toll collection. The costs of running a conventional toll collection facility are substantial, and a number of toll authorities around the world have been investigating the potential of AVI for some years. The technological advances made by Plessey in recent years, in particular in the Hong Kong project, have made the practical widespread automation of tolls a realistic possibility.

The system could also easily be applied for billing buyers of fuel; a simple loop at the entrance to a service station would be easy to install and could offer enormous administrative savings.

With well-defined and closely controlled access to the system, the system offers potential for tracing stolen vehicles. Because the system is quite securely designed, the movements of a stolen vehicle could be tracked between zones.

In the longer term, perhaps the most exciting use of the technology might be in systems that rely on two-way communication between on-board vehicle computers and roadside equipment. Automatic route guidance—based on genuine real-time traffic conditions—is indeed a practical possibility, as is a comprehensive in-vehicle driver information service.

POLITICAL RESULTS

After the technology was shown to be effective and reliable, local authorities in Hong Kong were invited to comment on the advisability of introducing it as a method of restraining the use of congested roads. The system was explained in a brightly colored booklet entitled *A Fair Way to Go (5)*, and the government undertook to reduce annual license fees if ERP were introduced, so that the cost of using vehicles on uncongested roads would fall substantially. But the local authorities did not support ERP, and the government has decided not to introduce it, except possibly as an optional method of paying tolls at the entrances to the Cross Harbour Tunnels. Observers believe that the opposition to ERP is due to vehicle owners objecting to paying more taxes and having their journeys monitored.

The second objection might have been met by giving motorists the option of paying a (large) fixed fee. The first is more difficult because the fiscal system of Hong Kong (like that of the United Kingdom) recognizes no formal connection between the amounts paid in road-user taxes and expenditures on roads. Although the Hong Kong Government proposed a reduction in vehicle licensing fees in its proposal for ERP, it did not satisfy the objectors, who feared that the fees could easily be raised subsequently.

A SELF-FINANCING ROAD AUTHORITY?

Might the Hong Kong authorities have been more successful if they had proposed to treat the financing of roads like that of other scarce resources such as, say, electricity or telephone *(6)*? A financially independent Hong Kong Road Authority could, for example, be established to act like a private concern by charging market-clearing prices, paying all its costs (including rent of land, payable to the city), and expanding the road network as far as was financially viable. Furthermore, the ERP technology developed in Hong Kong could allow private suppliers, independent of government, to add road links (such as the Cross Harbour Tunnel), install their own pricing loops, and collect payment by means of monthly bills, as do the private long-distance telephone companies in the United States. The Hong Kong ERP proposals, proven to be technically workable, can be used not only to restrain traffic but also to privatize road space. ERP offers the possibility of the private sector providing not only vehicles but also roads on which to run them. This possibility, if allowed, would give road users the strongest defense against the authorities' collecting excessive revenues from a road network restricted in size: the power of the private sector to provide, at a profit, alternative road links would limit the power of the government to extract monopoly profits from its own network.

CONCLUSIONS

The pilot scheme of the Hong Kong ERP system successfully met its objectives. The technology for a full ERP system has been demonstrated by the pilot scheme. Exhaustive tests of the system confirmed that the Hong Kong pilot system was accu-

rate, reliable, and robust enough to be extended to a full system.

The transport studies indicated that ERP is the fairest and most efficient restraint policy option open to the Hong Kong Government for dealing with the continued problems of traffic congestion that are expected to be associated with continued economic growth.

The Hong Kong project brought together a number of significant technological advances and combined these with established theory to demonstrate the practicality of road pricing as an important method of dealing with traffic problems.

Public reaction to the scheme has been mixed. ERP was often perceived as an additional, rather than an alternative, tax on the motorist. It was certainly not regarded as a price for using roads. Its reception by the public, and particularly by motorists, might have been more favorable if it had been designed not only to restrain traffic but also as a method of enabling road users to pay for maintaining and strengthening their road network.

REFERENCES

1. J. A. L. Dawson and F. N. Brown. Electronic Road Pricing in Hong Kong: A Fair Way To Go? *Traffic Engineering and Control*, Vol. 26, No. 11, Nov. 1985.
2. I. Catling and B. J. Harbord. Electronic Road Pricing in Hong Kong: The Technology. *Traffic Engineering and Control*, Vol. 26, No. 12, Dec. 1985.
3. B. Harrison. Electronic Road Pricing in Hong Kong: Estimating and Evaluating the Effects. *Traffic Engineering and Control*, Vol. 27, No. 1, Jan. 1986.
4. J. A. L. Dawson. Electronic Road Pricing in Hong Kong: Conclusion. *Traffic Engineering and Control*, Vol. 27, No. 2, Feb. 1986.
5. *A Fair Way To Go.* Government of Hong Kong, 1985.
6. G. Roth. *A Self-Financing Road System.* Research Monograph 3. Institute of Economic Affairs, London, England, 1966.

Impact of Toll Policy in the United Kingdom

KENNETH J. BUTTON

Historically tolls played a significant role in financing the development of roads in the United Kingdom, but, with the exception of a limited number of estuarial crossings, they have now fallen into disuse. This paper is concerned with two issues. First, the role that tolls played in the early growth of the road system is discussed and lessons that may be learned from this are considered. Second, current official policy with respect to existing tolled facilities is examined. Attention is particularly focused on the financial problems that have arisen because of the presently favored "accountancy" approach to tolling and cost recovery. Some evidence is also offered that there are effects on industrial location and traffic patterns when only specific links in the road network are subjected to tolls. The main conclusion of this work, which itself stems from a much larger study of the tolling of estuarial crossings in the United Kingdom, is that there are serious problems in initiating ill-thought-out toll policies. Although on first-best economic principles there is a logical case for charging the road user the relevant costs of the infrastructure provided, and doing it in such a way that the user is fully cognizant of the resource costs involved in each journey, in a world where annual taxation and other less direct means of road user charges abound it is difficult to devise the appropriate second-best pricing rules on which tolls should be based. Simply "tacking" tolled facilities on to an existing road network is seen to be potentially distortive.

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The road system in the United Kingdom is funded almost exclusively from central government taxation revenue and monies generated by local authority rates (i.e., property taxation). The designated trunk road network (including motorways) is the direct responsibility of central government, and the secondary and local road network comes under the local authorities (although there are substantial transfer payments from central government to supplement local rates in the financing of the system). Road users are not directly charged for using the vast majority of the road network and, indeed, although there have been attempts at assessing the relationship between the aggregate level of user charges (e.g., fuel taxes,

vehicle excise duty) and broad categories of road investment and maintenance costs, attempts at hypothecation remain crude *(1, 2)*.

This situation has not always existed and in bygone days direct charging for use was widespread across the road network. There are still a limited number of estuarial crossing links in the UK network where charges are levied. These historical and contemporary applications of pricing mechanisms to directly recover the costs of road provision afford insights into the merits and difficulties of applying market principles to the financing of the road system.

Discussion of the appropriate method for funding road infrastructure (including bridges and tunnels) is currently being resurrected in the United Kingdom. Several forces are stimulating the debate.

First, the politics of the Conservative administration in power since 1979 strongly favor market forces and the strengthening of the private sector. Privatization of several large, formerly publicly owned companies and liberalization of market regulation in fields as diverse as urban bus licensing and banking are manifestations of this. With regard to road infrastructure, desk-top studies have already been conducted to examine the possibility of a privately financed trunk road and the Secretary of State for Transport has gone on record as arguing: "I believe that there would be great advantage in future in getting these tolled crossings constructed by the private sector" *(3)*.

Second, the European Economic Community, in its attempt to develop a common transport policy, has become increasingly concerned with coordinating the provision of and charging for infrastructure *(4)*. This has been coupled with the adoption, by nonmember countries such as Switzerland, of tolling policies designed to recoup from transit traffic the costs of the damage inflicted on the national road network. Because toll roads are already common in France and Italy, there is in existence a body of knowledge relevant to the design of harmonized systems of charging and an empirical basis around which the debate is focused.

The financial cost of maintaining the UK road system, and in particular the need for considerable resources to essentially reconstructed large sections of the motorway system now reaching or exceeding their original design life, is causing the government to seek new sources of funding. Contracts for maintenance have already been privatized with considerable incentives offered for work completed within specified contract periods. Also, several of the estuary crossings that are tolled have been encountering financial problems, and the position of several others has been reviewed because their controlling bodies wish to raise tolls. The need to expand the capacity of at least one crossing (the Dartford Tunnel) combined with questions about the durability of another (the Severn Bridge) have provided specific focal points for debate.

In some ways these issues parallel those currently concerning policy makers in the United States. There are differences, however, that stem in part from historical factors but that are also the product of differing institutional arrangements *(5)*. Many of the United States already have extensive tolled turnpike systems that are physically comparable to the untolled trunk roads in the United Kingdom. The separation of this system from the tax-supported 42,500-mi Interstate highway system is an arrangement significantly different from the local-national division found in the United Kingdom. The traditional federal view that the Interstate system is a genuine network and that tolling of any part of it is therefore inappropriate conflicts with the situation in the United Kingdom where users of small fragments of the system are subjected to direct user charges.

The objective of this paper is to see what impact tolls had historically in the United Kingdom and, in more detail, to examine the current official policy of government on tolling estuary crossings. In a sense it is a negative approach that seeks to determine whether many of the long-espoused arguments against charging directly for road use stem from valid, intrinsic flaws in the policy or are due to a poor appreciation of history combined with an overemphasis on the effects of contemporary policies that are being applied incorrectly and inconsistently.

To begin with, however, it is appropriate to briefly outline the economic theory that underlies the debate about tolls policy. This becomes particularly relevant when assessing current bridge and tunnel tolls in the United Kingdom.

ECONOMIC PRINCIPLES

The economic debate surrounding the appropriate methods of pricing infrastructure services extends, at least, back to the seminal paper of Dupuit *(6)*. The problem is most easily handled if it is divided into two separate issues *(5)*:

- The toll level on potential new crossings (i.e., involving the investment decision about whether to build the facility and the question of the method of finance) and
- The toll on "historic assets" if the facility is already in place.

For simplicity, the basic public expenditure theory of tolling will be examined first. It is assumed that the long-run marginal cost (LRMC) of providing a bridge facility is invariate with respect to the amount and type of traffic carried (Figure 1). It is

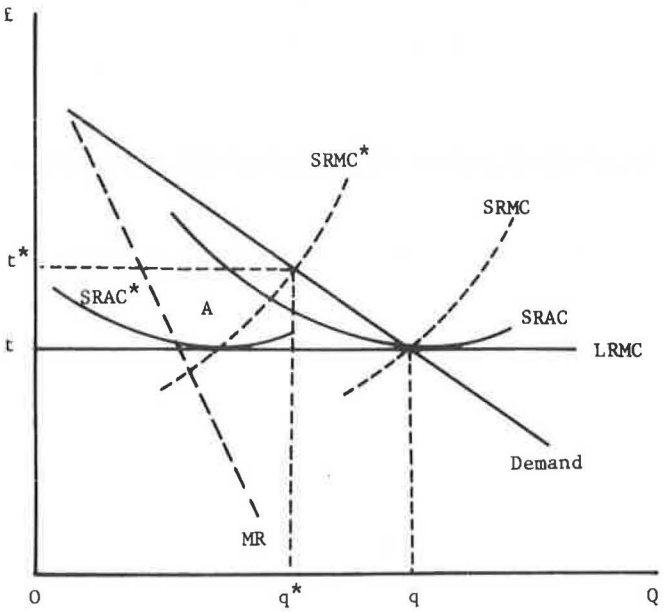

FIGURE 1 Public expenditure theory of tolling.

also assumed that demand is known and that it is constant over time (i.e., there are no peaks or troughs). It is further assumed that there are no problems of environmental damage associated with the bridge or, if there are, that they are fully internalized and included as cost items in the calculations.

If there is no facility in existence at present and if there are no binding financial restraints and resources are available at the market rate, the public supplier will compare the LRMC of providing bridge services with demand for bridge services in setting both the toll and the capacity level. In the diagram of Figure 1 this means that the capacity of the bridge will be q and the toll levied will be t. The system is thus of optimal size, the provider recovers costs (including an allowance for normal profits), and only users who genuinely enjoy a net social gain will use the facility. Because the LRMC is made up of the envelope of the short-run marginal cost (SRMC) curves, socially desirable equality among the toll, the LRMC, and the relevant SRMC is achieved.

In many cases a facility is in existence and the question, in the short term at least, is one of deciding the appropriate toll for a suboptimal capacity level. It is assumed that capacity is, indeed, suboptimally small. Taking the existing short-run cost structure to be represented as SRMC* and SRAC* (short-run average cost) in Figure 1, the optimal toll is t* (where SRMC* = Demand). This represents a charge that allows all existing long-run costs to be recovered and also yields a profit for the supplier. The excess of t* over SRMC may be regarded as a congestion toll that rations use of the facility to those who derive the greatest benefit from it. That a profit is earned above the normal level should also provide an indication that further investment is justified.

Of course, the world is nowhere near as simple as the diagrammatic analysis suggests. Although detailed examinations of the problems are discussed elsewhere in the literature, a few comments are perhaps helpful in summary:

- The analysis implicitly assumes that the provider of the facility is intent on maximizing social welfare. If profit maximization were the strategy, the supplier would determine optimal utilization and capacity in terms of equating appropriate marginal cost schedules with marginal revenue (MR). In the present example this would result in a lower utilization level and a smaller long-term capacity provision. To combat this, public ownership is often suggested although identical results may be obtained under private ownership via appropriate policies of taxation.
- The model assumes that LRMC is constant. However, it is more likely, given the nature of the costs involved, that long-run costs will fall with utilization of a bridge. If so, marginal cost strategies of the type outlined previously will lead to a financial loss. Public-sector ownership with subsidies or private ownership with public funds available to recompense for the financial deficits incurred is often advocated in such circumstances. Another approach used by private suppliers is price discrimination: users are not charged a uniform toll but a toll that corresponds to the benefits they, as specific groups of users, enjoy. The equity and efficiency merits and defects of price discrimination, coupled with the practical limitations of pursuing this latter approach in the specific case of estuarial crossings, are open to some debate the outcome of which is not entirely clear.
- The analysis assumes perfect divisibility of investment options whereas in reality there are normally only a limited number of practical alternatives available. This means that there may be no optimal capacity and that in the long run it is impossible to equate LRMC and toll. Problems of this type are common given the temporal growth in traffic flows and the obvious impossibility of continually adjusting the capacity of a bridge. Ad hoc rules of thumb can be evoked to deal with this type of difficulty when it arises.
- The diagram assumes demand to be constant with no variations due, for example, to peaking. If demand does fluctuate regularly, differing tolls are appropriate for each level of demand and optimal capacity is dependent on the effective demand of the peak users.
- The analysis is in first-best terms (i.e., it assumes that there is marginal cost pricing elsewhere in the economy). In practice this is not normally the case and, indeed, even within other, competitive sectors of transport this may well not hold. In particular, if an alternative overland route is available in most countries of the world, this route would not be subject to any direct charge and certainly not one that reflected the marginal cost of using it. Some discussion of this problem in the specific context of bridge tolls is found in the literature *(7)*. In these conditions the tolls must deviate from marginal cost if traffic is to be allocated most efficiently, and there are arguments that capacity provision should be adjusted in such a way that it, at least in part, corrects for suboptimal situations elsewhere.

The practical issue is whether private- or public-sector ownership and charging are likely to provide the most effective way of handling these issues. In theory the two sides of the debate are rather finally balanced; the key issues are really at the practical level. For example, does public ownership naturally lead to slack management and political, rather than economic, criteria determining investment priorities? Does private control lead inevitably to uncoordinated provision; exploitation of users; and, when regulated, the regulators being "captured" by the regulated? Observation of actual experiences is required to answer these questions.

TURNPIKE SYSTEM

The first turnpike authority (initially proposed as a temporary arrangement) was established in 1663 on the Great North Road between Wadesmill in Hertfordshire and Stilton in Huntingdonshire. It was another 32 years before the next turnpike was approved. Previously, under legislation of 1555, parishes were responsible for the maintenance of their own roads through a system of enforced labor. The state of the road system of the country was, however, deteriorating rapidly by the mid–17th century because of cumulative decay brought on by the lack of local engineering skills and the lack of incentive for the enlisted labor forces to work effectively *(8)*. Indeed, the 1663 measure was the culmination of half a decade of attempts to improve the financial status of the road system *(9)*. Many of these were initiated by sparsely populated parishes incapable of

maintaining even the most basic road system. The upsurge of traffic that accompanied early industrialization simply brought matters to a head.

The rapid growth of commerce during the early years of the 18th century saw a gradual increase in the number of special acts of Parliament enabling trusts to raise the capital required to construct turnpikes and to introduce toll collection facilities. In the main these bodies differed from the small number of earlier authorities in that they were composed of independent trustees (although often local men) rather than justices of the peace. By 1720 the system was becoming so widespread that private acts gave way to public acts, and trusts were created, in the first instance, for periods of 21 years.

The General Turnpike Act, 1773, was important in bringing together detailed legislation on various aspects of toll finance and control. It made repetition of legal requirements regarding excess tolls on large wagons and the like unnecessary in each act and removed from local magistrates all of the remaining powers they had over trusts. In addition, it established fairly substantial property qualifications for trustees.

In total some 1,600 turnpike trusts were created in England and Wales before 1800, and another 2,450 turnpike acts were passed during the next three decades (some of these consolidated several small trusts and others reestablished existing trusts). Consequently, by the 1830s there were some 22,000 mi of turnpikes in England and Wales controlled by 1,116 trusts (i.e., each trust was responsible for, on average, something under 20 mi of road). This accounted for about one-fifth of the total road system *(10)*.

The turnpike authorities funded their activities mainly from toll revenues but still (like the parishes) enjoyed the right to statutory labor (or, as was normal, money in lieu). Even in 1835, when the General Highway Act abolished the system, some 40 percent of turnpikes still received income from parish highway rates totaling £200,000 *(11)*.

The turnpike age came to an end with the advent of the steam engine (despite the efforts of Sir Charles Dance and others to initiate steam carriage services on the roads). Coastal steam shipping and the railways rapidly took freight and passenger traffic from the road system. The revenue collected by the trusts fell rapidly from the mid-1830s, and receipts dropped by 26.5 percent by 1847. By the middle of the century the trusts were in debt and as the trusts expired the responsibility for the road system gradually passed back to local authorities. Funding once again came from general local taxation sources rather than user charges. The demise of turnpikes was slow despite the recommendation of a 1862 select parliamentary committee that they be immediately abolished. The last turnpike ceased operation in 1895 when the trust expired. Tolled roads still remained, however, and in 1932 there were still 80 in existence in England and Wales; 24 of these tolled roads were in the trunk category.

The impact of the turnpike system on the overall economic development of the economy is generally agreed to have been less significant than the advent of either canals or railways. The more recent view of economic histories is, however, that turnpikes, nevertheless, were important because they generated necessary resources and provided a framework in which commerce and trade could expand more rapidly than under the parish system. In part, the role played by the turnpikes in helping create efficient road transport must be assessed in terms of the technology of the day and the legal and institutional framework in which they operated. It is possibly in this area that the greatest lessons for contemporary policy makers may be learned.

The most powerful criticism that has been leveled against the system is that, unlike in France where the Corps de Ponts et Chausées improved the trunk route system on the basis of a master plan, the turnpike system did not produce the network of roads industry required. In particular, until recently it was generally accepted that the turnpikes provided "not a system of radiating arteries of communication, but scattered cases of turnpike administration, unconnected with each other" *(12)*. The implications are clear that there was a belief that leaving, albeit rather crudely, the development of the roadway system to market forces had impaired the overall development of the system.

More detailed and comprehensive studies have subsequently questioned this view. In particular, drawing more on statistical records than contemporary commentary, these studies [e.g., Gravelle and Rees *(8)*] have taken a much longer term view of the development of the turnpike system and related it more fully to the temporal and geographic development of individual industrial sectors. By 1750, for instance, 7 major routes radiating from London had been turnpiked and led to 13 major trunk routes, of which nearly 90 percent had been turnpiked (Table 1). Many important routes between provincial towns were the responsibility of trusts by the 1770s. (Figure 2 shows details of the turnpike system in the East Midlands by 1772. Comparisons with modern maps indicate that the chronology of turnpiking corresponds closely to the present-day importance of the roads.) Trust development was tended to be slower in areas where demand for road transport developed later. Thus whereas the wool-growing areas of the West Riding of Yorkshire had important turnpike roads by the mid-18th century, the later turnpiking of Lancashire's roads (between about 1789 and 1810) can be explained by the rapid expansion of the cotton industry only after 1780. Examination of the chronology of trust development reveals that although there was not an exact

TABLE 1 THE EARLY TURNPIKING OF ROUTES RADIATING FROM LONDON

Road	Total Length (mi)	Length Not Turnpiked by 1750
The Great North Road to Berwick	387	33
London-Derby-Manchester	177	13
London-Coventry-Manchester	189	37
London-Coventry-Chester	183	9
London-Warwick-Birmingham	110	20
London-Birmingham-Shrewsbury	153	7
London-Oxford-Birmingham/Worcester	156	15
London-Oxford-Gloucester-Hereford	127	49
London-Cirencester-Gloucester-Hereford	132	6
London-Bath-Bristol	125.5	0
London-Portsmouth-Chichester	94	0
London-Dover	71	16
London-Harwick	68	0
Total (less double counting)	1,563.5	182

SOURCE: T. C. Barker and C. I. Savage. *An Economic History of Transport in Britain*. Hutchinson, London, England, 1959.

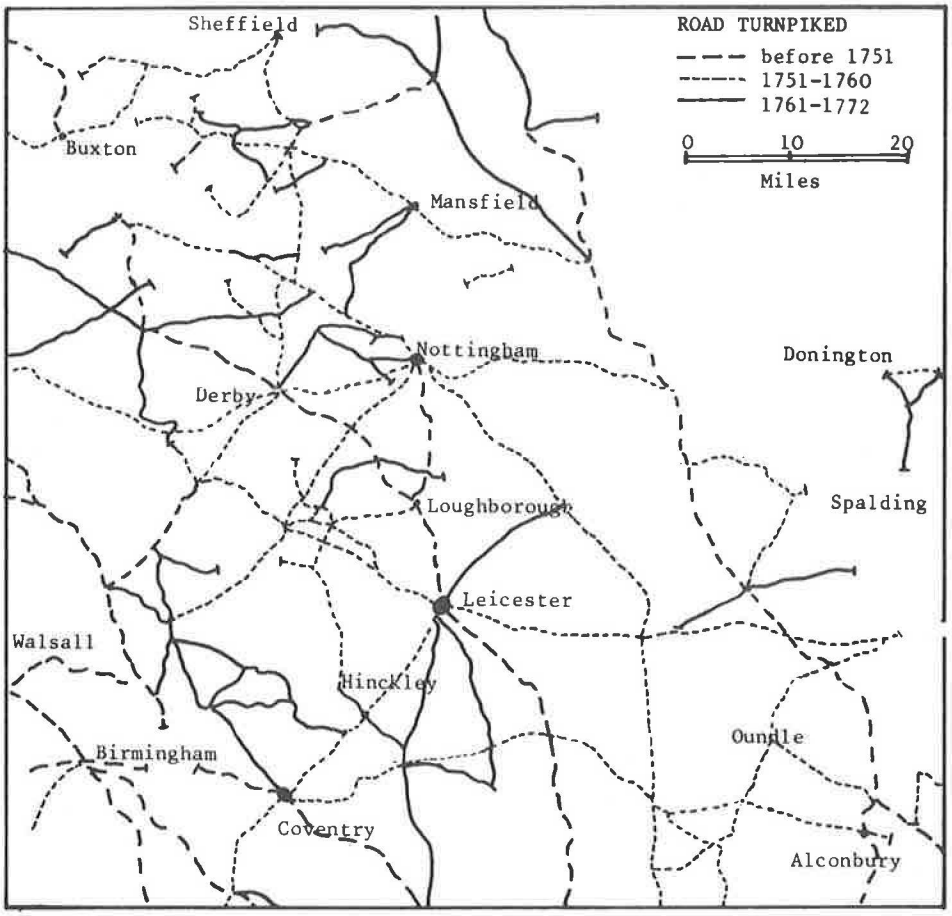

FIGURE 2 Turnpike system in the East Midlands, 1772.

continuity of turnpiking of key routes, filling in of gaps was nevertheless rapid. In the 1720s some 47 percent of new trusts formed links with existing trusts; in the 1730s this figure rose to 75 percent and it rose to 82.5 percent a decade later (these data exclude instances of adjacent trusts being formed in the same year).

A second major criticism leveled against the turnpike system was the lack of inducement for efficient management. (In terms of modern economic theory there was a tendency for X-inefficiency to emerge.) There was also an undeniable tendency for administrative costs (especially when toll collection was leased out) to be high in many cases and for resources to be wasted (or perverted) in the purchase of materials. This would appear to be a more powerful criticism than that there was direct exploitation of users. It is almost certainly true that malpractices existed in some cases and efficiency may not always have been what it ought to have been, but this needs to be put in the context of the times. The trusts, it must be recognized, were not homogeneous but operated under a diverse range of separate acts and were responsible for a wide range of different types of roads. Further, the turnpikes enjoyed no effective competition from alternative modes of transport and thus market constraints on managerial laxity were significantly less than they would be today. It is also true that techniques of financial control and accountancy were in their infancy in the 18th and 19th centuries, especially with regard to long-term finance. The trustees themselves were generally inexperienced administrators and in many cases they proved lax in the performance of their duties. In these senses, however, it appears that the turnpike authorities were probably no worse than many other statutory bodies of the period.

A related issue is that trusts were not entirely free agents but were subject to a variety of governmental restrictions especially in relation to the tolls that could be levied. Each act contained a schedule of tolls and, mainly in the 18th century, set limits on wagon weights, the number of draught horses, and wheel breadth. The restrictions, especially after the passing of the Broad Wheel Act of 1753 that was designed to reduce the rutting caused by narrow wheels, became more complex as time progressed and road users sought ways of minimizing costs by circumventing them. The effect was considerable confusion: trustees found it increasingly difficult to decide exactly what their powers were, and travelers became more uncertain of the exact payments required from them. The situation was further complicated by the general concessions that were periodically granted (e.g., to carriages during elections, for the Post). These factors were hardly conducive to the long-term efficient management of trusts.

Although anecdotal stories of corruption and inefficiencies abound, the overall impression from more detailed studies of the activities of turnpike trusts is that, in the prevailing circumstances, most were moderately well run. There is evidence, for example, that a fairly substantial proportion of toll revenue did find its way into funding the repair and improvement of roads

(8). The trusts also transferred the responsibility of maintenance from the normally unskilled surveyors of the parish system and introduced professionalism into the engineering of roads. Although the introduction of improved techniques of maintenance was slow, the funds of the trusts meant that traditional forms of maintenance could be employed more regularly and reliably and that gradually the improved methods of engineers such as Telford, Metcalfe, and McAdam were adopted. The use of wage labor is likely to have considerably increased productivity over that of the conscript system with its reliance on unwilling labor *(10)*. Some support for the view that the trusts, albeit perhaps not optimally, made a significant contribution to the improvement of inland transport in England and Wales is gained by contrasting the road system there with the corvée that existed in France in the 18th century. A common view, echoed on both sides of the channel by contemporary commentators, emerges: the turnpike system provided superior-quality roads *(13)*.

The lessons from the turnpike period have relevance for the 1980s although it is always dangerous to accept the experiences of a bygone age without reservations. Certainly there is evidence that, in a first-best economic sense, the trusts left a lot to be desired in terms of managerial efficiency and resource allocation. Compared, however, with the alternative systems that were available in the 18th and 19th centuries, the market orientation of the trust arrangements allowed a relatively rapid and effective response to the demands of society and industry. The system allowed significant amounts of resources to be transferred to transport at a time when bottlenecks in transport could have proved a serious impediment to economic growth. The demise of turnpikes did not stem from any major internal flaw in the system; the technology of road transport modes fell

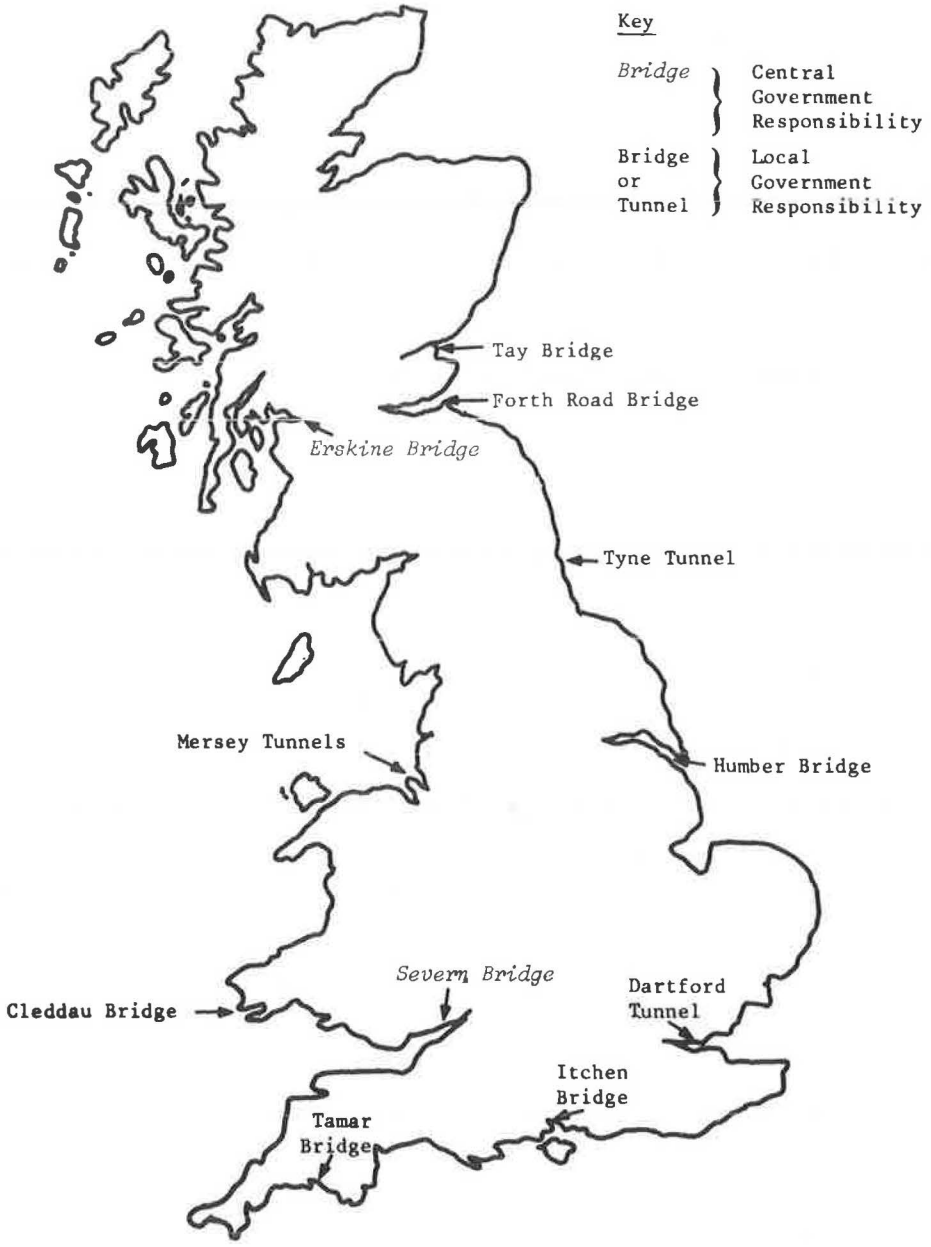

FIGURE 3 Toll facilities, 1981.

behind that of coastal shipping and was decidedly inferior to that of the emergent railways.

Following the decline and eventual abandonment of the turnpike system the responsibility for road financing in the United Kingdom was transferred initially back to local authorities and then, when these proved reluctant to spend on the large-scale improvements required with the advent of motorized traffic, to a Road Board (in 1909) that could draw on funds from vehicle and fuel taxation. This system generated so much excess revenue that in 1920 the government found it convenient to bring the system under the direct control of the Minister of Transport. Effectively, from that time forward any link between user payments and road expenditures, even at the aggregate level, ceased for the majority of the system. Certain bridges and tunnels, however, are exceptions.

TOLLED ESTUARIAL CROSSINGS

The existing 11 major tolled facilities in the United Kingdom are the result of a decision made in the 1930s to finance the Mersey Tunnel (Birkenhead) from user charges. Between 1934 and 1981 (when the Humber Bridge was completed) some 25 mi of tolled estuary crossings came into being. These are located across the country (Figure 3) and in nine cases form major parts of the national trunk road system. The actual financial arrangements for crossings differ (Table 2) although the major funding is from the central government or local authority sources (i.e., the Public Works Loans Board and Consolidated Fund). Two of the crossings (the Severn and Erskine Bridges) are administered directly by central government, and the remainder are administered either directly by local governments or by local boards nominated by local councils.

The public in the United Kingdom has a common law right to use the public highway system without let or hindrance. Consequently, for tolls to be levied special acts of Parliament are required (as they were for turnpikes) for each crossing. The objective of imposing tolls is to raise the monies required to cover annual running costs, maintenance and repair costs, interest charges, and the repayment of construction costs. In all cases to date (except for the Dartford Tunnel) the power to levy charges is permissive; the responsible authority has the power to suspend tolls if other sources of funds are available. The Dartford Tunnel authorities are required to toll users.

It is normal practice in the United Kingdom, when trunk roads and motorway investments are planned, to take account of estuary crossings and to fund them from general expenditure (i.e., they are not tolled). The Department of Transport's view is that if local authorities wish to construct other crossings this is their responsibility. (They can fund them from local taxation or through tolls.) The distinction is, however, a fine one; the division between trunk and local roads is in many cases almost arbitrary (e.g., the Forth Bridge in Scotland provides a crossing that links the M8 and the M9 to the south with the M90 to the north but is not part of the trunk road system and is thus tolled). However, the principle is not applied consistently; the Severn and Erskine Bridges are central government responsibilities but are tolled. (Details of the routes linked by crossings are given in Table 3.)

TABLE 2 ADMINISTRATION OF TOLLED FACILITIES

Crossing	Holders of Debt	Amount (£ million)
Severn Bridge	Consolidated Fund (central government)	46.07
Erskine Bridge	Consolidated Fund	47.72
Dartford Tunnels	Department of Transport	6.52
	Kent and Essex County Councils	
	Consolidated Loans Funds	59.64
Forth Bridge	Secretary of State for Scotland	21.75
Mersey Tunnels	Department of Transport	27.69
	Mersey County Council	
	Consolidated Loans Fund	60.95
Tay Bridge	Secretary of State for Scotland	3.00
	Constituent authorities	3.70
Itchen Bridge	Southampton City Council	Total debt
	Consolidated Loans Fund	= 10.86
	General Rate Fund	
	Capital Fund	
Tyne Tunnel	Department of Transport	14.82
	Tyne and Wear County Council	
	Consolidated Loans Fund	6.41
Cleddau Bridge	Government interest-free loan	3.60
	Local Authority Loans Pool	3.13
	PWLB	.52
Humber Bridge	Department of Transport	160.47
	PWLB	26.55
	Temporary loan	20.39
	Other liabilities	2.34
Tamar Bridge		

SOURCE: C. H. Sharp, D. Deadman, and K. J. Button. Tolls on Tunnels and Bridges in Britain—An Economic Study. In *Tolls: Are We Getting a Fair Deal?*, Freight Transport Association, London, England, 1985.

TABLE 3 ROADS LINKED BY THE MAJOR TOLLED CROSSINGS

Crossing	Road Location	County
Cleddau Bridge	Carries the A477 principal road that links the A477 and the A4076 trunk roads	Dyfed
Dartford Tunnels	M25 motorway	Essex/Kent
Erskine Bridge	M8 motorway	Strathclyde
Forth Bridge	M90 motorway	Fife/Lothian
Humber Bridge	Links the A15 (trunk) to the A63 (trunk) and the M62	Humberside
Itchen Bridge	A3025 principal road	Hampshire (Southampton)
Mersey Tunnels		Merseyside
Birkenhead	A57 local road link	(Liverpool)
Wallesey	Links the M53 to the A565, the A59, the M57, and the M58	
Severn Bridge	M4 motorway	Avon/Gwent
Tamar Bridge	A38 trunk road	Cornwall
Tay Bridge	A914-A929 trunk roads	Tayside/Fife
Tyne Tunnel	A1 trunk road	Tyne and Wear

Just why some bridges and tunnels in the United Kingdom are funded from toll revenues and others are not is not clear. There is some superficial consistency with regard to the official justification of tolls as can be seen from the following statements:

> It is reasonable in my view that the very high cost of major bridge projects of this type should be recouped by the imposition of tolls (Mr. Watkinson, Minister of Transport and Civil Aviation, 1957).

> Ministerial policy . . . is that major estuarial crossings involving exceptional saving in time and money costs to the user will be tolled in the ordinary way (Assistant Secretary of the Minister of Transport, 1969).

> Successive governments have taken the view that users should pay directly for at least some of the exceptional benefits of time and cost that major new and expensive estuarial crossings offer (Department of Transport statement, 1975).

> They (i.e., Ministers) see no case for departing from the general principle that tolls should be charged on crossings where exceptional benefits are provided to the users and that the revenue from tolls should be sufficient over time to cover the servicing and ultimate repayment of the capital debt as well as the maintenance costs of the crossing (Mr. Fowler, Minister of Transport, 1979).

> Governments of both parties have for many years considered it right that estuarial crossings, which are both expensive to build, but provide exceptional benefits to users, should be paid for by those who use them rather than by the general public (Mrs. Chalker, Minister of Transport, 1983).

> [T]olls are justified because users benefit from the exceptional saving in time and money which these expensive facilities make possible (Department of Transport statement, 1983).

> [T]olls have been restricted to the crossings where the benefit is so obvious that it would not pay people either in time or money or both to use alternative routes (Mr. Ridley, Secretary of State for Transport, 1985).

These are essentially normative economic arguments for extracting some of the producer surplus (the "exceptional benefits") enjoyed by users of specified pieces of high-cost infrastructure. It certainly appears that people who use tolled bridges and tunnels do enjoy economic benefits (Table 4), which is not surprising because they would presumably go elsewhere if they did not, but this is not a satisfactory justification for charging them. From an equity perspective, it is required that this policy be pursued in a consistent manner. In practice this is not the case for the tolling of estuary crossing in the United Kingdom. As can be seen from Table 5, there are many toll-free crossings that would appear to offer transport

TABLE 4 ESTIMATED BENEFITS DERIVED FROM A SINGLE JOURNEY OVER SELECTED CROSSINGS

	Calculated Benefits (£)		Current Toll (£)	
Crossing	Car	Heavy Lorry	Car	Heavy Lorry
Dartford Tunnel	4.64	20.59	0.60	1.60
Forth Bridge	5.28	23.43	0.30	0.80
Humber Bridge	10.08	44.73	1.00	7.50
Mersey Tunnel	6.40	28.40	0.40	1.20
Severn Bridge	9.60	56.80	0.50	1.00

SOURCE: Department of Transport, Evidence to the House of Commons Transport Committee, 1985.

TABLE 5 MAJOR NONTOLLED ESTUARIAL CROSSINGS

No.	Name
M5	Avonmouth Bridge, Bristol (trunk route)
A82	Ballachulish Bridge
A9	Moray and Cromarty Firth Bridge (trunk route)
M85	Friarton Bridge, Perth (trunk route)
A533	Runcorn-Widnes Bridge, Cheshire
A739	Clyde Tunnel and M8 Kingston Bridge, Glasgow
M2	Medway crossing (trunk route)
A9	Dornoch Firth Bridge (trunk route)

NOTE: The proposed East London River Crossing (trunk route) and the Blaydon Bridge to the west of Newcastle (trunk route) are also likely to offer exceptional benefits to their users, but no toll is to be levied.

TABLE 6 ESTIMATED REVENUES AND TRACK COSTS ASSOCIATED WITH DIFFERENT CATEGORIES OF ROAD USER, 1984–1985

Vehicle Category	Estimated Revenue from Taxation (£ million)					Costs Attributed (£ million)	Revenue-to-Cost Ratio	
	VED	Fuel Tax	Total	Car Tax	Total (including car tax)		Excluding Car Tax	Including Car Tax
Cars, light vans, and taxis	1,610	4,840	6,450	690	7,140	2,100	3.1:1	3.4:1
Buses and coaches	5	145	150	–	150	160	0.9:1	0.9:1
Goods vehicles over 1525 kg unladen								
Not over 3.5 tonnes GVW	10	20	30	–	30	10	3.0:1	3.0:1
Over 3.5 tonnes GVW	390	700	1,090	–	1,090	950	1.1:1	1.1:1
All vehicles	2,015	5,705	7,720	690	8,410	3,220	2.4:1	2.6:1

SOURCE: Department of Transport.

benefits on a par with those enjoyed by people who use tolled facilities. Many pieces of transport infrastructure other than bridges and tunnels confer major benefit on users (e.g., the removal of a 10-ft swath from any section of a major motorway, such as the M1 that links London and Leeds, would render the road useless and the "benefit" of reinstating this section would be "exceptional"). In addition, major items of infrastructure, such as "Spaghetti Junction" in Birmingham, and even full stretches of motorway, such as the M62 (trans-Pennine motorway), were extraordinarily expensive to construct and confer high levels of benefit yet remain untolled. It is also unclear why, on wider equity terms, users of specific road facilities should be subject to further charges when there is considerable evidence that road users in aggregate pay considerably more than the overall costs of the provision of infrastructure (Table 6). There may be a strong case for relating user charges more closely to the use made of the road network, but at present the toll system imposes a further inequality on top of an already inequitable system. Further, it is open to serious criticism from the perspective of allocative efficiency. Two lines of argument are of particular relevance here.

First, the actual tolls levied on estuarial crossing in the United Kingdom deviate considerably from those suggested by economic theory and appear unlikely to correspond to those that a private undertaking would adopt. It is clear, for example, that several of the facilities (e.g., the Humber Bridge) would never have been built if appraised on commercial criteria (even a full cost-benefit analysis would produce a negative result), yet toll policy is still designed to recover the full cost of construction. Essentially the tolls cover current costs, plus a contribution to debt repayment, plus interest (cumulative if unpaid for any year) on the debt.

In other words, if current policies are pursued, many of the facilities will never eliminate their debt (Table 7). From the perspective of privatization (and assuming that first-best tolls are levied across the road system), this situation would imply that these investments should not have been made. If, because of miscalculation or unforeseen changes in conditions, the capacity had been supplied, it would result (depending on the method the investment was funded) in the writing-down of asset values, zero dividends for shareholders, and possible bankruptcy (with subsequent asset revaluations). The physical structures would remain but the charges levied on users would be related to the current valuation of costs rather than the historic valuation.

Economic pricing, as seen in the earlier discussion, should reflect the full economic cost, including congestion costs where appropriate. The current debate on bridge tolls in the United Kingdom tends to concentrate on those facilities that have financial problems of the type just outlined. There are cases, however (e.g., the Dartford Tunnel and the Severn Bridge during summer months), in which the issue is virtually one of tolls being inadequate to ration the available road space. The acts under which tolls are levied differ in detail among crossings, and the circumstances under which tolls may be revised vary considerably *(14)*. Public inquiries are often required and the outcome frequently determined by accountancy or political, rather than economic, considerations. They are also time consuming and uncertainty of outcome hinders long-term planning.

The second line of argument concerns the spatial impact on the economy of pursuing inconsistent policies. Tolls, although they represent only a small fraction of financial costs to many users, still may influence the profitability of different locations for firms. Consequently, it is possible that inappropriate levels of charging may adversely affect the geographic distribution of employment and income. The impact is likely to be com-

TABLE 7 ESTIMATED PERIOD FOR DEBT ELIMINATION

Crossing	No. of Years Before Debt Eliminated	
	Low Growth	High Growth
Cleddau	89	47
Dartford	49	26
Erskine	X	X
Forth	14	13
Humber	X	X
Itchen	X	X
Mersey	X	X
Severn		
Tay	32	26
Tyne	X	X

NOTE: X = simulation and implies that debt grows indefinitely.
SOURCE: C. H. Sharp, D. Deadman, and K. J. Button. Tolls on Tunnels and Bridges in Britain—An Economic Study. In *Tolls: Are We Getting a Fair Deal?*, Freight Transport Association, London, England, 1985.

pounded by the psychological effect of having to pay tolls, which tends to enhance awareness of the transport costs of locating in these areas rather than in a region where there is no direct charge for access. In the United Kingdom the situation would appear to be particularly unfortunate because many of the tolled crossings represent key gates to the most depressed areas of the country. This is a point accepted by the recent House of Commons study *(15)*, viz: "Many of the tolled crossings are situated in or near Enterprise Zones or special development areas and with the present competition to attract new industry to depressed areas, the presence of a tolled crossing in a negative factor."

Once again, this cannot be said to represent a criticism of toll financing per se; rather, it is a consequence of the inconsistency of the policies pursued. It may point, however, to some of the problems that could arise if private infrastructures were suddenly superimposed on the existing road network. The second-best problems that can arise in a mixed system could well be considerable. Unlike the turnpike system, whereby an essentially nonexistent interurban road network expanded to meet emerging economic demands through the finance of toll revenues, the introduction of segments of tolled facilities superimposed on an established, toll-free system is likely to generate a long-term impact that is less certain.

CONCLUSIONS

The success of attempts during the last 500 years to finance road infrastructure in England and Wales through the imposition of user tolls has been explored. The evidence from the more distant past is that, given the circumstances and the institutional arrangements of the time, user charges provided an efficient means of financing the development of the road network. It is clear from this period that the monopoly powers enjoyed by the turnpike trusts did lead to levels of X-inefficiency in some cases, although there is much less evidence that, given the rate controls that existed, there was deliberate exploitation of users. Clearly, if private road provision is to return, it would appear to be desirable to have some greater inducements for efficient management. Although the road supply industry is hardly contestable, greater competition from other modes, coupled with a greater understanding of how regulatory policy may be effective in extracting the maximum managerial efficiency from private industry without the problems of monopoly exploitation, would appear to make the difficulties of the 20th century somewhat less severe than those of the 18th century.

The main lessons learned from current bridge and tunnel tolling in the United Kingdom are that piecemeal approaches can have a damaging effect on economic development and that inappropriate approaches to financial accounting may result in suboptimal tolls being levied. This is obviously not an argument against the private provision of road facilities, but it does suggest that their small-scale introduction alongside a publicly funded, untolled system needs to be handled carefully to ensure that potential distortions of this second-best situation are minimized.

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REFERENCES

1. K. J. Button. Heavy Goods Vehicle Taxation in the United Kingdom. *Transportation*, Vol. 8, No. 4, 1979, pp. 389–405.
2. A. J. Jennings. Determining a Global Sum for Taxation of Road Users. *Journal of Transport Economics and Policy*, Vol. 13, No. 1, 1979, pp. 68–78.
3. Oral evidence in House of Commons Transport Committee. In *Tolled Crossings*, Vol. II, House of Commons Paper HC 338, Her Majesty's Stationery Office, London, England, 1985.
4. K. M. Gwilliam. Realism and the Common Transport Policy of the EEC. In *Changes in the Field of Transport Studies* (J. B. Palak and J. B. Van der Kamp, eds.), Martinus Nijhoff, The Hague, 1980.
5. C. H. Sharp, K. J. Button, and D. Deadman. The Economics of Tolled Road Crossings. *Journal of Transport Economics and Policy*, Vol. 20, No. 2, 1986.
6. J. Dupuit. On the Measurement of the Utility of Public Works. *Annales des Ponts et Chausées*, Series 2, Vol. 8, 1844 (English translation by R. H. Barback in *International Economics Papers*, No. 2, 1952, pp. 83–110).
7. H. Gravelle and R. Rees. *Microeconomics*. Longman, London, England, 1981.
8. W. Albert. *The Turnpike Road System in England, 1663–1840*. Cambridge University Press, Cambridge, England, 1972.
9. F. G. Emmison. The Earliest Turnpike Bill (Biggleswade to Baldock Road) 1622. *Bulletin of the Institute of Historical Research*, Vol. 12, No. 35, 1934–1935, pp. 108–112.
10. P. S. Bagwell. *The Transport Revolution from 1770*. Batsford, London, England, 1974.
11. T. C. Barker and C. I. Savage. *An Economic History of Transport in Britain*. Hutchinson, London, England, 1959.
12. S. Webb and B. Webb. *English Local Government: The Story of the King's Highway*. Longmans, London, England, 1913.
13. H. J. Dyos and D. H. Aldcroft. *British Transport: An Economic Survey from the Seventeenth Century to the Twentieth*. Leicester University Press, Leicester, England, 1969.
14. Department of Transport. Evidence in the House of Commons Transport Committee. In *Tolled Crossings*, Vol. II, House of Commons Paper HC 338, Her Majesty's Stationery Office, London, England, 1985.
15. House of Commons Transport Committee. *Tolled Crossings*, Vol. I. House of Commons Paper HC 338. Her Majesty's Stationery Office, London, England, 1986.

Overview of Toll Financing in Countries That Are Members of the Organization for Economic Cooperation and Development

RICHARD B. ROBERTSON

In 1985 the Organization for Economic Cooperation and Development (OECD) established an international committee to draw information for future application from the experiences of OECD nations and developing countries in financing highway improvements through tolls or direct private-sector provision of highway services. As the representative for the United States, the author was selected to chair the group that included representatives from France, Italy, Spain, Ireland, England, Belgium, West Germany, Norway, the European Economic Community, and the World Bank. The purpose of this paper is to highlight the findings of the report prepared by this committee.

Toll financing has been used extensively in many Organization for Economic Cooperation and Development (OECD) member countries as a means of funding necessary highway improvements at times when increases in other taxes used to support highway projects might have been politically infeasible. Other OECD countries have chosen not to use tolls to finance highways. However, some of these countries, as well as a number of developing countries in various parts of the world, have expressed renewed interest in identifying revenue sources outside the traditional areas of government taxation. Among the topics addressed in this paper are

- A historical overview of toll financing,
- Economic principles underlying toll financing,
- Current practice in toll financing and direct private-sector provision of highway improvements including institutional arrangements,
- Innovative techniques such as shadow tolls or zone tolls, and
- Toll collection technology.

A number of conclusions are drawn regarding the viability of tolls as a financing mechanism and specific recommendations are included for consideration by governmental or private-sector entities contemplating the use of toll financing.

A significant number of new toll highways have been built since World War II, particularly in Italy, France, and Spain. In these countries the toll highways actually form a system of highways made up, in general, of important national highways. At the same time West Germany has developed its national highway system without the use of toll financing and in its efforts to assist developing countries the World Bank has taken a general position in opposition to toll highways.

Whether a developed country or a developing country is being considered, there is complete agreement that adequate surface transportation for the efficient movement of people and goods is essential to the economic development and vitality of a country or region. Nearly all consumer and industrial goods are transported on a highway at some point in their journey. In most industrialized countries, the vast majority of workers travels from home to work by automobile, and the location of commerical firms along accessible transportation corridors is often crucial to their success. Given the competitive nature of business decisions, those nations and regions with better transportation networks are more likely to benefit from economic development opportunities than are those areas where the transportation system is inadequate.

Unfortunately, most governments are finding it difficult to raise sufficient public funds to improve their highway systems as fast as may be desirable from a purely economic theory point of view. Given this situation, many governments permit, and some encourage, the use of alternative funding sources such as tolls. Toll financing normally allows highway investments to be made without placing significant additional pressures on the government's budget because private capital is involved.

The differing attitudes toward toll highway financing in the OECD countries is the product of an evolutionary process that has been shaped by political, financial, and economic conditions in each country. To understand the different attitudes it is necessary to look at the history of postwar development of the highway systems.

In those countries with a positive attitude toward toll financing there appear to be few objections to expanding the network, rebuilding, or increasing capacity, within a total framework of toll financing. In other countries the development of a toll financed road system is not very likely, even though tolls could be placed on a specific segment of an existing main highway system for future rebuilding, additional capacity, maintenance, and the like. However, this appears to be unlikely from a political point of view except in limited urban areas with heavy traffic problems. In these instances, zone tolls could be introduced as a means both to reduce traffic and to raise additional money for increasing network capacity. In these countries toll financing is likely to be used only for special projects that may not have priority within a shrinking highway budget and that have other attributes that make them fit for toll financing. It is

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difficult to suggest fixed criteria for the use of toll financing in such cases.

Nonetheless, evidence suggests that toll financing often provides a viable alternative to other methods of financing road construction or maintenance, or both. Toll financing is popular with governments in many developed and developing countries and is being actively applied in Europe, America, and the Pacific area to build freeways and supporting roadway systems. Those programs are wide in scope and objectives and are financed under a number of different toll-based plans. However, a common element is that in one form or another nearly all have been permitted by or have the support of national governments.

Toll financing has several major advantages and disadvantages. In most countries toll projects will usually be built sooner than projects that are financed through other user taxes. This is primarily because the starting point can be accelerated but also because complete funding is available at the beginning of the project so the construction period can be shortened.

The main advantage of toll financing, however, is that it enables society to raise more money for road construction than would be possible through ordinary public financing. In countries with toll roads it has generally been found that toll facilities provide better quality maintenance than comparable free facilities. This is because the typical financial arrangement for a toll facility requires periodic inspection and maintenance reports to protect users and lenders. Toll rates generally are established at a level to provide necessary funds for amortization, maintenance, and operation of the investment.

Finally, tolls can be used as a method of congestion pricing to encourage users to make more efficient route choices or use alternative modes of transportation. Even if the main purpose of such tolls is not to raise money but to reduce traffic, the toll revenues can, of course, be used to increase road capacities.

A major drawback generally associated with toll financing is that the cost of toll collection imposes extra expenses that are not incurred on a tax-supported project. This cost has been estimated at about 10 percent of gross revenue in OECD countries. An additional intangible cost of collection is the delays and increased fuel consumption that occur as motorists queue at toll plazas. Anticipated advances in toll collection technology will make the collection of tolls and the variation of rates easier and less costly, and this in turn should enhance acceptability to users.

Another aspect of toll financing is the interest cost for borrowing funds. This cost will vary depending on the type of financing arrangements, the nature of the bond market at the time, the estimated feasibility of the project, and the credit rating of the agency issuing the bonds. Even in areas where borrowing is used to finance nontoll highway improvements, the interest cost for toll revenue financing is generally higher than that for general obligation bonds issued by the government.

Motorists who pay a toll are usually paying a tax on fuel consumed while on the toll facility. Some would argue that this represents double taxation and as such is a disadvantage of toll financing. This point is more theoretical than practical. Considerations such as this have not, in practice, been a major factor in deciding whether or not to build toll facilities.

There are several conditions under which the selection of a toll financing alternative may be acceptable from a purely economic theory point of view:

- Tolls applied to captive users where no reasonable alternative mode of transportation exists and demand is, therefore, rather inelastic;
- Tolls used to relieve traffic congestion; and
- Situations in which it is considered desirable to transfer funds from the private to the public sector in order that economic road projects be constructed.

However, a definitive decision about the feasibility of implementing a toll financing scheme should not be made on economic grounds alone, especially because precise quantification of many factors that should be considered in such an analysis is virtually impossible. The interpretation of the economic analysis or the degree to which purely economic factors are considered in the final decision must be determined within the context of political and financial realities.

For example, it may be perceived to be politically difficult or impossible to finance specific highway improvements through existing revenue sources such as motor fuel taxes or vehicle registration fees. There may also be pressure on political subdivisions to preserve some part of their taxing power for other needs that do not have potential for revenue generation. Thus, to meet legitimate highway needs, alternative sources of revenue should be considered. Toll financing has provided this political and financial relief in many instances and, in effect, has freed available tax revenues in an equivalent amount for other necessary projects.

However, decision makers must be alert to distinguishing between the decision to construct a highway and the decision to use tolls as the financing mechanism; many of the benefits of a toll-financed highway can be achieved even if another financing mechanism is chosen, for example, use of gasoline tax revenues. Tolling may be preferable in some cases and not in others. There is no overall solution that can be applied to every situation; the ultimate analysis and decision must be made on a case-by-case basis. In addition, this ultimate decision should be part of an overall governmental transportation or development plan.

The concept of off-budget financing, or course, implies the involvement of private-sector capital for the front-end financing necessary to implement a toll project. In general, toll financing has involved the government sector in one of several ways: by itself as the issuer of bonds, in a joint venture with the private sector as is common in European concessionaire agreements, or through governmental guarantees of private financing arrangements.

Granting concessions to the private sector to construct and operate toll facilities allows the exploitation of business experience in maximizing the efficiency of an enterprise; however, the sharing of risks and responsibilities between the government and the private sector must be carefully evaluated. Wholly private toll financing arrangements are unusual and imply a degree of risk acceptance by the private sector that may raise the cost of financing a facility to a level that generally cannot be recovered through acceptable toll rate levels.

Other joint public-private ventures such as royalty financing, or shadow tolls, may have considerable merit provided that

their feasibility is verified. They have not been thoroughly tested on a widespread basis. The success of such schemes also hinges on the degree of risk each sector is willing to accept. Such potentially viable arrangements deserve more serious consideration to determine their ultimate feasibility.

Although it may appear to be desirable to heavily involve the private sector in the provision of highway facilities, there will always be concern about the autonomy and self-perpetuation of toll authorities or concessions. This situation can potentially be overcome by assuring that toll financing arrangements involving the private sector are under the jurisdiction of a government transportation agency. It is important to find some formulas, both with respect to state goals and the effectiveness of private management, in these agreements that clearly establish the duties and obligations of the two parties. However, the elimination of toll authority autonomy could negate some of the efficiencies associated with private-sector management.

Governments are also beginning to turn to the private sector for the provision of transportation services through methods that involve the recovery of the costs of public infrastructure from private-sector fees or contributions. This private funding has generally been the result of the desire of the private sector to improve access to commercial, industrial, or residential developments or to comply with a law or ordinance that specifically requires certain improvements to be made.

Finally, tremendous advances toward reducing the costs and inconvenience of toll collection are likely in the near future through the introduction of advanced technology such as automatic vehicle identification. However, the capital costs of such systems are still high, primarily because they are not yet used on a widespread basis. If the cost of such systems can be significantly reduced, one of the important disadvantages of toll financing will be significantly reduced. Thus continuing research in the area of toll collection technology is integral to the enchancement of toll financing as a viable funding alternative for transportation.

If governments are to consider toll roads in the context of their financial policies, due regard having been taken of macroeconomic theory, financial and political restraints, and international conventions, then such toll roads should be developed to accelerate a program of road development that is justifiable in its own right (i.e., with or without tolls) as a priority program when each project is ranked in priority order in accordance with the usual considerations of highway cost benefits, general economic considerations, and regional development, and the following conditions should be met:

1. Governments should permit maximum flexibility in the use of alternative funding sources.
2. Where toll financing is considered, techniques such as zone tolls and shadow tolls should be explored in addition to the more traditional toll financing mechanisms and their feasibility verified.
3. If toll highways are to be established, governments should take significant responsibility for their development and operation to ensure a cost-effective, integrated system of highways. The terms and conditions must be set out and controlled by the state according to specific requirements for the general design, minimum maintenance standards, and so forth.
4. Governments should pay particular attention to the economic and financial makeup of a toll concession operation in light of the evolving expectations of balancing factors under consideration. These conditions should be carefully monitored over the duration of the contract so that the government is prepared to take whatever action may be necessary to avoid a significant slippage from the anticipated time at which the project is no longer the responsibility of the concessionaire.
5. Governments should give consideration to the use of congestion pricing on toll highways in situations in which it is deemed desirable to effect route or transportation mode changes.
6. Continued research on collection methodologies that reduce the cost and inconvenience of collecting tolls should be encouraged and supported by governments.
7. Governments should examine and, under the proper circumstances, require nontoll private-sector contributions for the provision of highway services associated with new residential, industrial, or commercial development.

A Closer Look at Impact Fees

ROBERT W. DRAPER

Localities in five states use impact fees (charges collected during approval of land development) to support public facilities to serve proposed development. Such fees are especially useful for funding improvements in suburban and fringe areas where development pressures are particularly strong and land is readily available.

In this paper the emphasis is on impact fees for roadway improvements; some of the topics addressed are developers' concerns, determining traffic impacts, attracting development, and planning considerations.

It has been common practice as part of local subdivision approval to require that developers provide on-site improvements including water and sewer facilities, curbs and gutters, internal roads, and sidewalks. Providing internal road improvement has been viewed as a legitimate exercise of a locality's police power for more than 30 years *(1)*. A more recent phenomenon has been local officials expecting developers to pay for off-site road improvements to serve traffic generated by a new development. The use of impact fees is one device communities have used to require developers to fund off-site improvements.

Impact fees are charges collected by a locality during its approval of land development to support public facilities needed to serve the proposed development. Impact fees are used to fund a variety of public facilities including roads, schools, water and sewer facilities, and parks. This paper is focused on the use of impact fees for road improvements. The use of impact fees by various localities in the United States and the types of highway improvements funded with the fees are highlighted. Several important concerns and issues related to the use of impact fees are explored:

- Are they a tax or a fee?
- How do they address developers' concerns about up-front payment of fees, paying a "fair share," and decisions about improvements?
- Who really pays the impact fee?
- How are traffic impacts determined?
- How do impact fees affect a locality's ability to attract development?
- How can the planning process address privately funded improvements in scattered locations?
- What is the future of impact fees?

There is a broad range in the level and type of fees used in various localities (Table 1). Not surprisingly the fees are higher in localities that use impact fees to help support a mix of public facilities than they are in areas that use them to support only road improvements. Localities have different processes for collecting impact fees and generally use two approaches:

Office of Planning, HHP-23, FHWA, U.S. Department of Transportation, 400 Seventh Street, S.W., Washington, D.C. 20590.

- Local officials calculate the fees on the basis of information about the development; its potential traffic impacts; and, in some instances, a predetermined program of improvements needed to serve a developing area or
- Local officials and a developer negotiate fees and funding agreements for specific improvements to accommodate the traffic associated with a new development on a case-by-case basis.

Some localities use a combination of these two approaches, giving a developer the option of paying a calculated fee or negotiating for specific improvements. The impact fees are usually either imposed on all development or selected new development. Fees imposed only on selected new development are usually linked to a performance standard whereby a fee is triggered by the likelihood that traffic generated by a proposed development will cause a nearby facility (usually an intersection) to exceed a specific level of service.

TAX OR FEE?

A locality may legitimately require off-site road improvements, but a developer can only be required to pay the portion of the costs that reflects the needs created by the development and its increased accessibility provided by the improvement *(2)*. If a locality imposes an impact fee higher than the developer's share of the costs for improvements reasonably needed to serve the new development, the courts view the fee as a tax and overrule the impact fee *(3–5)*.

DEVELOPERS' CONCERNS

Cost and certainty are a developer's overriding concerns. Quite simply, early in the development review, a developer wants to know what fees or improvements local officials expect him to provide and he does not want any surprises later. On the basis of a recent FHWA study on developer-funded improvements *(6)*, the following observations can also be made about the developer's viewpoint:

- A developer wants to minimize up-front capital costs, so he prefers to phase improvements (or fees) to coincide with each phase of a development's completion or buildout.
- A developer wants other developers and the locality to share in the expense of off-site improvements that benefit more than the new development.
- A developer wants to have control over improvements constructed with his money, particularly when he funds the entire costs. Thus, a developer often prefers to assume responsibility for constructing the off-site improvements so he has

TABLE 1 USE AND IMPACT FEES IN SELECTED LOCALITIES

Locality	Approach	Amount of Calculated Fee	Basis	Types of Highway Improvement
Newport Beach, Calif.	Negotiated fee	NA	Performance standard: based on percentage of traffic generated by a development that will use a nearby intersection	Widenings Intersection improvements
San Diego, Calif.[a]	Calculated fee	SF unit: $1,900–$3,800 MF unit: $1,300–$2,700 Commercial acre: $4,000–$56,000 Industrial acre: $3,000–$22,000	Estimated cost of expanded facilities associated with undeveloped lots; varies by area within city	Arterials Collectors Local streets
Palm Beach, Fla.[b]	Combined approach	SF unit <2,000 ft^2: $804 ≥2,000 ft^2: $1,045 Commercial or industrial acre: $28,500	Highway construction costs and number of trips generated by development	Widenings Intersection improvements
Corvallis, Oreg.[c]	Calculated fee	SF unit: $1,500–$2,000 Commercial acre: $17,000	Value of development, lot area, structure area, cost of expanded capital facilities; varies by area within city	Widenings Intersection improvements Bridge replacements
Snohomish County, Wash.[d]	Combined approach	$150 per daily trip generated	Performance standard: developer's proportionate share of cost to improve roads that will operate at LOS D due to traffic generated by development	Widenings Intersection improvements
Waitsfield, Vt.[e]	Negotiated fee	NA	Cost of improvements in developing area, size of development, and its traffic impacts	Planning study to identify areawide improvements serving new development Intersection improvements Widenings

NOTE: SF = single family and MF = multifamily.
[a]San Diego's fees or facility benefit assessments are for three subareas within the city that have adopted financial plans. The fees are used for roads, parks, libraries, schools, fire stations, and other public facilities. Development fees are also collected in other areas of the city and tend to be toward the lower range of the fees shown in the table.
[b]The $28,500 represents a typical commercial development with a 85,000-ft^2 building that covers 25 percent of the site. In practice, fees for commercial and industrial uses are calculated on the basis of a $26.79 rate per ADT, which Palm Beach officials convert to a fee of $2,679 per 1,000 ft^2 (up to 80,000 ft^2) and a declining rate for larger developments.
[c]Corvallis uses the fees to fund water, sewer, and transportation facilities. The fees are divided equally among these three categories. Square footage of structure is used to calculate fees for commercial activities; the $17,000 per acre shown in this table is estimated.
[d]Although Snohomish County uses a combined approach (i.e., allowing developers to either pay a calculated fee or negotiate for the fees due), in most instances the developers have opted to negotiate the fee.
[e]Waitsfield is unique among these localities in that local officials are negotiating development fees solely on the authority of state statute. Vermont Act 250, a land use control law, requires a state land use permit for major development. Agreements are negotiated to correct "unreasonable congestions and unsafe conditions" on highways as part of the permitting process. Fayston and Warren are other Vermont localities that use the state statute to negotiate development fees.

more control over the cost and the timing and has assurance that the improvements will be constructed.

- A developer does not want long-term responsibility for road maintenance, so he prefers to turn over responsibility for the roads to the locality when they have been constructed. A locality will usually wait a year to accept the improvements, allowing sufficient time for any construction deficiencies to show up.

Unfortunately, it is difficult to structure an impact fee that is fully responsive to all the concerns raised by developers (Table 2). By nature, a negotiated impact fee provides greater flexibility to a locality and a developer. Some localities use a combination of calculated and negotiated impact fees. This approach works well in that small developers may pay the fees and proceed with their project. Larger developers, on the other hand, may find it worthwhile to negotiate for specific improvements that suit the needs of their development and its proposed buildout. A developer sometimes may be able to negotiate for improvements that he believes cost less than the sum of flat fees he would have otherwise paid.

WHO PAYS?

Although a developer pays impact fees to a locality, an important issue is who really bears this cost. Does the developer pass the cost on to the consumer (i.e., the "newcomer" who occupies or shops at the development)? Does the developer lower his offer for vacant land in anticipation of the additional development costs associated with impact fees? In that case the seller of the property actually bears the fee. Or, does the developer pay the impact fee in full from his own pocket or profit?

Some developers refer to impact fees as legal extortion; perhaps they pay impact fees from their profits. One California court believes that a developer pays an impact fee voluntarily *(7)*:

> The dedication of land or the payment of fees as a condition precedent to development is voluntary in nature. Even though the developer cannot legally develop without satisfying the condition precedent, he voluntarily decides whether to develop or not develop. Development is a privilege not a right.

The courts are also wary about newcomers paying the entire cost of expanding public facilities in developing areas. One Utah court has specified rigorous criteria that should be considered in determining the allocation of the cost of facilities funded through impact fees *(8)*:

1. The cost of existing facilities;
2. The manner of financing the existing capital facilities such as user charges, special assessments, bonded indebtedness, general taxes, or federal grants;
3. The relative extent to which the newly developed properties in the municipality have already contributed to the cost of existing capital facilities by such means as user charges, special assessments, or payment from the proceeds of general taxes;
4. The relative extent to which the newly developed properties and other properties in the municipality will contribute to the cost of existing capital facilities in the future;
5. The extent to which the newly developed properties are entitled to a credit because the municipality is requiring their developers and owners (by contractual agreement or otherwise) to provide common facilities (inside or outside the proposed development) that have been provided by the municipality and financed through general taxation or other means (apart from user charges) in other parts of the municipality;
6. Extraordinary costs, if any, in servicing the newly developed properties; and
7. The time-price differential inherent in fair comparisons of amounts of costs paid at different times.

Although the fee does not necessarily have to achieve a precise mathematical equity, the court notes that the locality must disclose the basis for calculating an impact fee to anyone who challenges its reasonableness.

The preferred approach is for the impact fee to be absorbed in the cost of land. To achieve this objective, Weitz *(9)* has suggested several guidelines for a locality planning to adopt impact fees:

1. Give adequate notice: Provide 4 or 5 years notice that impact fees are on the horizon. This is fair to citizens, land investors, and developers and will avoid a situation in which a developer buys land without expecting to pay for off-site improvements and then is hit with an impact fee imposed after purchase.
2. Tailor developer contributions to specific sites: Fees should be based on the expected impact of developments on surrounding facilities. The end result should be that land near facilities with excess capacity should cost more than land near facilities that are overcapacity. Other things being equal, the difference in the land price would be equivalent to the impact fees.
3. Do not constrict the supply of land: A sufficient supply of land is needed for the impact fees to be absorbed in the cost of land. The supply of land should not be constricted artificially through restrictive land use requirements. Preferably, land should be assessed at its full value so *(a)* vacant land will fully reflect the effects of impact fees and *(b)* a decision to sell is

TABLE 2 RESPONSIVENESS OF IMPACT FEES TO DEVELOPERS' CONCERNS

	Type of Impact Fee	
Developers' Concern	Calculated	Negotiated
Minimize up-front capital costs	Unresponsive: calculated fees are usually collected early in the development process	Varies: Sometimes improvements are required before building permit is issued. However, depending on scale of development and nature of improvements, they may be phased with development.
Pay "fair share"	Responsive: calculated fees are commonly levied on all new developments	Varies: Negotiation provides opportunity for cost-sharing agreements among multiple developers and the locality. However, when the need for improvements is triggered by performance standard, subsequent developers often get "free ride" due to excess capacity provided an improvement funded by an earlier developer.
Control overimprovements	Unresponsive: calculated fees are often collected, then earmarked by the locality for improvements in developing areas within the jurisdiction	Responsive: Developer and local officials negotiate for specific improvements. Developer usually has option to contract for the improvements directly or fund the improvement through a state or local contract.
Maintain roads	Responsive: the locality has full control of road construction and maintenance, impact fees usually support new facilities or major upgrade of existing facilities (beyond routine maintenance)	Responsive: Developer and local officials usually negotiate that the locality assumes full maintenance responsibility 1 year after construction is completed.

made on the basis of whether the anticipated appreciation will offset the carrying costs.

4. Design consistent land use requirements: Land use requirements should be predictable and pragmatic. There should be flexibility to trade off higher density for more developer contributions, but local officials should exercise this option cautiously. If developers believe approval of such a trade-off is automatic, they will bid up land in anticipation of building at a higher density. Local officials should also be wary that the increase in a developer's contribution approximates the increase in value associated with approval of a higher density.

5. Set realistic fees: Fees should reflect the proportionate cost of improvements associated with a development and the value of increased accessibility. If fees are too low, the developer will receive some windfall. If they are too high, the costs will be passed on to the consumer. If they are not substantiated, the courts will overturn the impact fee.

Who pays? The answer depends on the timing of the institution of the impact fees, the structure of the fees, and the supply of land. Theoretically, impact fees can be capitalized in the value of land. In practice, the cost is more likely borne by the consumer. A developer may haggle with a land investor about the price of land and perhaps discuss the financial implications of impact fees on its development. The price of land and development expenses (including impact fees) are separate line items in a developer's mind, especially when an option or offer has been accepted for the land. The final development program —the type, scale, and mix of development—is decided later during review and approval by local officials. The development program is the key factor in determining the impact fee whether the fee is calculated or negotiated for specific improvements. The impact fees associated with the development program become a fixed cost in the developer's base expenses for estimating his return. In turn, it is passed through to the newcomer who occupies or shops at the development.

DETERMINING TRAFFIC IMPACTS

Determining the traffic impacts of proposed development is an important issue for several reasons. It allows local officials to identify potential deficiencies of the highway network that could result from traffic generated by a proposed development. In turn, this provides the basis for devising improvements and negotiating a funding agreement with the prospective developer. This process can constitute a systematic process for calculating an impact fee and is essential if an impact fee is to withstand legal challenges. Broward County, Florida, developed one of the more widely recognized processes for determining the traffic impacts of proposed development *(10)*. Its computerized model, Traffic Review and Impact Planning System, is used to estimate the traffic impacts of proposed development and determines the development's fair share of the cost of planned improvements.

The traffic impacts associated with new development can be determined by using available transportation planning and engineering procedures. In simple terms, it is a matter of comparing future traffic with and without the proposed development. In reality, it involves a considerable degree of judgment and a good technical understanding of the subtle effects of different assumptions when applying the methodology. There follows a step-by-step description of a suggested process for determining the traffic impacts of new development and some of the issues that are critical in applying the methodology:

- Step 1: forecasting background traffic. Background traffic is a combination of existing traffic and traffic that will be generated by other development already approved within the general vicinity of a proposed development. The key issue is whether the background traffic includes any traffic that would be generated by the proposed development.
- Step 2: identify planned highway improvements and potential deficiencies. The background traffic is assigned to the highway network. The network should include proposed highway improvements that are expected to be constructed whether or nor the particular development under review is built. Highway deficiencies are identified with the background traffic. Ideally, no deficiencies occur. The key issue is making a realistic determination about the proposed highway improvements.
- Step 3: estimate the traffic generated by the proposed development. Trip generation rates and information on the size of the proposed development are used to estimate the amount of traffic associated with the development. There are several important issues. What trip generation rates are used? Often a locality will use rates compiled by the Institute of Transportation Engineers *(11)* or agree with the developer on rates that more accurately reflect local conditions. What mix of vehicles, vehicle occupancy rates, and peak-hour factors is used? Assumptions about these factors drive the all-important number of vehicle trips generated by the proposed development. These assumptions are especially important when decisions are being made about the effectiveness of special transit services or employer-sponsored ridesharing programs associated with the proposed development.
- Step 4: estimate the amount of pass-by traffic that will be attracted to the development. Pass-by traffic is background traffic that will be attracted to the development. Assumptions about pass-by traffic are important when estimates are being made of the traffic impacts of retail development. An estimate is needed of the number of drivers who will stop and shop as part of their normal trip by the site. For a mixed-used development, it is also important to separate the number of trips that will be generated on site between activities, such as the number of employees making midday shopping or lunch trips on site. Although pass-by traffic may be separated out as part of Step 1, it is important to recognize the distinctions among and assumptions about these trips when determining the overall traffic impacts of a proposed development.
- Step 5: assign traffic from the development to the highway network and identify deficiencies. The traffic from the development is assigned to the network with the background traffic. Traffic volumes are examined and potential operating deficiencies are identified.

Determining the traffic impacts associated with a proposed development is rather straightforward, but it can be a tedious, complicated exercise. Availability of data is a problem, especially getting reliable data on the results of transportation

management programs (Step 3) and pass-by traffic (Step 4). Local planners and the developer's representatives should agree on the critical assumptions for the analysis so the results will provide a constructive basis for determining the impact fees, especially when the intention is to negotiate improvements to serve the traffic associated with a development.

ATTRACTING DEVELOPMENT

A key factor that affects the feasibility of impact fees is the presence of a strong local economy. The supply of and demand for developable land must be sufficient to absorb the added expense of impact fees. An area with a soft local economy trying to attract development is an entirely different situation. Publicly funded improvements are often necessary to attract development to such an area.

Impact fees evolved as an element of a broader growth management strategy for localities experiencing strong development pressure in such places as California, Florida, and Washington. The objective was to encourage development to occur in areas within a locality where public facilities have adequate capacity to serve the development. Impact fees are used as a penalty for development in areas where there is insufficient capacity.

A complicating factor is border effects between localities. The traffic impacts of development sometimes occur in an adjacent jurisdiction. There is no formal mechanism for imposing impact fees across jurisdictions. Ideally neighboring localities need to coordinate development approvals near their boundaries and negotiate joint funding agreements with developers to share the cost of improvements in the area. A more unfortunate situation is the case of two jurisdictions with and without impact fees. The jurisdiction without the fees will have an advantage in attracting development, and the other jurisdiction will experience the traffic impacts with little prospect for negotiating a joint agreement.

PLANNING CONSIDERATIONS

During the planning process improvements that will be needed in developing areas can be identified and impact fees can be used to fund the improvements as development occurs. Broward and Palm Beach Counties, Florida, use this approach. Each county is divided into districts and officials identify road improvements needed to serve new development within each district. Impact fees are credited to separate accounts for each district. If the county does not use the fees to construct the improvements within several years, it must refund the money to the property owner.

San Diego, California, uses a similar approach to fund a broad array of public facilities. The developing portion of San Diego is divided into 14 communities. A comprehensive plan that identifies the public facilities that will be needed as the area develops—roads, parks, libraries, schools, fire stations, and other capital facilities—is prepared for each community. The cost of these facilities is estimated, and a fee is computed to cover the costs associated with each undeveloped parcel. In most areas, an agreement is negotiated with each developer on the basis of the calculated development impact fee. Financing plans, which reflect the capital improvements identified in each community's comprehensive plan, have been adopted for three communities and another is pending. Each financing plan also includes rates for calculating a facilities benefit assessment for the development of each lot. When a financing plan has been adopted, the fee is calculated during development approval and individual developer agreements are no longer necessary.

When funding agreements for the improvements are negotiated in a piecemeal manner, planning plays an important role in providing data for traffic impact studies and examining the broader effects of privately funded improvements in scattered locations. A regional planning agency and the localities within a metropolitan area can work together to share information under this approach. A locality is provided on-line access to regional traffic forecasts for use in estimating background traffic near a proposed development as part of the traffic impact analysis for that development. Information on privately funded improvements is funneled into the planning process. As part of subsequent plan updates, such improvements are reflected in the performance of the highway system when the need for area-wide improvements is determined.

CONCLUSION: FUTURE CONSIDERATIONS

Localities in California, Colorado, Florida, Oregon, Texas, and Washington use impact fees. Maine, Maryland, New Hampshire, New Jersey, New Mexico, and North Carolina are considering their use. Impact fees are accepted by the courts and are viewed by some developers as a normal part of doing business. They are in line with the current emphasis on user fees and increased private-public cooperation for funding capital facilities. They are a useful means of funding improvements in suburban and fringe areas where development pressures are particularly strong and land is readily available. In such localities they can represent a significant portion of the local revenue used for highway improvements.

As localities continue to grapple with the problems of traffic congestion and limited public resources, local officials will continue to view impact fees as another source of funds for needed improvements. When they have been accepted as an element of a more comprehensive growth management strategy, impact fees are commonly viewed in terms of their revenue potential.

Let no one be fooled. Impact fees are not a panacea. The application of impact fees requires deliberate thought by local officials about local factors that affect feasibility, administrative complexity, and equity.

A strong local real estate market is crucial to the feasibility of imposing impact fees. A concerted effort is needed to implement them. State or local enabling legislation, or both, is usually required. Impact fees are time consuming to administer: it is especially time consuming for local planning staff, local officials, and developers to negotiate and approve funding agreements on a case-by-case basis. If a calculated fee is used, local staff must identify improvements that will serve a developing area, estimate their cost, derive a formula for distributing the costs among prospective developments, collect the

fees as development occurs, and account for the fees used to fund improvements in specific areas. Finally, serious equity issues are raised by exacting a hidden fee for public facilities from newcomers.

Local officials should address all of these issues when considering whether to institute impact fees. Planners have a responsibility to raise these issues in the decision-making process. Impact fees are appropriate and desirable as part of a broader growth management strategy for a community. They are less appropriate and desirable when viewed strictly as an alternative source of revenue. A dedicated local add-on fuel tax, for instance, is administratively simpler, more flexible, and more equitable in distributing the cost of highway improvements among the general local population that uses all public roads. It is neither feasible nor appropriate from a public policy viewpoint to expect impact fees to be the primary source of funds for highway improvements. State and local governments should rely on a mix of revenue sources—both traditional use fees and more contemporary sources—to support future transportation improvements.

REFERENCES

1. Brous v. Smith, 106 N.E.2d 503 (1952).
2. Land/Vest Properties, Inc. v. Town of Plainfield, 379 A.2d 200 (1977).
3. Home Builders and Contractors Association of Palm Beach County, Inc. v. Board of County Commissioners of Palm Beach County, 446 So.2d 140 (1983).
4. Timothy Ross Lafferty v. Payson City, 642 P.2d 376 (1982).
5. Trent Meredith, Inc. v. City of Oxnard, 170 Cal. Rptr. 685 (1981).
6. Laurence J. Meisner, Kimley-Horn Associates, Inc. *Financing Urban Transportation Improvements*, "Report 2: Use of Private Funds for Highway Improvements." Federal Highway Administration, Jan. 1984.
7. Trent Meredith, Inc. v. City of Oxnard, 170 Cal. Rptr. 685 (1981).
8. Branberry Development Corp. v. South Jordan City, 631 P.2d 899 (1981).
9. S. Weitz. Impact Fees: There Is No Free Lunch. *Planning*, Vol. 50, No. 7, July 1984, pp. 12–14.
10. *Trip Generation—An Informational Report*. 3rd ed. Institute of Transportation Engineers, Washington, D.C., 1982.
11. R. Knack, J. Frank, and H. Stewart. How Road Impact Fees are Working in Broward County. *Planning*, Vol. 50, No. 6, June 1984, pp. 24–27.

Impact Fee Assessment Using Highway Cost Allocation Methods

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Although local governments have traditionally borne the cost of local roadway improvements to accommodate traffic growth, there has been a growing interest in the assessment of impact fees on developers to finance such improvements. Impact fees have been assessed as flat fees based on the size of the development; variable fees depending on the type and location of the development; and negotiated fees determined by the required investments, the interests of the local communities, and the resources of the developer. Variable fees are analogous to roadway user taxes in that roadway costs vary with traffic and a desired revenue target is to be met. Techniques used in highway cost allocation studies can be directly applied to the design of equitable variable impact fees. Because highway cost allocation studies have received considerable attention and have been widely applied, these allocation methods might be usefully adopted for impact fee assessment.

Economic implications of roadway cost allocation methods for impact assessment are discussed.

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Historically, municipal and county governments have borne the cost of providing transportation infrastructure. More recently, infrastructure has been financed by imposing impact fees on developers *(1, 2)*. To withstand challenges in court from developers and citizens and to effectively finance road improvements before traffic from developments affects the local area, impact fees must be equitable, consistent between developers and over time, and administratively feasible. Furthermore, impact fee revenues together with available public funds should be sufficient to cover the cost of required improvements. Impact fees should also be economically efficient and occasion as little cost and resource misallocation as possible *(3, 4)*. This latter objective has received greater attention in the theoretical literature than in practice. The objectives of governing bodies in setting impact fees have been primarily

to cover costs and ensure equity among developers, whereas an economist's objective might be to set efficient impact fees that might not cover costs and might or might not necessarily be equitable.

TYPES OF FEES

Impact fees paid by developers to finance off-site improvements have evolved as local governments have been unable to finance improvements through special assessments and tax increments or in lieu of dedications and exactions. Following Vaughan *(5)*, an impact fee is viewed herein as an extension of a user fee. In this framework, there are three types of impact fees, as defined by Palomino *(2)*: a flat fee, a variable fee, and a negotiated fee. Although the emphasis in this paper is on variable fees, each type of fee is briefly described. An example application is also given to illustrate the use of such fees by municipal or county governments.

Flat Fee

The flat fee is based on a unit related to the size of the development such as dwelling units, square feet of space, or number of employees. The developer is charged a fixed dollar amount per unit for off-site improvements. For example, the Boston Redevelopment Authority charges a flat fee of $6 per square foot of office space to developments of more than 100,000 ft^2 for neighborhood improvements and housing *(6)*. This fee has recently been overturned as an illegal tax in court and the city of Boston is appealing the ruling *(7)*.

Flat fees may be levied on a developer in proportion to the traffic generated by the development. Typically, the expected traffic generated is determined from the Institute of Traffic Engineers *(8)* generation rates and the size of the development.

The flat fee has some serious drawbacks. Such fees do not demonstrate a cause and effect relationship between development and the need for improvements. For example, a development next to an interchange on an uncongested freeway is given no credit for the location of the site. Nor do these fees give credit for large-scale mixed development including residential, office, and retail space on one site in which much of the traffic is internal.

Variable Fee

Variable fees are analogous to roadway user taxes in that roadway costs vary with traffic and a desired revenue target is to be met. The design of equitable variable impact fees can be achieved through the direct application of highway cost allocation methods such as attribution of costs to vehicles by "incremental assignment" or "uniform removal" *(3, 9, 10)*.

The variable fee varies with amount of traffic generated by the development and its origin and destination. Such fees have been implemented in Broward County, Florida *(1, 11–13)*. Although the details of implementation may differ from place to place, the fee charged to a developer is typically determined using the sequential urban transportation planning process. The area affected by the development is modeled as a network and the following six tasks are undertaken:

1. Identify developments: the location, type, and size of potential developments over a specified planning horizon are determined.
2. Determine required improvements: the urban transportation planning process is applied to forecast future traffic, design improvements to add capacity for the increased traffic volumes, and estimate the cost of improvements. The process is applied as follows *(12, 14)*:

Step 1: Traffic generated at and attracted to each development site is estimated. Typically, historical average generation rates *(8)* are used. For example, a residential development is assumed to have 0.9 trips per single-family dwelling unit generated in the morning peak hour.

Step 2: Traffic generated at (both into and out of) each site is then distributed to origins and destinations throughout the network either using a gravity model *(14)* or according to existing trip distributions determined from a survey.

Step 3: Traffic is then assigned for all potential developments from each origin in the network to the development sites, and to each destination from the sites. The assigned volume on each link in the network after the developments are completed is equal to the existing volume plus that generated by the developments determined in the preceding step. In practice, traffic from developments is added to existing traffic ignoring other developments. Commonly, all-or-nothing assignment is used.

Step 4: Improvements are designed for links or intersections on which the level of service falls below a specified minimum level. For example, the intersection level of service may be required to be C or better *(15)*. Estimated costs are obtained for each improvement. Alternatively, a predetermined set of improvements is reviewed to determine which improvements should be implemented.

3. Attribute costs: any improvements, such as site accesses, that can be attributed to a particular development are determined.
4. Allocate remaining costs to developers: for each improvement, costs are prorated to developers in proportion to the amount of traffic using the intersection or link in the network that was generated by the development. This traffic may be determined by repeating Steps 1–3 of Task 2 and omitting or adding a development at each site. In practice, developments are often viewed in isolation in this allocation.
5. Allocate any costs attributed to more than one development.
6. Aggregate improvements costs for each development and each improvement.

Implementations differ primarily in the method used to prorate improvement costs to developers. The process is particularly sensitive to the technique used to assign traffic to the network. Different methods will assign different proportions of total traffic using a given improvement to the traffic that is generated by the development. For example, the nature of equilibrium assignment *(14)* is such that little traffic from a development site may use a particular intersection initially, but when improvements are implemented the development-gener-

ated traffic that uses the intersection may increase significantly. On the other hand, the results are consistent among developers because the process is usually implemented as a computer model *(11)*.

Negotiated Fee

With a negotiated fee the developer and the community bargain to determine the amount of the fee. For example, the developers of the Coal Creek Station power plant in North Dakota agreed to provide $40,000 for local public works, improved local roads, and housing development, all with citizen participation *(5)*. This process is slow because many actors are involved in the negotiation. It is also difficult to ensure consistency; results often depend on the abilities or political influence of the parties involved. However, Vaughan *(5)* argues that the negotiating process sidesteps unreliable models and data that do not permit the trade-offs necessary to coordinate a large-scale development.

In sum, the current practice of impact fee assessment ensures that the revenue target is met, except in the case of negotiated fees. However, because fee assessment procedures are usually static and provide little accounting for the spatial variation in traffic, there is no guarantee that the resultant fees are equitable. In the following sections are discussed the use of highway cost allocation procedures and transportation planning models for setting impact fees that satisfy the objectives described in this section.

HIGHWAY COST ALLOCATION METHODS

Highway cost allocation studies have received considerable attention from both state and federal legislators and have been widely applied *(9, 12, 16, 17)*. The objective of highway cost allocation studies is to determine equitable charges to the various vehicle classes that use a set of transportation facilities.

The application of highway cost allocation methods to the assessment of impact fees assumes that a class of vehicle users defined in highway cost allocation studies by axle weight and vehicle size may also be defined as traffic generated (or attracted) by a development. The methods used in roadway cost allocation allow flexibility to design tolls *(18)* or to assess impact fees.

Two highway cost allocation methods have been widely used: proportional allocation and incremental allocation. In the latest federal highway cost allocation study *(9)*, the uniform removal method was used *(10)*. Other methods, such as modified incremental methods and optimization *(19)*, have not been widely applied in practice. The uniform removal method was preferred in the latest federal study because it proved to be administratively feasible and did not unduly favor one vehicle class or another.

Proportional allocation methods assess the cost responsibility of each vehicle class in proportion to its use of the highway facility. Use of a facility may be measured by number of vehicles, vehicle miles of travel, equivalent single axle loads, or vehicle weight. Proportional allocation is closely related to uniform traffic removal.

Incremental allocation methods determine cost responsibility by sequentially introducing or removing vehicle classes to or from the traffic stream. Total amounts allocated differ when vehicles are added or removed in a different order. This problem, and the use of highway cost allocation methods in general, is illustrated by applying the incremental allocation method as follows. Required improvements are designed and costs are estimated assuming all developments are completed. Developments are then "removed" sequentially and the required road improvements are costed. The difference in these costs when the development is and is not executed is obtained. The difference is allocated to that development. The process is repeated until all developments are "removed." Due to the "lumpy" nature of highway improvements, such as adding an additional lane, it is possible that some developers will not be allocated any costs. However, if the order in which developments are considered is changed, a different set of allocated costs is obtained. To overcome some of these difficulties the uniform removal method has been used.

The uniform traffic removal procedure involves removing equal proportions of traffic from each class until all costs have been allocated. The method as applied to highway cost allocation is described elsewhere *(9, 10)*. Uniform traffic removal can be derived from a set of axioms originally developed in the context of game theory *(10, 20, 21)*.

Highway cost allocation methods would relate a developer's responsibility to the traffic that uses an improvement to go to or from a site. This traffic is commonly estimated using the Urban Transportation Planning System (UTPS) *(14)* or a similar approach. The UTPS approach for determining impact fees can be shown to be equivalent to the application of attribution techniques under different assumptions. As an illustration, costs are commonly allocated to developers as an impact fee, in proportion to the ratio of estimated development traffic to total traffic using the improvement. This is equivalent to the uniform removal method under the assumption of a continuously differential cost function with no fixed costs and to the incremental assignment techniques under the assumption of a linear cost function.

The remainder of this paper is devoted to the description and application of the uniform traffic removal method to the assessment of impact fees. The proportional and incremental allocation methods are shown to be equivalent to the uniform removal method with specific assumptions.

UNIFORM TRAFFIC REMOVAL COST ALLOCATION

The uniform removal technique is based on a cost function that relates the required improvement costs to the traffic from each development using the improvement. The cost function used for highway cost allocation typically includes agency costs; for impact fee assessment, it includes only construction costs. In the latter case, facility operating and maintenance costs are ignored and other general costs such as vehicle operating costs and pollution are disregarded.

The uniform removal technique exhibits four properties *(10)*:

1. The sum of allocated costs equals total costs. This property ensures that the primary objective of meeting agency costs

by assessing an impact fee is met. User costs including congestion and vehicle operating costs may also be included.

2. Costs allocated to any class of users are nonnegative. This property prevents any developer from receiving payments.

3. The cost allocation procedure is additive. Additivity ensures that, if the cost function is separable, identical allocations are obtained if the procedure is applied to the total cost or the separate parts. This property is important because development usually involves improvements at many different locations, and total improvement costs are the sum of the costs at individual links or intersections.

4. Cost allocation is consistent. If vehicle volumes are identical in their effect on cost, allocated costs are proportional to the volumes of the classes. This property is consistent with the equity objective expressed earlier.

Billera and Heath *(21)* show that the cost allocation procedure exhibits these properties and is unique.

To apply the uniform removal method, assume that the traffic using the improvement is a vector (x) of traffic from each of n development sites

$$x = (x_1, \ldots, x_i, \ldots, x_n)$$

where x_i is the traffic to or from developer i's site. Let $f(x)$ be the long-run cost of serving volume x, and assume that there are no fixed costs [$f(0) = 0$]. Furthermore, assume that the cost function is continuous and has a nonnegative first derivative, that is $\partial f(x)/\partial x_i > 0$ and continuous.

For roadway improvements, the cost function relates the cost of improvement to the additional traffic using the improvement. This is commonly a step function but may be approximated by a function such as the logistic curve, which is appropriate when it is recalled that the actual traffic volume is only forecast not known.

Also, assume that the present capacity is adequate for the existing traffic and existing traffic is therefore ignored in the analysis. According to the uniform removal procedure, equal portions of each developer's traffic are removed until all of the costs have been attributed. The uniform removal cost allocation to developer i is given by *(10)*

$$c_i(x) = x_i \int_0^1 f(t \cdot x_1, \ldots, t \cdot x_i, \ldots, t \cdot x_n)dt \quad (1)$$

where x is a vector of traffic using the improvement. Assuming direct equivalency between each developer's traffic, it can be shown *(10)* that the cost allocated to developer i is proportional to use:

$$c_i(x) = f(x)\, x_i/x_t \quad (2)$$

where x_t = total traffic = $x_1 + \ldots + x_n$.

As is demonstrated elsewhere *(10)*, this allocation exhibits the four properties described previously and is unique. Similar results can also be obtained for many improvements and developments.

This method is also equivalent to a proportional allocation procedure with respect to the number of vehicles using the improvement and is equivalent to an incremental allocation procedure assuming constant returns to scale for construction. Furthermore, these allocated costs, and prices that equal marginal costs, are identical for a cost function that has constant returns to scale. The results obtained here are similar to those obtained by the methods used in Broward County *(11)*.

The uniform traffic removal technique can still be used with scale economies of construction, although it will not be equivalent in this case to proportional assignment. Also, it is possible to include allocation of costs to existing roadway traffic or, alternatively, to existing plus forecast growth in roadway traffic up to the point at which improvements are desirable. For additional traffic growth due to specific developments or to regional changes, cost allocations can be performed using uniform traffic removal.

A difficulty with the cost allocation methods described here occurs in cases in which route choice for new traffic is ambiguous. Standard equilibrium traffic assignment methods simply indicate equilibrium flows but do not indicate the specific origin-destination (O-D) flows that will use a particular link. Thus the proportion of traffic that uses a particular link cannot always be immediately identified as coming from a particular origin. Several alternative methods of estimating the origin or destination of traffic on a link may be employed, although each requires additional assumptions. First, by reducing specific O-D travel volumes and observing the reduction in flows on particular links, it may be possible to infer the contribution of particular developments to specific link flows and then to proceed as described previously. Second, the actual traffic assigned might be used as part of a traffic assignment algorithm *(22)*. This would require keeping an account of the origin or destination of traffic flows at each iteration of the assignment algorithm. Although it does not represent an explicit model of route choice, this procedure is relatively simple and can be readily replicated. Third, an analyst could employ a secondary algorithm to distribute specific O-D flows among minimum travel time paths on the basis of a criterion such as entropy maximization and subject to the actual volumes identified in the assignment phase. Finally, all-or-nothing assignments avoid such distribution problems. Each of these methods would estimate the proportion of the volume on a facility orginating from or destined for new developments.

Another problem arises in considering developments that are scheduled for later implementation. In this case, cost allocations could be made for each year in the planning horizon, and the equivalent uniform annual cost of improvements could be allocated in each year.

IMPACT FEE ASSESSMENT USING UNIFORM TRAFFIC REMOVAL: EXAMPLE WITH NETWORK ASSIGNMENT

The six tasks usually applied to assess variable impact fees were presented in the first section of this paper. The uniform removal method presented in this section represents a procedure for allocating costs to developers as required in Task 4. As Equation 2 indicates, the allocation of costs requires knowledge of the volume of traffic that is generated by each development ($i = \ldots n$) and uses each improvement (j). This volume is estimated using an urban transportation planning approach described in Steps 1–3 of Task 2. The process is crucial to the

application of any allocation method and is described more fully elsewhere *(14)*.

The process is usually applied with existing traffic, anticipated growth outside the study area, and potential developments as inputs. Generation rates and gravity models, common in many computer implementations of the process [UTPS *(14)*, MINUTP *(23)*, MicroTRIPS *(24)*], are often supplemented by or replaced with local data from surveys. The assignment of traffic to the network may be all-or-nothing or equilibrium assignment *(22)*. In the former, all traffic from each origin and to each destination is assigned to the shortest path between the origin and the destination. Equilibrium assignment is based on the principle that "a stable condition is reached only when no traveler can improve his travel time by unilaterally changing routes" *(22)*. In practice several methods, including incremental, iterative, and stochastic assignment, are used to approximate equilibrium assignment. Clearly, the consistency and equity of the allocation are dependent on the accuracy of the estimated traffic volumes.

The following hypothetical example demonstrates the application of the uniform removal method for allocating costs and the UTP approach for estimating volumes for the afternoon peak flow. The hypothetical study area is shown in Figure 1 with two potential developments sites. Site A (located in Zone 5) is 10 acres and has a proposed 500,000-ft^2 office complex. Site B (located in Zone 6) is 15 acres and a 800,000-ft^2 office complex is proposed. Zones 5 and 6 are the only internal origins and destinations and the numbers 1 through 4 represent external origins and destinations. Intersections are numbered 7 through 11. Finally Link 1-3 represents an Interstate highway; Link 2-4 a major road; and Links 5-10, 6-11, and 7-8 access roads. All links are two way and existing traffic, capacities, and lengths of links are as given in Table 1. The tasks described previously are performed to determine and allocate improvement costs.

1. Developments: two developments, A and B, have been identified.

2. Determine improvements.

Step 1: ITE rates are used to determine the traffic generated by the site on the basis of square footage of development *(8)*. Generation rates and traffic are given in Table 2.

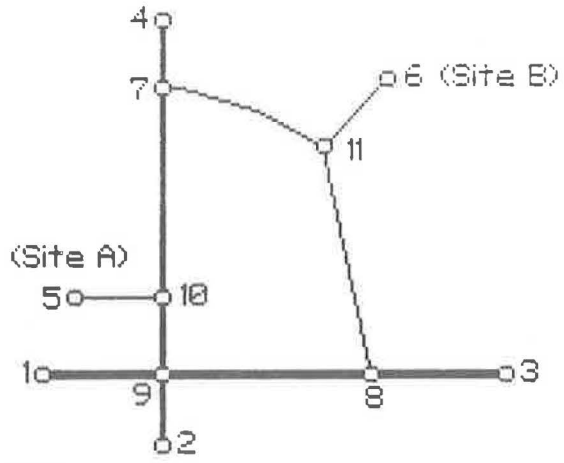

FIGURE 1 Hypothetical study area.

TABLE 1 INPUT LINK DATA FOR EXAMPLE SITE

Link	Length (mi)	One-Way Capacity (vph)	Existing Volume
1-9	0.8	4,000	2,000
			3,700
2-9	0.6	1,700	700
			1,500
3-8	0.2	4,000	3,200
			1,500
4-7	1.1	1,900	1,900
			1,100
5-10	0.3	1,700	0
			0
6-11	0.3	1,700	0
			0
7-10	1.0	1,900	1,800
			800
7-11	0.1	1,400	100
			300
8-11	1.4	1,700	300
			100
9-10	0.3	1,900	800
			1,800
8-9	0.6	4,000	2,900
			1,400

Step 2: For this example, distributions are assumed to be known and as given in the O-D matrix of Table 3.

Step 3: The O-D matrix is then assigned to the network and the resultant link volumes are obtained. All-or-nothing and incremental assignment (using increments of 0.4, 0.3, 0.2, and 0.1) are used and the link volumes are as given in Table 4. The results obtained using the two assignment techniques differ for alternate routes to Site B from the Interstate.

Step 4: If intersection capacities are ignored, Links 9-1, 9-2, 8-3, 4-7, 7-10, and 9-10 are overcapacity and require additional capacity. Proposed improvements and estimated costs are given in Table 5.

3. None of the links that require improvement are site accesses, so this task may be skipped. Links 5-10 and 6-11 are site accesses, but they are not overcapacity.

4. Table 5 gives the proportion of each developer's traffic on each of the links found using incremental assignment. Costs are allocated according to these values using the uniform removal method and incremental assignment. The allocated costs for Developer A are also given in Table 5. Remaining costs are allocated to Developer B. Column I represents allocated costs using the uniform removal method. They are the proportion of additional traffic that belongs to Site A and uses the improvement times the estimated cost. For example, for Link 9-1, 5/13

TABLE 2 TRIP GENERATION (afternoon peak)

	Traffic Volume	
	In[a]	Out[b]
Site 5 (500,000 ft^2)	197	930
Site 6 (800,000 ft^2)	312	1,488

[a]Generation rate per 1,000 ft^2 = 0.39.
[b]Generation rate per 1,000 ft^2 = 1.86.

TABLE 3 TRIP DISTRIBUTION

From	To 1	2	3	4	5	6	Total
1		300	1,200	500	100	160	2,260
2	200		200	300	25	40	765
3	2,800	100		300	40	80	3,320
4	700	1,100	100		2	32	1,964
5	500	90	250	90			930
6	800	160	400	128			1,488
Total	5,000	1,750	2,150	1,318	197	312	

of the costs are allocated to Developer A. Columns II and III represent allocated costs using incremental assignment. For Column II, Development A's traffic is added to the existing traffic first, and, for Column III, Development B's is added first. For example, for Link 9-1, Developer A's traffic alone puts the link overcapacity; therefore Developer A pays the full cost of improvement. If Development B's traffic is added first, Developer B pays the full cost of the improvement. In cases in which only one direction requires improvements, costs are allocated accordingly, but in practice improvements would usually be made in both directions.

5 and 6. Costs allocated to Developer A are $1,859 and those allocated to Developer B are $5,291 using uniform removal. In this example incremental allocation was also used to determine the costs allocated to Developers A and B to demonstrate the differences among the allocation methods and the effect of different orderings on incremental allocations. Allocated costs using incremental allocation with Site A developed first are $3,850 and $3,300 for Developers A and B, respectively. If Site B is developed first, the developers' costs are $300 and $6,850, respectively. These results demonstrate that different allocation methods result in quite different costs to developers.

An incremental method was used to determine how much of the traffic increase on each link should be attributed to each developer. It should be pointed out that there are two different incremental methods for attributing traffic to two different developers. One would be to add Developer A's trips to the base trip table and assign the volumes to the network, then assign the total trip table (including trips from both developers). Developer A would be assigned the traffic increase in the first assignment over the base assignment, and Developer B would be assigned the difference between the total development assignment and the assignment including base plus Developer A's trips. A second way of attributing traffic would be to apply the same procedure reversing the order of the developers—adding Developer B's trips to the base table first.

A different amount of traffic on a link could be attributed to each developer under each of the two orderings using the incremental allocation method because of the nature of equi-

TABLE 4 LINK VOLUMES

Link	Existing	Volume with Proposed Developments (all-or-nothing)	Incremental	One-Way Capacity (from Table 1)
1-9	2,000	2,260	2,260	4,000
	3,700	5,000	5,000	
2-9	700	765	766	1,700
	1,500	1,750	1,750	
3-8	3,200	3,320	3,320	4,000
	1,500	2,150	2,150	
4-7	1,900	1,968	1,968	1,900
	1,100	1,318	1,318	
5-10	0	930	930	1,700
	0	195	195	
6-11	0	1,488	1,488	1,700
	0	316	316	
7-10	1,800	2,792	2,696	1,900
	800	1,090	1,090	
7-11	100	336	336	1,400
	300	1,388	1,292	
8-9	2,900	2,940	3,036	4,000
	1,400	1,650	1,650	
8-11	300	380	380	1,700
	100	500	596	
9-10	800	1,165	1,166	1,900
	1,800	3,600	3.504	

TABLE 5 ALLOCATION OF COSTS

Link	Improvement	Estimated Cost ($000s)	Traffic Volumes for		Cost Allocated to Developer A[a] ($000s)		
			Developer A	Developer B	I	II	III
9-1	Additional lane	2,400	500	800	925	2,400	0
4-7	Widen lane and shoulder	550	32	32	275	550	0
9-2	Widen lane and shoulder	300	90	160	108	0	300
7-10	Additional lane	3,000	32	864	107	0	0
10-9	Additional lane	900	840	864	444	900	0
Total		7,150			1,859	3,850	300

[a]I = uniform removal, II = incremental assignment with Developer A's traffic first, and III = incremental assignment with Developer B's traffic first.

librium (or incremental capacity restraint) assignment. This result occurs because as traffic increases on a network link, travel time increases. Thus trips loaded subsequently onto the network are less likely to use the link. The differing capacities of the various links cause different sensitivities to volume increases. The proportion of Developer A's trips that might use the link if Developer B's trips were loaded first is different from the proportion of Developer A's trips that might use the link if Developer A's trips were loaded first.

Other ways of attributing traffic can also be used. These include averaging the results of the two incremental method orderings and allocating the total development traffic (difference between the assignments of the total and base trip tables) proportionally to the trips generated by each development. The former method involves increasingly more computation as the number of developments grows. The number of different possible orderings of developments equals the factorial of the number of developments under consideration.

The simplicity of the network used in the example resulted in assignments that were identical under both possible orders of development when incremental traffic allocations were used. Thus the assignment results from any of the methods mentioned would yield the same apportionments of traffic between the two developers. The impact fee assessments obtained using any of the allocation methods are therefore, in this case, unique to the method. Further research is currently being done to determine an assignment method that is independent of the ordering of the developments in more realistic networks. Such a method would conform to the objective of consistency in the assessment of impact fees.

This illustration demonstrates a rational approach to determining impact fees using the uniform removal method. The impact fees cover costs and are consistent among developers.

CRITIQUE OF COST ALLOCATION METHODS

The example demonstrates some of the problems with the cost allocation approach. Problems include the dynamic nature of development and its relationship to the economies of scale that are inherent in roadway improvement and the practice of ignoring user costs in assessing impact fees.

There are significant unresolved technical problems with these analytical techniques:

- It is assumed that existing demand does not vary with the improved facility; therefore induced demand and changes in user costs and their effects on level of service are ignored.
- These techniques represent a snapshot or static view of development. Although they may account for future development, they do not account for the staging of projects and the time value of money. This problem is exacerbated by the desire of local governments to capture economies of scale and construct projects larger than required to accommodate future development without doing any economic analysis to justify the project.
- There is an ill-defined relationship between investment planning principles and the size and nature of the required improvement. Improvements are implemented to ensure a minimum level of service for users. The allocation process does not evaluate the cost-effectiveness of achieving this objective. It may be that greater net social benefit, assuming the project is economically feasible, may be attained by implementing a smaller or a larger project.
- User costs are ignored. The allocation process includes improvement cost, but reduced or increased levels of service for existing users are not accounted for.
- These methods depend on uncertain estimates of traffic volume and improvement costs and identification of the origin and destination of traffic that will use an improvement. This can lead to "double counting" of traffic if there are significant traffic volumes from one site to another or diversions from existing traffic patterns.

The issues involved in determining road user fees and impact fees are equity, economic efficiency, consistency, and the need to cover costs. In this paper the uniform removal technique was used to demonstrate the use of highway cost allocation methods to assess impact fees in a way that ensures that such fees are unique and consistent.

Practical problems with the application of these techniques include determining the traffic that will use the improvement to go to and from the developer's site. However, this type of analysis and empirical evidence indicate that it is possible to develop a rational technique for determining impact fees.

REFERENCES

1. R. Knack. How Impact Fees Are Working in Broward County. *Planning*, Vol. 6, No. 50, June 1984.
2. O. D. Palomino. *Impact Fees: Making Development Pay Its Way*. Undergraduate thesis. Princeton University, Princeton, N.J., 1985.
3. C. Henderickson, M. Whol, and S. McNeil. *Economic Issues Inherent in the Allocation of Roadway Costs*. FHWA, U.S. Department of Transportation, 1981.

4. C. Hendrickson and M. Wohl. Efficient Prices for Roadways and Transit Service. *Transportation Quarterly*, July 1982.
5. R. J. Vaughan. *Rebuilding America: Financing Public Works in the 1980's*. The Council of State Planning, Washington, D.C., Vol. 1, 1984.
6. *Boston's Prospective Development and the Linkage to Housing Needs*. Boston Redevelopment Authority, Boston, Mass., Oct. 1983.
7. Judge Rules Boston Linkage Plan Is Invalid. *Boston Globe*, April 5, 1986.
8. *Trip Generation*. Institute of Transportation Engineers, Washington, D.C., 1984.
9. *Final Report on the Federal Highway Cost Allocation Study: Report to Congress*. FHWA, U.S. Department of Transportation, Technical Report, May 1982.
10. C. Hendrickson and A. Kane. Cost Allocation by Uniform Traffic Removal—Theoretical Discussion and Example Highway Cost Applications. *Transportation Research*, Vol. 4, No. 17B, 1983.
11. *TRIPS Traffic Review and Impact Planning System Summary Description*. Broward County Office of Planning, Broward County, Fla., Sept. 1983.
12. J. Frank. How Impact Fees are Working in Broward County, The Computer Model. *Planning*, Vol. 6, No. 50, June 1984.
13. H. Stewart. How Impact Fees are Working in Broward County, The Legal Path. *Planning*, Vol. 6, No. 50, June 1984.
14. P. R. Stopher and A. H. Meyburg. *Urban Transportation Modeling and Planning*. Lexington Books, Lexington, Mass., 1975.
15. *Special Report 209: Highway Capacity Manual*. TRB, National Research Council, Washington, D.C., 1985.
16. D. B. Lee. Recent Advances in Highway Cost Allocation Analysis. In *Transportation Research Record 791*, TRB, National Research Council, Washington, D.C., 1981, pp. 1–5.
17. *Motor Vehicle Cost Responsibility Study*. Oregon Department of Transportation, Salem, 1975.
18. C. Hendrickson and S. McNeil. An Illustration of Allocated Costs for Turnpike Toll Design. *Transportation Quarterly*, No. 38, Oct. 1984, pp. 575–597.
19. A. Villarreal-Cavazos and A. Garcia-Diaz. Development and Application of New Highway Cost-Allocation Procedures. In *Transportation Research Record 1009*, TRB, National Research Council, Washington, D.C., 1985, pp. 34–41.
20. R. J. Aumann and L. S. Shapley. *Values of Non Atomic Games*. Princeton University Press, Princeton, N.J., 1974.
21. L. J. Billera and D. C. Heath. Allocation of Shared Costs: A Set of Axioms that Yield a Unique Procedure. *Mathematics of Operations Research*, Vol. 7, No. 1, 1982, pp. 32–39.
22. Y. Sheffi. *Urban Transportation Networks*. Prentice-Hall, Inc., Englewood Cliffs, N.J., 1985.
23. *MINUTP Technical User Manual*. COMSIS Corporation, Mountain View, La., Nov. 1983.
24. *MicroTRIPS User's Manual, Version 4*. PRC Engineering, McLean, Va., Feb. 1985.

Economic Arguments on Tool Roads

FRIDA JOHANSEN

From the economic point of view, tolling is an instrument that can be uniquely suited to the collection of efficient road use prices. Because they affect resource allocation, toll rate levels need to be considered when decisions are made about the appropriateness of a toll scheme. It is argued that tolling (at rates above marginal costs) is equitable—those who benefit should pay—but beneficiaries may not pay in full or at all if they are not users of the toll road. Nevertheless, tolls are generally imposed for the purpose of raising additional net revenue, and they appear to be a suitable instrument if the object is revenue earmarking or private financing and management of roads. However, investment lumpiness and increasing returns make roads a commercially viable enterprise only occasionally. Means other than explicit tolls may be better for attracting private intervention. High associated costs are a disadvantage of tolling; in some cases the cost of distortions introduced by tolling may make incompatible the objectives of revenue generation and efficient resource allocation. It is important to ensure that effects on the economy at large, not only on the toll agency, are included in toll road analysis. This is not generally done and is the reason for this paper. There are, however, a number of conditions under which tolling may be appropriate (i.e., not worsen resource allocation or even improve it over untolled roads despite higher costs inevitably entailed in tolling with current technologies). Examples of results from tolling in two developing countries are provided. In this paper only tolling of interurban roads in discussed.

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Toll roads are generally equated with high-standard roads, and nontoll roads with low-standard roads. Most analyses are limited to cash-flow considerations of the agency in charge. Such analyses, which may be appropriate for the toll agency, leave out economic costs to society at large. Such costs may be important enough to change the outcome of the analysis and the

resultant recommendations. Thus toll roads may not be the best option for increased funding of the road sector.

In this paper are reviewed the objective and major issues of tolling: road use pricing, additional revenue, high collection costs, earmarking and decentralization, and equity. The quite different effects of tolling in two developing countries are also reviewed.

ECONOMIC ARGUMENTS

Objects of Tolling

Tolls are generally imposed for the purpose of raising additional net revenue. As a revenue-raising device, they appear to have equity in their favor: the user pays. In addition, tolling allows the revenue streams from roads or from particular roads to be segregated. Tolls therefore appear to be suitable instruments if the object is revenue earmarking or private financing and management of roads. It is, however, as an instrument of efficient pricing of road use that tolls appear to possess unique advantages that are of importance in relation to rational resource allocation. Any particular tolling scheme may have a variety of objectives, and when a proposal to toll is examined, two questions need to be answered: First, to what extent will tolls achieve a given objective, ignoring all others? Second, are the different objectives mutually compatible and, if not, what is the cost of pursuing one in terms of the others?

Major Issues

Road Use Pricing

A main argument for tolls is that they could allocate road users between tolled and untolled roads so as to ration available road space to users for whom it has the highest value. Toll rates may be varied flexibly (even discontinued) according to hour and day of the week to reflect varying cost conditions, such as congestion, as accurately as they can be evaluated so that road use cost is recovered without cross subsidizations. Where there are alternative roads, tolling of one may achieve service level differentiation on both; differentiation is the more desirable the more heterogeneous the traffic mix (i.e., relegate congesting, slow, or nonmotorized traffic to one road and allow motorized traffic to circulate at higher, free-flow speeds on the other; or separate local and long-distance traffic). Tolling also enhances users' awareness of costs and provides a direct link between the cost and the benefit of the trip. If tolling raises efficiency or improves resource allocation, the extra cost of collecting tolls may be fully justified.

These advantages operate within limits. Practical considerations reduce the potential flexibility of toll rates. Tolling hitherto untolled roads may be politically unacceptable, and toll evasion reduces the potential pricing effect. Service level differentiation could also be achieved without tolling. In some instances, the provision of additional road capacity may be a better way of reducing congestion than is reduction of demand; this depends on the costs of expansion and the benefits from additional trips or trips that tolls would discourage.

Another major limitation is that there is no economic justification for tolling uncongested roads to capture marginal use costs. General road user charges can be made to do that at a lower cost. If there is a fiscal justification for charging users of uncongested roads more than marginal costs, this can be achieved as well, if not better, by general road user charges.

Additional Revenue

The primary fiscal objective of tolling schemes is to raise revenue over and above the yield of general road user charges (e.g., fuel taxes). Rates set to cover social marginal cost when there are externalities will have a yield greater than current expenditure on the tolled road. If tolling causes traffic diversion to untolled roads, the cost of maintaining those will rise so that the final outcome is uncertain. The situation changes when traffic volumes are such as to lead to some congestion on all substitute roads because congestion on the untolled alternative roads sets a limit to traffic diversion from the tolled roads. It is then possible to raise additional net revenue through toll rates equal to social marginal cost. Tolls may be raised even higher but with the consequence of a distortion—some desirable traffic is suppressed. The question is then whether tolls are a lower-cost means of raising general revenue than are other taxes. It is known that raising public revenue has a high cost. The stage may have been reached at which public investments with potential returns higher than overall opportunity costs cannot materialize because raising the rate of a tax would no longer increase its yield or because a ceiling on the public debt constrains borrowing. Income taxes may be administratively too costly, or evaded, in developing countries. In such cases, tolling above marginal costs may improve the efficiency of overall resource allocation despite its costs.

The target revenue from tolls is frequently taken as the full cost of the roads including construction and financing. In few cases have toll revenues reached that level, in spite of high traffic levels. Negative cash flows for (sometimes long) initial periods entail refinancing costs, and some toll operations could not break even even if repayment periods were extended. Tolls do add to revenues from road users at large, but only marginally. In developing countries generally, lower traffic levels may not pay enough to cover the fixed, minimum cost of even simple toll collection systems. Some 5,000 vehicles per day would appear to be the minimum required to yield a net revenue from tolling.

High Collection Cost

A major argument against tolls is that other road user charges can raise the same revenue with lower collection costs: raising the rate of an existing tax entails no extra collection cost. There already exist electronic technologies that can reduce collection costs on high traffic roads and thus do away with a main drawback of tolling. Traffic levels, however, are normally not high in developing countries, and it will take a long time before such technologies can be widely applied in those countries. In the meantime, manual methods would have to be used; manual methods have relatively low direct costs but also potentially high indirect costs on account of revenue diversion. Collection also imposes on users the cost of delays and vehicle operation in the stop-go cycles at barriers.

Experience with high-traffic-volume toll roads (expressways with controlled access) in member nations of the Organization for Economic Cooperation and Development indicates that, on average, road construction costs increase from 10 to 15 percent on account of toll-related facilities; collection and other ad hoc toll road operation costs are about equal to road maintenance costs, and collection costs absorb some 10 to 15 percent of toll revenues. This can be compared with collection costs of some 14 percent of general tax revenues in the United States. In developing countries with lower traffic volumes, experience with two-lane toll roads is more varied. Additional costs are relatively low, but revenue diversion can be extensive. Collection cum revenue diversion costs have been observed to vary between 7 and more than 50 percent. On the other hand, it is not clear whether the overall economic distortion from tolling is costlier than that arising from general taxation; an additional U.S. $1 revenue from taxes has been estimated to result in a welfare loss of up to U.S. $0.33 in the United States.

Earmarking and Decentralization

Toll revenues can be fully or partly earmarked; this may permit private management and financing of roads (construction, maintenance). Such revenues may alternatively accrue to the general treasury. In practice, toll revenues in most developed countries have been insufficient to fully recover road costs because of investment lumpiness and long initial periods of negative cash flows and consequent refinancing charges. For private interest in a concession to materialize, a sizable government equity contribution is needed as well as guarantees against revenue falling short of projections. Even so, private financing costs more than general government borrowing or bonds because of the higher risks involved. Public-private joint ventures could reduce the need for public funds. Developing countries should expect difficulties in attracting private risk capital for road construction against toll revenue promises, given the generally low traffic levels that do not justify tolling and more general questions of creditworthiness.

Toll revenues can be earmarked for the agency in charge of the road network. This still allows private intervention under contract, not by way of toll concessions, and may lead to improved maintenance of tolled roads. However, it may also lead to less maintenance on untolled roads and, more generally, to a misallocation of resources if revenues exceed justified road maintenance budget levels. This pitfall can be avoided if revenues above a certain level accrue to state or general treasuries and are not earmarked for road activities, as is done in Mexico.

Equity

Tolling appears to be equitable inasmuch as "the user pays." However, it may be inequitable when only some roads are tolled (especially if substitute roads are not tolled) and even when all roads are tolled, if rates exceed marginal costs. The toll collection system itself and the location of toll collection booths have an effect on equity (e.g., the rate can be a fixed amount or reflect distance traveled, can equal marginal cost or exceed it, can represent discriminatory pricing, or can be collected from all or only some users). In developing countries slow-moving vehicles such as bicycles and animal-pulled carts that circulate on untolled roads cause a higher than average road use cost by creating congestion but may not pay even the average road use cost.

Whether tolling can achieve equity in the sense of income redistribution is debatable and has not been proven. The lowest income road users may suppress trips if cost increases on both the tolled and the untolled roads; high-income users may have a net benefit even when paying the toll if this saves them time. The distributional effect of what revenues are spent on may be more important than the incidence of the toll: more roads that will also require contributions from general revenues but mainly benefit the rich or social schemes.

Balance of Considerations

Tolling is neither good nor bad per se: Its desirability depends on how prices (toll rates) are set and on what allocation objectives are accepted. Its desirability also depends on how the cost of raising revenue through tolls compares with the cost of raising revenue by other means and with the loss of benefits attributable to not having additional revenue. The cost of raising revenue through tolls, in turn, depends on the network configuration and traffic levels (are there substitute roads? are other roads tolled? is it desirable to provide service level differentiation?), which determine costs or benefits of traffic diversion; on collection costs; on the cost of initial investment and operation and whether provision is made for alternate roads for local traffic when access to the tolled road is restricted; and on the cost of potential toll revenue diversion.

The various objects of tolling would not conflict, and tolling may therefore be appropriate, when

- Toll rates are equal to social marginal cost (marginal use cost plus cost of externalities) or when they are "what the traffic will bear" short of diverting;
- Tolls are levied on *(a)* facilities with less than free-flow conditions and reduction, redistribution, or reallocation of traffic to another mode is sought (i.e., where road supply is not fully elastic) or *(b)* facilities with captive traffic and traffic levels high enough to justify collection costs (i.e., where demand is relatively inelastic because of absence of substitute roads); and
- Toll revenue surpluses, if any, after road operation costs and load amortization are covered, accrue to the general treasury (i.e., revenues are not, or only partly, earmarked).

However, equity is not preserved.

In other situations the main objectives of tolling may conflict. If there is a net revenue objective, the least-cost toll system that can achieve the revenue objective should be ascertained. This system may be adopted if it improves resource allocation [i.e., if its costs are lower than *(a)* costs of alternative means to raise the same revenue and *(b)* the cost of benefits that would not materialize in the absence of the revenue]. Equity considerations may affect the decision. It is also possible that no toll system can meet the objective, either because traffic

levels are too low or because raising toll rates may not increase revenues.

New roads should be constructed to common design standards according to their priority in the overall public program. Priority should be determined on the basis of economic cost-benefit and least-cost analyses and intermodal, safety, and regional objectives. Whether or not to toll the road may be analyzed thereafter; the expectation of toll revenues may advance construction of a lower priority road and, if this is so, it is particularly important that prospective costs and revenue estimates be realistic because other, higher priority roads may be deferred.

Government road agencies can operate toll roads directly or through contractors. If concessions including construction and financing of a new road are to be established, governments should take responsibility for their development and operation to ensure a cost-effective, integrated system of highways. The terms and conditions must be set out and controlled by the state according to the general design, minimum maintenance standards, and other rules applicable to all roads. Concessions should only be awarded if they are viable without government guarantees that eliminate all risks to concessionaires; government equity will probably be needed.

Against this background, tolling should be viewed as a limited means of raising net revenues. Where traffic levels are low in general, general road user charges can better capture average road use costs from all users. Only roads with some degree of congestion may be worthwhile analyzing to ascertain whether tolling may be a preferred option. The possibilities for economically "successfully" tolling interurban roads will be relatively few.

EXAMPLES FROM DEVELOPING COUNTRIES

In one developing country, toll collection is probably as efficient as it can be: charged in one direction only, collection costs are reported to average about 7 percent of revenues, although there are wide variations among road sections because of variations in traffic levels. The open toll system adopted results in higher charges for those traveling shorter distances, but it implies few other economic costs or distortions given the lack of alternative routes and thus little traffic diversion because of tolling. The same government agency responsible for roads at large is in charge of toll operations. Tolls are not related to road construction but are seen as a user charge; however, fuel charges and licence fees would be better means for recovering average costs from all users.

In another country, with many alternative routes, tolling of one of them is not efficient. The country has a well-developed system of free federal and state roads. There has been a fast growth of traffic generally and on the Federal Route 1, where an additional 782 km of new expressway was to be provided. The cost would have been high and it was decided to operate the expressway as a toll road in the hope that this would bring in additional resources, permit a faster pace of construction, raise public awareness of the cost of infrastructure, and assure equity by making the beneficiaries of this new high-quality road pay for the privilege.

The highway authority was created in 1980 as the toll authority. Although this was an autonomous agency under the ministry of works, it could not set toll rates or invest without ministerial approval. The income from grants, toll revenues, and other earnings and borrowing was expected to pay for operating expenses and loan service. The government was neither to guarantee repayment of borrowings by the authority nor to fund its operations. The government transferred to the authority an expressway section, ongoing works on a number of other sections, and related commercial loans; but it did not endow it with other capital funds. The authority was staffed with personnel seconded from other government agencies and relied heavily on private consultants and contractors.

Until 1985 only two sections were operated as open toll roads. These sections, 84 km long, were ready and in use before tolls were imposed. Some 36 km of the length to be built had been completed, 234 km were in various stages of construction, and studies on the remainder were ready or under way. Loans of some $2 billion were obtained, mainly from foreign banks. The authority as a whole had a negative cash flow, which should worsen when loan repayments start. Toll levels with the existing volume of traffic would have to be quadrupled to meet the financial obligations. Any increase of that order, however, would divert most traffic and be politically unacceptable. The financial autonomy of the authority appears to be no greater than that of the ministry of works. Its creation had no visible effect on the rate of construction, and it is not obvious what advantage was gained by creating it rather than leaving the ministry of works in full charge of the federal road network.

The prospect of toll revenues did not mobilize additional resources for road construction. No private company was found to accept the risk of recovering an investment through tolls. Government guarantees were necessary to borrow for road construction. The cost of borrowing was not affected by the prospect of toll revenues; the amount of borrowing for a particular road program was not affected either; tolls only accrue after construction is paid for, and accumulated revenues from existing toll roads are relatively insignificant and would be no different from general revenues. Expected toll revenues from a new road would not cover the interest on the capital (let alone amortize it); yet the capital cost increases by at least 10 percent on account of tolling installations, and this diverts resources from other potential projects. The pace of road construction was not affected; overall budgetary constraints prevailed, as they do in any other public investment program.

The effects of tolling the expressway section have been analyzed. This section is part of a corridor that is also served by Federal Route 1, state roads, and the railway. Omitting the latter, total traffic in the corridor in 1983 was 67,000 vehicles per day (vpd) near the northern end (24,000 on the expressway) and 29,000 vpd near the southern end (15,000 on the expressway). This traffic consisted mainly of commuters and, on weekends, beach-related traffic. Before the 63 km of expressway were opened to traffic in 1977, the only direct link between the two centers was Federal Route 1, which was approximately the same length as the expressway but was built to a lower standard. Access to the expressway is limited and, since June 1982, it has been operated as an open toll facility with two toll plazas. Nearby state roads running almost parallel to the expressway permit vehicles to bypass the toll plazas but still

use the rest of the expressway, at the cost of travel over a longer distance and on roads of lower standard.

Motorcycles pay no toll; commerical vehicles up to medium size pay twice the passenger car rate; and heavy trucks pay three times that rate. The northern plaza charges one-half the rates charged at the southern plaza. If the full length of the expressway is used, the average toll per car-kilometer is less than 10 percent of related vehicle-operating expenses including other road user taxes but excluding the value of time. Even such low rates appear to have had a considerable impact on route choice. Before tolling, the expressway had consistently higher traffic growth than the alternate federal route; after tolling, the proportion of traffic that used the expressway declined. On the basis of conservative assumptions, it is estimated that 14 percent of the expressway traffic deviated at the northern plaza and some 12 percent at the southern. This diverted traffic consisted of only some 5 percent of long-distance traffic but a higher proportion of local traffic. It may be concluded that road users are sensitive to price variations and that car users are particularly sensitive to time savings.

Conservative estimates of the effects of tolls on road users, the government, and the economy at large can be summarized as follows:

- Government increased its net revenues from road users by $10 million (only 0.5 percent) at a cost to the economy of $5 million in real resources. Collection costs amounted to some $2.6 million, 20 percent of gross revenues from tolls.
- The administrative cost in the form of collection costs added between 33 and 100 percent to road use cost, depending on vehicle type. Also considered should be the cost of the separate public administration that was set up to carry out functions that could have been carried out by the existing ministry of works.
- Toll revenues are earmarked, but with the current low toll revenues earmarking makes little difference. This will become more important as more road sections are tolled and if overall budgetary constraints prevail.

The "equity" argument—those who benefit should pay—is not supported by the effects of tolling. Taxes on road users are high and cover both maintenance and construction costs of roads, and tolls represent a further taxation. The toll structure that was adopted lessens income tax progressivity; the structure becomes more "equitable," in the sense that the tax incidence on different vehicle types is more similar, but the level becomes more "inequitable." Tolls add between 33 and 100 percent to existing taxes on road users, depending on vehicle type. The same tax revenue could have been obtained by increasing existing taxes on all road users by 0.5 percent (i.e., the share current toll revenues are of total revenues). Such a measure would also imply a larger payment by those vehicles that pay no toll but benefit indirectly from a good expressway that lowers congestion on alternate roads. However, it would also make vehicles elsewhere pay more, for no benefit. An increase, if any is needed, would be more equitable if raised by local taxes. Only when electronic tolling becomes available at low costs can tolling become the best possible means to recover from each road user the "exact" cost of the roads and externalities corresponding to the form and time of use.

Public awareness of the cost of public infrastructure increased as intended, but public willingness to pay did not. Most people recognized that it was "fair" for those who use a faster road to pay a premium. Nevertheless, traffic diversion indicates resistance to paying. Only those who perceive that paying the toll is cheaper than deviating stay on the tolled facility.

In this experience, tolling has a high economic cost. Half of every dollar of net revenue from tolling is conservatively estimated to be lost in uneconomic uses. One-half of this cost is the cost of toll collection. The remainder is the higher transport cost incurred by people who deviate from the expressway when a toll is levied because the toll exceeds the perceived value of the extra operating cost and the extra time associated with traveling on alternative roads. Road users are sensitive to price increases but indifferent to whether the increase is due to a pure financial transfer (toll) or to a higher use of resources (vehicle-operating costs on poorer alternate roads and time). They will try to minimize the perceived cost increase. The perception of cost may not be accurate and may lead to choosing a more costly alternative. Current toll levels are low, but it is not certain that an increase in toll rates would improve the revenue-to-economic cost ratio. Traffic diversion would also increase, as would total uneconomic costs. Tolling (of uncongested roads) generates least economic costs where alternative roads are not available or are also tolled.

When general resources were used for toll facilities, the end result may have been to curtail, rather than increase, economic investments. The standards adopted for the expressway, particularly in providing limited access and grade intersections, would probably have been lower on a "free" road. The needed pavement rehabilitation of the section, on the other hand, might have been deferred had it not been for the tolling argument.

More data and analyses are needed for a full assessment of the economic impact of tolling, but, even in the absence of fuller information, the chief results of tolling in this case are clear. By and large, the tolling policy did not achieve its objectives: the premium for attaining these objectives is nevertheless being paid in high economic and administrative costs. The government is currently reviewing the organization of the highway authority.

Key Features of Privatization Financing

LAWRENCE D. SHUBNELL

This paper is a brief outline of the types of projects that are good candidates for privatization, the essential cost components and savings potential of privatized projects, and the essential elements of a structure for financing privatized projects.

The types of projects that are the best candidates for privatization are

- Projects that lend themselves to the provision of services, are operationally oriented, and require manpower and equipment. It is most desirable to have both management and operation under the control of a private party through a service contract. It is also helpful if the facility can serve multiple users and is equipment intensive.
- Projects that require new construction are better candidates because they are unencumbered by existing public asset transfers or leases that may taint the privatization contract. It is also easier to package performance guarantees, personnel, and ownership.
- Projects with track record technology are easier to finance, as are projects whose essentiality of service is unmistakable. In some cases in which new technology is involved, privatization may be easier to implement because the private party may be party to the development of the technology and offer complete performance guarantees.

ESSENTIAL COST COMPONENTS AND SAVINGS POTENTIAL

The principal savings in a privatization result from the equity contribution. The amount of equity will usually range between 20 and 30 percent of the fully capitalized cost. The equity participants receive their compensation from the tax benefits (savings in federal income taxes) and from cash flows that result from project operation. The savings in financing cost alone resulting from private participation may approximate 10 percent of the annual debt service payment that would otherwise be required. Additional savings may be realized through lower construction and operating cost (resulting collectively from lower labor cost, faster procurement timetable, value engineering, vendor buy-ins, and economic incentives).

Although there may be reasons other than savings to enter a privatization (such as avoiding the incurrence of direct debt or avoiding seeking voter approval at referendum), savings will be an important aspect of the decision. In this regard, the governmental entity should determine the overall acceptable level of savings that must be realized in order to justify entering the transaction. Experience indicates that savings in the range of from 5 to 20 percent are acceptable and expected by most governments, depending on the sharing of project risks and the presence of other considerations (such as the desirability of obtaining "off-line" project implementation). In measuring the materiality of savings the technique of calculation ought to be agreed on in advance, understood, and benchmarked for calculation by all parties to the transaction. A preferred technique is the discounted–cash flow method whereby the present value of the stream of payments under the privatization agreement is measured against payments under conventional government borrowing. The bottom line to calculating savings is comparing the life-cycle cost of a project under the privatized and nonprivatized scenarios and determining if the savings are "worth it" in terms of contract procurement and negotiations, risk sharing, and the buy-out features of the service contract.

There are certain threshold costs that must be dealt with during the earliest stages of a privatization. If not adequately accommodated, these costs could obviate any savings that might otherwise be realized. More particularly, private-sector owners of tangible personal property and real estate are subject to governmental fees, levies, and taxes that might not be incurred as a cost under public ownership. If the private project cannot bear the cost of these charges and still demonstrate a savings, the project may be financially unfeasible, particularly in instances in which the public charges are interjurisdictional in nature and therefore become tantamount to intergovernmental transfers. Likewise, insurance coverage may be required for such risks as business interruption and catastrophic loss; these costs add to the cost of a privatization project in a direct way whereas they would be "hidden" if the project were publicly owned. Finally, if entering a privatization means that federal or state grants are lost, these lost revenues must be accounted for in the measurement of savings.

ESSENTIAL ELEMENTS OF FINANCING STRUCTURE

An important objective in structuring a privatization transaction is attaining a security structure that supports a credit-quality bond rating. It is most desirable to seek a credit level that is as near as possible to that which the service recipient (government) enjoys. To accomplish this, the following criteria are important credit concerns:

- The service being provided should be essential public service that is basically nondiscretionary in nature.
- There must be a pledge of project revenues and assets to the bond trustee in order to establish the bondholders' lien on these sources of repayment. In some cases the flow-of-funds may be through the trustee.
- Although the actual appropriation of funds may occur through an annual budgetary process, the enforceability of the

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monies due under the service contract ought to be incumbent on the appropriating entity.

- Legal opinions must be rendered on the enforceability and assignment of all contracts; such opinions should cover bondholder and trustee rights in bankruptcy.
- Force majeure (uncontrollable circumstances such as changes in laws) events must be resolved as to risk in favor of the bondholders.
- The private partnership or entity engaged in the transaction with the public sector should be limited in purpose to the scope of the transaction.
- The contracting public agency must enter an agreement guaranteeing the payment of a fee for a service; service fees should be payable without set-aside or offset.
- The obligation to pay fees begins when the facility has passed acceptance tests; therefore, debt service on any issued bonds must be provided for until acceptance tests are met.
- The contracting private party must agree to provide the service and to guarantee such, save force majeure; liquidating damages at least equal to the amount required for debt service must be available for any interruption of service.
- Methods of providing for facility expansion or modification should be provided for in advance; provisions governing additional indebtedness must set certain affordability tests.
- Construction will be for a fixed price with completion on a date certain. Payment and performance bonds must back up construction guarantees, including liquidated damages covering debt service.
- Partnerships making guarantees must have substance to back up obligations and commitments. Partnership structure and right of substitution are important.

Public-Private Involvement in the Development of Roadways and Interchanges in Colorado

JOSEPH F. DOLAN

This paper is a history of private-sector involvement in the provision of roadways in Colorado. Major early developments are sketched to provide background for what has occurred since 1975. Financial and political problems associated with unmet present demand, land use planning for future growth and development, and quality-of-life issues are discussed. Three ways in which the private sector is involved in the provision of roadways are described: *(a)* private contributions to finance interchanges, *(b)* governmental associations to provide major transportation improvements, and *(c)* involvement of private interests with local governments to build major highways without the participation of state or federal government.

In 1821 William Becknell, a Missouri businessman who wished to further his trade with Mexican soldiers in what is now New Mexico, forged the first road through Colorado—the Santa Fe Trail. Forty years later a fur trapper built a shortcut on this same route over Raton Pass in southeastern Colorado, set up a booth, and established Colorado's first toll road: a dollar a wagon, funerals and Indians free.

One of Colorado's earliest and greatest state legislators, Otto Mears, made his fortune the same way, building and operating toll roads throughout the state. In all, he owned 383 mi of tolled "wagon roads," including the Million Dollar Highway between Ouray and Silverton, so named because supposedly a million dollars' worth of gold was discovered in the gravel used to surface the road.

As the free enterprise system crisscrossed Colorado with roads, other visionaries saw a dollar to be made in Denver transportation. Five full years before Colorado attained statehood in 1876, Denver had fixed-guideway transit: horse-drawn cars on 2 mi of track. By 1886, Denver was the second city in the world to have electric-powered streetcars; and by the 1890s, eight different companies were plying 156 mi of city lines with cable cars, streetcars, and trolleys.

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Stiff competition among these lines spurred the first major instance of public-private cooperation in Denver's history. One of the tram companies shared with the city the cost of building the 16th Street and Larimer Street viaducts in order to provide easier access for its streetcars over the Platte River into downtown Denver.

Government Takes Over Transportation

As was the case in many states, private enterprise built the majority of Colorado's early transportation systems. Private involvement in providing highways, however, did not last long. As a booming Colorado went careening into the 20th century, government stepped in to take over the task of integrating, connecting, and financing roads. By the middle of the century, the automobile had sufficiently enticed most riders away from transit companies, so privately run transportation was no longer a going concern. In just a few decades, both highways and mass transit had become the exclusive purview of the public sector.

There are a number of cogent reasons why the 1980s should witness a rebirth of private-sector involvement in providing transportation. Part of this renaissance is surely due to the Reagan administration's view that, whatever government can do (or cannot do), the private sector can do better.

However, the growing trend of private enterprise reentering the transportation business is mostly a matter of money: government at all levels can no longer afford to finance all needed transportation improvements.

The power of the Organization of Petroleum Exporting Countries in the 1970s, double-digit inflation, deferred maintenance, the design life of bridges and roads, more fuel-efficient automobiles, and government regulations that place government at a competitive disadvantage all have contributed to an inability of government to supply enough transportation improvements to meet the increasing need.

In Colorado, and in the Denver area in particular, unplanned and unchecked suburban growth probably is as responsible as any other factor for creating unmet transportation demands. That this monstrous growth should now rear its head is, of course, no surprise to urban observers, who long ago sounded the alarm over the implications of metropolitan development. Indeed, Colorado's present Governor, Richard D. Lamm, was elected in 1974 as a candidate who warned of the dangers of urban sprawl and the need to promote slower growth and preservation of Colorado's natural resources and beauty.

Soon after taking office in 1975, Governor Lamm tried to convert his campaign philosophy into state policy. Candidate Lamm was sure that highways were the chief cause of urban sprawl and so had vowed to kill Interstate 470, a proposed 26-mi beltway-type Interstate highway to encompass southwest Denver and connect the ends of the two major Interstates that cut through Denver like a plus sign. As governor, Lamm saw no plus in the proposed freeway. "I-470 is really a solution of the past," Lamm told the press, "and what we're looking for is a solution of the future. Interstate 470 is dead. If I have to drive a silver stake through its heart, I will do so."

What started out as a simple battle over a suburban freeway soon became a bitter and complex free-for-all over the future form of urban development. Governor Lamm eventually did succeed in winning some concessions, but for all intents and purposes, he lost on the overriding issue of planning the future of Colorado's growth. The proposed Interstate was changed to a proposed parkway, and was reduced from six to four lanes. By December 1985, 12 mi of CO-470 were open, and the entire 26-mi parkway should be completed by 1988.

As damaging as this war was to the governor, he had not yet fired his final shot. In 1979 Lamm launched his next salvo at unplanned urban development with a sensible, reasoned approach, ineptly and inaptly called Colorado's Human Settlement Policies. Again citing the dangers of "sprawling development patterns," Lamm said that his Human Settlement Policies were developed to provide direction for accommodating growth and facing the problems of the 1980s. Almost by the sheer weight of their name, the Human Settlement Policies soon sank from sight.

Governor Lamm was again bloodied but unbowed. Less than 6 months later, he initiated another major attempt at land use planning—The Front Range Project. The aim of this project was to examine how Coloradans might adjust to the expected population increase of 1.25 million more people by the year 2000 in the 13 Front Range counties yet maintain and enhance their way of life. The project was a nonpartisan, public-private sector cooperative effort, based on the principles of participatory democracy and extensive citizen involvement. More than 600 volunteers worked with a professional staff to examine the key issues facing the Front Range. Although the project itself was successful in involving the public in the issues of land use and open space, it failed to capture the support of the general assembly, and what the governor feared has come to pass. Today all of Denver's key indicators indicate trouble:

- Population: The city of Denver actually lost population between 1970 and 1980; population dropped 5 percent to 490,011. The population of suburban Denver increased by 59 percent, from 712,028 to 1,130,891. By 2010, the population of metropolitan Denver will have increased by more than 1 million people; 93 percent of the increase will occur in the suburbs.
- Employment: Employment in the city of Denver increased 19 percent last decade; during the same period, suburban employment leaped 110 percent. The Denver Tech Center, a southeast Denver activity center 15 mi from downtown Denver, now rivals the downtown central business district (CBD) as an employment center and is expected to become Colorado's largest employment district in the 21st century. In the next 30 years, 800,000 more employees will work in metropolitan Denver; 80 percent of them will work in the suburbs.
- Transportation: Vehicle miles of travel increase 5 percent a year, the number of vehicles 3.4 percent a year, and the automobile occupancy rate slides down closer and closer to 1. Denver has the second highest number of cars per capita ratio in the United States and the worst air pollution. Rush hour has ballooned from 3 hr a day to 4 ½ hr a day.

The Public Sector and Unmet Transportation Demand

A recent study by the Colorado Department of Highways (CDOH) identified $25 billion of highway and transit improve-

ments needed in Colorado between now and the year 2001. The study projects only $15 billion of revenue over the same period, which leaves a forecast shortfall of $10 billion, without allowing for inflation.

The majority of the problems and much of the funding deficit fall in the Denver region. The Denver Regional Council of Governments (DRCOG) estimates that 1,062 lane miles of new highways and a 77-mi network of busways or light rail must be built in metropolitan Denver by the turn of the century to handle exploding traffic volumes. DRCOG projects that transportation revenue for necessary improvements will fall $3 billion short: total cost of needed transportation = $9.9 billion; total projected revenues = $6.9 billion; highway and transit revenue shortfall for the Denver area alone = $3 billion.

Clearly, existing revenue sources will not be adequate to finance metropolitan Denver's transportation needs. Several options have been considered to overcome this large deficit, including a motor fuel tax increase, a statewide sales tax increase, a sales tax on motor fuel, a regional sales tax increase, bond financing, toll road financing, ton-mile tax increases on trucks, and a grade crossing tax on railroads.

The 1986 Colorado General Assembly spent a good share of its time addressing this matter during its just completed session. The legislature passed two key pieces of legislation: a statewide increase of 6 cents a gallon in the gasoline tax (7.5 cents a gallon on diesel fuel) to expire in 1989 and enabling legislation that allows the six-county Denver metropolitan region to ask voters to approve a 3-cent regional fuel tax for transportation improvements. The governor allowed the first to become law without his signature but vetoed the second arguing that a Denver regional fuel tax would undermine the concept of a state highway department and would make statewide increases in the fuel tax more difficult in the future. However, the new 6-cent statewide fuel tax increase will generate about $306 million during its 3-year life and thus will reduce the expected statewide highway and transit needs shortfall from $10 billion to $9.7 billion.

Obviously, given the expected growth in Denver's traffic, the public's attitudes toward tax increases, and the federal government's announced support for "privatization," the private sector's role in planning and building public-sector infrastructure must become more significant in the future.

The private sector in Colorado has a long history of participation, through direct contributions, in financing construction of local capital improvements, such as utility easements and dedicated local street rights-of-way. The state or local government has provided necessary road improvements. In recent years, private-sector participation has expanded in Colorado to include financing the construction of intersections, access roads, interchanges on major state highways, and highway widenings.

Since the late 1970s, the CDOH has been inundated with requests from the private sector and local governments for new highways as well as additional or better access to the state highway system. Frequently, these requests are for the rebuilding of existing interchanges or the construction of new interchanges (or entire new highways). Today there are more than 50 interchanges proposed for Colorado's state highway system, at a cost of more than $300 million, which is far more than the available funding.

Requests for new interchanges and highways on the state system are submitted to the Colorado Highway Commission, a nine-member group that sets policy for the state highway system in Colorado. A cornerstone policy of the commission, called the Five Year Program of Projects, establishes a multiyear set of priorities for highway construction and rehabilitation. A new fifth year is added each state fiscal year, and the first year of the Five Year Program of Projects is substantially reflected in the annual construction budget.

The present policy of the Colorado Highway Commission is to concentrate revenue on maintaining the present system and thus avoid the need for more costly rehabilitation in the future. Because of this emphasis, the commission realizes that there are many capital needs on the highway system that cannot be met through present state funding sources.

In response to the growing role of the private sector and local governments in financing transportation improvements on the state system, the commission in October 1982 adopted Policy Directive 1686 called Non-State Financing of State Highway Improvements. This directive was created "to establish standards for nonstate financing of highway improvements where the proposed improvements are primarily of benefit to a particular private development or local governmental entity." Policy Directive 1686 provides:

> Requests by local governments or developers to have a proposed project budgeted for construction out of sequence or inconsistent with the current annual construction budget or Five Year Plan shall be considered by the Highway Commission as follows:
>
> a. If the proposed project is included in the latest Five Year Plan, the project may be considered for budgeting provided an appropriate share of the cost is provided from sources other than the State Highway Fund. The exact amount to be borne by sources other than the State Highway Fund shall be negotiated on a case-by-case basis, using criteria to be promulgated pursuant to a procedural directive.
> b. If the proposed project has a prior construction commitment, i.e., inclusion in the Interstate Cost Estimate, both the transportation improvement program and the long-range element of the transportation plan of the urban transportation planning area which have been concurred in by the Highway Commission, or if the project has been identified as one of the top three priority projects by a County in its annual request before the Highway Commission, the project may be considered for budgeting provided sources other than the State Highway Fund represent over one-half the estimated project cost.
> c. If no prior construction commitment can be documented, the project may be considered for budgeting provided all or nearly all of the project cost is borne by sources other than the State Highway Fund and if located in an urbanized area, the project is included in both the transportation improvement program and the long range element of the transportation plan of the urban transportation planning area which have been concurred in by the Highway Commission.

With this policy directive, the Colorado Highway Commission and the CDOH took the first steps necessary to deal with the anticipated problems associated with growing private involvement in financing public highways.

THE PRIVATE SECTOR AND METROPOLITAN DENVER TRANSPORTATION

Although private involvement in transportation is now occurring statewide, the private sector is most active in transportation financing in the Denver metropolitan area. Thus far this activity has taken three forms:

1. Private contributions to finance interchanges. Since 1983 the CDOH has been involved with the private sector in constructing or modifying nine interchanges on the state highway system in the Denver region. Nineteen additional interchanges for metropolitan Denver have been requested.
2. Intergovernmental associations to provide major transportation improvements. The major example of this type of association in Colorado is the Joint Southeast Public Improvement Association (JSPIA) in southeast Denver.
3. Involvement of private interests with local governments to build major highways without the participation of state or federal government. E-470, a proposed 50-mi beltway to skirt metropolitan Denver on the east side, is now being planned without the state's involvement.

Private Contributions to Build Interchanges

The Colorado Highway Commission's recently adopted Policy Directive 1601, Interchange Approval Process, took effect on April 1, 1985. The aim of this directive was to establish consistent guidelines for reviewing and evaluating requests for new interchanges and improvements to existing interchanges on major state highways. The highway commission recognized that controls had to be placed on the location of interchanges in order to prevent deterioration of level of service. Policy Directive 1601 provides:

> It is the policy of the Commission that all requests for interchange construction or improvements will be reviewed and evaluated in a fair and consistent manner. Since each request for an interchange has its own unique circumstances, the Commission will take into account these unique circumstances in judging the relative merits of each request. Further, in evaluating each request, the Commission will consider the system feasibility study, the project level feasibility study, the environmental assessment and any other impacts and consequences of the interchange.
>
> So that each interchange request is treated fairly and consistently, it is deemed necessary by the Commission that general guidelines be established. These guidelines will stipulate what material must be provided to the Department and Commission so that a determination can be made on the request . . . [The interchange request process] is general in nature and each interchange request may necessitate slight variations from this process. No attempt is made in this Policy Directive to account for all possible variations. The District offices are directed to notify the requesting party of these variations as soon as possible to minimize any delays.
>
> The costs of preparing all studies required by the guidelines to this directive shall be the responsibility of the applicant. The financing of the interchange request is governed by the standards set forth in Policy Directive 1686.

The "guideline" steps include

1. The applicant must be a governmental entity, and the CDOH must follow the guideline steps.
2. Traffic impacts must be examined in a system feasibility study. To be studied are alternate routes, accident history, congestion effects on the existing system, effects on adjacent interchanges, economic development impact analysis, and local commitment to improving local roadways.
3. The proposal must be in the local transportation plan and transportation improvement program.
4. A project-level feasibility study must be conducted.
5. Federal approval must be obtained if the proposed interchange is to be on the federal-aid system.
6. An Environmental Assessment (EA)—Finding of No Significant Impact (FONSI) or an Environmental Impact Statement (EIS) must be completed.
7. A funding package must be proposed.

The words sound fine, but all that is established is a stated intention to require all applicants to jump through the same hoops.

Policy Directive 1601 is of some help in evaluating a proposed interchange. However, because it lacks specific criteria for evaluating proposed improvements, such as interchange spacing, traffic volume requirements, interchange design, and other threshold values, it is still perceived as being insufficient by those who follow the process.

Intergovernmental Associations to Provide Major Transportation Improvements

Interstate 25 runs through the Front Range area east of the continental divide from the Wyoming to the New Mexico borders. Eighty percent of Colorado's population lives along it. It was begun in 1947 as a Denver freeway (known as the Valley Highway). The Valley Highway, completed in 1962, snakes through Denver and ends in the southeastern part of the city. The next large city to the south is Colorado Springs, 70 mi away. The Denver–Colorado Springs portion of I-25 was completed in 1960.

Middle-class residential areas lie north, west, south, and east of Denver's downtown. The industrial area is to the northeast, and the highest income area is to the southeast. Residential subdivisions soon sprang up close to the new I-25 and were annexed to Denver. New suburban-type office park developments, the largest of which is the Denver Tech Center, also sprang up around the interchanges of the Valley Highway in the southeast part of town. There were dramatic increases in traffic volume as the metropolitan area spread to the southeast.

The data in Table 1 indicate that in the 25 years between 1960 and 1985, the average annual daily traffic volume went from 8,100 vehicles a day to 148,100 on I-25. The traffic volume on a cross street, Arapahoe Road (CO-88), increased from 300 vehicles a day to 51,900. These increases produced tremendous public demand for improvements, and the lack of improvements threatened to stall commercial growth in the corridor along I-25. JSPIA was the outgrowth.

JSPIA, a coalition of 11 statutory metropolitan districts, was established in 1981 to plan, design, and construct regional

TABLE 1 AVERAGE DAILY TRAFFIC

Highway	Location	Average Annual Daily Traffic				Increase (%)		
		1960	1971	1981	1985	1960–1971	1971–1981	1981–1985
I-25	North of Arapahoe Rd.	7,600	22,500	75,000	97,900	+196	+233	+30
I-25	North of Belleview Ave.	8,100	31,200	114,600	148,100	+285	+267	+29
CO-88	West of I-25	2,500	11,300	27,800	35,600	+352	+146	+28
CO-88	East of I-25	300	7,250	23,200	51,900	+2317	+220	+124

transportation facilities to relieve the growing traffic and access problems being experienced 15 mi southeast of the Denver CBD adjacent to the I-25 corridor between I-225 and (Arapahoe-Douglas) County Line Road.

The legal basis for JSPIA is the Intergovernmental Relations Act (CRS 29-1-201). This act permits and encourages governments to make the most effective use of their powers and responsibilities by cooperating and consulting with other governments. Governments under this act include any political subdivision of the state, any agency or department of the state or of the United States, and any political subdivision of an adjoining state. Such association of governmental entities carries the metropolitan district concept further by allowing for the financing of regional transportation improvements that could not be undertaken by individual districts. More important, it also allows JSPIA to deal with other governmental agencies—in this instance, the CDOH and Denver and Arapahoe counties—in working out financial plans and construction schedules.

Specifically, governments may cooperate or contract with one another to provide any function, service, or facility lawfully authorized to each of the cooperating units of government. This includes sharing costs, imposing taxes, or incurring debt to provide these services.

In 1985 total assessed valuation within JSPIA's boundaries was nearly one-quarter of a billion dollars. Commercial office space in the southeast corridor is expected to approximate the commercial office space in the Denver CBD sometime early in the 21st century. JSPIA's territory is 6,000 acres, nearly 15 times the size of the downtown Denver CBD, and includes 85 percent of the commercial office space in the southeast corridor.

JSPIA has a board of directors composed of a member from each metropolitan district and a member at large, the chairman, who is chosen by the board. Action by the 12-member board requires a two-thirds majority in all matters except decisions involving financing, in which case total agreement is required. Dissolution of JSPIA would require a two-thirds vote. However, dissolution would not free any member from any preexisting financial obligations.

JSPIA provides the framework within which money is raised to build capital improvements. Although it does not legally commit its members to participate in any specific capital project, in practice they all do. The actual commitment to capital projects is provided for under a separate financing agreement among the 11 participating metropolitan districts.

The cost of various regional transportation capital improvements is shared in a unique manner. Initially, money is raised through the sale of bonds by member districts. The debt service on the bond is calculated annually on the basis of each district's assessed valuation relative to the total. The result is a floating obligation that reflects the differing rate of growth in each district. Any new member of JSPIA will become a part of the financing agreement and share in the cost of JSPIA transportation capital projects.

The most interesting aspect of this agreement is that all members share in capital improvement projects, even though they are not necessarily constructed in or adjacent to their district. The assumption is that any transportation capital improvement in the JSPIA area is likely to provide indirect benefits to all associated districts.

Since 1981 JSPIA has cooperated in six major highway projects along the southeast I-25 corridor. All of these projects were in the Denver Metropolitan Planning Organization (MPO) Year 2000 Regional Transportation Plan and were considered priority transportation projects in the Denver metropolitan area. In addition, JSPIA has recently committed to cooperating on three additional projects within JSPIA's boundaries.

The total cost of these nine projects is $21.6 million. The 11 member districts of JSPIA have contributed or will contribute $14.4 million. The balance of funds comes from CDOH (state funds), $1.2 million; federal 4R funds, $5.5 million; federal primary funds, $260,000; and federal-aid urban systems funds (Arapahoe and Denver counties), $294,000. Also, on some projects, there was supplemental funding from the individual metropolitan districts that make up JSPIA. The projects are

1. Belleview Street–I-25 interchange: This project was completed in 1983 and included restriping, signalization, and intersection modification at East Belleview and Quebec Streets. The total cost of the project was $763,000; $294,000 came from federal and urban system funds, $84,500 from state funds, and $384,000 from member districts of JSPIA.
2. Yosemite overpass: This overpass over I-25, providing continuity for Yosemite Street, was completed in 1983. The total cost of the project was $5.5 million. JSPIA paid for the entire project.
3. County Line Road–I-25 interchange: This project was completed in 1984 and included construction, structures, and widening on and adjacent to the I-25–County Line Road interchange area. The total cost of the project was $1.34 million: $1.1 million came from federal 4R funds; $107,000 from state funds; and $131,000 from JSPIA member districts.
4. Arapahoe Road–I-25 interchange: The project was completed in 1985 and included bridge widening, construction of a partial cloverleaf, ramp metering, and additional lanes on Arapahoe Road. The cost of the project was $6.1 million: $3.8 million came from federal 4R funds, $713,000 from state funds, and $1.6 million from JSPIA districts.
5. Orchard Road–I-25 interchange: This project was started

in 1985 and will include curbs, gutters, pier removal, and additional lanes on Orchard Road. The total expected cost of the project is $1.3 million: $1.2 million from the member districts of JSPIA and the balance from state funds.

6. Dry Creek Road–I-25 interchange: This project was started in 1985 and will include a full diamond interchange at I-25 and Dry Creek Road. The total expected cost of the project is $5.4 million. JSPIA will be the sole financial contributor to this project.

Three additional projects have been initiated within the JSPIA geographic area:

7. Union Street overpass: This project is to examine the feasibility of constructing Union Street as an overpass over I-25 to serve commercial development. JSPIA has contributed $30,000 for the preliminary engineering of this project.

8. Dry Creek–County Line Road–I-25 interchanges: This project is to design and construct ramp metering at the Dry Creek and County Line Road interchanges. The total projected cost of the project is $661,000, to come from federal 4R funds, state funds, and the member districts of JSPIA.

9. Arapahoe Road–Belleview Street–I-25 interchanges: This project will analyze spot capacity improvements in the vicinity of the Arapahoe and Belleview interchanges on I-25. The total projected cost of the project is $492,000, to come from federal primary funds, 4R funds, state funds, and the member districts of JSPIA.

Private contributions to build interchanges and the activities of JSPIA have clearly demonstrated that privatization can be perceived, if it is on a relatively small scale, as profitable. What has not been established is that large-scale privatized projects can be profitable.

Private Sector–Local Government Highway Construction

E-470 is a proposed 50-mi, $500 million beltway-type freeway to be built around eastern metropolitan Denver to connect with the I-25–CO-470 interchange in south Denver and with the I-25–158th Avenue interchange in north Denver.

Planning this road is the E-470 Authority, an intergovernmental agency formed in 1985. The consortium consists of Adams, Arapahoe, and Douglas counties, the city of Aurora, and private interests.

The 10-member Board of Directors of the E-470 Authority is made up of the three county commissioners from each of the three counties and an Auroran city councilwoman. The authority's yearly operating budget is $400,000: $50,000 comes from each of the four governmental jurisdictions, and $200,000 is donated by private interests.

Pursuant to the orders of Governor Lamm, the state of Colorado has taken no active role in the development of this project; the extent of the CDOH's participation is to act as an observer at E-470 meetings.

The authority intends to have those who benefit from E-470—users, land owners, and developers—pay for the highway's construction; the entire road will be built without state or federal money.

To develop financing strategies for the construction of the highway, the E-470 Authority recently selected Public Financial Management of Philadelphia as financial adviser and Shearson Lehman and George K. Baum & Co. as bond underwriters. A number of public-private financing alternatives, both to retire bonds issued to pay for E-470 and to reduce the overall cost of the project, are being considered by the authority's financing team:

- Tax increment financing: additional taxes collected due to the increase in value of land adjacent to E-470 would be applied to pay off road construction bonds.
- Lease-purchase: parts of the highway would be paid for by private developers and then leased back to the E-470 Authority; developers would be able to take advantage of investment tax credits and depreciation.
- Special districts: assessments or property taxes from special districts would be used to pay off bond debt.
- Dedicated right-of-way: twenty-five percent of needed E-470 right-of-way has already been dedicated by land owners, and the authority is projecting that more than two-thirds of total right-of-way will be dedicated.
- Land banking: the E-470 Authority could acquire more land than needed for right-of-way, and then resell this surplus land at market value when the highway has been finished.
- Tolls: the authority envisions the possibility of eventually using tolls when traffic levels are sufficient; the most promising section of E-470 to be tolled would be near the new Denver regional airport, which is proposed to be completed in the early 1990s.

The authority intended to have between $100 million and $200 million worth of bonds issued by September 1, 1986, and thus avoid problems associated with possible congressional changes in the status of tax-exempt bonds. Revenue from these government-backed bonds will be placed in escrow until long-term funding mechanisms are in place. The interest earned on the escrow account, above what is needed to pay off the bonds, will be used to pay for authority activities.

The E-470 Authority also plans to pursue innovative ways of maintaining the highway after it is constructed, including packaging a construction contract with a multiyear maintenance contract.

THE FUTURE OF PRIVATE-SECTOR FINANCING: ROSY OR RISKY?

In June 1986 three major stories dealing with the private sector and transportation financing appeared in Denver's daily newspapers: On June 5 the *Rocky Mountain News* printed a story entitled Debt Weakens Douglas, Analysts Warn in which it was asserted that

> Douglas County has gone deeply in debt financing its "astounding growth," making it vulnerable to an economic downturn and costing taxpayers thousands of additional dollars to repay local bonds.

> The county school district this week fell victim to growing concern about Douglas County's rising debt when Moody's Investors Service of New York lowered the school district's bond rating.
>
> Analysts at Moody's said they dropped the bond rating because of a $375 million debt racked up by developers who form special districts in Douglas County, then sell tax-free bonds to finance certain improvements, such as roads.

On June 12 the *Denver Post* carried a story, Hitting Below the Metro Beltway? School District Revenues Could Be Frozen To Pay for E-470, in which it was reported:

> Officials may try to finance the E-470 highway—a 50-mile beltway to be built around eastern metro Denver—under a plan that would deprive two school districts of badly needed tax revenues. . . . As property values and tax revenues increase along E-470 as it is built, tax increment financing would guarantee that these additional revenues would be used to pay off road construction costs. But the Aurora and Cherry Creek school districts are counting on using increased tax revenues from E-470 development to expand education facilities for the area's burgeoning student population.

On June 22 the *Denver Post* carried another story, Voters' Concern About City Sprawl Runs High, in which it was said that

> urban sprawl and other growth-related problems are of major concern to many Coloradans and very likely will affect the outcome of this year's election. . . . A surprising 39 percent of Coloradans across the state say they believe their quality of life will be "ruined" if their communities continue to grow at present rates.

John Arnold, the executive director of the E-470 Authority, summed up well the problem facing many public-private ventures across the country: "It's the kind of thing that hasn't been done before, and there aren't any models. It raises all kinds of institutional questions and public policy questions that we're going to try to work our way through and handle."

JSPIA, the E-470 Authority, and public-private interchange agreements are likely to be replicated throughout Colorado. Such arrangements do indeed raise fundamental public policy questions that have not been successfully addressed and cannot be successfully addressed by the Colorado Highway Commission or Colorado's governor, and they have not been addressed at all by the state legislature.

Land use planning in Colorado is not carried on by the state government. The nastiest words that can be heard around the general assembly, after "tax increase," are "land use planning." Land use planning is left to local government and done principally by private developers.

There are some in Colorado who believe that private-sector financing of transportation is not only counterproductive but dangerous. They make three points:

- First, it creates the false illusion that public-private agreements can solve long-term transportation problems.
- Second, it allows developers to plan highways and interchanges, which may not be in the public interest.
- Third, private financing only results in more interchanges and more highways so that developers can generate more unplanned growth, which increases the dependence on the car, which increases the demand for more highways, and so on and so on and so on. Cities become wall-to-wall sprawl and highways become wall-to-wall crawl. As voters are painted into a corner by this vicious cycle, instead of questioning how they got here, they are concerned about how to buy the second coat of paint.

In the past few years, major and bitter battles have been waged in Colorado over these questions. When local jurisdictions in 1984 requested two additional interchanges on CO-470, Governor Lamm angrily threatened to veto any highway department construction budget that contained new interchange funds for CO-470. As mentioned earlier, Governor Lamm has also refused to allow any state involvement in the E-470 project.

But, also in the past 3 years, the Colorado Highway Commission has entered into 15 separate funding agreements with private interests to expedite the construction of highway interchanges in exchange for sizable private contributions. When all of these interchanges are completed, the private sector will have funded $48 million of the total $64 million cost.

CONCLUSION

No doubt Colorado's land wars will continue to be fought as forays are made across new financing frontiers. But it is important to remember that the private sector in other parts of the world has for decades been a partner with government in providing transportation facilities. Ten thousand miles of Western Europe's major highways were built as toll roads under various public-private agreements that provide that concessionaire firms construct, operate, and maintain the roads.

Today the French and Spanish are planning to link their countries by highways and tunnels through the Pyrenees Mountains. A significant portion of the cost is to be borne by private investors. The French and English have agreed to build twin rail tunnels under the English Channel at a cost of $2.3 billion. The entire project is to be privately financed.

Brazil, Argentina, and Venezuela have all constructed toll roads using the European concessionaire model and a mixture of public and private funds.

The Cross-Harbour Tunnel in Hong Kong was privately constructed in the early 1970s, and a private Japanese group was recently selected to build a second tunnel under the Hong Kong harbor for $450 million.

Portions of the private sector have clearly demonstrated a willingness to pay their share of Colorado's transportation costs. It is government's responsibility to ensure that the public good is served in the process, and that means that

- Taxpayers of tomorrow should not be unduly burdened by capital and maintenance obligations undertaken today;
- Transportation decisions should not be based solely on the availability of private money;
- The physical environment and Coloradans' way of life should be enhanced, not hampered, by new transportation facilities; and
- Additional transportation facilities and services should mesh with and not undermine the overall transportation network.

From the gold rush days of the 1800s to the rush hours of today, Coloradans have been in a hurry. The race continues to be to the swift, but rapid growth and slowed government spending threaten the quality of the transportation systems and way of living.

Syndicated columnist Neal Pierce, in his 1983 book, *The Book of America, Inside the Fifty States Today,* said that

> Coloradans have never become serious in deciding how they are going to accommodate their love of unfettered growth with their love of the outdoors. . . . Its people may have been lulled into thinking there will be no crisis, that a solution can be found to all growth problems. But we see a gathering crisis of deeply disturbing proportions: the gradual decline in the quality of life, a steady loss of agricultural land, open space, wildlife habitat, landscape diversity, all accompanied by worsening traffic and deteriorating air quality. If this is the model of the "developed" Western state in America, then it will not be just one politician or another who appears a failure: a once-in-a-generation opportunity to build a resilient, conserving society in one of the most exquisite places on earth will have been forsaken.

Transportation decisions will determine, literally and figuratively, the direction of Colorado's development during the next decade. How the state and federal governments work with the private sector to finance highways may well be the key to deciding, once and for all, which road Colorado intends to travel down.

The outlook for successful privatization certainly has not been improved by the actions of the Reagan administration, the Congress, or the Colorado legislature in recent years. A penetrating analysis of the *Rules of Governmental Accounting* and the *Internal Revenue Code* is needed to allow the establishment of rules that would make privatization on a larger scale profitable. Until the would-be practitioners of privatization are able to turn a profit, the privatization picture is, to quote Liza Doolittle, nothing but "words, words, words."

Arterial Road Funding for Southeastern Jefferson County: Equity Based on Traffic Impact

VALDIS ZEBAUERS AND AL ZEIKUS

Rapid development has resulted in a sudden deterioration of traffic conditions in southeastern Jefferson County, Colorado. This has led to an intensive effort to develop a funding and construction program to alleviate the deficiencies and provide for future needs. Traffic projections were used to size the needed roadway system and derive improvement costs, which were apportioned to each land use category on the basis of traffic generation. This apportionment became the main parameter for establishing a 20-year funding plan made up of three revenue sources: property tax, sales tax, and traffic impact fees on a 1/3, 1/3, 1/3 basis. The total revenue target was set at $120 million in present value. Property tax revenue by land use was projected and credited toward the funding responsibility of each land use. Sales tax revenues were credited toward only the retail responsibility. Traffic impact fees on new development were used to ensure that the projected revenue from all three sources by land use was equal to the total revenue responsibility by land use. The amount generated by existing land use would be approximately equal to the cost of presently needed improvements. The Board of County Commissioners of Jefferson County adopted the fees at a reduced level for the first year during which implementation of both the property tax district and the sales tax district is being processed through the state legislature.

Sometimes known as the gateway to Colorado ski country, Jefferson County makes up the western portion of the Denver metropolitan area and extends into the mountains (Figure 1). Spectacular rock formations, stands of Ponderosa Pine, and magnificent views of Denver and the plains as well as the peaks of the continental divide have long attracted visitors and enticed people from all over the United States to establish residence in this setting.

The county has historically been one of the fastest growing counties in the United States. The population has increased

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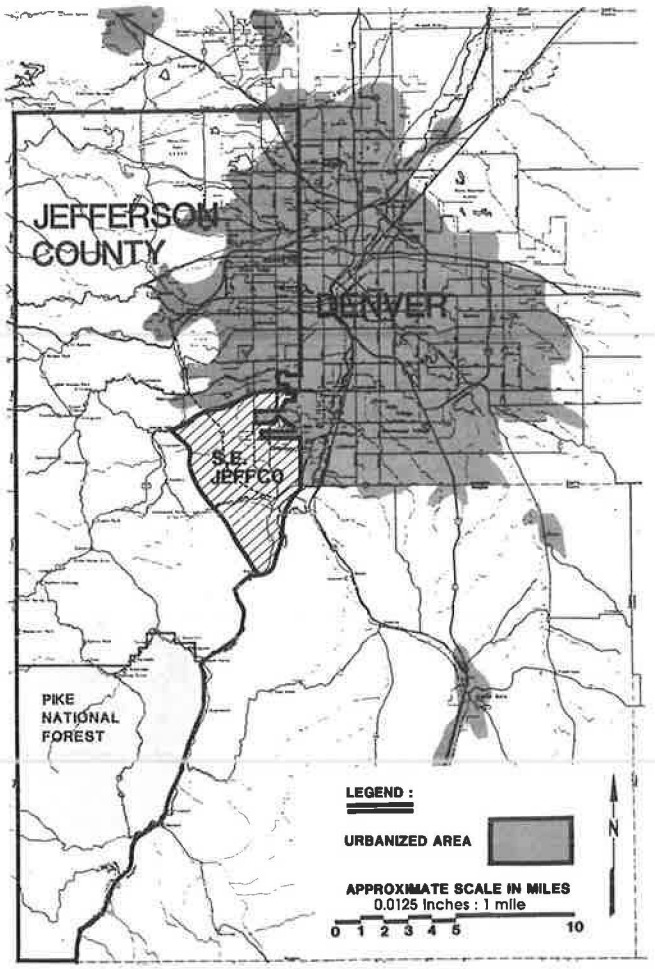

FIGURE 1 Jefferson County and Denver metropolitan area.

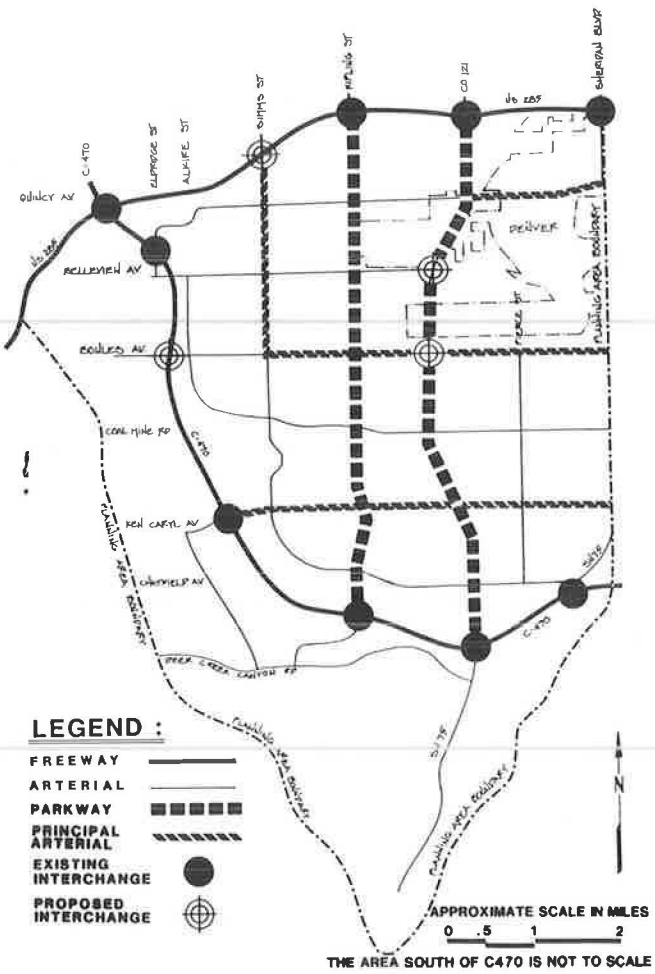

FIGURE 2 Southeastern Jefferson County study area.

from 322,700 in 1975 to an estimated 430,100 in 1986. Although much of the growth has occurred in cities within the county, rapid growth has also been occurring in the southeastern portion of Jefferson County, which is unincorporated (Figure 2). This population has grown from an estimated 21,000 in 1975 to a present population of 65,000. Population is anticipated to reach 120,000 in this area in 20 years.

Past development occurred under provisions of the county's subdivision regulations that require improvements to the arterial road system within or adjacent to development. The piecemeal nature of development, however, led to sporadic spot improvements but provided no significant system or corridor capacity. In the last 4 years the area has experienced a surge in retail as well as residential development; the most significant single development was a 2.5 million square foot regional shopping mall. The rapid retail development resulted in a sudden deterioration of traffic conditions in this area. Traffic volumes doubled on some roads that were already congested. An angry outcry from the community led to an intensive effort to develop an updated comprehensive plan for this area to be followed by a funding and construction program to alleviate the major roadway deficiencies and provide for future needs.

STUDIES

In 1984 the county commissioners appointed a special task force made up of a variety of representatives from business interests as well as homeowners' groups. With the assistance of county planning and transportation staff, this task force developed a Land Use Policy Plan for the area. With respect to transportation considerations, two important criteria were established: The plan stated that level of service (LOS) C was to be achieved on all portions of the major thoroughfare system; LOS D was to be accepted only for limited time periods. In addition, the number of through lanes on arterial roads was not to exceed six. In some cases, these limitations implied the use of interchanges.

The Major Thoroughfare Plan was updated for this area on the basis of the new land use projections.

The traffic model provided the usual traffic-loading information that was used to size the needed system and identify a list of improvements and associated costs ($164 million). The model also yielded the information needed to derive an apportionment of that cost to each land use category on the basis of traffic generation. This apportionment became the main parameter for establishing a funding plan made up of three revenue

sources particular to this part of Jefferson County: property tax, sales tax, and traffic impact fees. It was clear that the needs of this area were disproportionately large (65 percent) compared with those of the total county. Thus the commissioners opted for funding strategies to be applied to this area only.

A special team of attorneys and financial consultants, assembled by the county commissioners, structured the concepts of a special improvement district funded by property tax and a special improvement district funded by sales tax. The sales tax district would require a change in Colorado statutes. Elections would be required to form both districts. The county transportation staff structured the traffic impact fee concept, which could be enacted by the board of county commissioners, for the area. It was decided to focus further studies on a 20-year time frame instead of the longer term, full development, scenario. The 20-year funding needs were estimated to be $120 million.

Traffic impact fees had to be based on traffic impact by land use type in order to be legally defensible. The transportation staff used the data from the model and the system improvement costs to derive the overall funding responsibility for residential, retail, office, and industrial uses.

In defining this responsibility, it was necessary to develop a cost per trip as well as the number of "chargeable" trips per land use category. Multiplying the cost per trip by the chargeable trips for each land use category yielded the amount of revenue each land use should generate over the study period.

Chargeable trips by land use had to be carefully computed to avoid double counting and to properly assign trips to land uses. For example, in the case of a trip from home to office where both home and office are within the study area, the trip was charged to the residential use category. On the return trip from office to home, the trip was charged to the office category. External trips were all charged to the land use within the study area. Thus, in the previous example, if the office had been outside of the study area, both trips would have been charged to residential land use. The total number of chargeable trips by land use was derived using initial aggregated land use tabulation, trip generation factors, the trip table, and the relationship between internal and external productions and attractions. The *National Cooperative Highway Research Program Report 187 (1)* was a helpful reference for estimating non-home-based productions and attractions. The results of this procedure are given in Table 1.

Estimates of revenue by land use from the two tax districts were applied toward the responsibility by land use, with the sales tax revenue applied totally toward the retail responsibility. After the expected revenue by land use was applied toward the responsibility by land use, traffic impact fees were computed to make up the difference.

TABLE 1 20-YEAR FUNDING RESPONSIBILITY BY TYPE OF LAND USE

Land Use	Funding Responsibility ($ millions)
Residential	71.13
Retail	67.97
Office	18.27
Industrial	7.13
Total	164.50

TABLE 2 20-YEAR REVENUE BY FUNDING AND LAND USE ($ millions)

Land Use	Property Tax	Sales Tax	Traffic Impact Fees	Total
Residential	23	0	22	45
Retail	7	40	9	56
Office	6	0	7	13
Industrial	4	0	2	6
Total	40	40	40	120

STRATEGY

On reviewing the funding concepts recommended by the consultant team and staff, the commissioners decided to pursue a strategy that collected approximately 1/3 of the revenue needed from each funding source while collecting the appropriate amount from each land use category. This approach enhanced the aspect of equity and helped avoid overburdening any one funding source. The property tax would primarily affect current residents and businesses and to a lesser extent future residents during the 20-year period. Revenue from property tax could be distinguished by land use type and appropriately credited toward each land use. The sales tax is a means of capturing revenue from retail users and a way of collecting revenue for roads from shoppers who live outside the study area. This revenue would be applied toward the retail responsibility. The traffic impact fees demonstrated that substantial funding of future needs would be provided by new development. The results of this funding distribution are given in Table 2, and the resulting fee structure is given in Table 3.

On further analysis, it appeared that with this strategy approximately $46 million would be collected from existing development. This amount is relatively close to a $42 million estimate of current improvement needs. Thus the argument that future development would pay to solve existing problems created by others was avoided. The estimates (in millions of

TABLE 3 PROPOSED TRAFFIC IMPACT FEE

	Dollars Per Square Foot[a]
Residential Multifamily @ $659/dwelling unit Single family @ $942/dwelling unit	0.54[b]
Retail	2.37
Office	1.31
Industrial	0.33

[a]Escalated by Colorado construction index (for highways) for previous year.
[b]Estimated average.

TABLE 4 REVENUE BY EXISTING VERSUS FUTURE DEVELOPMENT ($ millions in present value)

	Existing	Future	Total
Property tax	25	15	40
Sales tax	21	19	40
Impact fees	0		40
Total	46	74	120

dollars of present value) of the breakdown of revenue by existing and future developers are given in Table 4.

IMPLEMENTATION

The strategy, dubbed "Three Prong" by the community and the press, was introduced to homeowners' association representatives, the Chamber of Commerce, and the Home Builders Association, which ultimately became the main element representing land developer interests. Although general support was expressed by the Chamber of Commerce and homeowners' representatives, the developers' representatives expressed concern over the traffic impact fee portion of the plan. The main concerns were that if the two tax districts did not pass election, the impact fees would be expanded to cover the entire cost of the system, and that the county's growth and traffic projections were too high. At the same time, all groups recognized that there was little chance that the needed sales tax legislation would pass or that subsequent property tax and sales tax district elections would succeed without the traffic impact fees in place.

To address all concerns, on February 24, 1986, the county commissioners enacted the traffic impact fees at 20 percent of the recommended fee level for a period of 1 year. Thus the development interests would have an opportunity to fund an independent study to address growth projections for and traffic needs of the area during the next 20 years. The study would serve as a basis for review of the fee structure and establish subsequent fees to fund the 1/3 share of the 20-year need. The continuation of the fees was also made contingent on passage of one of the other two funding mechanisms. Should neither pass, the collected fees would be returned and the total strategy reviewed.

At the present time the needed legislative changes are being considered in the state legislature and a committee of community homeowners and business leaders has defined a service plan for the property tax district to be voted on in October 1986. The developer interests are currently raising funds for an independent study to be directed by a task force made up of developers, staff, and community representatives.

In a 2-month period more than $100,000 in traffic impact fees has been collected by the county. Obviously, the final chapter of this funding program cannot yet be written; however, at this point, the chance of being able to use new revenue sources for arterial roads in southeastern Jefferson County appears good. Although not yet passed, the sales tax district legislation has had a strong showing in the state legislature and the property tax district proposal also appears to have substantial support from the community. The commitment to have traffic impact fees on new development match the revenues from property tax adds considerable incentive to the property tax proposal. Under the traditional countywide application of property or sales taxes to fund capital improvements, chances of success would be substantially less because of the localized nature of the roadway problem.

REFERENCE

1. A. B. Sosslau, A. B. Hassam, M. M. Carter, and G. V. Wickstrom. *NCHRP Report 187: Quick-Response Urban Travel Estimation Techniques and Transferable Parameters.* Comsis Corporation, Wheaton, Md.; TRB, National Research Council, Washington, D.C., 1978.

Public and Private Cooperation in the Provision of National Forest Roads

Z. ANDREW FARKAS

The U.S. Department of Agriculture Forest Service, a public lands and natural resources management agency, manages one of the world's largest transportation systems for extraction of resources by the private sector and for access to public recreational and private land holdings within national forests. Much of the land within the exterior boundaries of national forests is still privately owned, which results in a patchwork of public and private lands and a problem of accessibility to these land parcels. There is an established tradition of public and private cooperation in resources development and in the provision of transportation in national forests. The national forests transportation system includes approximately 321,000 mi of roads, foot trails, air fields, aerial tramways, waterways, and cableways. Low-volume roads make up most of the system. The objective of this research is to examine the legislative history, policies, and administrative requirements of the Forest Service for cooperative public and private finance, construction, and maintenance of national forest roads. The policies and requirements may be applicable to rural road systems in other regions of the world.

The U.S. Department of Argiculture Forest Service, a public lands and natural resources management agency, manages one of the world's largest transportation systems for use, protection, development, and management of national forest lands, including providing access to the private sector for natural resources extraction and to the public for recreational activities. The national forests contain 87 million acres of commercial forests and 41 million acres of rangeland. The forests also contain 2.5 million acres of surface water (*1*, pp. 3-1–3-3). Much of the land within the exterior boundaries of national forests is still privately owned. These public and private land and water resources support commercial timber harvesting, mining of energy and nonenergy minerals, commercial ranching, fishing and trapping, and an assortment of public outdoor recreational activities, such as boating, camping, hunting, snowmobiling, and skiing. There is a tradition of public-private cooperation in resource development and in transportation of goods and services.

The entire Forest Service transportation system includes approximately 343,000 mi of roads, foot trails, air fields, aerial tramways, waterways, and cableways. The predominant part of the transportation system is low-volume roads. Most of these roads are located in the western United States in national forests and a few national grasslands. National forest roads often carry fewer than 100 vehicles per day and traffic volumes vary significantly by season and use. Of the 343,000 mi of roads, 19 percent are currently closed to all traffic, 31 percent are maintained for passenger car use, and 50 percent are maintained for high-clearance (including two- and four-wheel drive) vehicles (*2*, p. 32).

The Forest Service plans, builds, and maintains road systems on which types of users and traffic vary considerably. The hauling of forest products and minerals, use by recreationists, use by landowners within or near national forests, and administrative use make up the bulk of traffic on forest roads. In situations in which the Forest Service and other public road agencies both have jurisdiction, local commerce, busing of school children, and mail delivery traffic may also occur.

The agency is responsible for various resource outputs and land uses that are heavily influenced by their location vis à vis national forest roads (*3*, p. II-3). To meet the various demands on its road systems and to meet resource management objectives, the Forest Service has relied extensively on cooperation with the private sector in the provision of roads.

The objective of this research is to examine the legislative history, policies, and administrative requirements of the USDA Forest Service in cooperative public-private finance, construction, and maintenance of national forest roads. Because the economies of rural areas in general are natural resource–based, Forest Service policies and requirements may be applicable to the provision of other rural road systems in developed and developing countries.

LEGISLATIVE HISTORY OF NATIONAL FOREST ROADS

The establishment of the national forests of the United States came about with the enactment of what was commonly referred to as the Creative Act of 1891 (*4*, p. 5). The act empowered the President of the United States to set apart into forest reserves those public lands in any state or territory bearing forests. The national forests in the western United States were created from the abundant land still in federal ownership. In the East and the South, however, little public land remained. Private forest lands were heavily logged, and by 1900 the federal government recommended to Congress the establishment of a national forest purchase program. In 1911 Congress passed the Weeks Law enabling the purchase of "forested, cutover or denuded lands within the watersheds of navigable streams. . . ." (*4*, p. 19). In 1924 legislation allowed the federal government to purchase land for timber production on national forests (*5*, p. 15).

Within the exterior boundary of national forests a great deal of land, a nationwide average of approximately 20 percent, is in private ownership (*6*, p. 3995). In some of the western states, square mile sections of land may alternate in federal and private ownership in a checkerboard pattern as a result of the railroad land grants made in the latter part of 19th century. In the eastern and southern states, national forests contain rela-

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tively more land in private ownership. The southern national forests, for example, contain 23.7 million acres of which 12.3 million are in government ownership and the rest are in private ownership *(6)*. One southern national forest, the Uwharrie in North Carolina, has only 20 percent of its land in government ownership (*5*, p. 201).

Until 1962 owners of land within national forests were regarded as having statutory right of access to those lands by way of federally owned land. However, the administrative mechanism for granting access was cumbersome and legally tenuous. The U.S. Department of Justice determined that authority to grant access over national forest lands to private land parcels did not explicitly exist (*7*, p. 3996). This situation made negotiations difficult between the Forest Service and private landowners in the granting of permanent access rights over each other's lands to their respective land parcels. Private owners wanted a statutory guarantee of access to private lands, particularly when the Forest Service wanted such access to public lands.

In 1964 the National Forest Roads and Trails Act provided explicit authority to the Secretary of Agriculture to grant easements to private landowners within national forests (*7*, p. 3995). Specifically, permanent or temporary easements could be given for road rights-of-way on federally owned parcels. Also, private landowners could be granted the right to use national forest roads on federal and nonfederal parcels as well.

As part of the recognized need for increased access to national forest lands, the act also provided for the construction of access roads to a standard that would serve the long-term needs of all users of national forests. These roads were called maximum economy roads. The construction of these roads could be financed through *(a)* appropriated funds, *(b)* payments from or credits against purchase price to purchasers of national forest timber and other products, *(c)* cooperative financing with other public agencies or private groups, or *(d)* a combination of all of these methods (*7*, p. 3998).

Before the enactment of the Road and Trails Act, purchasers of forest resources built roads as part of the cost of removing those resources and the Forest Service built roads for its own resource management duties. There was no legal basis for cooperative provision of roads to serve the needs of all users.

When the act was before Congress, the Forest Service requested authority to require timber and other product purchasers to pay for roads at the maximum economy road standard rather than the minimum standard required for removal of the product. That request was rejected by Congress. The act in its final form stipulated that if a higher standard is required for uses other than removal of timber or other products from a particular sale, that sale shall not bear the cost of the higher standard (*7*, p. 3999). Thus federal government appropriations or other road user payments would have to be used to build the higher standard road.

PLANNING OF FOREST SERVICE ROADS

In 1976 the U.S. Congress enacted the National Forest Management Act, which requires each national forest to develop an integrated land and resource management plan every 15 years. The management plan is the basis for each national forest's management program, including the transportation system plan. The management plans and programs are guided by nationally established goals and locally established issues of resource production and protection, environmental quality, and social and economic impact. These plans identify the potential for resource outputs and examine management program alternatives for production of resources. The management program alternatives are analyzed in terms of maximizing certain resource objectives within various environmental and financial constraints.

Transportation system planning is used to determine the national forest road system needed to meet the resource output objectives of the management program. Roads management planning includes economic analyses of projects and establishment of road standards, facility construction, maintenance, and operational levels needed to meet the resource output objectives (*8*, p. 7). Roads on the national forest system are generally of two types: temporary and permanent. A temporary road is one that is used for a short time to haul a resource. Temporary roads are usually obliterated after resource haul or closed until the road is needed for another haul. A permanent road may be used for resource hauls as well as for long-term management of resources or recreational activities. Permanent roads are those needed by the agency for a year or more to manage the resources in a forest.

FUNDING OF NATIONAL FOREST ROADS

Forest Service cooperation with other public and private bodies occurs in the development and use of forest resources and in the provision of roads needed to support commercial and public activities. The Forest Service is often involved in cooperative road work and ownership with other jurisdictions when such work or joint ownership is essential to providing access to national forests or other lands managed by the Forest Service. The agency and state, county, or local jurisdictions often agree cooperatively on finance, construction, reconstruction, and maintenance of roads, according to the amount and types of use *(9)*. The cooperators agree formally to obtain satisfactory jurisdictional status *(10)*. The advantage of joint government ownership and cooperative management of roads is that the costs of roads are better allocated among types, origins, and destinations of use.

The relationships between the Forest Service and private firms in the financing and management of roads are of even greater significance than is cooperation with other jurisdictions. The Forest Service does build national forest roads from appropriated funds, but purchasers of timber and other forest resources for commercial purposes are authorized to build and maintain roads as well *(11)*. Purchasers of national forest timber or extractors of other resources pay for those resources either through a competitive bid process, as in the case of timber, or through set fees and royalties, as in the case of minerals mining. Under most circumstances, the purchaser or extractor incurs the cost of a temporary road used only to haul out a resource.

Permanent roads on the national forest road system are funded from three sources: *(a)* the Purchaser Credit Program, through which timber purchasers build roads in exchange for

timber; *(b)* the Purchaser Election Program, which allows small purchasers to use timber payments to compensate the Forest Service for road construction; and *(c)* the Forest Road Program, through which roads are built with appropriated government funds (*2*, p. 31).

Timber purchasers receive "credit" for the cost of road work, subject to the terms of a timber sale contract, if the road is to be actively used by the agency for national forest management purposes. The purchaser credit may consist of a sum deducted from the timber purchase amount. In effect the agency exchanges timber assets for road assets. Purchasers are required to build only the minimum standard of road needed to harvest and remove timber or other products, subject to environmental regulations *(12)*. If a road of a higher design standard can be achieved without increasing the total transport cost (construction, hauling, and maintenance) for a sale, the higher standard road may be required of the purchaser.

When the Forest Service requires a relatively high-standard road for future resource protection or administrative purposes, the Forest Service may construct all or part of the road with government funds or may enter into a cooperative agreement with the purchaser. In the latter case the Forest Service may construct a road with a combination of purchaser credit and government funds or furnish the materials or funds to the purchaser for construction. Sometimes the minimum-standard road is still prohibitive for the profitable harvesting and removal of timber by a purchaser. Government funds or materials may be contributed to the purchaser to build the road so

TABLE 1 ROAD AND BRIDGE CONSTRUCTION AND RECONSTRUCTION BY STATE (FY 1983)

State, Territory, or Commonwealth[a]	From Appropriated Funds			By Timber Purchasers		
	Roads (mi)	Bridges (No.)	Cost ($ 000s)	Roads[b] (mi)	Bridges (No.)	Cost ($ 000s)
Alabama	17.5	1	1,270.0	29.1	0	468.0
Alaska	71.2	33	23,396.5[c]	60.3	14	8,153.7
Arizona	47.2	3	6,193.9	285.9	0	3,047.3
Arkansas	39.0	0	3,904.2	151.9	0	4,587.8
California	206.1	11	42,208.7	885.8	6	28,364.5
Colorado	55.1	6	8,847.5	163.5	0	1,269.3
Florida	.2	0	710.0	54.5	0	786.0
Georgia	5.8	0	2,893.2	39.6	0	530.0
Idaho	179.3	18	24,019.9	470.1	6	6,322.0
Illinois	0	0	358.8	6.1	0	88.3
Indiana	4.5	0	939.8	1.1	0	20.2
Kentucky	33.8	0	1,845.0	38.7	0	333.0
Louisiana	18.3	0	1,715.0	74.0	0	1,341.0
Maine	0	1	129.0	0	0	0
Michigan	42.8	2	2,213.5	51.2	0	213.2
Minnesota	58.1	3	4,929.6	46.8	0	279.0
Mississippi	0	0	899.0	136.2	0	1,572.0
Missouri	34.1	0	1,817.9	37.6	0	177.6
Montana	344.2	14	27,291.9	615.8	3	6,030.9
Nevada	0	1	417.1	0	0	0
New Hampshire	0	5	456.7	16.8	0	190.6
New Mexico	12.4	0	4,311.9	219.0	0	2,540.0
New York	0	0	0.8	0	0	0
North Carolina	65.1	11	4,088.9	88.5	0	1,794.0
North Dakota	0	0	216.6	0	0	0
Ohio	0	0	19.9	2.4	0	33.8
Oklahoma	6.9	0	301.0	6.7	0	464.0
Oregon	261.4	10	39,468.0	1,198.7	0	39,973.1
Pennsylvania	5.8	0	840.3	23.1	0	353.1
Puerto Rico	0	0	71.0	0	0	0
South Carolina	14.5	2	1,155.0	106.3	0	1,602.0
South Dakota	33.0	1	1,792.6	92.0	0	468.5
Tennessee	35.0	5	1,595.0	42.5	0	525.0
Texas	0	0	1,108.0	83.4	0	2,021.0
Utah	54.3	6	5,991.4	57.6	0	418.9
Vermont	5.1	1	653.4	.8	0	26.4
Virginia	108.0	2	4,715.9	67.0	0	385.0
Washington	135.0	11	19,326.2	431.5	0	15,256.3
West Virginia	37.6	0	2,609.4	16.1	0	229.8
Wisconsin	79.5	2	4,467.2	31.3	0	175.0
Wyoming	5.3	5	3,541.7	100.0	0	1,772.2
Total	2,016.1	154	252,731.4	5,732.8	29	131,812.5

SOURCE: *Report of the Forest Service, Fiscal Year 1983*. Forest Service, U.S. Department of Agriculture, 1984, Table 50, p. 133.

[a]States not listed had no Forest Service road programs in 1983.
[b]Does not include 662 mi turned back to Forest Service for construction.
[c]Includes $19,735 of Tongass Timber Supply Fund.

that the purchaser may incur a normal appraised profit *(13)*. This public financial assistance for the private-sector harvesting of timber on public lands has been the subject of much public and political debate *(14*, p. A17). The purposes cited for such assistance are to help maintain timber industry–dependent communities or to facilitate resource management (e.g., removal of climax tree species or opening land to public recreational activities).

Most road construction and reconstruction projects provide access to timber sale areas. Timber purchasers built 5,733 mi of roads in FY 1983 in national forests, whereas the Forest Service built 2,016 mi with appropriated funds (Table 1). The cost of purchaser-built roads was just over half as much as that of the appropriated roads. In FY 1985 purchaser credit and election programs constructed 2,566 mi and reconstructed 3,618 mi of roads in national forests at a cost of $117 million or approximately $19,000 per mile. Appropriated funds were used to construct 757 mi and reconstruct 1,101 mi at a cost of $67.1 million or approximately $36,000 per mile (2, p. 31). Purchaser roads consistently have cost less to build because of efforts to reduce road design standards for resource hauls.

Roads built with appropriated funds are usually used for public access to outdoor recreational sites and must be of a standard conducive to public comfort and safety. Appropriated funds are allocated approximately 33 percent for road and bridges construction and 66 percent for engineering support, such as survey, design, inspection, and program management (2, p. 31).

MANAGEMENT AND MAINTENANCE OF ROADS

When roads already exist for a planned timber sale, the agency must analyze the current traffic situation to determine if the additional timber traffic can be accommodated. Purchasers may be required to reconstruct or improve the existing roads to accommodate the additional traffic. Traffic management measures, such as time restrictions or temporary road closure to general traffic, may be instituted for short-term traffic impacts *(15)*. For example, if public recreational use is high during one season, timber hauling may be restricted and vice versa. Road closure is the most extreme management step and the agency must coordinate that with other jurisdictions, the general public, and private landowners. Roads may be closed, when there is no need for a road for a certain period, to protect public safety and resources and to maintain the investment in the road.

Although the agency may not restrict owners' access to property within national forests, those who may use roads during restricted or closed conditions must adher to rules of use and conditions of a special permit and may have to pay a bond to repair any damage. Existing mining laws allow miners the right of entry into national forests on restricted or closed roads for mineral exploration and development. A special use permit may require them to perform maintenance or make payment for maintenance expenditures for damage caused by mining-related traffic *(16)*. In any case, commercial users are responsible for traffic-related maintenance commensurate with their uses.

The Forest Service is responsible for maintenance generated by national forest administrative and recreational activities. Levels of maintenance for a road are generally determined by the average daily traffic. The levels range from closed intermittent service roads of any standard to double-lane, paved roads that provide a high degree of user comfort and convenience (Table 2). A level of maintenance that may be required by commercial activities and would be higher than that required by administrative and recreational uses is the financial responsibility of the commercial user. Users may either maintain the roads themselves or deposit funds with the agency for such maintenance *(17)*.

SUMMARY AND CONCLUSIONS

The USDA Forest Service has a long legislative history and has developed policies and requirements for cooperative provision

TABLE 2 MAINTENANCE LEVELS

Level	Description
1	Level 1 is basic custodial care as required to protect the road investment, to see that damage to adjacent land and resources is held to a minimum. Level 1 maintenance requires an annual inspection to determine what work, if any, is needed to keep drainage functional and the road stable. This level is the normal prescription for roads that are not opened for traffic. Level 1 is to maintain drainage facilities and runoff patterns.
2	Level 2 is used on roads where management requires that the road be open for limited passage of traffic. Traffic is normally minor, usually consisting of one or a combination of administrative use, permitted use, or specialized traffic. Level 2 requires the basic care of Level 1 plus logging out, brushing out, and restoring road prism as necessary to provide passage. Also, route markers and regulation signs are to be in place and usable.
3	Level 3 is used on roads which are opened for public traffic and generally applies when use does not exceed 15 average daily traffic (ADT). ADT should be used as a guide in determining the level and not as a sole criterion. A road may receive only one or two vehicles a day for most of the year. However, during a brief period, such as hunting season, the road may receive 20 or 30 vehicles a day. Total traffic types and planned land use are important criteria for selecting the maintenance level. The road is to be maintained for safe and moderately convenient travel suitable for passenger cars.
4	Level 4 generally applies when use of a road is between 15 and 100 ADT (see comment concerning ADT under Level 3). At this level, more consideration is given to the comfort of the user. These roads are frequently surfaced with aggregate material, but some routes may be paved because of limited aggregate sources and surface replacement cost factors.
5	Level 5 is generally maintained for use of 100 ADT and greater (see comment concerning ADT under Level 3). Roads in this category include both paved and aggregate surfaces. Safety and comfort are important considerations. Abrupt changes in maintenance will be posted to warn travelers until deficiencies are corrected.

SOURCE: *Forest Service Manual*, Forest Service, U.S. Department of Agriculture, 1978, Section 7732.11—Maintenance Level.

of national forest roads. National forest management plans contain the program for private-sector development and public use of forest resources. The national forest road systems are planned to support those objectives.

The Forest Service relies heavily on private involvement and cooperation for its road systems finance and resource development efforts. Although the agency often financially assists timber purchasers to build roads, the agency claims to benefit from these roads because appropriated funds are not sufficient to build the roads needed for resource management.

Maintenance is an important road management tool that is actively used to prolong the road investment and to allocate road use among appropriate segments of a road system. With maintenance as with construction and reconstruction, the private sector plays an important role in direct provision of national forest roads.

The experience of the Forest Service in the United States provides a unique but applicable example for the provision of other rural road systems. Varied land uses, ownership patterns, and transport objectives in rural areas may complicate the application of such a model. Institutional and legal constraints to more extensive public-private cooperation in the provision of roads exist in this as well as other countries and would have to be lessened for greater cooperation in rural areas. For the public and the private sectors to properly manage and use rural resources, road systems must provide a high degree of accessibility to those resources. Road systems will likely be more responsive to the dynamics of economic activities when public-private cooperation in their provision occurs.

REFERENCES

1. *Draft Environmental Impact Statement, 1985–2030 Resources Planning Act Program.* Forest Service, U.S. Department of Agriculture, 1984.
2. *Report of the Forest Service, Fiscal Year 1985.* Forest Service, U.S. Department of Agriculture, Feb. 1986.
3. R. Carder and C. Mandt. *Transportation System Planning for Forest Service Management: Introduction to the Transportation System Planning Project.* Technical Report ETR-7700-42. Forest Service, U.S. Department of Agriculture, June 1971.
4. *The Principal Laws Relating to Forest Service Activities.* Forest Service, U.S. Department of Agriculture, Sept. 1983.
5. W. E. Shands and R. G. Healy. *The Lands Nobody Wanted.* The Conservation Foundation, Washington, D.C., 1977.
6. *Land Areas of the National Forest System.* Forest Service, U.S. Department of Agriculture, Sept. 30, 1979.
7. *1964 United States Code Congressional and Administration News.* Vol. 2, West Publishing Co. and Edward Thompson Co., St. Paul, Minn., 1964.
8. *Integration of Transportation Analysis with Resource Allocation and Scheduling Analysis for Forest Planning.* Forest Service, U.S. Department of Agriculture, 1980.
9. Cooperative Work. In *Forest Service Manual,* Forest Service, U.S. Department of Agriculture, 1976, Section 7713.22.
10. State, County, or Local Subdivision Agreements. In *Forest Service Manual,* Forest Service, U.S. Department of Agriculture, 1976, Section 7715.1.
11. Timber Purchasers. In *Forest Service Manual,* Forest Service, U.S. Department of Agriculture, 1976, Section 7713.25.
12. Maximum Economy Roads. In *Forest Service Manual,* Forest Service, U.S. Department of Agriculture, 1976, Section 7713.3.
13. Contribution. In *Forest Service Manual,* Forest Service, U.S. Department of Agriculture, 1979, Section 7713.31.
14. U.S. to Continue Sales of Timber Below Cost. *The Washington Post,* Sept. 13, 1984.
15. Reconstruction. In *Forest Service Manual,* Forest Service, U.S. Department of Agriculture, 1979, Section 7713.32.
16. Ingress and Engress. In *Forest Service Manual,* Forest Service, U.S. Department of Agriculture, 1978, Section 7713.41e.
17. Maintenance by Forest Commercial and Non-Forest Commercial User. In *Forest Service Manual,* Forest Service, U.S. Department of Agriculture, 1978, Section 7713.13.

Private-Sector Roadway Funding in Texas

WILLIAM G. BARKER AND LARRY C. COOPER

In this paper are examined current use of and issues related to the following seven nontraditional roadway-financing mechanisms in Texas: transportation corporations, road utility districts, municipal utility districts, county road districts, tollways, developer fees, and negotiated improvements and donations.

Texas supports the largest network of publicly financed roadways in the nation: 70,933 mi of state-maintained roadways and approximately 200,000 mi maintained by other government entities. During 1984-1985 Texas spent nearly $4 billion on its roadway system.

The continued urbanization of the state has placed increasing pressure on state and local government roadway funds, and local and state policy makers have looked to nontraditional roadway funding sources and have encouraged the participation of developers and others in private industry. In addition, the development community has sought ways to accelerate roadway implementation. This has resulted in new legislation at the state, city, and county levels to facilitate private sector involvement in roadway development. Although most of these innovative roadway financing methods have been used in other states, some are unique to Texas.

At least seven nontraditional financing mechanisms have been created in Texas: *(a)* transportation corporations, *(b)* road utility districts, *(c)* municipal utility districts, *(d)* county road districts, *(e)* tollways, *(f)* developer fees, and *(g)* negotiated improvements and donations.

TRANSPORTATION CORPORATIONS

Texas state legislation (Article 6 15281, Vernon's Texas Civil Statutes) allows private property owners to form nonprofit, tax-exempt corporations that can accept property and funding donations primarily to assemble right-of-way for highway transportation projects. The legislation also states that such corporations may assist in the planning and design of transportation facilities, and preliminary alignment studies have been done with donated funds. A recent policy statement by the State Department of Highways and Public Transportation (SDHPT) Commission stipulates, however, that the entities are to be viewed as "financing and advisory vehicles only with all decisions with respect to location, design, construction and related matters made solely by the SDHPT" (*1*, p. 11).

A transportation corporation may be formed by the filing of a written application to the SDHPT Commission by at least three qualified electors. The petitioners do not have to own property or reside in the geographic area to be targeted. The petition requests the creation of a corporation that will act on behalf of the commission within a designated area. There is no filing fee or charge for this application, and the geographic area may include territory from one or more of the state's political subdivisions. The commission will then vote on a resolution approving the creation of each corporation. If approved, the corporation will be issued a certificate of incorporation by the Texas Secretary of State.

The corporation is governed by a board of at least three directors who are appointed by the commission. The commission recently adopted a policy statement that prohibits elected officials and persons with substantial financial interests from serving on the boards. Donating landowners, or their representatives, may serve as nonvoting advisory members only. All business meetings of the corporations must be conducted under the Open Meetings Law. The commission may remove board members at will (*1*, p. 11).

Six transportation corporations have been created since 1984, although the commission has appointed a board of directors for only three of these. The lengths of their roadways ranges from 7 to 155 mi (Table 1).

It is too early to comment on the success of the corporation concept in reducing public roadway expenditures. The first corporation, the Grand Parkway Association, has succeeded in obtaining large tracts of donated rights-of-way but is still far from meeting its goals. Because of the size of the proposed Grand Parkway (approximately 155 mi and $600 million), smaller, more recently formed corporations may accomplish their objectives sooner.

ROAD UTILITY DISTRICTS

The Texas Legislature passed the Road Utility District (RUD) Act during 1984. This legislation allows property owners within a designated area to create a legal entity to do any or all of the following: construct, acquire, or improve major arterials or feeder roads to be financed by an ad valorem tax on property within the district. All of the property owners within a proposed district must petition the SDHPT for approval to create a RUD. The RUD acts as an official subdivision of the state.

Petitioners who desire to form a RUD (100 percent of landowners) must pay a $5,000 filing fee to the commission. A five member board of directors is to be elected by voters in the district. Prospective directors must be 18 years of age, Texas residents, and either own land subject to taxation in the district or be registered to vote in the district. Also, with the approval of the affected voters, the district may levy taxes on all property within the district, issue bonds, and collect a maintenance tax not to exceed $0.25 per $100 assessed valuation of property. After the roadway improvements have been made and paid in full, the RUD may dissolve and convey the road to the state, city, or county if there has been prior agreement to do so.

The RUD concept appears to be most applicable when only one or a few landowners are involved because of the 100

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TABLE 1 TEXAS TRANSPORTATION CORPORATIONS

Name	Urban Area	Date Formed	Approximate Length (mi)
Grand Parkway Association[a]	Houston-Harris County	October 1984	155
MoKan Corridor Association[a]	Austin-Travis County and Williamson County	August 1985	31.5
Galveston-Alvin-Pearland Transportation Corporation	Galveston-Brazoria County	November 1985	43
Plateau Region Outer Parkway Corporation	Austin-Travis County	February 1986	7
MoPac South Transportation Corporation[a]	Austin-Travis County	April 1986	8.2
San Marcos Parkway Corporation	San Marcos	May 1986	26

[a]This corporation has appointed directors as of May 1986.

percent cooperation necessary. Its major advantage is that it reduces the burden on a private developer to pay the full costs of roadway improvements. Instead, tax-free bonds are sold and paid for through the special ad valorem tax to spread the costs both over time and among affected users. It is limited by its applicability to only major arterial and feeder roadways.

To date, one RUD in Denton County has been approved by the commission. Another in Harris County is under consideration.

MUNICIPAL UTILITY DISTRICTS

Texas Municipal Utility Districts (MUDs) are established by the State Water Commission primarily to fund the development of drainage-related projects in a district. New state legislation allows a MUD, with the water commission's approval, to petition the SDHPT Commission to acquire powers granted to road utility districts (RUDs). As with the RUDs, 100 percent of the district landowners must petition the commission for this designation. If the petition is granted by the commission, the district calls for an election to determine whether the MUD should exercise road utility district powers. On voter approval, the district must follow the procedures required for RUDs described previously.

The major advantage of a MUD obtaining these powers is that the district with its governing body and taxation powers already exists. It also permits the district to implement a more comprehensive development plan that considers transportation along with drainage, navigation, and other natural resource development.

Currently, no MUDs have formed RUDs under these provisions. However, a MUD in Bastrop County has shown interest in the idea. Another MUD at the Las Colinas development in Irving has received special permission to use MUD taxation powers to fund a peoplemover project connecting office complexes in the planned development.

COUNTY ROAD DISTRICTS

Texas state law allows special county road districts (CRDs) to be established to levy an additional tax for roadway improvements within a district. CRDs are authorized and governed by the elected County Commissioners Court of the county in which the district lies. This court has the authority to develop roadways within the county.

The Commissioners Court can establish a CRD by adopting an order declaring the district established and defining the boundaries of the district. The County Commissioner, in whose precinct the district is located, becomes the road superintendent of the district. All expenditures in excess of $50 must be approved by the full Commissioners Court.

Levy of the special road tax must be initiated by a petition to the court by 50 qualified electors from the district. The court then orders an election to determine whether the county shall levy the tax, which cannot exceed $0.15 per $100 assessed value of property. Majority voter approval is needed to pass the tax. Bonds not to exceed 25 percent of the assessed value of district property may also be issued by the district. Two-thirds voter approval is necessary to pass bond issues.

Several CRDs have been established. The first was the Southwest Travis County Road District One created in 1984. This 7,000-acre district was predominantly woodland and pasture and now plans to spend $20 million to upgrade its arterial system. CRDs are more popular than RUDs because they do not require the 100 percent landowner approval or the establishment of a separate governing body and can be used for any type of roadway. They can, however, meet the intended goal of developing roadways within the district and may be initiated by the private sector with Commissioners Court approval. Indeed, several proposed RUDs have decided to apply as CRDs because of the relative ease of CRD formation.

At least 11 such districts are proposed or in existence in Travis and Williamson counties near Austin. The driving force for their establishment has been local development and lawyers. According to the Municipal Advisory Council of Texas, Texas Municipal Report Index, Austin, Texas, the following counties have CRDs:

Bexar	Kaufman
Bosque	Montague
Bowie	Montgomery
Brazoria	Nacogdoches
Ellis	Sherman
Galveston	Travis
Hays	Williamson
Hidalgo	Wilson
Jasper	

TOLLWAYS

Several toll facilities have been developed through the Texas Turnpike Authority, an agency of the state of Texas created in 1953. In addition, there is renewed interest in private-sector and local government involvement in toll road development. The recently formed Harris County Toll Road Authority was created by the Harris County Commissioners Court and received voter approval for $900 million in bonds in September 1983. Two toll roads are proposed for the Houston area—a 28-mi West Belt Toll Road and a 21.6-mi Hardy Toll Road. Right-of-way assembly has begun, and construction of both roadways is expected to be completed by 1990.

Several other local governments are examining the concept of toll roads to reduce government expenditures. Galveston County currently operates a toll bridge from the west end of Galveston Island and several Texas cities along the Texas-Mexico border operate toll bridges.

Direct private-sector involvement in Texas tollways is currently limited to operation of several toll bridges and a ferry across the Texas-Mexico border. Federal law, the International Bridge Act of 1972, requires that these private bridges be sold to a public agency when their cost plus a modest profit have been recouped. Table 2 gives toll facilities found in Texas.

DEVELOPER FEES

The concept of a local government charging a developer a fee to pay for roadway improvements necessitated by the impacts of new traffic generated by the development is not a new idea. It has been used in several states, for example California and Florida, for some years. Its use in Texas is, however, relatively new, although similar provisions related to utility improvement fees have existed for years.

The cities of Dallas and Farmers Branch (a suburb of Dallas) have passed ordinances that require traffic impact fees to be paid by developers applying for new developments in certain areas of the cities (Parkway Center in northern Dallas and eastern Farmers Branch). Both city ordinances require payments of $0.50 per square foot of office space on a one-time basis as a prerequisite to issuance of a building permit. The collected fees are then to be used by the cities for roadway and traffic signalization improvements in the area affected by the developments.

Under a similar program, the city of Austin requires new developments to issue a letter of credit for a dollar amount determined case by case on the basis by the city staff's determination of traffic impacts and needed improvements before plat approval. Other Texas cities (Garland, Irving, Richardson) assess developers for cost sharing of roadway expenses on the basis of abutting footage or a set ratio of costs based on the type of development (e.g., developer pays 70 percent of arterial costs related to an office complex, 65 percent for apartments, and 50 percent for single-family developments).

Several other Texas cities are currently looking at the feasibility of imposing similar traffic impact fees. Issues related to the legality of such ordinances and the impact that these fees would have on office location are questions now being examined.

TABLE 2 TEXAS TOLLWAYS AND BRIDGES

Facility	Length (mi)	Ownership
Dallas North Tollway	9.8 (+7.4 under construction)	Texas Turnpike Authority (state)
Mountain Creek Lake Bridge	2.1	Texas Turnpike Authority (state)
Houston Ship Channel Bridge	4.2	Texas Turnpike Authority (state)
Cameron County International Bridge	±1	County
Brownsville-Matamoras Bridge	±1	Private
Progresso International Bridges (2)	±1	Private
McAllen-Hidalgo Bridge	±1	City
Los Ebanos International Ferry	±1	Private
Rio Grande City Bridge	±1	Private
Roma International Bridge	±1	County
Laredo International Bridges (2)	±1	City
Eagle Pass Bridge	±1	City
Del Rio Bridge	±1	City
El Paso International Bridges (2)	±1	City
Galveston County Toll Bridge	±1	County
Hardy Toll Road (under development)	21.7	County
West Belt Toll Road (under development)	27.5	County

SOURCE: Texas Turnpike Authority, Mexico-Texas Bridge Association, Harris County Toll Road Authority.

NEGOTIATED IMPROVEMENTS AND DONATIONS

It appears to be quite common for developers in major Texas cities to negotiate with city transportation or planning staff to help provide needed roadway improvements in the area of the new developments. Developers in Dallas, for example, negotiate directly with the city on what roadway improvements they will provide as a provision to their certificates of occupancy. This can include new roadway construction, roadway upgrades, traffic signalization, and intersection improvements. The specifics of those requirements are given in the city ordinance permitting development construction. Austin, Houston, and San Antonio use similar negotiable procedures.

Developers in several Texas cities and counties have set a precedent of donating land for prospective road rights-of-way to cities that in turn present it to the state to encourage new state roadway projects in growing areas.

In San Antonio, $3.3 million in right-of-way of a $122.5 million project to construct State Highway 151 (Northwest Freeway) was donated by the private sector through local government. Forth Worth officials have recently offered $6.3 million worth of right-of-way toward construction of State Highway 121 (Southwest Freeway). San Antonio and Bexar County have also offered the state right-of-way donations estimated at $18 million toward construction of an 18-mi roadway to extend US-90 west of San Antonio northward to State Highway 16. At the Woodlands, a planned community in

TABLE 3 INNOVATIVE ROADWAY FINANCING MECHANISMS IN TEXAS

Name	Authorizing Body	General Purpose	Geographic Area	Confirmation Election Required	Funding Mechanism	Initiated by	Examples
Road Utility District (RUD)	State Highway and Public Transportation Commission	Construct, acquire, improve arterial or main feeders only	County, city or part or combination; not required to be contiguous	Yes	Bonds (⅔ voters approval) $0.25 per $100 assessed value for maintenance bonds from 20 to 25% of land values	All landowners	Denton County Proposed in Dallas, Austin, and Houston
Municipal Utility District (MUD)	Texas Water Commission; may petition SDHPT Commission to acquire RUD powers	Preservation of all natural resources	County, city or part of combination; not required to be contiguous	Yes	Bonds (majority voter approval)	Majority in-value landholders or by 50 persons	Bastrop County
Transportation Corporation	Texas State Highway and Public Transportation Commission	Promote, develop public transportation facilities and systems; secure and obtain rights-of-way; assist in planning and design; assist financing state highways	All or part or combination of political subdivision of the state	No	Bonds or donation	Three or more qualified electors in area	Grand Parkway (Houston) and Galveston-Alvin-Pearland
County Road District	County Commissioners Court of County	Construct, acquire, maintain, operate roads and turnpikes; privately constructed roads purchased	All or part of county or contiguous counties	No	Bonds up to 25% of land value; bonds (⅔ voter approval); road tax based on property value (majority voter approval up to $0.15 per $100 assessed value tax)	Commissioners Court; 50 voters in district petition road tax election	Southwest Travis County and Williamson County
Tollways	Texas Turnpike Authority, city, county, political subdivision, or private	Develop, operate, maintain transportation facilities	City, county or political subdivision or private land	No (yes if bonds issued)	Bonds or user fees	City, county, political subdivision, private landowners	Dallas North Tollway; Mountain Creek Lake Bridge; Houston Ship Channel Bridge; Ham's County Toll Authority; Galveston County Toll Bridge; and Rio Grande River Toll Bridges at El Paso, Laredo, Del Rio, Eagle Pass, Roma, Hidalgo, Progresso, and Brownsville
Traffic impact fees	City, county	Develop transportation facilities to reduce impacts of new developments	City, county or defined part thereof	No	Fee paid by developer, developer-funded improvements	City, county	Farmers Branch (eastern), Dallas (northern), and Parkway Center (Austin)
Negotiated improvements	City, county	Develop transportation facilities to reduce impacts of new developments	On or adjacent to development site	No	Developer-funded improvements	City, county in agreement with developer	Dallas
Developer donations	City, county	Expedite thoroughfare improvements	Any	No	Donations to city or county then to state	Local government and developers	Fort Worth, San Antonio

Montgomery County north of Houston, a 1983 Minute Order by the State Department of Highways and Public Transportation allowed local businesses and governments to contribute land and finances to speed improvements bordering Interstate 45.

CONCLUSIONS

Table 3 gives a summary of the financing methods described in this paper. Although many of these methods have been used in other locales, a few are unique to Texas.

Involving the private sector in project funding has resulted in an attendant interest in accelerating project implementation. Because "time is money," a developer is willing to donate funds to advance a project's schedule.

The practicality of the new schemes has yet to be clearly established. Some limitations are

- The inability of developers to deduct local taxes from income tax when such taxes directly benefit the taxpayer,
- The concern that roadway alignments and priorities are overly influenced by the location of large parcels of land, and
- The risk of relying on property value increases to fund roadway projects.

On the other hand, it is also evident that new approaches to funding are evolving. Although there may be some shortcomings in these new approaches, experience in their application should result in refinement of these approaches.

REFERENCE

1. *Transportation News*. Texas Department of Highways and Public Transportation, April 1986.

Private Enterprise and Highways

ALFRED GOLDSTEIN

In the activities required to create a highway—identification, promotion, land acquisition, design and construction, operation, maintenance—there is a spectrum of possibilities for involvement of the private sector and market processes. The current position in the United Kingdom is described and on that basis, with some wider generalization, future possibilities are analyzed. Highway maintenance is progressively moving to the private sector. There appears to be no reason why most of the maintenance program for main roads could not be delegated to the private sector. A preferred method is outlined. For highways generally, statutory position limits the degree of market provision. It is argued that Parliament would not generally provide powers of compulsory acquisition of homes to private enterprise. Hence the market alone cannot be expected to provide new roads. Some possibilities for the government and the private sector acting together so that the latter could become more involved in highways are explored. An experiment with private funding that was finally declined by government is described. It is argued that this experiment was not necessarily representative and that further trials should take place. Estuarial and river crossings, about which public attitudes appear to be different, provide much scope for privatization. Government would underwrite the requisite statutory powers and could call for bids for the design, construction, operation, and maintenance of the project. The bids would effectively be the tolls required by the bidder, to be collected either directly from users or from the government on the basis of vehicle counts. The Channel Tunnel and the Dartford Crossing of the Thames are examples.

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Activities involved in the creation of a highway may usefully be categorized as

1. Identification of a viable route,
2. Promotion,
3. Acquisition of requisite land and other rights,
4. Design and construction,
5. Operation, and
6. Maintenance.

These activities may be grouped into three stages: Activities 1–3 are the preconstruction stage, Activity 4 may be termed the construction stage, and Activities 5 and 6 are the postconstruction stage. In the following discussion these stages will be treated separately. Also, the provision of highways by the private sector is considered a possible part of the highway network, not a substitute for the status quo.

"Privatization," in the context of highways and at the present time, covers a spectrum of possibilities. At one extreme all of the activities for a highway are implemented by private-sector enterprises using the market mechanism. Activity 2 would then relate to the establishment of sufficient capitalization for the enterprise. At the other extreme all activities are carried out by government (national or local), that is, the public sector. Activity 2 then relates to achieving a measure of consent.

At present in the United Kingdom there is a mix of government and private enterprise involvement. For most roads, all but Activities 4 and 6 are wholly or mainly within the domain of government. Construction is generally carried out by private firms of contractors. Design is sometimes done by government but often by private consultants. Until recently maintenance has generally been carried out by the public sector, often using direct labor (i.e., "force account") and sometimes contractors. Throughout, government maintains its role in setting standards and enacting regulations.

UNITED KINGDOM PERSPECTIVE

As this paper is inevitably written from a United Kingdom perspective, a discussion of some of the relevant attributes of the highway scene in the United Kingdom is in order.

Britain, a small island with high population density, has a dense and pervasive highway network. The first motorway construction program is coming to an end *(1)*. With some exceptions, such as in Glasgow and Leeds, most of the new roads are interurban. Comparatively little new highway construction has taken place in cities—virtually none in London.

As car ownership increased after World War II, demands for new roads increased, but financial stringency prevailed and it was not until December 1958 that the first modest (8-mi) stretch of motorway was opened, and the "1000 miles motorway programme" got under way. This was essentially an interurban program and it was realized that urban roads would need to be added to it. Until the end of the 1960s there was a large measure of consensus about the desirability of new roads, both rural and urban. This position has changed increasingly since the early 1970s.

As is the case in a number of other developed countries, increasing environmental and other concern in some sections of the community manifested itself as hostility to plans for new highways, especially within cities. As a result, substantial proposals for new roads in towns were abandoned. More recently, a number of new studies of road improvements in cities have been mounted. The time taken for statutory processes enabling construction to proceed has become extremely long (10 to 15 years between initial survey and start of construction are not uncommon) *(2)*.

There is no recent history of significant private road building in Britain. By the late middle ages, the system of Roman roads had fallen into a sad state of neglect. The dissolution of the monasteries, which had maintained roads in their neighborhoods, hastened road decay. The Highways Act of 1555, noting that the roads were "very noisome and tedious to travel in and dangerous to all passengers and carriages" laid the responsibility for upkeep on the Parishes. For 4 (later 6) days between Easter and Midsummer landowners had to provide labor, horses, and tools; householders and laborers had to work themselves or provide substitutes. Fines were payable in default. This was, in effect, a system of forced or, as it became known, statutory labor.

As might be expected, that system did not work well. By the mid–17th century road conditions were worse than ever. This led to the creation of the Turnpike Acts (the first in 1663) that incorporated tolls. These were private acts of Parliament that established toll road trusts on petition from groups of local citizens. The trustees would set tollbars or tollgates at each end of the road in question and levy charges on the users. By 1829 there were more than 1,100 such trusts controlling nearly 20,000 mi of road. It was "privatization of highway maintenance" in almost a strict sense (the charges levied were defined in the act and could not easily be changed).

Though the system was quite successful in substantially improving the state of many roads, the financial results were, overall, disappointing for the trustees. The initial 21-year duration of the acts was increased to 31 years in a vain attempt to improve out-turn. By 1830 the total debt of the trusts was £8.5 million of which £1 million was unpaid interest. The advent of the railway hastened the end. In 1864 a parliamentary committee recommended handing over the trusts to public authority. For more than 100 years now, virtually all roads in the United Kingdom have been in the domain of government and the Queen's Highway has been free of direct user charges.

It should be added that tolls on bridges have survived rather better and that there are a few privately owned bridges. Interestingly, public attitudes toward bridges or tunnels appear to be rather different from those toward highways. The kind of objections often heard during public inquiries on highway schemes are seldom encountered on estuarial or river-crossing schemes.

Since the advent of the present United Kingdom government, encouragement of private enterprise and privatization of various publicly owned enterprises have been policy. In transport infrastructure, the proposed Channel Tunnel and the intended privatization of the existing Dartford Tunnel are cases in point.

CAN THE MARKET ITSELF PROVIDE?

Leaving aside, for this paper, political philosophy, the following main advantages of greater privatization are advanced:

- The same outputs would be achieved with less input as measured by money, time, or physical units (productive efficiency).
- There would be less misallocation of resources, hence less economic distortion, through greater use of the market mechanism (allocative efficiency).
- Because funding would be external to the Treasury exchequer (i.e., not included in the Public Sector Borrowing Requirement) more roads would be built, or roads would be built earlier than would otherwise be the case, to the benefit of the community.

For this paper, these propositions are taken as given.

For a private enterprise to "supply" a road (i.e., carry out all of the stages mentioned previously) there are at least two prerequisites:

- The road would have to be financially profitable and
- The enterprise would have to obtain authority to build.

Whether or not a new interurban toll road in the United Kingdom would be financially profitable to the enterprise is arguable, given the existing free network. Certainly the possibility cannot be excluded, though it may well be that there is more scope in the case of urban or semiurban roads with their denser traffic flows. The question, however, does not need to be addressed for two reasons. First, if all of the facilities the market was to provide were in fact available and the market did not provide, it must be assumed to know what it is doing. Far from being a failure, this could be a market success—avoiding productive or allocative inefficiency. Second, the facilities are not indeed present and, for the reasons advanced later, are quite unlikely to become available in the United Kingdom.

Authority to build would need to be acquired by normal private acts of Parliament. The powers thus granted would have to include powers of compulsory acquisition of property, as is the case when government or its agencies build public works. To rely on acquisition by negotiation—the enterprise paying sufficiently to persuade all unwilling vendors to sell—would render the whole effort nugatory.

Studies of householders' surplus (the difference between the price at which a householder willingly sells and the market price) have indicated that there is an irreducible minority that will not sell. There are examples, both in the United Kingdom and the United States, of householders who have been determined not to sell and have withstood the great nuisance (and sometimes reduction of property value) of major private development being built around them. For the author, this was epitomized by a charming 80-year-old widow living in a lovely "Rose Cottage" who very naturally had no interest whatever in even discussing a possible sale. The alternative route would cost an extra £250,000 (1965 prices); the market price of the cottage was perhaps £15,000.

The power to acquire compulsorily would have to be accompanied by "house rules" regarding compensation. In the United Kingdom this would be market price, sale costs, disturbance costs, and a conventionally formulated home-loss payment. In the absence of agreement between the parties, the statutory Lands Tribunal would settle the values. No such generally applicable compensation code can be universally equitable. Householders' surplus varies substantially across the community and the unwilling seller of his home would be manifestly a loser.

Whether or not a private enterprise would obtain the requisite powers from Parliament to build a road would depend on attitudes in the community. Attitudes toward a person's home and land ("real property") can be distinguished from attitudes toward other ("personal") property. For example, the law treats land matters differently from others. It may be atavistic, but land—and especially its compulsory acquisition—is seldom other than an emotional issue. Free market provision assumes that government itself would not substantially intervene. In such circumstances this author does not believe that Parliament in the United Kingdom would grant such power as to enable a private enterprise to promote, build, and operate a new highway "for profit" (as it would be represented).

Against this view could be advanced the precedent of the railways in the 19th century. In the United Kingdom they were promoted, built, and operated by private enterprise using Parliamentary bills to obtain powers. (Interestingly, the first, worldwide, motorway proposal was the private London-Brighton Motorway Bill, lodged in Parliament in November 1905. An extraordinarily farsighted measure, it was not followed through for reasons that can now be only speculative.) But times change. The railways were built at a time when all new technology was usually perceived as manifestly in the public interest. Population and built-up areas were less. Fewer homes had to be compulsorily acquired. The early railways had opened economic and social horizons for nearly all people by orders of magnitude. Promotion of new railways, and their Parliamentary bills, became a lively and extensive "industry"—it was not accidental that leading engineers had their offices near Parliament. Few bills were rejected; most of the rejected ones had been opposed by other, existing, railway companies for commercial reasons. It has been stated that at the height of the railway era, half of the Members of Parliament had railway interests. Attitudes were very different then. Present attitudes and circumstances lead to the view expressed here. Whether attitudes may change with time to enable future roads to be established by the free market and private enterprise must be a more open question. In the United Kingdom there is no significant evidence of such changes.

In other countries, where population density is less, population is more mobile, and attitudes toward individual property rights are different, circumstances may well permit market provision of highways with government involvement limited to only benevolent encouragement and subsequent statutory protection. But the very characteristics that may ease the previously mentioned land problem (e.g., lower population density) may make profitable routes more elusive. That may be the situation in some developing countries where the generation effect of a new highway is its main economic justification.

In such cases, the private enterprise considering investment in a new road would need to look to revenue beyond toll income. Development gain on land acquired with the highway land itself may offer possibilities. There are historic precedents for such internalization of external benefits in the case of railways, and more recently in the case of transit stations *(3)*. Little in this area appears to have been done in the case of highways. It is a possibility worth active exploration, but the time scale would be long, hence political stability would be essential.

THE MARKET AND GOVERNMENT TOGETHER?

In the foregoing the market has been considered in a rather strictly defined sense, so as to remove from further consideration possibilities that in the author's view would not be practical. That is far from saying that there cannot or should not be greater private involvement. Before the public-private mix of highway activities is considered, two kinds of government involvement in that mix may usefully be distinguished.

First, government could limit itself to the provision of statutory powers for the selected enterprise and the enactment of regulations—including if thought necessary the setting of operational limits (e.g., maximum unit tolls). It could call for bids—positive, negative, or neutral—for all other activities. It would in this way set the legal and administrative framework within which the market alone would be encouraged to operate.

Examples of that approach in the United Kingdom are the Channel Tunnel and the recent call for bids for the taking over by private enterprise of the two existing toll road tunnels under the Thames at Dartford coupled with the provision of a third crossing. It is noteworthy that government intends to proceed by act of Parliament without the usually protracted local public inquiries. Certainly the latter would normally be inconsistent with the tempo required by viable private enterprise.

There are few if any conceptual or systemic difficulties in such a procedure and there are clear advantages. Though both the Channel Tunnel and the Dartford crossing are rather special cases, discrete river and estuarial crossings appear to be suitable for this approach: the property taken is comparatively small, environmental disbenefits are limited, and public attitudes toward such projects are and have for a long time been different from attitudes toward major roads. Also, even where government carries out such schemes under the normal Highways Act, the river or harbor authorities have long-standing statutory powers. Often government must therefore use some form of parliamentary procedure in any event. For such schemes, adoption for the entire procedure of what are known as Parliamentary "hybrid" bills would not be considered so exceptional, but such procedure for the whole program of new trunk roads would not be practical. A more limited approach, using hybrid bills for a small specific number of urban roads, might be feasible.

The second kind of government involvement is the provision of statutory powers and entry into the public-private mix of activities as outlined previously. In the next three sections possibilities for altering the existing mix within the three stages involved are considered.

PRECONSTRUCTION STAGE

Given that government requires a road from A to B, specifies the physical standards, and later ensures statutory authority to build, there is little reason in principle why it could not at that stage call for bids from the private sector for a package including the construction stage (also maintenance) and most if not all of the preconstruction stage activities.

In the United Kingdom this would not be feasible in practice. The main reason is that, with existing highway legislation and procedures, government could not specify the "product" for which it was seeking bids with sufficient certainty to enable sensible, equitable, and firm bids. Two examples suffice:

- The preparatory and statutory procedures could take anything from 5 to 15 years; both the actual duration and the required resource intensity during that period are unpredictable.
- In a fair proportion of schemes, both the alignment and some material details of the road must be changed as a result of, inter alia, public inquiries.

Were government prepared to use Parlimentary bills, many though not all of these objections would be mitigated. Deposited plans for bills have wide though specified limits of deviation, and procedures in Parliament normally take 12 months only (at the time of writing, increasing procedural objections against the Channel Tunnel Bill indicate that the time scale may be rather longer). However, it must be added that to attempt such a change of procedure generally would be an act of bravery, if not heroism, by any Secretary of State for Transport. Public opinion would be unlikely to support him. Parliament itself does not take kindly to considering specific bills when the authority and procedure for the project are already available in existing legislation.

For a more limited objective of, for example, a small number of specified roads in London, Parliamentary bill procedure may become workable. At some stage, a United Kingdom Government may decide that a small number of new roads should be built in London. If it decides to seek powers using the normal Highways Act, two matters arise. First, the time between that decision and contractual commitment to build will be such that the contract stage will be reached not in the life of that government, not even in the life of its successor, but perhaps in the administration after that. Whether policy can survive such changes is doubtful. Second, for the reasons mentioned, the scope for increased private-sector involvement would therefore be limited. If government proceeded by hybrid bill, the outcome would be more (though not entirely) certain. Government would then also have the option of adopting more private-sector involvement. But, as is seen in the next section, the omens are not promising.

CONSTRUCTION STAGE

Enterprises could bid for constructing and maintaining the road on the basis of collecting "tolls" for, say, 25 years rather than conventional payment. It would be the unit toll values that would form the substance of the bid. In countries where toll roads were normal there could be actual toll collection. In other countries, such as the United Kingdom, government could pay the enterprise a toll for each vehicle counted (automatically) using the road. The enterprise would thus take the risk of usage. Government would have the advantage of deferred payment, which would be based on a measure of utility. This would be a modest step to greater private involvement. The advantage of funding external to the Treasury exchequer is captured by this method.

In 1983–1984 there was an effort in the United Kingdom by the West Midlands County Council to mobilize this method *(4)*. The "Black Country Route," a 7-mi dual carriageway traversing an industrial area, was in the process of detailed design and specification and had high local priority. Using conventional funding from the Department of Transport program, however, priority was less and completion was not expected for 10 to 12 years. By virture of "toll-bidding" it was expected to halve this time using private-sector finance.

The council had reached an agreement with one consortium (a bank, a national contractor, and a finance company) whereby the latter would bid on a toll basis, effectively a royalty arrangement to last 25 years. The actual construction contract was intended to be let to tender by the consortium. Government was asked for authority to proceed. If authority were granted, government would be committed to 70 percent of the final cost including royalties. The proposal was rejected.

Details of the rejected proposals have not been published. The departmental press statement quoted the minister as saying that "proposals for private financing of this scheme are not acceptable . . .," and the departmental view was that they "contained unacceptable financial uncertainty and risk. . . ." At the time, the view in the industry was that government had found the proposal too costly compared with conventional funding. The council had estimated the final cost of the proposal at between £87 million and £123 million before contracts were signed and any private finance became involved. The scheme had been earlier referred to elsewhere as a "£30 million road" (conventional price estimate). Departmental estimates based on a firm bid are not publicly known.

As stated in a recent paper by Osborne *(5)*, financing cost in the private sector is bound to be greater than the borrowing cost to government. Also, the target return for the investment will be higher than that provided by government securities because the former is subject to market risk. Whether or not the efficiency of the market and private sector can make sufficient inroads into these acknowledged ex ante differences is the real question. What is certain is that government would be mistaken if by deploying private-sector funding and enterprise it expected a "free lunch." Osborne's principal conclusion *(5)* is "that Government (or at least the civil service) is not truly committed to the idea of private finance for public sector infrastructure. It seems to us that Government is having difficulty in striking a balance between the unviable project and the bonanza . . . so as to yield a reasonable return on investment for the risk and expertise involved."

A further advantage of the proposal was said to be that the consortium would take the whole construction cost risk whereas conventionally in the United Kingdom a significant proportion of that risk is taken by government under the terms of the normal construction contract used for highways. But that advantage cannot be claimed as linked solely to the proposal. If government wished to avail itself of such facilities it could write its conventional construction contracts accordingly.

The negative result of this proposal was disappointing, but this sole example does not offer a sound basis for concluding whether or not such schemes are beneficial. There are at least two reasons for that. First, competitive toll bids from several consortia were not obtained. Second, it is known that government was concerned about the possibility of too high a royalty cost and the consortium about too low a revenue. It is understood that the proposal incorporated lower and upper cut-off points.

Before conclusions can be drawn about the viability of such private financing of new roads, competitive bids without cut-off points should be invited. Whether or not the market would deliver such bids may be speculative.

For such further experiments it could be desirable to include the detailed design activity in the bidders' obligations. If the centerline of the road has been established and the land acquisition settled, or nearly so, there is no compelling reason why this should not be tried. It would not materially increase private involvement in the United Kingdom because design is already carried out mostly by private firms, but it could be more attractive to bidders.

Two conventionally funded highway schemes, where the department already owns the requisite land, are about to be the subject of experimental "design and build" bids. Ideally such bids should include maintenance for a long period (12 years is being considered), but it is understood that the period will be open to offer by the bidder. The results of these experiments will not be available for a considerable time but will be awaited with interest. A claimed advantage of this system, viz less construction risk to government, is not an advantage generated by this system alone.

POSTCONSTRUCTION STAGE

In relation to highway maintenance, which is traditionally the province of the public sector (local government in the United Kingdom) and is often done by direct labor ("force account"), much is already happening with the objective of deploying greater private-sector input. The Local Government Planning and Land Act (1980) has since April 1981 required direct labor organizations to tender for work in competition with the private sector. Since then government has progressively lowered the threshold level of cost above which such tendering is compulsory.

Consultants have been and are increasingly being appointed to manage the maintenance of long stretches of roads. The site work is then done by contractors. "Lane rental" schemes have been developed and found a useful technique.

The original lane rental schemes involved a contractor bidding time as well as price. He was then paid a bonus if early or charged a rental if late. The rental rate was a proxy for the delay costs to the traveling public. Later schemes charged the contractor a rental from the beginning, which he allowed for in his bid. Such a rental could be either "overall" or "lane by lane" depending on how many lanes were rendered inoperative by the contractor. Early reports of the results of these schemes appear to be favorable.

There is clearly much scope for deploying the market and the private sector in highway maintenance. This is especially the case in developing countries where most highway maintenance is done by force account. Studies in such countries have shown that the value of the existing highway asset base is often sharply declining as a result of poor or insufficient maintenance. Studies have also shown that the unit costs of maintenance by force account are far from those achievable by private enterprise.

Even where contractors are employed, the conventional method—unit price payment for detailed activities that the contractor is instructed to carry out by the supervising agency—may not be the best procedure. More trials should be made of a "per kilometer" method, which is quite consistent with the deployment of market processes.

The per kilometer method is one whereby the contractor bids for a long-term contract to keep a substantial length of road

"convenient to the user" for a rate of payment of £X per, say, month. The level of these rates would be "profiled" over the duration of the contract, either by the bidder in his offer or by the employer in the specification using normalized indices. "Convenient to the user" would be specified not by telling the contractor what he has to do but by setting up objectively measurable criteria and defining exactly how they are to be measured. For example, the contract would not require the contractor to rod drains or clean gullies. It would require the pavement surface to be clear of accumulated water and would spell out the test that would establish whether or not the pavement passed or failed in that respect. At specified frequencies, which would have tolerances and could vary over the year, a monitoring team would inspect the road and if any of the tests were failed the month's payment would be forfeit. (A more complicated method would be to have a sliding scale of forfeiture depending on the number and kinds of tests that were failed). The normal sanctions for successive nonperformance would apply. The profile of monthly payments would mitigate "gaming."

The crux of such a system is whether or not practical objective and readily determinable tests can be established. Such tests need be only proxy for the required quality but need to give unequivocal results. It is fair to add that opinion appears to differ among maintenance experts as to whether or not such tests can be established. The author is advised that with a reasonable amount of preparatory work in the country (standards will of course differ) it should be possible to devise the tests and requisite form of contract.

Development and fairly extensive trials of this system are advocated because, if a successful and widely applicable method of this kind emerges, there will be considerable advantages in its deployment, not only in developing countries. Among such advantages would be the generation of expertise for achieving the ends of maintenance among contractors who would not be instructed by the government employer as to means. Contractors would of course engage and retain the necessary technical expertise. The role of government, or its supervising agency, would be to monitor contractual compliance and implement sanctions in the event of failure. That appears to be preferable to the status quo.

Finally, under the rubric "operation" of highways, the main function other than maintenance is policing. Though conceptually highway policing could also be delegated to the private sector, it would undoubtedly be unacceptable to the community and is not considered further.

CONCLUSIONS

This paper is based on circumstances in the United Kingdom, and is in effect a report from the United Kingdom to the conference. But it may be of wider interest. In countries that share the relevant attributes, conclusions are likely to be similar. The absence of such attributes and the constraints they offer would correspondingly offer wider possibilities.

In the maintenance of highways, private enterprise and the market mechanism can be extensively deployed. Prima facie there appears to be no compelling case for the use of anything other than private enterprise on the main highway network.

For design and construction, where private enterprise is already extensively deployed, there appears to be scope for further trials of funding by the private sector with revenue from government based on the usage of the highway and the unit rates the main subject of the bid.

For particular river or estuarial crossings, the "set pieces" so to speak, there is considerable scope for government to carry out prompt statutory processes and invite bids for other activities from the private sector. This may also apply to a limited number of urban roads.

For highways generally, if government can underwrite the statutory requirements, there may be scope—but if so it would be modest—for increasing the contribution of the private sector to the preconstruction stage activities.

The market alone cannot supply highways in the United Kingdom.

In several countries circumstances are currently favorable to the wider deployment of market processes and private enterprise in highways. Accordingly,

- The opportunity should be taken to try out many variants of such deployment. Not all will be successful but those that are will provide a valuable addition to the repertoire of highway methods.
- It is essential to take the opportunity to monitor carefully, over a long time, both the methods and the results so that after the event conclusions about their validity may be soundly based.

REFERENCES

1. D. Starkie. *The Motorway Age*. Pergamon Press, London, England, 1982.
2. A. Goldstein. *Highways and Community Response*. 9th Rees Jeffreys Triennial Lecture. Royal Town Planning Institute, London, England, 1975.
3. L. E. Keefer. Joint Development at Transit Stations in the United States. *Transportation*, No. 12, 1985, pp. 333–342.
4. *Black Country Route*. Summary of Submission to the Department of Transport. West Midland County Council, Birmingham, United Kingdom, July 1983.
5. A. Osborne. Project Finance. Presented at Third Congress of Civil Engineers, The Institution of Civil Engineers, London, England, April 1986.

Phasing in the User-Pays Concept on Urban Freeways: The Privatization Strategy

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There is a role for the private sector to play in helping to solve what one transportation economist termed the "plague of the century," urban traffic congestion. For a variety of reasons, increasing the number and capacity of freeways as a means of reducing traffic congestion is unlikely. Similarly, meliorist traffic- and driver-management techniques are limited as long-term solutions to this problem. The expansion of public transit also lacks promise as a long-term solution. The introduction of the user-pays principle could make a significant contribution to ameliorating traffic congestion if a politically feasible strategy to phase in the user-pays concept can be developed. The successful application of privatization to other public services suggests that a privatization strategy may have an excellent chance for success. Such a strategy is outlined and incentives, which might overcome the opposition of interest groups that have hitherto opposed the user-pays concept, are suggested.

More and more of America's large cities and major metropolitan areas face traffic congestion that significantly reduces the quality of urban life and threatens their economic vitality (*1*, p. 2092). Traffic congestion may be the major transportation problem of the late 1980s and early 1990s according to C. Kenneth Orski, former Associate Administrator of UMTA and currently a transportation consultant *(2)*.

Public officials from large cities such as Los Angeles predict regular gridlock by 1990 *(3)*. However, some prominent transportation economists reject this possibility, arguing that when traffic reaches a certain threshold level, commuters and businesses will seek to relocate their economic endeavors to less congested areas. They predict, instead, central city stagnation and more decentralized development rather than regular gridlock.

Transportation economists indicate that a major reason for much peak-hour traffic congestion is that vehicle users pay for road use indirectly through license fees and the gasoline tax. Such indirect pricing fails to take into account the location and time of use. Thus motorists consider only their own time costs and not the time effects on other users (*4*, p. 3) or what some economists term "congestion externalities" *(5)*. As economists have shown, beyond a certain threshold point the addition of more motorists to the traffic flow has an increasingly cumulative effect on traffic congestion.

To reduce peak-hour congestion, traffic engineers and public officials have traditionally sought to expand the supply of roads to meet peak demand. In recent years, however, budgetary constraints and environmental concerns have slowed new construction, so engineers and public officials have sought to reduce traffic congestion through the use of more efficient traffic and driver management techniques as well as the fostering of public transit.

More than 20 years ago, a few courageous economists began to research the feasibility of another approach to reducing traffic congestion: the application of direct pricing to road use. Transportation economists generally have agreed that direct road pricing could significantly reduce traffic congestion, although a number of problems would have to be addressed and resolved. By the mid-1970s, UMTA was sponsoring research and seeking to implement a direct road-pricing demonstration project.

In spite of the generally strong endorsement of transportation economists (*4*, p. 1) and the willingness of UMTA officials to sponsor road-pricing experiments, the direct road-pricing movement screeched to a halt. As one of the first economists to suggest direct road pricing, Alan A. Walters, observed (*6*, p. 50):

> [T]he main and abiding failure has been on the political front. . . . Road pricing has been a progeny of the technocrat or even the administrator, but politicians have generally disowned it.

Thus the major obstacle to road pricing in the United States appears to be one of political feasibility. As UMTA learned in its unsuccessful attempts to set up a direct road-pricing demonstration project in three U.S. cities, opposition to road pricing arose from several different transportation interests who were, for the most part, impervious to strong economic arguments.

Within the next few years, a new approach to the delivery of public services may provide or add enough additional incentives and advantages to overcome the strong opposition from these interests and to garner support from the general public. This approach is known as privatization, the transfer of services and assets from the public to the private sector. The successful application of privatization concepts in both U.S. local and state governments and in Britain at the local and national level suggests that there may be untapped resources with which to generate additional incentives to overcome the opposition from interests opposed to direct road pricing.

TRAFFIC CONGESTION BECOMING INTOLERABLE

The severity of traffic congestion in some urban areas is indicated by congestion that may begin as early as 5 a.m. or 6 a.m. and that often lasts until midnight on some freeways in Dallas, Houston, Los Angeles/Orange County, and Long Island (*1*, p. 2092).

The environmental costs are also becoming increasingly high. According to one Urban Institute researcher (*7*, p. 5):

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> In some areas where dense traffic occurs primarily at peak periods, traffic congestion and large volumes of carbon monoxide emissions go hand-in-hand. In most cities, peak period traffic accounts for about one-third of total traffic in an eight-hour period; as a result, reductions in peak traffic alone will substantially reduce carbon monoxide pollution.

In Los Angeles, pollution generated by just 10 percent of daily traffic (upwind, morning, and peak hour) may be responsible for 40 percent of vehicular smog and congestion (*8*, p. 1).

There is certainly reason to expect that traffic congestion will have increasingly serious effects on particular businesses. For example, the effect on central city retailers may be quite detrimental (*9*, p. 91):

> Shoppers are increasingly discouraged from entering the city centres by time wasting congestion. This means that those whose time is valuable are the first to attempt to buy their goods in less congested suburban centres, while it is those whose time is least valuable who tend to shop in congested areas.

The effect of severe congestion may also lead to limited-growth measures that cannot help but retard overall economic development. In Los Angeles, for example, several powerful city council members spearheaded a successful initiative, passed on November 4, 1986, to impose strong restrictions on future development in order to prevent worse traffic congestion *(10)*.

OTHER SOLUTIONS LIMITED

Four basic approaches have been used to relieve traffic congestion. The first, increased supply of freeways and highways, has had limited success for several reasons. These include environmental concerns, increasing construction and operations costs, budgetary cutbacks, and the perception that newly built freeways rapidly reach high levels of congestion.

A second approach has been the development of increasingly sophisticated traffic management techniques such as freeway information displays and ramp meters. Many traffic engineers assert that ramp meters improve traffic flow. On the other hand, freeway meters reallocate much of the congestion to on-ramps and feeder streets *(11)*. Another traffic management technique is the designation of special traffic lanes for buses and carpools. But, as California learned in its reserved "diamond" lane experiment in the mid-1970s, initial political opposition from motorists and the media can bring such experiments to an abrupt halt. Moreover, even with buses and carpools, such reserved lanes may remain underused (Ward Elliot; Fumbling Toward the Edge of History: California's Quest for a Road Pricing Experiment; undated, unpublished paper; Claremont-McKenna College, Claremont, California; p. 10.)

A third approach consists of driver management techniques. These include urging employers to institute flextime and employee carpools and vanpools. But, as was seen in Los Angeles, government exhortations have had little effect in reducing congestion in any long-term sense.

Expansion of public transit is a fourth approach pursued by many transportation engineers and public officials. One such measure is to subsidize public transit fares. However, few motorists appear to be ready to abandon their automobiles even given significant fare reductions.

Another public transit approach is to build huge heavy rail transit projects, but rider projections have traditionally "overestimated patronage and underestimated costs" *(12)*. Moreover, the touted Washington, D.C., subway, for instance, provides service at an exhorbitant cost of $10 per ride according to UMTA *(13)*.

In sum, relief of traffic congestion by a significant increase in the supply of freeways and highways is unlikely. Although traffic and driver management techniques provide some short-term relief, they will not provide a long-term solution. Finally, the expansion of public transit as a means of relieving traffic congestion also appears to be unpromising.

DIRECT ROAD-PRICING SOLUTION

Superiority of Direct Pricing

Only if indirect road pricing is replaced with direct road pricing will there be continuing economic incentives for avoiding peak-hour use of roads. As Gabriel Roth argues (*9*, p. 89),

> Since it is impossible to meet unlimited demand without congestion, there are only three alternatives: either regulation, restriction by congestion, or road pricing.

The need for continuing (and thus long-term) incentives is one of the main lessons of the Los Angeles Olympics. In Los Angeles, short-term measures, including voluntary agreements with the business community and appeals to the public, did reduce traffic congestion by a small percentage for the first week or so. Even this small reduction in the percentage of traffic volume caused substantial improvements in traffic flow *(14)*. Direct road pricing would provide ongoing, long-term incentives and, as demonstrated in Los Angeles during the Olympics, it would only have to reduce peak-hour traffic by a small percentage in order to produce significant improvement in traffic flow.

Transportation economists have demonstrated that direct pricing of roads could substantially reduce urban traffic congestion during peak periods and would have beneficial effects on pollution, noise, and neighborhood intrusion (*15*, pp. 101–103). Because direct pricing has the advantage of taking into account the time, location, and degree of impact of road use (*15*, pp. 112–113), employees least in need of regular work hours, for example, will have an ongoing incentive to commute during off-peak periods (*11*, p. 306). This is not likely with indirect road pricing. As Gabriel Roth wrote (*16*, p. 54),

> The imposition of additional charges at peak times is beneficial in that it promotes the better use of scarce resources. Peak charges are taken for granted in the telephone and electricity services, although for psychological reasons they are described in terms of "off-peak reduction" rather than "peak hours increases." But the principle is the same.

In addition, direct pricing provides a better indicator of whether new capital investment should occur. Direct road pric-

ing will better permit market considerations rather than political considerations to determine the extent of response to demand for new freeways in a given area (e.g., double-decking existing freeways). Indeed, if congestion continues in the face of full-cost pricing (including noise and pollution externalities), it suggests the need to consider additional supply for that area. Direct road pricing based on supply and demand principles inherent in the private sector will provide the best process by which to ascertain the need for additional roads or the abandonment of economically unjustified roads.

Direct Road-Pricing Technologies

There are several feasible technologies available to implement direct road pricing. One approach would be the use of stickers as permits to enter congested areas or enter congested areas through specific corridors. Stickers can be purchased to make daily trips, acquired on a monthly basis, or for seasonal commuting. The nuances of a sticker system have been worked out to a point (stickers can be strategically torn, color coded, self-cancelling through chemical treatment, etc.) where there is a tremendous flexibility to meet most needs. Another major advantage is the low capital investment that would be required to implement such a system. The use of the permit-sticker technology has been proven workable in Singapore where, after implementation in 1975, morning peak-hour traffic was reduced by an impressive 44 percent (*15*, p. 103).

Enforcement of Singapore's sticker-permit system is achieved through the stationing of police observers on the handful of access highways to the central city. These observers record the license plate numbers of violators who later receive citations through the mail. For urban areas with many access roads to the central city area, technology may soon be available to permit photographic surveillance (of the licenses) of large numbers of vehicles *(17)*.

Another available technology is on-vehicle meters. Meters with flags or outside-visible lights could be mounted in cars to register the time of road use. These meters could be activated by the driver or, preferably, by external electronic signals. A major advantage of on-vehicle meters would be the amount of privacy afforded. Payments could be made periodically by bringing in the meter for assessment as is done with postal meters (*18*, p. 27). Enforcement could be provided by basically the same system as was described for sticker permits.

Probably the most flexible and viable technology in a long-term sense is that of electronic road pricing (ERP). For many years economists and engineers projected the development of a technology that would automatically register road usage but that would involve little effort on the part of the user. After examining several road-pricing technologies, Hong Kong selected electronic road pricing as the best of several approaches to implementing road pricing in its city. In 1985 a pilot project was completed that conclusively demonstrated the viability and robustness of the technology *(19)*. By its nature ERP, which electronically identifies individual users, should present less of an enforcement problem than other methods. However, there is always the possibility of tampering with the transponder attached to the vehicle. The developers of the technology used in the Hong Kong pilot program have considered this problem and believed that the transponder they developed is substantially tamper proof. Drivers of vehicles without transponders or with irregular transponders may attempt to use priced roads. During the Hong Kong project special camera equipment to photograph the license plate of an offending vehicle was developed and tested (*19*, pp. 614–615).

One major concern with electronic road pricing has been the issue of privacy. However, electronic road pricing can be implemented in ways that minimize this problem. There is little doubt that road pricing is economically, technologically, and administratively feasible.

ADVANTAGES OF GOING BEYOND DIRECT ROAD PRICING

The campaigns to implement direct road pricing in the United States in the 1970s were unsuccessful to a large degree because of political opposition. The incentives offered by UMTA to local officials, even for demonstration projects, were insufficient to overcome the opposition of various transportation interests and the natural resistance of the public to such new ideas as direct road pricing. Early opposition from the media and the business community, often based on limited information, was a primary barrier to UMTA road-pricing proposals (*7*, p. 84).

UMTA's efforts were unsuccessful for several fundamental reasons. First, and perhaps foremost, was the lack of an adequate educational and public relations campaign to lay the groundwork for such a policy innovation as direct road pricing. Second, the concept itself may have been presented as too much of a fixed package without enough incremental options and variables to be tailored to the individual needs of different cities (*7*, pp. 80–89).

Direct pricing of road use, as opposed to indirect pricing through gasoline taxes and license fees under which users as a class pay for roads, is a more advanced form of private financing inasmuch as individual private users are charged on the basis of the time and place they use the service. Thus, under direct pricing, road users who wish to use freeway space during a time of high demand will tend to be charged a rate closer to the full costs of providing the service at that time—in this case, driving during premium hours. Nevertheless, the obviously greater efficiencies and advantages of direct road pricing were insufficient to persuade transportation interests in the three U.S. cities approached by UMTA to participate in a road-pricing experiment.

In addition to private user financing of road use or "direct road pricing," other privatization measures may add enough additional advantages to the partial privatization approach of direct user charges to overcome political barriers to road pricing and gain public support.

First, a phase-in of additional privatization measures such as contracting out operation and maintenance would introduce competition into the development and operation of a road-pricing program and thereby be more likely to generate creative implementation and lower operational costs. These advantages could make a marginal difference in selling the program and make additional funds available to insure against risk and to compensate negatively affected interests.

Second, full privatization through sale of freeways to the private sector could free the capital now unproductively frozen as a government asset in such a way as to generate even more incentives to obtain the support of interests that perceive serious risks and possible negative effects. This capital (along with the stable revenue stream created through the application of direct road pricing and the advantages of using efficient private management to operate and maintain a freeway) could provide the leverage needed to attract new private investment to finance badly needed rehabilitation of many economically productive U.S. highways and freeways. Moreover, it could provide an additional incentive to accept the risk of direct road pricing, even at the early stages of a phase-in plan. For example, transportation interests that perceive serious risks and possibly negative effects might be enticed by the opportunity to participate in a consortium that would have an ownership interest in the freeways.

Full privatization via sale to the private sector will also no doubt entail the need to obtain enabling legislation at the federal, state, and possibly even the local levels of government.

A third major benefit of full privatization would be the addition of yet more incentives for cost-efficient and cost-effective operation of freeways. Private owners would have more of a personal stake in ensuring that their customers, the paying users, were satisfied. Private ownership, in contrast with political ownership, would better ensure that revenues were allocated to consumer demand and not redistributed for the benefit of politically influential special interest groups. Privately developed fee schedules would be much less likely to be politicized to *(a)* provide for cross-subsidies between types of users or *(b)* keep them artificially low at the expense of long-term maintenance and rehabilitation needs.

Finally, as suggested by Gabriel Roth in one of his many insightful comments on an earlier draft of this paper, full privatization may well make it easier to sell direct road pricing to the public. Private user charges would not be perceived as a tax increase. Moreover, the introduction of private provision of some freeways would tend to act as a competitive influence on the prices charged for use of governmentally provided freeways.

IMPLEMENTING POLITICALLY FEASIBLE USER-PAYS CONCEPT

There are two basic challenges to phasing in the user-pays concept: the natural reluctance of the general public to accept the idea of paying directly for use of the roads and the opposition from interests that perceive possible negative effects. Each step of the phase-in process must be tailored with these challenges in mind.

Stage 1: Identification and Analysis of Problems

The first stage in phasing in road pricing would be to establish that a change must be made in advance of drastic problems. (If a city waits until a crisis, this step will be unnecessary. But unnecessary suffering and economic dislocation will result.) Lessons learned from UMTA's experience in the 1970s indicate that the best way to do this is for farsighted political and civic leaders to establish a technical advisory committee composed of independent transportation economists and planners.

Such an independent committee of experts is needed at this early stage to provide, as much as possible, an objective, credible determination of the extent of the problem and to analyze all possible solutions with a minimum of political considerations. It is vital that such innovative ideas as direct road pricing receive as objective a consideration as possible and not be killed before receiving a fair hearing.

The mandate of this committee would be to determine if there is or will be a problem that needs to be addressed, to examine all possible alternatives, and to assess the short-term and long-term advantages of each alternative. The committee would also have as a major part of its responsibilities the task of identifying the full indirect and direct costs of each alternative, including the option of doing nothing.

If such a committee determines that the problem will become increasingly severe, seriously affecting central city viability and the quality of urban life, it should recommend specific short-term and long-term solutions. In many localities, direct road pricing may well be included as one of the long-term solutions. If it is, the measures described in this section and the following section for mitigating the impact of direct road pricing, reducing risks, and providing incentives for affected transportation interests to accept direct road pricing should be articulated.

The next step in this phase would be the creation of a task force composed of representatives of all interests that are affected by direct road pricing including media representatives, affected business and commercial interests, and representatives of the poor. The task force should be charged with the mission of casting the recommendations of the technical advisory committee into a concrete plan for adoption by pertinent local and state governments. The task force should also hold extensive public hearings to receive testimony from all affected interests.

At this stage, efforts must begin to construct a coalition of interests that favor direct road pricing. One major interest group to be approached would be environmentalists because one of the side effects of direct road pricing would be a reduction in air pollution. Health organizations, such as the American Lung Association, could also be approached on this basis. Another interest that might participate in such a coalition would be developers who increasingly face special transportation assessments and limited-growth policies. Even groups that might initially be thought of as opposing direct road pricing should be consulted. For example, in Los Angeles the local chapter of the Automobile Club is reportedly interested in the concept (unpublished paper by Ward Elliot).

Stage 2: Educational Campaign

The next step should be an educational campaign to persuade the media, the general public, and interests that perceive risks or negative effects of the need for and feasibility of direct road pricing. According to Emerson et al. (*20*, p. 56),

> The potential for generation of public antagonisms by . . . unfamiliar new measures is so great that as much atten-

tion must be given to this negative aspect during preimplementation planning as is normally given to planning of more orthodox project elements.

As a part of the educational campaign, the feasibility of the technology, for example, could be demonstrated to the media as it was in Hong Kong in order to convince reporters of the technical and administrative feasibility of direct road pricing (*21*, p. 22). The campaign should refer to analogous situations such as telephone and utility service.

The educational campaign should also stress, as did Hong Kong, the draconian nature of the alternatives such as regular gridlock, bans on automobiles in the central city, "non-automobile" days, and substantial increases in gasoline taxes and license fees that would price low-income people out of car ownership as occurred in Hong Kong (*22*, p. 235). Such draconian measures, it could be noted, would substantially harm the image of the business community. The campaign should furthermore stress the fail-safe provisions developed for worst-case situations.

The educational campaign should emphasize that the use of roads is not now a "free" good. People must be educated about how they are already paying indirectly for roads through gasoline taxes and license fees. What is being proposed, it should be emphasized, is a change in the means of financing roads to promote more efficient usage. Moreover, the campaign should stress that this change is not an additional tax burden. Those who are directly charged for road use will be able to receive a proportional reimbursement of their gasoline taxes. It could be further pointed out that the freer flow of traffic will reduce vehicle operation and maintenance costs.

Another major theme to articulate would be the issue of privacy. This is not a major problem in reference to sticker systems because enforcement is basically dependent on identification of a violator via existing license plates. However, ERP presents a different problem in the sense that people will be fearful of the government and other potential abusers tracking their movements. The campaign must therefore emphasize the legal provisions for inviolability and security of data collection and other provisions that minimize the possibility of misuse. Of course, after full privatization of freeways, such data would be removed from direct government control and would be handled in the same way that telephone companies and private utilities maintain information about their services.

The campaign could furthermore educate the public about the historical precedents for private toll roads and the general success of public toll roads in many U.S. states. Other examples throughout the world could also be cited including a major private toll road in France owned and operated by La Société Cofiroute.

Many people oppose direct road pricing on the basis that they have little choice about when they use certain roads. Thus another important theme to stress is that people with strong economic reasons for using the freeway at peak times are probably already paying disproportionately more in terms of congestion costs (the value of their time) than are marginal users who receive less economic return from using roads during peak hours. Road pricing would permit people who do have more of a choice about when they use the freeway to reschedule their trips or pursue other alternatives (e.g., telephone).

Finally, the campaign must include discussion of the equity of road pricing and how negatively affected interests shall be compensated. For example, one measure used in Hong Kong was the development of a videotape and pamphlet entitled *A Fair Way to Go*. It is vital that any perception that direct road pricing will entail discrimination against the poor be dispelled because equity for the poor is considered a major issue by policy makers and the media (*15*, p. 107)

Stage 3: Pilot Project

The third stage in phasing in direct road pricing would be a successful demonstration project on a badly congested freeway (*8*, p. 12). It could be set up so that those who did not wish to pay could easily switch to an alternative route (*23*, p. 4). Another option would be to limit the period during which direct road pricing would be in effect to morning rush hours (*23*, p. 11). In this way, there would be little threat to downtown retailers concerned about the loss of shoppers, but commuters would still be significantly affected. A drawback would be that through-traffic taking alternative routes in the morning hours could switch back to former routes in the evening (*24*, p. 224). Nonetheless, the contrast in congestion levels between morning and evening rush hours would provide a dramatic demonstration of the benefits of direct pricing.

Those who use freeways that are priced could be allowed to receive full, refundable tax credits against state and federal gasoline taxes in order to remove the objection that they are paying twice. There is precedent. Farmers receive gasoline tax refunds on tractor fuel because they are not using their tractors for travel on public roads (except perhaps incidentally) (*25*, p. 44). In some states road taxes are cancelled for mileage logged on toll highways (*26*, pp. 445–446).

The road-pricing demonstration project should begin with the use of sticker technology because of the low-capital investment required (*9*, p. 56) and flexibility (*27*, p. 2). An important feature would be provision for a refund for the stickers to ensure that if the program fails, no one loses money through the advance purchase of stickers. The sticker program should furthermore include massive off-freeway support for the purchase of stickers, perhaps along with on-freeway sticker plazas that would not impede traffic flow (e.g., on outlying freeways far from congested central areas) (*8*, p. 13).

Another option at the pilot-project stage could be to use just one lane of an expressway. Ward Elliot of Claremont-McKenna College in Los Angeles County has suggested, for example, using Los Angeles's San Bernardino busway lane to accommodate not only high-occupancy buses and carpools but also vehicles displaying stickers purchased by users. Such a measure might not only speed the commutes of additional vehicles using the reserved lane, it might also provide more optimal use of road capacity. This is because it would have the added benefit of diverting some traffic off other lanes, thereby benefiting other users. Alternatively, bus-lane separation could be a part of the road-pricing pilot project (*28*).

Lanes reserved for permit purchasers as well as carpools, vanpools, and buses would probably provide the successful demonstration project needed to persuade doubters. A review of the unsuccessful "diamond" lane project on Los Angeles's

Santa Monica Freeway suggests that prospects for success are good. In the last week before the diamond lane was terminated, Santa Monica Freeway traffic equaled the preexperiment passenger carrying rate in overall traffic flow. If pricing had been applied to permit some motorists to use the diamond lane that was only operating at one-third of its capacity, it might have optimized use of the diamond lane and probably drained off enough commuters from other lanes to achieve an overall improvement in the traffic flow of all lanes (unpublished paper by Ward Elliot). Furthermore, at this stage of road pricing no one would believe that they were being excluded because of price.

Oversight of the pilot project could initially be by public officials from the affected jurisdictions, including surrounding jurisdictions. Representatives from various affected transportation interests including representatives of the general commuting public might also be included (*23*, p. 39). Perhaps better would be an advisory committee composed of these affected interests that would work closely with management.

Sticker prices could be adjusted to optimize roadway capacity. Prices should probably initially be set high and then quickly reduced if optimal usage is not forthcoming (*15*, p. 104).

An important part of the pilot project would be the simultaneous deregulation of transit along the participating corridor area (*29*, p. 19). For example, it might be assumed that some of the traffic that was "tolled off" would take alternative routes along major street thoroughfares. To enable these street thoroughfares to handle the increased traffic, local authorities should completely deregulate (except for health and safety) private transit-for-hire, especially private jitneys. Another measure to reduce initial opposition would be to exempt for some period buses, carpools, motorcycles, and perhaps commercial vehicles. Commercial vehicles could also be charged a reduced rate for a limited period of time.

Another privatization measure for improving public transit would be to contract out for additional public-transit capacity to handle expected increases in public transit (thus avoiding violation of Section 13c of the Urban Mass Transit Act of 1964).

Finally, during the pilot project, electronic road-pricing infrastructure should be tested as it was in Hong Kong to determine its operational viability and robustness. At this stage it would be important to assess the potential of using any existing ramp-meter systems for adaption or use in ERP infrastructure. Perhaps freeway on-ramps with meters could be more easily accommodate such things as electronic information boards and cameras to identify the licenses of vehicles without electronic transponders or stickers. Government agencies, private fleets, and citizen volunteers could participate in the ERP experimental program at this time, although no charges would be recorded against these vehicles during this period.

Stage 4: Expansion to Major Freeways into Central Business District

The next step in phasing in full privatization would be to extend road pricing from one corridor or pricing area to several freeways entering a central business district (*8*, pp. 16–17). At the same time, oversight management for the project could be handed over to an independent public authority that would administer a trust fund collected from charges. Such an independent highway authority would tend to generate more public confidence by fixing, for example, responsibility for protection of data collection and ensuring that funds were used only for local freeways and streets (*21*, p. 82). The authority would finance operation and maintenance of the system out of the trust fund.

Public authorities have many advantages over government departments. They are largely independent and self-financing, which reduces the political considerations in budgeting and the pressure from special interest groups. Because they are self-supporting, public authorities tend to better maintain their facilities (*30*, p. 82).

Another option at this stage would be to turn over the actual operation and maintenance to a contractor after competitive bidding. Experience and scientific studies have both demonstrated that significant operational savings can be achieved by contracting for the actual supply of public services, if it is done properly.

This stage would also be the appropriate point at which to introduce electronic road pricing to largely replace permit stickers. Large-scale ERP infrastructure could be financed through tax-exempt bonds (the debt for which could be eventually assumed by private owners).

There must always be strong assurances that ERP records will be confidential. One such provision in the projected Hong Kong ERP system is a requirement for the destruction of all detailed records as soon as a charge is credited to an account (*19*, p. 604). This would be similar to what the telephone company does for message units (*4*, p. 9).

Stage 5: Expansion to All Freeways in an Entire Congested Area

The final stage would be the extension of direct road pricing to all the freeways in an entire congested area (*8*, p. 18). Because financing (e.g., assumption of debt) and operation and maintenance will have already been handed over to the private sector, this would be the appropriate point to complete full privatization by transferring ownership from the public authority to the private sector (*30*, p. 89):

> The state would simply sell their ailing highways and bridges to private investors to be operated as business paid for entirely by user fees collected from AVI [i.e., electronic road-pricing] systems and other incidental sources of revenue. The level of tolls would be set by the company's management to cover the cost of operation and maintenance. They will presumably depreciate the highways and bridges and provide in their revenue requirements for rehabilitation of the highways as well as future preventative maintenance in order to maintain long-term viability of their investment. Additionally, liability laws will force the road owner to maintain the roads in safe condition.

Given the political sensitivity of turning ownership of freeways over to the private sector, an important strategy would be to institute certain conditions in the sale such as requiring profits to be reinvested in the roadway. If there are several economically viable and competitive corridors, these should be sold to different companies, or, if economically feasible and admin-

istratively practical, different segments of the same freeway could be sold to different management firms—provided, of course, that as a condition of sale they agree to cooperate and to coordinate their operations. If these measures designed to ensure direct competition were not feasible, the agency disposing of the assets could provide formulas to ensure that future prices would not be excessive (*30*, p. 90).

Finally, the possibility of full privatization might help persuade transportation interests that perceive possibly negative effects to incur the risk by giving them the option of purchasing stock in the privatized freeway at reduced prices. Future stock might be reserved for use in a trust fund to finance transportation vouchers for the poor.

MITIGATING THE EFFECTS ON VARIOUS INTERESTS

One of the major lessons learned by UMTA and the Urban Institute in the 1970s is that strong theoretical and even empirical evidence is insufficient to persuade interests that perceive possibly negative effects of road pricing. The previous section reflects many of the suggestions of Urban Institute policy analysts that, with better education and implementation policies, might overcome these barriers. In this section will be stressed, as recommended by the Urban Institute policy analysts, the need to prepare for worst-case situations and offer guarantees of compensation.

One of the major barriers to road pricing has been the issue of equity to the poor; that is, would the effect of direct road pricing be progressive or regressive (*31*, p. 111). This issue has been studied by a variety of economists who have come to different conclusions based on different assumptions. A number of arguments can be cited to the effect that the poor will benefit from road pricing, under certain conditions or types of compensation programs. One suggestion of Urban Institute policy analysts (*4*, p. 20) is to use revenue collected from road-user charges to expand public transit as a means of compensating the poor. According to Bhatt (*32*, p. 24),

> [r]oad pricing policies will generate substantial revenues which, if targeted for the poor, would be more than sufficient to redress the inequities they incur because of the pricing policy. This could be achieved in a number of ways: by providing various types of tax advantages to the poor, by improving and expanding public transportation with the poor as the primary target group, or—at least in principle—even by compensating the poor through direct payments.

However, there are serious questions as to whether people tolled off the freeway will turn to public transit in its present form. In addition, deregulation to allow various forms of private paratransit such as jitneys may provide greater benefits to the poor.

Certainly, if many of the poor do turn to public transit, it may be expected that part of the negative impact will be mitigated by the probability of faster bus trips. In addition, public transit could be temporarily exempted or have a lower initial charge for using the freeway.

If lower-income commuters are individually priced off the freeways, Gabriel Roth points out that they will have another, probably more viable alternative—carpooling or shared rides. And, again, it is important to remember that the cost per individual will be lower than if they rode alone and that automobile trips will be faster.

Given the extent to which equity is a barrier to road pricing, a more fundamental question that some have begun to ask is whether it is desirable to redistribute income through the transit system (*33*, p. 19). If it is determined that the poor should be subsidized, a voucher system could be implemented. Using a voucher would have two advantages. First, as one transportation economist suggests, if subsidization of the poor is a social welfare function, it is the obligation of everyone in society to provide the subsidy and not just road users (*9*, p. 39). Second, this makes the subsidy explicit, thus enhancing accountability.

Probably some of the strongest opposition would be from downtown business and commercial interests. A number of arguments can be marshalled as to why such business and commercial interests would not be negatively affected and perhaps could even be benefited. For one thing, a decrease in traffic congestion does not necessarily mean fewer people traveling to the area. The following probable effects could be beneficial to such interests (*9*, p. 89):

- Less peakish traffic downtown,
- Ability to make more business trips at off-peak times,
- Encouragement of high time value individuals to remain downtown,
- Improvement in traffic conditions that would encourage off-peak users to shop downtown, and
- More downtown parking available.

To mitigate the impact of possible negative effects on business and commercial interests, a number of measures could be used. First, revenues collected in road pricing could be used to offset reductions of business taxes (offered as an incentive to business and commercial interests) in the priced area (*7*, p. 29). Second, the fleet departments of affected businesses could be provided with data on their own fleet usage. This concept is included in the full plan for Hong Kong (*21*, p. 81). (This author does not believe that the provision of data on fleet use necessarily infringes on the privacy of commercial vehicle users because this type of monitoring can be considered a condition of employment. However, if a government entity is providing or operating the direct road-pricing technology, the dissemination of such information, with reference to providing fleet information to commercial users, should be strictly regulated to prevent abuse.) Third, businesses would be given a guarantee against financial losses out of the highway user-fees trust fund or the right to purchase roadway stock at a reduced price as a part of the sale to the private sector.

Ultimately, downtown business and commercial interests will have to decide if central city stagnation (caused by the congestion resulting from indirect road pricing) and the possibility of comprehensive, highly restrictive growth policies (brought about by political overreactions to traffic congestion) are a better alternative than direct road pricing. Direct road pricing may, indeed, be a major part of the solution to declining central city commercial areas.

Parking and taxi interests will represent a subset of business interests with a particularly strong natural opposition to road

pricing. At one point, UMTA agreed to ensure taxi revenues would not fall below a negotiated baseline. Special new incentives would have to be developed to reduce their opposition.

Another category of possibly negatively affected interests would be occasional out-of-town visitors and persons who refuse to accept ERP because of privacy concerns. Out-of-town visitors could be made aware of the need to purchase stickers and short-term supplementary licenses for peak-hour use on major arterial highways (*4*, p. 10). They would be able to purchase day stickers or rent loaner transponders from retail outlets. Those users concerned with privacy could also use stickers.

Another major affected interest to consider would be the general car user or commuter. General users could be partly compensated through reduced registration and license fees (*23*, p. 39) or refunds on gasoline taxes proportional to their use of direct-priced roads.

General users may not be as opposed to transit user charges as was once thought. According to the Executive Director of the International Bridge, Tunnel and Turnpike Association, recent polls and elections demonstrate that if the benefits and facts are properly presented, users will approve toll projects (*34*, p. 69). Indeed, public toll road authorities in Illinois and Pennsylvania are moving forward with plans for significant expansion of highway toll roads (*35*, p. 27; *36*, p. 13).

Still another group that may be unenthusiastic about road pricing is road builders who consider it contrary to unrestricted, unlimited mobility (*37*, p. 1). Offsetting that perception are potential increased road repair and new road construction made possible by road-pricing revenues. A recent bill in the California state legislature to permit the private financing, operation, and ownership of new private freeways supported by user charges appeared to this researcher to have the support of some road-building interests.

The final interest to be placated is that of the government bureaucracy, especially the public transportation agencies. Deregulation would permit the entry of private-sector operators that would mitigate the impact of any peak-load increases on public transit. Moreover, as in Singapore, with more rapid speeds, public transit would be able to provide more trips (*7*, p. 29).

To protect freeway operation and maintenance employees, contracts to turn over the provision of such services or to relinquish total ownership of freeways could include conditions requiring that the transportation department workers be given the right of first refusal of new jobs with the private contractor or private owner. A number of other measures could be implemented to reduce the adverse effects of privatization on transit department workers *(38)*.

Other government departments such as the police department would expect to benefit from reduced traffic congestion and experience cost saving (*9*, p. 59).

CONCLUSION

In many cities in the United States traffic congestion is rapidly approaching the intolerable point. Even with the introduction of traffic management and driver management strategies and expansion of public transit, traffic congestion will not be substantially ameliorated. And, with the limits on financing of new infrastructure, it is unlikely that supply can be increased. Even if it could, economists have demonstrated that demand for what is perceived as "free" supply will overwhelm that supply.

Transportation economists have demonstrated that only road pricing will substantially relieve the urban traffic congestion problem. Yet, strong economic arguments even when supplemented by the offer of subsidies have been unable to persuade policy makers to accept an experimental direct road-pricing project. A phase in of full privatization may generate the additional incentives and advantages necessary to overcome the opposition of transportation interests that perceive possibly negative effects and to gain the support of the general public.

REFERENCES

1. N. R. Pierce. Suburbs Are Grappling with Highway Gridlock. *National Journal*, Sept. 9, 1985.
2. W. Trombley. Suburbs Gear Up to Beat Traffic: Congestion Looms. *Los Angeles Times*, Jan. 28, 1986.
3. R. Connell. Business Panel Offers Plan on L.A. Traffic and Growth. *Los Angeles Times*, April 20, 1986.
4. D. J. Kulash. *Congestion Pricing: A Research Summary.* Urban Institute, Washington, D.C., 1974.
5. A. Glazer. Congestion Tolls and Consumer Welfare. *Public Finance*, Vol. 36, No. 1, pp. 77–83.
6. A. A. Walters. Summary of Barriers to Implementing Pricing Innovation. In *Special Report 181: Urban Transportation Economics: Proceedings of Five Workshops on Pricing Alternatives, Economic Regulations, Labor Issues, Marketing, and Government Financing Responsibilities*, TRB, National Research Council, Washington, D.C., 1978, p. 50.
7. T. Higgins. *Comparing Strategies for Reducing Traffic Related Problems: The Potential for Road Pricing.* Urban Institute, Washington, D.C., 1974.
8. W. Elliot. *Road Use Charges and Jitneys: Some Thoughts on How to Introduce Them.* Rose Institute of State and Local Government, Claremont Men's College, Claremont, Calif., July 14, 1976.
9. G. Roth. *Paying for Roads: The Economics of Traffic Congestion.* Penguin Books, Harmondsworth, Middlesex, England, 1967.
10. M. Braude and Z. Yaroslavsky. Let's Cut Los Angeles Down to Size. *Los Angeles Times*, April 1, 1986.
11. W. Block. Congestion and Road Pricing. *Journal of Libertarian Studies*, No. 4, Summer 1980, pp. 299–330.
12. T. Snow. The Great Train Robbery. *Policy Review*, No. 36, Spring 1986, pp. 44–49.
13. D. Kennedy. Ottawa Builds a Busway. *Technology Review*, Nov.-Dec. 1984, pp. 71–72.
14. M. A. Stein. Freeways: Victory Lies in Flexibility. *Los Angeles Times*, Sept. 2, 1984.
15. T. Higgins. Road Pricing: A Clash of Analysis and Politics. *Policy Analysis*, Vol. 7, No. 1, Winter 1981, pp. 101–103.
16. G. Roth. *A Self-Financing Road System.* Institute for Economic Affairs, London, England, 1966.
17. Now Computers Can Track Down Speeders. *Business Week*, Oct. 10, 1985.
18. R. S. Taylor-Radford. Rush Hour Remedy. *Reason*, Jan. 1982.
19. I. Catling. and B. J. Harbord. ERP in Hong Kong: The Technology. *Traffic Engineering and Control*, Vol. 26, Dec. 1985, pp. 608–616.
20. N. H. Emerson, G. O. Smith, and W. P. Stern. Transportation Planning in Los Angeles. In *Special Report 181: Urban Transportation Economics: Proceedings of Five Workshops on Pricing Alternatives, Economic Regulations, Labor Issues, Marketing, and Government Financing Responsibilities*, TRB, National Research Council, Washington, D.C., 1978.
21. J. A. L. Dawson and F. N. Brown. ERP in Hong Kong: A Fair Way to Go? *Traffic Engineering and Control*, No. 26, Nov. 1985.

22. P. K. W. Fong. The Electronic Road Pricing System in Hong Kong. In *Innovative Strategies to Improve Urban Transportation Performance: Proceedings of a Specialty Conference*, American Society of Civil Engineers, New York, 1985.
23. K. Bhatt, J. Eigen. and T. Higgins. *Implementation Procedures for Pricing Urban Roads*. Urban Institute, Washington, D.C., 1976.
24. J. R. Meyer and J. A. Gomez-Ibanez. *Autos, Transit and Cities*. Harvard University Press, Cambridge, Mass., 1981.
25. F. R. Sproule. Double Charge on Toll Roads. *Freeman*, No. 8, Jan. 1958.
26. C. L. Dearing. Toll Road Rates and Highway Pricing. *American Economic Review*, May 1957.
27. K. Bhatt, R. Kirby, and M. Beesely. *Transportation Improvement and Road Pricing: A Demonstration Program*. Urban Institute, Washington, D.C., 1976.
28. E. Berglas, D. Fresko, and D. Pines. Right of Way and Congestion Tolls. *Journal of Transportation Economics*, Vol. 18, No. 2, May 1984, pp. 165–181.
29. R. F. Kirby. *Road User Charges—Some Practical Considerations*. Urban Institute, Washington, D.C., 1974.
30. D. E. Conway and J. Peron. *The Road Not Taken: Resolving Connecticut's Highway Crisis*. Connecticut Institute, Storrs, 1984.
31. D. J. Kulash. *Income-Distributional Consequences of Roadway Pricing*. Urban Institute, Washington, D.C., 1974.
32. K. Bhatt. *What We Know About Urban Traffic Congestion: A Pricing Approach*. Urban Institute, Washington, D.C., 1975.
33. M. Kemp. Summary of Experience with Transit Pricing. In *Special Report 181: Urban Transportation Economics: Proceedings of Five Workshops on Pricing Alternatives, Economic Regulations, Labor Issues, Marketing, and Government Financing Responsibilities*, TRB, National Research Council, Washington, D.C., 1978.
34. Public Support for Tolls. *Public Works*, Dec. 1985.
35. Illinois Officials Propose a $300-Million Toll Road. *Engineering News-Record*, April 19, 1984.
36. Major Toll Road Program Planned. *Engineering News-Record*, Jan. 9, 1986.
37. R. J. Coit. *Legal Issues Surrounding Roadway Pricing on City Streets and Bridges*. Urban Institute, Washington, D.C., 1974.
38. P. E. Fixler, Jr. Increasing Employee Options Under Privatization. *Fiscal Watchdog*, No. 118, Aug. 1986.

Intraurban Road Privatization

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Although the assumption has been made that intercity highways would provide the natural testing ground for increased private participation in the provision of road services, such an assumption may be unwarranted. It is true that intercity highways more easily fit the mold of a traditional toll road. However, there is no compelling necessity to adhere to this mold. The urban environment, in contrast, offers some significant attractions as a testing ground for privatization innovations. The need for innovative solutions is much more apparent in the urban setting. Urban traffic congestion and the higher cost of constructing new capacity point to a more urgent need for cost-effective solutions. The urban setting also presents more diversity of options for examining privatized alternatives. The possibilities for comparison and competition among possible approaches are much broader in an urban environment. For example, the potential problem of abuse of private monopoly power is less pronounced in a city street system with numerous parallel routes than in a rural highway system route that has no close substitutes. This paper will be conceptual in nature. The goal is to examine the thought processes that could guide experimentation with privatization in order to consider whether the best candidates for initial test cases might be urban rather than rural roads.

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Where there are no means of transportation, the decision to build a road is a relatively simple one to make. Under such circumstances even the public sector can scarcely go wrong in plowing ahead with a decision to build. The margin for error that can be tolerated is large. The inherent and notorious inefficiency of government in providing goods and services may easily go unnoticed. The completion of almost any facility is bound to produce greater returns than costs.

Where there are many means of transportation, the decision on whether to build or even to maintain an existing road loses its simplicity. In such complex circumstances there are many opportunities for the public sector to go wrong regardless of whether the decision is to build or not build a facility. The potential margin for error is small. The endeavor is no longer merely to make travel between two points feasible. The pay-off from contemporary roadway investments is more incremental in nature. Improvements to existing systems may result in shaving a few minutes off travel times, making a ride smoother, marginally enhancing access, and the like. The returns are more subtle and difficult to measure. At the same time, the cost to build and maintain modern roadways is considerable.

The combination of high cost and marginal returns places a premium on efficient decision making. Efficiently deploying

resources for maximum return on investment is not a task well suited to the public sector. Government lacks both the knowledge and the incentive necessary to achieve optimal efficiency in the production of goods and services. In contrast, in the private sector, the presence or absence of profit provides both the knowledge and the incentive to efficiently produce goods and services to meet consumer needs.

The key source of private-sector knowledge about the efficiency of a firm's production of goods and services is the income statement. The information from this statement tells whether the firm's efforts are generating profits or losses. Profits indicate that the undertaking can be sustained. Large profits indicate the possibility for expansion. Losses suggest that some changes may be in order: either improve efficiency or go out of business. This useful knowledge is not commonly available for the public sector's highway activities. Financial statements for highway agencies are typically confined to mere cash flow data. For this reason, the budget is usually in balance. The revenues received are spent. Allowances for depreciation of long-lived highway assets are not made. Consequently, real losses that can threaten the solvency and sustainability of the highway system can be concealed in the reported data.

The lack of a profit-and-loss statement for public highways creates the need to improvise. To project a picture of the profitability (or lack thereof) of the U.S. highway system, a pseudoincome statement can be estimated. In constructing this estimate it has been assumed that user taxes represent sales revenues. Nonuser revenues have been excluded because these represent subsidies rather than "earnings."

As can be seen from Table 1, the trend is not favorable. Losses are the likely future outcome of present trends and practices. Depreciation of Interstate facilities is increasing. As more of these highways reach the end of their design lives, major rehabilitation expenses loom. In addition, overhead costs have been outpacing construction activity. In the early 1960s the ratio of overhead to construction outlays was about 7 percent. By the early 1970s this ratio was around 12 percent. More recently this ratio has risen to 17 percent.

The purpose of presenting these figures is not to alarm but, rather, to illustrate. User taxes are not really customer sales receipts. Responsibility divided among federal, state, and local governments contributes to rising administrative costs. The public monopoly status of the road system short-circuits the transmission of valuable information that could come from a more competitive market environment. Under current conditions, the public sector has limited knowledge with which to make decisions affecting the efficiency of production and operation of the highway system.

TABLE 1 LONG-TERM INCOME STATEMENT FOR THE U.S. ROAD SYSTEM BASED ON HISTORICAL COSTS ($ billions)

	Estimated		Forecast
	1970	1980	1990
Revenue			
User taxes	15.3	22.5	41.4
Investment income	0.6	2.1	3.9
Total	15.9	24.6	45.3
Expenses			
Maintenance	4.8	10.9	21.8
Administration	1.2	3.0	7.8
Law enforcement	1.2	3.8	10.0
Depreciation	6.1	10.6	21.1
Interest	0.7	1.5	2.1
Total	14.0	29.8	62.8
Net	1.9	(5.2)	(17.5)

SOURCE: *Highway Statistics*. U.S. Department of Transportation, various years.

Perhaps even more important than the knowledge problem is the question of incentives. Private-sector firms that do not make profits face extinction. The absence of this threat as a realistic possibility for public-sector highway agencies impedes the incentive to pursue efficiency. It is not so much that departments of transportation are totally oblivious to efficiency concerns. It is just that conflicting goals and objectives are often thrust on the highway agency. Advocates of various social goals think little or nothing of demanding that a public highway agency provide service that is not economically justified. The real financial losses generated by such service reduce the agency's ability to fund more urgent needs.

A prime example of how the public sector is maneuvered into bearing the burden of unprofitable service is the case of the underpricing of heavy truck traffic. The Federal Highway Administration estimates that user taxes on the heaviest trucks cover only about 70 percent of the cost incurred in providing facilities to serve these vehicles. The political influence of the trucking industry is sufficient to secure below-cost pricing from the public highway agency. In a private-sector market context, this type of outcome cannot be sustained. Competition and the threat of bankruptcy from unprofitable and uneconomic operations prevent persistent inefficiencies like those found in the public sector.

Although awareness of the public sector's problems in the areas of knowledge and incentive has encouraged many to suggest more private-sector involvement in the provision of highways, the form that this involvement should take is subject to much debate. Some proponents of private-sector involvement urge public-private partnerships for roadway development. "Partnerships" may make for good publicity, but the scope for improvement over current methods of doing things is severely limited. Under most partnership proposals, roads remain much as they are. The only difference is that some private-sector money is made available to aid in construction.

If significant inroads into the inefficiencies of public-sector highway management are to be made, more substantial steps toward privatization need to be taken. Actual road segments will have to be transferred to private ownership. Only when the potential for profit or loss becomes a reality will the necessary knowledge and incentives for efficiency be in full force.

WHY URBAN ROADS?

It has often been assumed that the best place to start testing the concept of roadway privatization is in the intercity setting. Existing toll roads serve as the models for this assumption. The attractions of such an approach are apparent. Successful intercity toll roads are known to be feasible. Tolls are perceived as the logical means by which privately owned roads would col-

lect revenues. Under currently used technology, tolls are perceived as inconvenient, if not infeasible, as a means of collecting revenues on most urban roads. The necessity of stopping or at least slowing the vehicle to pay the toll would hamper the flow of traffic. In urban areas, where traffic volumes strain existing capacity, hampering traffic flow lowers the efficiency of the facility. In rural intercity settings, more manageable traffic volumes diminish the impact of slowing or stopping vehicles to collect tolls. Thus the rural route is perceived as most appropriate for privatization.

Given the premise that the traditional toll collection method is the only feasible means of obtaining revenue, the conclusion that rural routes provide the best prospects for privatization is eminently logical. Fortunately, there are other prospective means of obtaining revenue. In addition, there are reasons beyond the revenue collection issue for favoring the selection of urban road segments for privatization.

A prime consideration in the decision to experiment with privatization is whether institutional barriers might impede the effort. Intercity rural routes present more potential institutional barriers than many intracity routes might pose. The most lucrative potential intercity routes are likely to be state system roads that have been built, in part, with federal aid. Current federal law prohibits the institution of tolls on roads built with federal aid unless that aid is paid back to the federal government. This is not to say that federal law cannot be repealed. Suggestions to this effect have been repeatedly made. However, it does make it clear that a state cannot unilaterally effect a conversion to a toll road without substantial cost.

In addition to this specific federal barrier to the implementation of toll roads, there is the more general proposition that it is harder to bring about a change in direction of a large entity. Changing direction in a state would be easier than changing direction in the whole nation. Likewise, getting a whole state to revise its policy toward privatization is apt to be more difficult than convincing a local government to try a new idea. The numbers alone help illustrate this point. To change the nation, one-out-of-one government must be persuaded. To change a state, one-out-of-fifty governments must be persuaded. To change a local government, only one-out-of-eighty-thousand must be persuaded. In addition, roads owned by local governments are less likely to have been built with federal aid—thus the issue of paying back funds for converting to a toll facility is avoided.

The volume of traffic likely to use a road is another factor that affects whether rural or urban roads should be considered as candidates for privatization. In Arizona, for example, many rural intercity road segments have quite light traffic. Some of these roads probably never should have been built and would not have been if economic feasibility had been the deciding criterion. Other roads may have been economically justified at one time but have diminished in importance with the decline of travel in the region. Roads like these are more suited as candidates for abandonment. Privatization may be resisted by those who are aware that private firms sustaining losses on such roads are wont to abandon them. Worse, the all too predictable failure of such privatized routes could be cited as "proof" that privatization itself is a failure.

In contrast, higher traffic volume on urban streets presents many more viable options for privatization. The prospect of earning adequate revenues from continued operation of the facility helps subdue the fear of abandonment and loss of service. This should make the privatization experiment politically more palatable. There will also be more possible candidate facilities for privatization. People appear to tolerate the existence of public-sector monopoly of the "only" route between Points A and B, but similar tolerance of a private-sector monopoly is not as likely. The existence of multiple options for privatizing one or more parallel urban routes that serve as competing means of getting from Point A to Point B can help avoid this perceived problem.

A side benefit from privatizing more heavily traveled urban routes is that the government agency divesting the facility may realize a substantial sum of money from the capitalized present value of future earnings on the route. Rural routes with poor traffic cannot be expected to generate much in the way of earnings. Consequently, their selling price to a private firm will be low—probably lower than the cost to construct the facility. Conversely, the selling price of heavily traveled urban segments is apt to be quite high—possibly more than the cost of construction. For example, the urban segment of US-60 that becomes Grand Avenue and Van Buren Street in Phoenix generates more than $200,000 per mile per year in highway user taxes. Over a 20-year period, the present value of such a route will be considerably more than a rural segment if the same US-60 that produces only about $20,000 per mile per year in highway user taxes. The funds flowing to a city from the sale of busy urban streets could be used for meeting other community expenses.

Revenues collected directly from road users are only part of the potential earning power of roadways. Several other possibilities suggest themselves. All of these possibilities have much greater potential impact in an urban than in a rural setting. A most obvious possibility is the prospect for advertising revenue. Advertisements along the side of the road are seen by more people on heavily traveled urban streets than on more lightly trafficked rural roads. Renting space to advertisers is likely to bring larger sums on urban routes. A second source of earning power would be the value of the air space over the roadway. In rural areas, this value is apt to be nil. In crowded urban environments, where real estate is expensive, the right to build over the roadway right-of-way could be worth some money. A third source of earning power could come from access charges on businesses located along the roadway. Convenient access could enhance the commercial success of businesses abutting a roadway. Payments for enhanced convenience could provide another important source of revenue to the roadway owner.

In any case, whatever the sources of additional earning power might be, it is clear that urban segments are likely to prove more lucrative than rural segments. This extra earning power raises the value of the urban route. More private firms would be likely to bid to acquire urban route segments. More bidders will increase the selling prices of the divested roadways. Because this could enable the selling government either to use this money to reduce other taxes or to augment other services, additional political support could be generated.

Even if the financial benefits from the sale of heavily traveled urban roads were not of concern, privatization of city streets might be considered first because of the greater need for

solutions to urban travel problems. It is in the urban regions that traffic is daily brought to a standstill in the ironically named "rush hour." In most large cities there is little rushing going on during these periods. Highways are clogged beyond their capacity to serve traffic. If necessity is the mother of invention, there should be more potential for invention in the urban transportation situation.

It almost goes without saying that the reputations of the public and private sectors in the realm of invention and innovation are vastly different. Governments at all levels are charged with representing the popular will. The public sector is moved to action by consensus or majority rule. Invention, by its very nature, challenges popular wisdom. Invention poses new and untried ways of doing things. Obviously, invention and consensus are largely incompatible.

Fortunately, the private sector is not as tightly constrained as the public sector when it comes to implementing new ideas. Whereas a democratic political structure requires majority approval in order to act legitimately, a capitalistic economic structure requires only that a sufficient amount of resources be obtained to support new ventures. This "sufficient amount" is obtained much more readily, for many more new ideas, than is majority support through political processes. Inspired eccentrics can succeed in private-sector capitalism. Their fate in political democracy is less sanguine.

Privatizing urban roadways will bring together the powerful forces of great need and economic capitalism. Unchained by political restraints, private-sector roadway operators may engage in a wide variety of experimentation. The feast-and-famine of swings from excess to inadequate capacity on urban roads during off-peak and peak periods is a problem in need of solutions. Merely building more capacity—the only politically safe option in the public sector—is expensive. Finding ways to adjust demand to spread it more evenly over existing capacity is less expensive but politically volatile. Private-sector firms will have more latitude in addressing this problem.

Private firms have already experienced some successes in smoothing out peaks and valleys in demand. Other industries with heavy fixed and light variable costs have used differential pricing to rechannel a portion of demand to off-peak periods. Movie theaters feature midweek and twilight-hour special reduced prices to fill otherwise wasted or underused capacity. Electric utilities and telephone companies offer time-of-day rate schedules to entice consumers to shift some of their demand to off-peak hours. And, in the transportation field, airlines offer a plethora of travel plans designed to lure price conscious fliers into what would otherwise be empty seats.

The urgency of traffic congestion problems in urban settings provides a much more potent force for solutions that are possible with privatization than does the overcapacity situation of most rural roadways. Experiments with signalization, speed controls, one-way streets, and access restriction are all more apt to be tried under privatized roadway ownership. With the cost of new urban roadway capacity so high that construction is often infeasible, better use of existing capacity is crucial to the fiscal well-being of our cities.

A final rationale for preferring urban to rural roads as the best candidates for privatization is that the urban environment provides the better market model. The private sector is at its best when there is competition among various providers and would-be providers of some service. This competition pushes providers to improve their market offerings by either lowering the price or upgrading the quality, or both. The urban environment is more apt to exhibit the features of a competitive marketplace. Intercity rural routes are prone to exhibit the features of monopoly.

In the city there are numerous ways of getting from here to there. Many of these ways are comparable in terms of convenience and ease of access. The opportunity for road users to select alternate routes helps reduce the potential for monopoly abuse on the part of road owners. In a competitive market a consumer's selection of service from one firm reduces the revenues of other firms. This acts as an incentive for the unselected firms to better their market offerings. Under a monopoly situation, where there is no opportunity to choose, the incentive to better market offerings is greatly reduced. For example, given contemporary monopoly-type conditions under public ownership of roads, highway agencies often have somewhat ambivalent attitudes toward the inconveniences and delays posed by construction activities on existing roads. Personal pride may work to encourage expeditious completion of projects; however, there is little financial incentive to speed up the work. Occasionally there is even an "off-the-record" opinion that construction delays can be beneficial to highway agencies: poor fuel efficiency in traffic jams or over rough roads under construction may increase gasoline consumption and the tax revenues from the per gallon levy, and the frustrations experienced in traffic tie-ups may make citizens desperate enough to favor tax hikes for the purpose of building more roads.

The ills of monopoly and the inferior service and efficiency that epitomize monopoly are well documented in the economic literature. There will not be as good a test of the potential advantages of privatization if an approach that is severely limited in terms of competitive possibilities is pursued. Use of rural intercity routes as the testing ground for privatization is an approach with limited competitive possibilities. The absence of close substitutes for the privatized intercity route will probably inspire the imposition of regulations and controls aimed at reining-in prospective monopoly abuse by the private owners of roadways. These regulations will tend to stifle the experimentation and innovation that promise to result in some of the major advantages of private versus public ownership of highways.

In contrast, the urban setting presents the opportunity to test relatively unregulated competition. The larger number of potential road segments that could be sold should invite more bidders. It will not be necessary to own the whole road in order to have a viable economic unit of an urban street. Many smaller firms could own a few miles of a route and still have a chance to profit. Achieving varied and dispersed ownership is an important objective in privatization. Different owners may choose different methods of operating roads. More of a variety of options can be tested. The successful techniques can be copied and modified by competitors. This will speed up the pace of evolution of the road operation industry from the glacial deliberateness it now evinces under public ownership.

The few traffic management innovations that have been developed in recent years have come in urban areas. Singapore was the site for testing whether access to congested areas could

be controlled via a visual identification system and differential pricing. Hong Kong is the site of an ongoing experiment with automatic vehicle identification technology. In this experiment differential pricing and automated billing techniques are being used as a means of managing urban traffic's use of limited capacity.

The faster pace of city life also argues for selecting urban over rural routes for the first steps toward privatization. City dwellers are more attuned to rapid change. New ideas and new products are more frequently introduced and tested in urban markets. Economies of scale—the ability to get a quick reaction from a large and diverse group of people—are one of the attractions of the urban environment. City people are also less insular than their bucolic counterparts in the countryside. Consequently, city people are apt to be more willing to try new ways of doing things. In contrast, one of the main attractions of a rural life is the slower pace of change. This leads to a natural conservatism that may prove a less fertile ground for experimentation with privatized roads.

HOW TO PRIVATIZE?

If it is concluded that privatization is desirable, there still remains the question of how to accomplish such a feat. The red tape facing those who would like to privatize the highways is formidable. Governments at the federal, state, and local levels have pretty thoroughly entangled themselves in many aspects of each other's business. As was mentioned earlier, this entanglement in itself argues for looking at locally owned roads as the easiest to untangle in order to privatize.

Specific authority to privatize may or may not exist for any given community. However, such authority may not even be needed. Municipal charters routinely grant powers to acquire and dispose of properties for public purposes. It should not be assumed that the absence of a detailed authority to privatize prohibits privatization. Privatization is an appropriate environment for "loose constructionists." That is, any power not expressly forbidden is granted. The public sector's responsibility in any of its tasks is to see that the job gets done. It is not an ineluctable necessity that the public sector do the job itself. The growth of contracting-out of assorted community services like trash pickup and street sweeping is evidence of the feasibility of non-public-sector provision of service.

In some cases specific authority for disposing of erstwhile public roads is granted by statute. The Arizona Revised Statutes, for example, allow the State Transportation Board to dispose of unneeded state highways. These same statutes also permit local governments to dispose of public roadways. The Statute (ARS 28-1902) does take pains to protect the access rights of property owners whose land abuts the roadway to be disposed of. The concern is that a landowner not be cut off from access to his property by abandonment of the only roadway providing such access. Because the objective of privatization is not to close roadways but to employ the substantial regenerative powers of the marketplace to improve service, it is not clear that these restrictions of the statute would even be relevant.

However the actual transfer of ownership may be governed, the issue of how the new private owners are to reap revenues is a major concern. As things now stand, government collects significant user taxes from those who drive on the roads. These taxes are earned as the vehicles and drivers paying them travel the roadways. The more miles one drives, the more gasoline taxes one pays. The question is what will become of the user taxes earned on roads that have been sold to the private sector? If none of these user taxes attach to the roadway it will be difficult, if not impossible, to sell many roadways. If the user taxes do attach to the roadway, some means of measuring or estimating the magnitude of earnings will need to be established in order to properly transfer these monies to the road owners.

It will be important to tie revenues received from user taxes to actual traffic on a given roadway. If revenues are not tied to traffic, as they frequently are not in public-sector distributions of user taxes to state and local governments, the road owner has an incentive to discourage traffic. Traffic always represents an expense in terms of wear-and-tear on the roadway. If revenues that can be earned rise with traffic, road owners will compete to attract traffic. Owners who find efficient ways to move more vehicles will increase profits.

The ways cities or states measure traffic may well differ. Most highway agencies now perform some form of traffic measurement. Even the crude tube count method would provide some reliable data with which to set compensation from shares of user taxes. Because this crude method cannot be comprehensive and continuous, it would be best that it be conducted in a spontaneous and random fashion to better assure the integrity of the statistical information gathered. It will not do to allow advanced warning because this may contribute to rigged data and false extrapolations that result in a projected sum of the parts that is greater than the whole.

Other than determining the appropriate share of highway user taxes due a private-sector road owner, government should not seek to control pricing policies. Road owners should be permitted to pursue varying marketing strategies. Some will opt for low price to generate high volume. This might entail granting partial rebates of user taxes paid to the road-owning firm and pass-through to consumers. Some may opt for improved quality at a higher price. This could attract time-sensitive travelers who would rather pay more to save a few minutes per trip. Other more complicated strategies may be employed as well. In any case, it is not the role of the public sector to review and approve prospective marketing strategies. Attempts to do so will have negative effects. Competition will be reduced. Second, the selling price the public sector can realize by divesting various roads will be higher with fewer constraints on how the sold facility is to be operated.

Perhaps the private-sector owners of roads will develop technological innovations that will aid in marketing their product and collecting revenue. Existing transponder devices represent a possible avenue of exploration. Whatever the possibilities, it is not for those in the public sector to predict or prescribe what should be done. The aim is to unleash the private sector so that it may use its abundant creative

capabilities for the provision of highway transportation facilities.

The great success of the public sector in America has been in the creation of a framework of law within which individuals and businesses can pursue their own ideas of what constitutes happiness. Free men and women are the source of material prosperity. Those in the public sector must be satisfied with cultivating the conditions that are conducive to private solutions to human needs. The same market forces that succeed in turning raw land and seed into our noontime repast are eminently qualified to transform our highways into more efficient mechanisms for benefiting the general welfare.

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