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.

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Impact of Toll Policy in the United Kingdom

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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

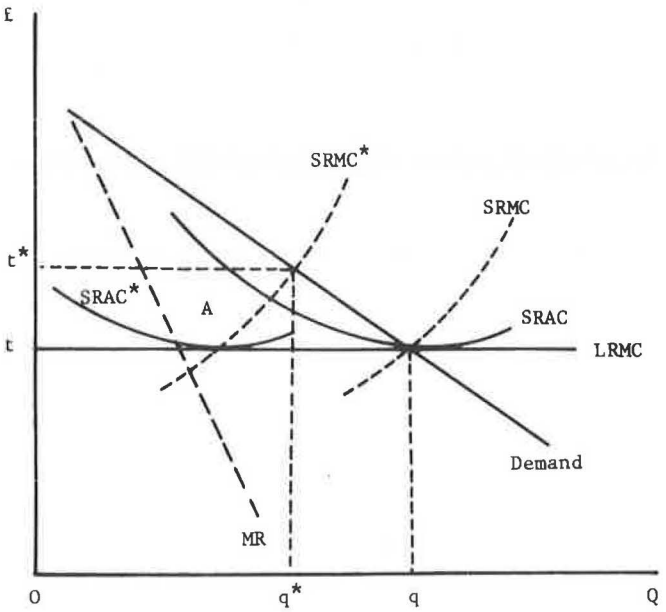

FIGURE 1 Public expenditure theory of tolling.

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.

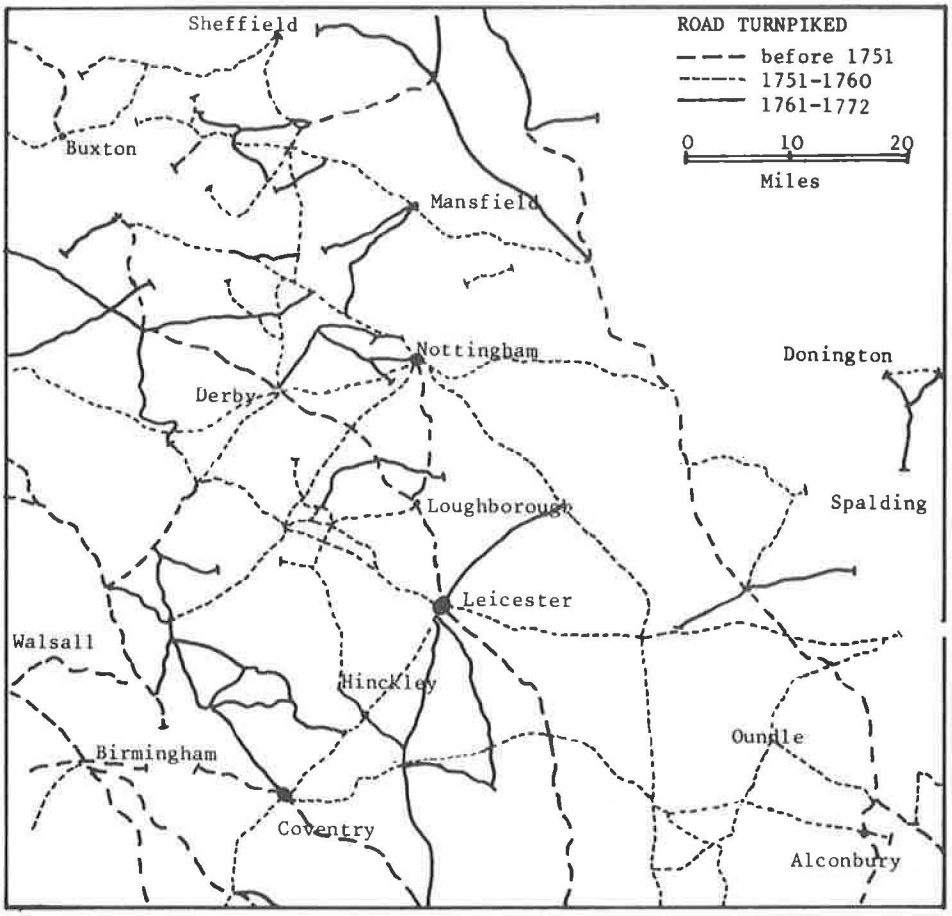

FIGURE 2 Turnpike system in the East Midlands, 1772.

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

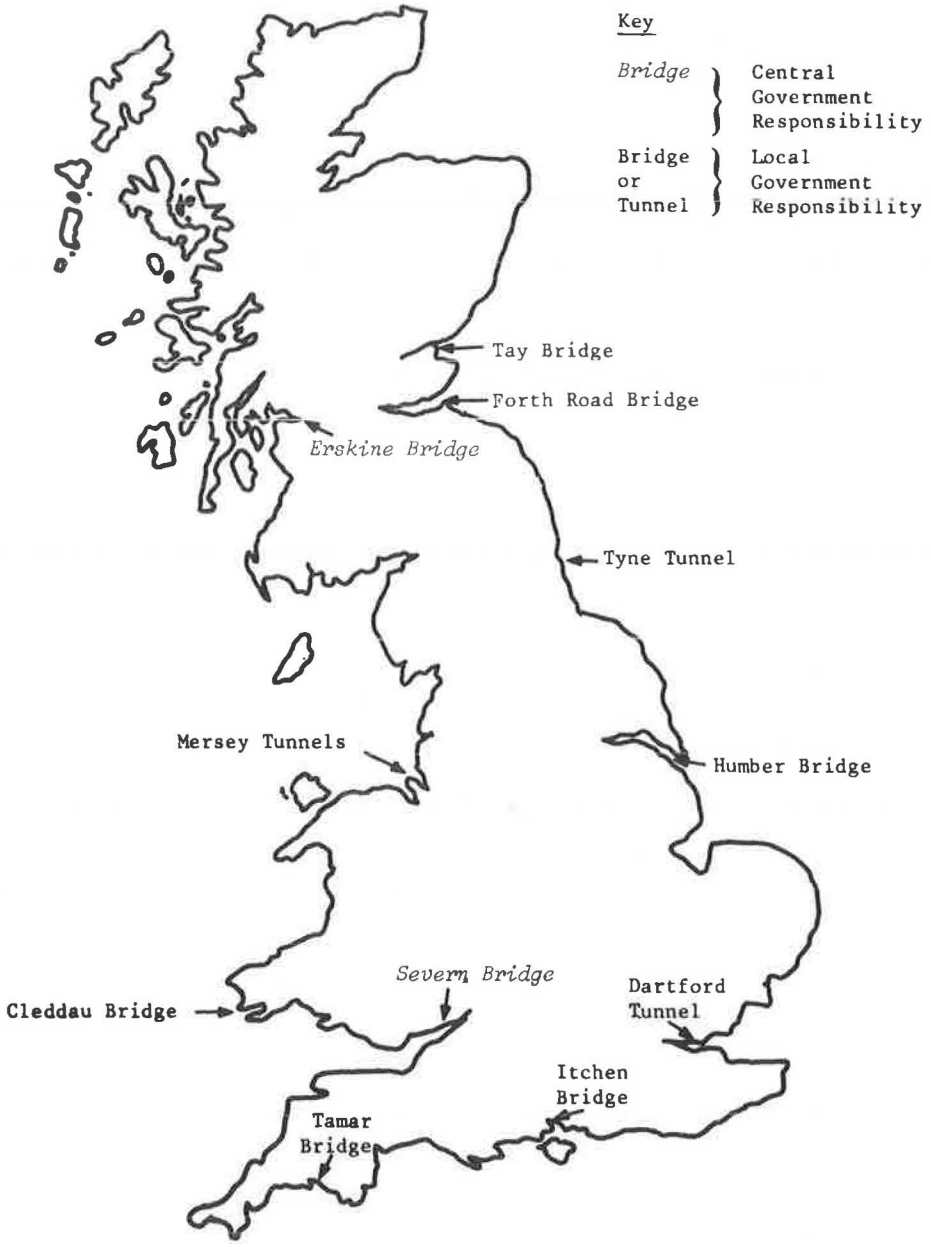

FIGURE 3 Toll facilities, 1981.

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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