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# **Case Study: Road Pricing in Practice**

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## Case Study: Road Pricing in Practice

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### ABSTRACT

*The history of turnpikes from their first deployment in the 17th century through their decline in the 19th century, and some restoration in the 20th century is analyzed with a view to understanding the systematic causes of these changes. Key factors posited to explain both the rise and decline include the length of trips using the roads, the size of the governing jurisdiction, the degree of excludability, and the transactions costs of collection - which dictate the size and scope of the free rider problem associated with financing. This paper concludes with some discussion of what is required for turnpikes to become the preferred financing mechanism for highways.*

**Key Words:** Road Pricing - History, Congestion Pricing, Toll Roads, Turnpikes, Network Financing

**EXECUTIVE SUMMARY:**

Proposals to price road use for infrastructure financing, congestion mitigation, or air quality improvement have been surfacing at a regular pace over recent years (Small et al. 1989, TRB 1994, Roth 1996). However, the current interest in road pricing needs to fully recognize the long history of turnpikes. A positive explanation for both the rise and fall, and the conditions for a significant re-emergence of turnpikes is called for. That explanation should include the fundamental factors in the historic rise and decline of turnpikes, such as transactions costs, jurisdiction size and trip length, and the nature of the free rider problem (in both the original and modern sense of the term) need to be understood before new efforts are likely to succeed. This report posits that jurisdictions generally attempt to maximize net benefits to their own residents (voters and road users). Jurisdictions consider the amount of additional revenue raised by tolls from non-residents against the inconvenience of tolls on their own residents and the costs of toll collection when choosing to tax or toll.

This report examines in depth the history of priced roads, including both their initial deployment and the subsequent disturnpiking. Toll roads have come in four eras. The first, which lasted from the 1700's and peaked in the early-to-mid 1800's, saw turnpikes under the control of local companies and trusts chartered by states or Parliament. Both push and pull factors created the initial pressure to charter turnpikes in the 1600s. Pull factors include a modest advance in technology - the increased use of wheeled vehicles, along with the economic factors promoting more long-distance trade. The push factors were the difficulties in the existing system which utilized statute labor for maintaining roads.

A brief second wave came about with the automobile and the first significant deployment of smooth paved roads. However, in the U.S. most roads were financed by states, and later the federal government, by means of a gas tax. With the relatively slow speed of highway travel, most trips remained within states; through trips were not as significant as later in the twentieth century. However, a number of parkways featuring the property of excludability, were toll financed.

A third and significant wave of toll financing arrived with the deployment of grade-separated highways. As both vehicles and highways improved, trips of longer distances could be made in the same time and trip lengths increased. This in turn implied more trips between states, and the emergence of the free-rider problem when the basis over which roads were financed (taxes or tolls) did not coincide with those who used the system. Since financing was at the state level, turnpikes were effective for collecting revenue from all users and mitigating the potential free-rider problem. But when national financing

became dominant, the definition of “local” changed to include everyone, and the revenue mechanism with lower collection costs (the gas tax) was preferred to tolls. As a result, new toll roads stopped being built in the U.S., though international experience varies. Furthermore, unlike earlier roads, grade-separated roads are easily excludable, that is, the number of entrances is limited and tolls can be cost-effectively assessed at each. The same is not true of roads without grade separations.

Finally, upon completion of the interstate (intercity grade-separated highway) system in the U.S., new road financing has largely become a local problem again, and new toll roads are being constructed, including some private roads. Because of the length of trips, and because of the ease with which tolls can be collected on these excludable roads, as well as a reduction in toll collection transaction costs on both the government and traveler side with electronic toll collection, tolls are again a feasible option. New road pricing proposals depend on electronic toll collection. Further, cordon tolls are being placed around a number of cities internationally, which will collect revenue from non-local residents for traveling on urban streets. The cordons establish excludability for use of a network from outside, though not for any particular link once the network is entered. In places where cordons can easily be established, such as river crossings and ring roads, this is a feasible option for localities wishing to switch the road financing burden to suburban residents. Ironically, the attempts of localities subject to obsolete political boundaries to finance infrastructure for the “wrong” reason - the offloading of costs on non-residents - creates opportunities to achieve a more efficient infrastructure pricing and financing system.

From the evidence here, two key conditions are required to bring about more widespread use of toll financing emerge. First, a decentralization of the authority for road operation to the point where a significant number of the trips are non-local to the relevant decision-making authority would foster a willingness to use tolls, following the traditional saying “don’t tax you, don’t tax me, tax the fellow behind the tree”. Second, a decline in transaction costs to the point where they are equal or lower than the costs of other revenue streams is necessary, where transaction costs include both delay to users and collection costs for operators. These two factors should shift beliefs about the utility of imposing tolls, as they are designed to toll someone else (not the individual making the decision to support them) and they raise at least as much revenue at the same amount or less inconvenience.

## **1. INTRODUCTION**

Proposals to price road use for infrastructure financing, congestion mitigation, or air quality improvement have been surfacing at a regular pace over recent years (Small et al. 1989, TRB 1994, Roth 1996). However, the current interest in road pricing needs to fully recognize the long history of turnpikes. In particular, fundamental factors in the historic rise and decline of turnpikes, such as transactions costs, jurisdiction size and trip length, and the nature of the free rider problem (in both the original and modern sense of the term) need to be understood before new efforts are likely to succeed. Hybrid solutions which have been tried in the past, and remain in limited current use, such as lower rates for local traffic and mixed financing between toll revenue and local tax rates may enable new efforts, while theoretically efficient solutions such as pure usage charges remain politically infeasible or economically impractical.

Explanations for the decline of turnpikes in the 19th century cite the new modes of transportation, the canal and then the railroad, which diverted a great deal of long-distance traffic, while urbanization and its concomitant use of public transport further changed travel patterns (Goodrich 1960, Hilton 1960, Warner 1962, Gray 1967, Bobrick 1986, Smerk 1991, Dilts 1992, Martin 1992, Hood 1993 ). Yet the railroads brought with them an expansion of the economy and a growth in total traffic, if not an increase in long-distance road traffic. But when the automobile-truck-highway system emerged in the 20th century, toll financing did not resume its previous significance. A positive explanation for both the rise and fall, and the conditions for a significant re-emergence of turnpikes is called for.

This report examines the history of turnpikes while developing evidence for an explanatory hypothesis of the choice by jurisdictions to finance roads using tolls. It is posited that jurisdictions generally attempt to maximize net benefits to their own residents (voters and road users). Jurisdictions consider the amount of additional revenue raised by tolls from non-residents against the inconvenience of tolls on their own residents and the costs of toll collection when choosing to tax or toll. Whether toll roads are managed by government, quasi-governmental organizations, regulated franchises, or unregulated private firms is a secondary question. The underlying hypothesis predicts that when jurisdictions responsible for managing sections of the road network are relatively small compared to the length of trips, an attempt will be made to shift the financial burden from local residents (local trip-makers) to those who make through trips.

The hypothesis can in part explain the rise and decline of turnpikes. When trips by road were long distance (made by out-of-towners) they were expedient to toll by the simple placement of cordons across which one could not pass without paying a toll. But when

long-distance trips were diverted to canals and rail, imposing sufficient tolls on local residents to raise the required revenue was politically difficult and inefficient, and the toll financing system collapsed. The hypothesis also suggests that in the present era one is more likely to see tolls on highways constructed by a small jurisdiction (such as Delaware or other states in the northeastern part of the United States), than on those constructed by large states (such as California or other western states)<sup>1</sup>. Furthermore, when roads are financed by a large integrated jurisdiction (like the United States federal government), where all trips are “local” in that they remain within the large jurisdiction, the motivation to reduce the transaction costs which have traditionally been associated with toll roads is higher than when financing is by a smaller jurisdiction (any state which is a subset of the larger United States).

The burden of the transaction costs of tolls in the smaller jurisdiction falls in part on those who don’t vote in the smaller jurisdiction. In the larger jurisdiction, where road use is pervasive (voters and road users are essentially identical groups), there is no apparent immediate gain to residents by using tolls rather than taxes (aside from the efficiency arguments of congestion pricing and focused internal organization), while in the smaller jurisdiction, the benefits of tolls falling on non-residents is clear. Still, if toll financing is the only means available to construct new roads, there are benefits even in the larger jurisdiction.

This hypothesis does not claim to be a total explanation under all circumstances, as a socio-political system like infrastructure financing has many influences. For instance, perfect excludability on roads coupled with the presence of “free” alternatives, reductions in toll collection costs, and private ownership, may all increase the willingness of a jurisdiction to tolerate tolls even on local residents. Further, the influence of key players in business and politics with specific preferences are unpredictable and may greatly shape the decisions made over time. A third factor is the prevailing ideology of government. In the 18th and 19th centuries, a philosophy of limited, decentralized government, or *laissez faire*, was conducive to private enterprise at all levels, including roads. However, this philosophy declined in America in the twentieth century, at least through the early 1970’s. Finally, regional rivalry and the idea of progress certainly have their place, promoting one-upmanship and construction for the sake of construction.

This report begins with a review of the status of roads before turnpikes. The weakness of the pre-toll financing system of statute road labor is the progenitor of turnpikes. The next section discusses the factors which led to the expansion, and ultimate contraction of, turnpikes. Following is a discussion of what has happened since the beginning of the twentieth century, the era of modern roads, which assumed importance

first with the bicycle, then more importantly the automobile. A wave of turnpike construction beginning with the introduction of limited access highways and lasting to the beginning of the interstate highway system is examined. Finally, current efforts at building toll roads in the post-interstate era and various road pricing schemes are discussed. General conclusions are drawn from an examination of the history.

## **2. ROADS BEFORE TURNPIKES**

The roadway network of Britain has been heavily studied, and as English common law has become the underlying standard throughout much of the world, it is a reasonable starting point for understanding the status of roads before the imposition of tolls. This section relies heavily on the history of English roads by the Webbs (1913). It is believed that roads (in Britain and elsewhere) began as trails, running from high ground to fordable points on rivers or seaports. Through a process of cumulative causation - a cleared path attracts more traffic, which helps keep the path clear - these tracks became ensconced as the backbone of the original transportation network. The Roman occupation of Britain resulted in the construction of four main roads, principally for military communication, and numerous minor ones. After the Romans left, road use may have diminished, though certainly did not vanish.

The conception of the road in this period is described as more of a right than an object, a road is a right of passage on another's land, rather than the paved surface owned by some central authority that we imagine today. The highway constituted "good passage" rather than the beaten track, so if the track were in poor condition, travelers could skirt it. The English word "road" is of the same root as the word "ride" - the Middle English "rood" and Old English "rad" - meaning the act of riding (Webster's II 1984).

The first English law dealing with roads was the 1285 Statute of Westminster, requiring residents of manors to clear two hundred feet on each side of their roadway of "bushes, woods, or dykes" where a "man may lurk to do hurt". The wide right-of-way was to ensure protection from highway robbery rather than enhance movement. However, the roadways began to deteriorate over the late middle ages and renaissance. An important cause is the decline of the religious orders associated with Henry VIII's break with Rome, which reduced pilgrimages and levels of traffic on the roads. Monasteries which had maintained roads were no longer able to, while the successors to their property had much less incentive. As cumulative causation works in one direction creating the roads, it also can work in reverse leading to their deterioration through neglect.

The next legal milestone, "2 and 3 Philip and Mary, C.8.", was passed by the Parliament of 1555. This law set the obligation of maintaining public highways upon

several parties: the parish and every resident thereof, the newly created Surveyor of Highways for each parish, and the Justices of the Peace within the Parish's Division. Any or all of the parties could be brought before a judicial tribunal if they failed to fulfill their obligation. Parishioners with property were required to send plows, carts and horses to help maintain the roads, while others were required to labor for six consecutive days each year (about two percent of the working year) under the authority of the Surveyor of Highways.

As might be expected with growth in the economy and changes in the price level, over time the penalty for not performing the obligatory labor became less onerous than actually doing the work. By 1649, in some British localities, taxes were beginning to be assessed for road improvements to pay the Surveyor of Highways, formalizing the process. However the system of compulsory labor remained through the 1700's, until finally being eliminated in 1835. With the decline of the feudal manor system, this mechanism of "financing" road improvements was viewed as more and more inequitable. Furthermore, it became increasingly inefficient as steadily higher and higher quality roads were demanded. The efficient division of labor called for something other than everyone serving the same six day period on roads, it makes little sense to have people responsible for spreading gravel on the roads working (or not working) over the same six days as those who had to dig the gravel.

Similar laws existed in North America, for instance in New York in 1800 all free males over the age of 21 were assessed highway labor "in proportion to the estate and ability of each", with a minimum of one day and a maximum of 30 days as determined by town highway commissioners. Failure to contribute led to fines which steadily increased over time, commutation of labor cost 62.5 cents per day in 1801 (Klein and Majewski 1994). These laws lasted into the twentieth century in some rural areas, including parts of Texas (Goddard 1994).

The American system collapsed for similar reasons to the British, the mandatory labor was viewed as a burden and the laborers did not contribute their utmost effort. There was no incentive to work hard in general, particularly so when your co-workers shirked. Unlike money which is fully fungible, labor's value depends on the effort put in as well as the amount of time spent. The stream of money for roads was inconsistent, coming from fines rather than any dedicated revenue, making planning difficult. The districts, which were small, could only draw on local laborers for construction, even if the road which it governed served a broad area.

### **3. THE FIRST TURNPIKE ERA: 1656 - 1900**

#### **3.1 Turnpikes in Britain**

The initial deployment of turnpikes in seventeenth century Britain, their growth through the eighteenth and early nineteenth century, and decline in the late nineteenth century provides insight into current discussions of private toll roads. The English word “turnpike” derives from the spiked spear (pike) which was stretched across the road so it could be swung open for toll payers (McShane 1994). Turnpikes were comprised of both new and reconstructed roads (Buchanan 1990). In some important cases, the turnpiking of a road was accompanied by its reconstruction; in others, the government subsidized the reconstruction of an existing turnpike.

The first English turnpike is recorded in the Vestry of Radwell, Hertfordshire, which petitioned Parliament for road improvements in 1656. By 1663, Parliament permitted the placement of three toll gates to raise funds for the repair of the Great North Road by the County Justices in Quarter or Highway Sessions (Payne 1956). Some other toll gates followed. The upturn in turnpike acts in 1695 reflects a return to domestic stability in England after the Glorious Revolution. (Albert 1972, p12).

Turnpike acts were promoted by local residents (town councils, merchants, manufacturers, farmers, landowners) responsible for maintaining at least part of the road in question. The turnpikes covered multiple parishes, though only a large subset of those parishes were required to push through an act (Albert 1972, p24).

After 1706 in Britain, Parliament chartered “turnpike trusts” to improve selected roadways. A typical turnpike trust might have well over 80 trustees, though only a dozen or so attended meetings regularly (Payne 1956). The trusts were chaired by the treasurer, while the turnpikes were managed by an appointed surveyor (who generally did not serve as a trustee, to avoid the accusation of jobbery). The surveyor supervised maintenance and construction along the road, and was rarely limited to serving on only one turnpike. Ultimately, the collection of tolls was franchised to toll “farmers” who, after paying a fixed sum to the trust, were permitted to collect tolls at specified gates on the turnpike or turnpike system. Toll farming began as early as 1702, when the first leases were agreed to, only in 1773 were tolls auctioned using a formal procedure. Initially the toll farmers were local businessmen, but as the system matured the toll farmers became larger and larger. By 1825 one partnership rented three/fourths of the tolls in London, amounting to between £400,000 and £500,000 (Albert 1972, p85).

Pawson (1977) provides the most comprehensive history on the deployment of turnpikes. Figure 1 shows the number of turnpike trusts in Britain, approximating the classic “S-curve” (the cumulative version of a normal distribution) through 1850. The theory underlying the S-curve is straight-forward. As knowledge of a technology and realization of its benefits spreads, the rate of adoption increases. Each project acts as a demonstration to potential new users. Furthermore, the advantages to adoption may increase with the number of users if there are network or inter-firm scale, scope, or sequence economies. As the technology diffuses, those who expect to attain the most benefit adopt it first. After a point, diminishing marginal returns set in. It is expected that, after complete exposure, technology is adopted by those who gain the most, and then by those who gain less and less from it, until it is fully deployed. The life of a technology may be cut short by competing technologies (such as canals and railroads in the case of turnpikes) or because a technological problem is discovered (as in the case of plank roads). Phillips and Turten (1987) describe two basic patterns of British roadways during deployment: radial roads focusing on towns (initially London and later others), and inter-regional roads serving intercity traffic.

In Britain, not everyone was subject to tolls. The government paid an annual fee in lieu of tolls, while residents of the road’s locality typically paid a fixed annual fee rather than a per-use charge (Payne 1956), thereby enabling some degree of free (or subsidized) riding. In economic terms, British turnpikes were viewed as local public goods, with outsiders able to pay for limited use, as with a club good (Cornes and Sandler 1996). It is unlikely the fixed annual fee provided revenue in proportion to the costs of use, though the financial situation in terms of costs and revenues on turnpikes in this era remains to be satisfactorily examined. In other locations, the mails and religious persons were exempt, as were the construction workers improving the roads (Copeland 1963). The tollgates, which generally formed, at minimum, a cordon around the part of the road network operated by a single authority, extracted revenue from trips originating and/or destined for areas outside the toll authority’s coverage. The tolls were used to pay off mortgages incurred by the trusts for road improvements, including extending, resurfacing, straightening, and widening the turnpike, constructing footpaths, arching over sewers, and lighting the road in urban areas.

The deployment of turnpikes was not without some opposition. Prior to the turnpiking of a road, it had been open to free passage under English common law. But because “free” roads were of poor quality, carriages belonging mostly to the rich could not easily pass. The turnpikes, which improved road quality at a price, were thus viewed as a transfer from the poor, who could always pass for free with carts and horses before tolls,

to the rich, who gained the most when the roads were improved. This was quite similar to the enclosure movement, which also created similar new property rights. The inequity led to several turnpike riots (Albert 1979). Colliers who resented the placement of tolls between the coal mines and market in Kingswood, Bristol smashed gates and tollhouses during riots in 1727, 1731, and 1749. However, unlike laborers in other sectors who also had resentments, the coal miners were far better organized and had been given fewer dispensations than local traffic elsewhere. To combat these riots, the government in 1727 raised penalties on destroying turnpikes or riverworks to 3 months in prison and public whipping for the first offense and seven years of transportation (being sent abroad to a penal colony) for the second. Yet the rioters were not deterred. In the 1730's resistance moved to the Gloucester and Hereford regions. The last 18th century riot took place in 1758 near Bradford and Leeds, where tolls had been doubled and new gates imposed. In 1843 the Rebecca riots took place in Wales (Duckham 1984), leading to a restructuring of turnpike management.

After the 1843 Rebecca riot, a Welsh commission recommended that turnpikes be consolidated at the county level (Duckham 1984). Further, tolls were to be made uniform throughout the six counties of Wales for each type of good, and toll booths were to be placed only every seven miles (12 km). Produce was to be exempt and agricultural inputs such as lime only tolled at half the normal rate. In an early recognition of the link between transportation and land use, the road taxes were deducted from the rent paid by tenant farmers. While the counties continued road maintenance, tolls were again farmed. The tolls were auctioned to the highest bidder, who over time became a representative of a national organization who attained one main economy of scale - the spread of risk over multiple operations. Risk was steadily increasing in the mid 1800's due to the railroading of the countryside; as soon as a railroad arrived, toll revenues dropped. When a railroad came in, or for any other good reason, the toll farmers tried to obtain a reduction in their lease payments from the county boards, who only sometimes acquiesced.

It should be noted that revenue dropped when the road board operated tolls themselves (Duckham 1984). Several reasons have been suggested, including higher administrative expenses and less thoroughness in catching toll evaders. A third reason to be noted is that cause and effect are reversed here; because toll revenues dropped, the county road board had to assume toll collection on the turnpike when the toll farmer defaulted. Toll farmers only paid a short period in advance for the right to collect revenue, minimizing capital outlay and providing them the opportunity for renegotiation with some leverage. While the tolls covered maintenance, the county still subsidized major capital

expenses through the road rate (general taxes). In 1889 the county took over the road boards and dissolved the turnpikes.

The arrival and deployment of railroads from the late 1820's eroded the market share for inter-city transportation belonging to roads. The railroads, running on steam power, were significantly faster than horse-powered transport, a speed which made up for the increased access costs: the railroad depot may not have been the ultimate origin and destination, and trains ran on fixed schedules. Still, since much intercity transport was provided by carriage services, road transport in the mid-1800's more closely resembles a competition between bus and rail than car and rail.

The Times (of London) in 1816 editorialized on the inconvenience of toll collection every mile (1.6 km), describing the collectors as: "men placed in a situation unfavourable to civilized manners, and who might be usefully employed in mending the roads which they now obstruct in a most disagreeable manner" (Albert 1972, p65). Certainly tolls were not heralded with universal acclaim, and as the situation made itself amenable, pressure to remove tolls increased. The Webbs (1913) date from the early 1860's the public determination to rid themselves of tolls. Tolls were replaced by local tax revenue in Ireland for funding roads in 1858, and the results were perceived adequate. Parliament member George Clive's 1862 retirement was seen as the removal of a key impediment to removing tolls, more precisely, in not renewing the terms of turnpike trusts as had been done in the past. The main complaints against tolls were that they were a costly and wasteful means for collecting revenue, inconvenient to the public, that they impeded traffic, and that the tax was inequitable. The recommended solution was to vest the roads in a public authority (highway districts or the local highway parish). From 1865, tolls in Scotland were abolished piecemeal. From 1864 onwards, turnpike trusts in Britain were dissolved at a rapid rate, as shown on the right side of Figure 1. The final turnpike toll was collected November 1, 1895 on the Shrewsbury and Holyhead Road.

The loss of turnpike revenue increased the financial burden on local authorities to finance and maintain roads. Grants from the national government were intended to mitigate these factors. Eventually, authority for the roads moved up to the County level outside urban areas, and was paid for by local taxes sent to the County, Town, or special district.

### **3.2 Turnpikes in America**

In the United States, turnpike deployment began about a century after Great Britain. The causes were similar: the quality of the roads were insufficient to meet the demands placed upon them. In particular, before turnpike deployment, there was a feeling of inequity where rural residents paid to maintain roads used by urban dwellers for intercity

travel. Before bringing in private enterprise, states tried solve the problems themselves. Americans unsuccessfully tried to emulate the British Turnpike Trust system, using taxes for construction and tolls for maintenance, but turned to corporations formed by interested merchants and well-to-do landowners after the earliest deployment. Thus the first turnpikes often had the assistance of tax funding in the 1780s, but in later years, outside of Pennsylvania, most turnpike companies received little state aid. The rationale for state assistance was based on the premises of positive externalities or spillovers that roads would increase both land values and commerce (Durrenberger 1931, p37, 97). Without subsidy, it was believed that there would be an underinvestment in roads.

In 1785, Virginia authorized tolls on public, tax funded roads, and chartered a short distance turnpike from Alexandria to Berryville (USDOT 1976); Maryland followed suit in 1787 (Klein and Majewski 1994). The first significant U.S. turnpike company was chartered in Pennsylvania in 1792, connecting Philadelphia and Lancaster, and completed two years later (USDOT 1976). To look at the rate of deployment, Table 1 shows the number of turnpike companies chartered in several states from 1790 to 1845. Like turnpikes, bridges were private toll facilities. From 1786 to 1798, 59 toll bridges were chartered (Klein 1990). Baer et al. (1993) illustrate the basic pattern in New York as a series of roads radiating from that state's main artery, the Hudson River, and later the Erie Canal. In California, most toll roads were deployed in the mining counties of the Sierra Nevada (Klein and Yin 1996).

The Federal Government was not permitted under the Constitution to collect tolls, according to President Monroe, who vetoed attempts to place tolls on the National Road (running from the Potomac River to the Ohio River), which was already beginning to deteriorate less than ten years after its 1813 opening. By the 1830s, Congress turned over the road to the relevant states, who imposed tolls to maintain the road (USDOT 1976).

Much of the American turnpike construction was due to competition between towns to gain trade. Durrenberger (1931, p 47) argues "The rivalries and jealousies that existed among the states seems unbelievable today" and one can extend the observation to rivalries between towns. The subscribers to turnpikes, as with canals, were a mixed group including citizens, municipalities, and state governments, as well as foreign nationals in later years. Although the federal government had subsidized new turnpikes and roads through land grants in the public lands (western) states prior to 1830, attempts to have the federal government subscribe to turnpike company stock offerings were ended by President Jackson's 1830 veto of the Maysville Road Bill, which had been sponsored by the state of Kentucky to get federal funds for what Jackson deemed a purely local road. It was twenty years before federal subsidies to infrastructure, then railroads, came again (USDOT 1976).

Despite the sparse federal involvement, town leaders realized that an early edge in attaining access to other areas, and thus becoming a key cross-roads would have long-term payoffs (Klein and Majewski 1994). Individuals would relocate to the towns with turnpike access, which would attract others individuals, provide revenues to the turnpike, and encourage additional transportation investments. Towns without access would wither.

Klein and Majewski (1994) argue that after the first few were chartered, turnpike investments were recognized as unprofitable, and were really an example of voluntary private provision of a public good for the good of the public. Towns and their leading citizens were looking for economic spillovers from the roads. Because towns were more autonomous in this era, citizens felt more obligated to contribute. Investors, constituting the social elites of towns, invested in turnpikes to promote the town's interest (and only indirectly their own). The voluntary private provision of public goods can be individually rational if the provider's contribution is outweighed by the benefits received from their own contribution (Olson 1965). Furthermore, social pressures were placed on members of the elite to ensure sufficient subscription to new investment. These pressures enforced good behavior (meeting social obligations) due to the repeated interactions of the local business elite, in multiple spheres, which would socially or economically discipline a member who shirked responsibilities. Gray (1968) finds similar practices in the chartering of the Chesapeake and Delaware Canal.

Although there is some aspect of voluntary private provision of a public good with possible private benefit from spillover in the construction of many turnpikes, other turnpikes were just as surely speculative ventures attempting to be profitable in their own right. Foreign (or even non-local) investment provides evidence of this (USDOT 1976). However, Durrenberger (1931, p100) argues that "while foreign capital was in abundance after 1815, it played a very minor part in turnpike finance", and that the largest part of foreign impact was associated with dollars lent to the state of Pennsylvania. Durrenberger suggests that capital was mostly local; at no time did state ownership exceed one-third of invested capital, though in a few instances towns and cities did invest. He gives support to the argument that turnpike "subscribers were usually more interested in the possible benefits the new lines of communication would bring them than in the [profitability] of the investment" because of the wide distribution of stock and the character and interests of subscribers. From the point of view of dividends and capital return, turnpike stocks were poor investments; at best returns were 8% annually, with 3% being more common, and financial problems set in even before the deployment of canals and railroads.

In New York, toll booths were spaced at ten mile (16 km) intervals, thereby allowing local trips to be free riders. The free rider problem was significant. For instance,

Massachusetts law exempted people going to and from gristmills or church, people on military duty, or on journeys within the toll-gated town for common and ordinary family business (Rae 1971). Furthermore, “shunpikes”, illegal toll gate bypasses, frequently arose to allow travelers to avoid the road section with the toll booth. These two factors limited the profitability of turnpike.

The California turnpike experience differs from that in the eastern states. In addition to beginning about fifty years later in the wake of the gold rush, the rationales for the road differed. California law borrowed heavily from eastern states, including financial requirements that may have hindered the deployment of the new roads (Klein and Yin 1996). In the eastern states toll roads emerged from community enterprise, without a significant profit motive; in California turnpikes operated more like businesses, interested in the residual revenues from roads. It is unclear to what extent the California roads succeeded in being profitable enterprises: some were and some weren't, though the exact proportions are not known (Klein and Yin 1996). Many of the owners of California's toll roads were resource extraction companies such as mines and lumber companies. In addition, a number of tourist roads were built, including to Yosemite and on Mount Wilson (Klein and Yin 1996).

Spin-offs of turnpikes include taverns (early rest stops), which were a highly structured market. Three different kinds of taverns were typical, showing up as often as one per mile (1.6 km) on the heavily traveled Philadelphia and Lancaster Turnpike (Durrenberger 1931, p124). These include marketing to the relatively freer-spending stage passengers, to wagoners, and to livestock drovers. While stage passengers required food and sleep, wagoners needed yards and stables, and drovers needed pasture and feed for their droves.

The argument can be made that some of the toll roads were required as a component in the production process. For instance, roads and mines (particularly in California during the nineteenth century) are complements. A mine without access is useless, but the traffic to the mine does not utilize the full capacity of the road. Because roads exhibit economies of scope - it doesn't matter whether the trip is to the mine (or resort) or not, the road equally serves both - and are lumpy investments (the lanes of a road cannot be made significantly smaller in proportion to the scale of traffic, they represent an indivisibility), the California road owners were trying to reap the rewards associated with the necessary construction of a road.

In the first turnpike era, turnpikes were believed to increase the value of land where they were placed and decrease it elsewhere by changing the pattern of relative accessibility. The changes resulted in a reduction in rents in some areas in competition with those newly

turnpiked. The consequence was a push to improve transportation accessibility in many localities, either to increase rents or prevent them from falling. Adam Smith (1776) notes that “not more than fifty years ago, that some of the counties in the neighborhood of London petitioned against the extension of the turnpikes into the more remoter counties. These remoter counties, they pretended, from the cheapness of labour, would be able to sell their grass and corn cheaper in the London market than themselves, and would thereby reduce their rents, and ruin their cultivation.” The complementarity between transportation and the points they access has also been noticeable in the construction of streetcars and their associated suburbs in the late 19th and early 20th century (Warner 1962) and more recently in developer-financed roads, including some toll roads opening up new areas like the Dulles Greenway in Virginia.

As in Britain, opposition occurred in the United States, for many of the expected reasons. On principle, many thought that roads were a public not a private function, and that payment of tolls was a payment to usurpers of public roads (Durrenberger 1931, p81). More practically, locals were opposed to paying a toll when travel had been free; much of this opposition was mitigated by charters which enabled local residents to be free riders. Further, there was resentment of those who owned the turnpike, who would get rich (or at least were thought to get rich) at the expense of travelers; and opposition to the corporate form in general, which was new in the early 1800’s (Klein and Majewski 1994). Over the long term, these opponents of corporate governance had little effect, as the corporate form has become the dominant means of organizing business. The opposition to urban highways that emerged after the interstate program was initiated was due to destruction of local communities as well as NIMBYism (NIMBY is an abbreviation for Not In My Back Yard), opposition to any noxious facilities nearby. There is no record that opposition in the first turnpike era had any similar causes. As in Britain, laws protected infrastructure and punished vandalism. The main arguments for abolishing turnpikes drew from those opposing their establishment: that roads were utilities and should be free, that turnpikes drew patronage mostly from local traffic which meant taxing the farm class, that people would benefit from freer social intercourse, and that tolls were an annoyance to travelers (Durrenberger 1931 p162).

As in Britain, in the United States the driving forces behind disturnpiking were other modes: canals and railroads. At first these modes, particularly canals, killed the competing trunk roads, while in fact promoting the construction of complementary branches (Baer et al. 1993). The Erie Canal opened in 1825 and soon found its first victims: the First, Second, and Third Great Western turnpikes, which saw annual revenues decline. Just as the turnpikes declined, the fortunes of towns on the turnpikes declined,

while those on the canal rose. Nevertheless, the turnpikes were not immediately put out of business.

Turnpikes were not helped by the Supreme Court's 1837 decision in the case *Charles River Bridge v. Warren Bridge* ((11 Pet. (36 U.S.) 420 (1837)) (Monroe in Hall 1992)). In 1785, Massachusetts legislators incorporated the Proprietors of the Charles River Bridge to build a connection between Boston and Charlestown. In 1828, the legislature authorized Charlestown merchants to build the new Warren Bridge, and to collect tolls until they were reimbursed, at which time that bridge would be free and revert to the state. The Charles River Bridge proprietors sought an injunction against the new bridge. The question turned on whether the Charles River Bridge proprietors had a vested right to a monopoly between the two locales, or simply permission to operate a bridge and collect tolls, while the ambiguity in the original contract permitted multiple interpretation. Taney, a Jackson democrat and recent judicial appointee wrote the opinion in a 4 to 3 vote which justified the destruction of old property "rights" so that new ventures might prosper. The state was authorized to provide new charters so long as the narrow constitution of the private property right in the original charter was not diminished, that narrow interpretation being simply toll collection. The consequences of this decision were broad and not helpful for turnpikes, which had hoped to use exclusive franchises to delay competing canals and railroads (McShane 1994).

The roads in New York faced a second blow with the advent of major railroad construction beginning in 1848. "The turnpikes disintegrated in stages, abandoning their road piece by unprofitable piece (Baer et al 1993)." By the end of the 1850's New York's major trunk turnpikes were dissolved and became public roads. Partial abandonments were permitted, and this was the most common form of the dissolution of turnpikes (Durrenberger 1931, p156). However, as older turnpikes saw long-distance traffic wither and collapse, new feeder roads were being constructed as complements to the railroads. Rose and Durrenberger argue that the number of new charters did not diminish greatly until 1875 (Durrenberger 1931 p 154, Rose 1953). The number of charters from 1830-1860 exceeded the number from 1800-1830 in the middle Atlantic states, in Pennsylvania the numbers were 630 vs. 200, in New Jersey 124 vs. 48. Still, it must be remembered that the nature of the later roads was as feeder to intercity transportation via canal and railroad, while the earlier roads were themselves more often trunk roads (Durrenberger 1931, p139).

A brief exception to the decline of turnpikes occurred with the emergence (and disappearance) of plank roads between 1846 and 1857 (Klein and Majewski 1994). Plank roads overcame many of the competitive disadvantages suffered by gravel roads - they were smooth and thus enabled faster speeds. They were most prevalent in areas where

lumber was cheap. Unfortunately, the planks deteriorated after only a few years, much sooner than expected, and shortly after they were deployed they were abandoned. In New York, the length constructed was over 3500 miles (5800 km) between 1846-1853, where the plank roads served principally as branch roads in the Erie Canal and Hudson River regions, as well as radial roads to several upstate cities.

Though the first turnpike abandonments were found in 1817 in New York, turnpikes did not die with a bang; in 1898 in Maryland there were still 497 miles (828 km) of turnpiked road, and in Pennsylvania in 1903 there were still 1101 miles (1835 km) of turnpike (Durrenberger 1931, p115). The Lancaster Pike, the first significant turnpike, was not finally dissolved until 1902 (USDOT 1976). Durrenberger suggests several main causes of unprofitability: poor organization and management, high overhead (fixed cost) of toll collection relative to their scale, early undercapitalization and excessive debts so that tolls were diverted to interest payments rather than maintenance, poor location and insufficient traffic due in part to speculative construction in advance of traffic which never materialized, and competitions from railroads and canals.

Turnpikes were established with charters which intended them to ultimately revert to the states, typically after a ninety-nine year run in the private sector or the achievement of some maximum return on capital. The actual method of reversion or disturnpiking was through abandonment, condemnation, or sale; few actually lived out their charters. In the 1870s counties and towns were given authority to purchase and disturnpike roads and bridges at local expense. By 1897, rules, such as those in New Jersey, were drawn permitting two-thirds of fronting property owners to petition the state public roads commission to disturnpike the road, sharing a fair and just price paid to the turnpike's owners between the state (33%), county (57%), and frontage properties (10%) (Durrenberger 1931 p164). In the early 1900s, as states established state highway systems, the remaining toll roads were acquired by state and local governments.

## **4. TWENTIETH CENTURY TURNPIKES**

### **4.1 The American Experience**

The advent of the bicycle, and then the automobile, created a new set of needs for highways. While previously roads had been designed first for pedestrians and animals (pack animals to carry people and goods, cattle and swine being herded to market), wheeled carts and carriages require an improved surface. The technological change of the wide(r)-spread adoption of wheeled vehicles, coupled with socio-economic factors and

regional growth, led to a change in highway financing in the 18th century. Similarly, rubber-wheeled vehicles traveling at higher speeds required a smoother surface yet again. To support the new vehicle stock, roads needed to be improved with smoother surfaces and more gradual curves that could be taken at higher speeds. In the United States, two highway systems were deployed in the twentieth century to support the automobile. The first “U.S. Highways” created a national network of paved roads, the second “Interstates” created a network of grade separated freeways. Both were largely free of tolls. In 1914, before significant federal involvement, but after the beginning of the good roads movements, the United States had 257,293 miles (428,822 km) of surfaced roads, of which 75,400 miles (125,700 km) were macadam, 1,591 mi. (2652 km) were brick, and 2,349 mi. (3915 km) were concrete (Flink 1990).

Prior to federal involvement with “U.S. Highways”, some modern 20th century roads had been toll financed, though this was limited in scope. In 1908, William Vanderbilt started a turnpike company to construct the Long Island Motor Parkway, intended for car enthusiasts in New York (McShane 1994); however the road, only one lane in each direction, never made much money and had technical problems with its surface. The toll idea was borrowed by Robert Moses, New York’s Park Commissioner, to fund “parkways” throughout metropolitan New York from the 1920’s (Caro 1974). Ironically, Moses’ Northern States Parkway paralleled the Vanderbilt route, and bankrupted it in 1938 (the route became a power line right of way). The DuPont family built a similar private roadway in Delaware (McShane 1994).

Financing in the era of U.S. Highways was principally by gas tax, beginning in Oregon, New Mexico, and Colorado in 1919; by 1929 it was national in scope. In 1921 property taxes and general funds paid about 75% of the cost of roads, by 1929, 21 states no longer used any general funds or property taxes for funding, and most money came from gas taxes (Flink 1990). The federal aid program paid for no more than 7% of the road miles in a state; by 1924, this amounted to \$15,000 per mile (\$9,000 per km). Beginning in Britain in 1909 came the idea of non-divertability of gas taxes, which said that gas revenue would be spent on roads, not on general budget issues or even for other transport modes. This concept disappeared in Britain in 1926 (Flink 1990), and later in the United States (in 1973 some gas tax revenue could be diverted to other transport modes and in 1993 a fraction of gas taxes were diverted to the general fund at the federal level).

Before the federal government’s involvement in grade-separated roads, a number of states, particularly in the northeast, had already chartered turnpike authorities to construct those inter-city roads. Proposals by the Roosevelt administration for a transcontinental toll road from 1934 came to naught (Goddard 1994). In 1939, the Bureau of Public Roads, a

long-term opponent of tolls (Goddard 1994) published “Toll Roads and Free Roads” which argued that tolls would cover less than half the annual cost of a system of interstate roads (Rae 1971). However, their estimates were quite off, given the experience of actual toll roads opened in the next two decades; for instance, a projection of 715 vehicles per day on the Pennsylvania Turnpike versus actual demand in the tens of thousands (Rae 1971, Gifford 1983). Gifford (1983) argues forcefully that the conclusions of the report to oppose federal toll roads would have been reversed had accurate demand forecasts been used and accepted. Even President Eisenhower thought the interstate system should be toll financed, though Congress, led by Senator Gore, Sr. disagreed (Goddard 1994).

Many tunnels and bridges were constructed as toll facilities, both before and during the interstate era. Those before the interstates include the Golden Gate and San Francisco Bay Bridges in the Bay Area, and the Holland and Lincoln Tunnels and George Washington Bridge in New York.

Just as the first American turnpike was in Pennsylvania, so was the first in the new era of limited access highways. The Pennsylvania Turnpike, constructed in part along the abandoned South Pennsylvania railroad right-of-way and through already partially bored tunnels, opened in 1940 connecting Pittsburgh with Harrisburg along a higher quality and shorter route than the existing U.S. 30 (The Lincoln Highway) and U.S. 22 (The William Penn Highway). The South Pennsylvania had begun construction under the direction of Commodore Vanderbilt and Andrew Carnegie as a competitor to the Pennsylvania Railroad, which had a spatial monopoly on long-distance freight traffic through the state. Vanderbilt, who owned the New York Central, believed the Pennsylvania RR was supporting a competitor in New York, and the South Pennsylvania was begun as a competitive response. J. P. Morgan brokered a deal which led to the abandonment of both competitive projects (Cupper 1990). Though the road was built without any federal transportation funds, other New Deal financing sources were used, including a \$29.25 million grant from the Public Works Administration and \$40.8 million purchase of bonds by the Reconstruction Finance Corporation (Deakin 1989, Cupper 1990). The road was not only the first new era toll road, it was also the first long distance limited access highway built in the United States. The original toll was \$1.50 end to end, or just over a penny a mile (\$0.006/km), but that was not enough to keep the road uncongested. The first traffic jam occurred (27,000 vehicles on a single day) the sixth day the road was open, as Sunday drivers took advantage of views of fall foliage (Cupper 1990). The toll road was extended several times to Ohio and New Jersey, the road was widened and improved in places, and over time the toll has risen to 3.1 pennies/mile (\$0.019/km) and traffic flow to 97 million vehicles per year in 1989.

Owen and Dearing (1951) note that the cost of collecting tolls ranged from 3.5% of total revenue on the Pennsylvania Turnpike to 18% on the Merritt Parkway, while the gas tax in the same era entailed a 4.0% collection loss. The capital cost of constructing toll booths on the Maine Turnpike was 1.3% of total costs. The advantages of turnpikes recognized at the time include a decentralized institutional structure enabling market evaluation and a limit to the misplaced uniformity (all roads at the same standard, a ubiquity of construction even in areas without demand) of a centralized publicly funded system. The disadvantages were empire building by a quasi-autonomous government agency which may use cross-subsidies against the public interest and over-extension in the case where forecasts outpace actual demand.

There was considerable controversy over how to treat toll roads in the context of the toll-free interstate highway system, particularly whether states should be compensated for toll roads already constructed. Ultimately, 2700 miles (4300 km) of the pre-interstate toll roads were included in the interstate system. Over 4000 miles (6400 km) of toll facilities were built in the period from 1940-60 in over 30 states (Shaevitz 1991). These include the turnpikes shown in Table 2, as of 1963, and shown chronologically in Figure 2. As can be seen, the toll roads were built largely in the physically smaller eastern and midwestern states, while the large western states relied on “free” roads. At least two factors help explain this difference.

The first, which is the hypothesis of this research, relates to jurisdiction size relative to trip length. In general, a larger proportion of traffic in smaller states is made by residents of other states than in large states. The welfare of local residents increases when others (e.g. residents of other states) pay for a greater share road construction, operation and maintenance. Thus we expect to find toll financing more in smaller states than in larger states. While taxes have lower collection costs than tolls, in small states this is more likely to be offset by the gains from non-local revenue than in large states, where almost all of the traffic is local. This hypothesis assumes that trip lengths are approximately equal, and are independent of jurisdiction size. This is not strictly true, but the differences in trip length are much less significant than differences in size between east and west.<sup>1</sup>

The second factor has to do with federal land ownership, which is significantly higher in western states, and led to higher federal matching shares for construction of “free roads”. In eastern states, the federal match was only fifty percent before the advent of the interstate program; in the public lands states, the match was as high as eighty-five percent (Gifford 1983).

A few additional toll roads have been built since the completion of the interstate system, several under private ownership. Some thirty-five projects over 1900 km in length

of new toll roads are under study, design, construction, or recently opened (Deakin 1989, Schaevitz 1991, Gomez-Ibañez and Meyer 1993, Reason 1994). Some of these roads are intended to accommodate new development, others to serve existing travel demands. The Dulles Greenway, a private road, has been built with major donations of land from adjoining landowners hoping to develop. Along California's SR91, in the median of an existing highway, High Occupancy/Toll lanes were constructed with land control transferred from the state to a private company.

## **4.2 International Experience**

While in the United States the twentieth century toll road experience has been almost completely public, the same is not true in other countries. In some countries, private sector toll roads have been constructed with the government's consent. Unlike many toll roads in the U.S., these roads apply perfect excludability, so no one can free ride on the roads. A price for this is longer spacing between exits than traditionally found in the U.S., where toll roads are more often (though not exclusively) cordons on a state line or across a waterway. A key transportation implication is the increase in back-tracking costs as users must drive beyond a destination to exit and then backtrack, or spend more time in travel on the slower parallel free roads.

France had granted concessions to private and mixed public-private corporations to finance, build, operate and receive revenue from intercity toll roads, while the government retained ownership and the right to repurchase at the end of a fixed time period. By the 1990's France had constructed 6000 km of intercity autoroutes, all but 500 of which are tolled (Gomez-Ibañez and Meyer 1993). However, the 1500 km of urban autoroutes remain untolled. The intercity routes compete with a 30,000 km network of untolled national roads, built to less stringent standards and often not grade separated. The eight major concessionaires originally had significant private sector involvement, but only one, Cofiroute, which operates 732 km, remains; the rest were taken over by government when they hit financial difficulties. Those difficulties were not solely the product of a free market; rather, the government in the 1970's took to regulating prices and allowing them to rise at a rate lower than that of inflation, hurting the companies' balance sheets. The socialist government of Mitterand forced consolidation and conversion of the private companies to mixed public-private companies, and implemented cross-subsidies between routes.

Spain began similarly to France, establishing Autopistas in the 1960's, a private concession to operate toll roads. This system was followed by an untolled publicly owned intercity highway system, the Autovias, promoted by the socialized government of

Gonzalez in the 1980's. Both systems are about 2000 km in size. The Autopistas system is comprised of 13 companies, nine of which are still private (Gomez-Ibañez and Meyer 1993). In advance of the 1992 Olympics and World's Fair, some new Autopistas routes were established. Gomez-Ibañez and Meyer (1993) conclude that the system as a whole is profitable, though not each route.

Mexico established publicly owned toll roads in the 1950's and constructed about 1000 km by 1970 (Gomez-Ibañez and Meyer 1993). During the 1980's two concessions totaling 215 km were granted to the national development bank, with equity split between the bank, contractors, and state governments. In 1989, a program to build 4000 km of toll roads was proposed, the government selected the roads, performed the design and set the initial tolls, which would be permitted to rise with inflation. Twenty-nine new concessions, of an average duration of 11 years, were signed between 1989 and 1991, and roads were opened at the rate of 500 km per year. The toll rates were set high and the roads are thought to be underutilized. The government has subsidized construction on the less profitable routes. There has been a move to privatize the existing publicly owned toll roads as well as more recent discussion of nationalizing the private toll roads.

Malaysia, Indonesia, and Thailand have also experimented with private toll roads (Gomez-Ibañez and Meyer 1993). In Malaysia, a private firm connected with the government received a concession to collect tolls and operate 424 km of road that had already been constructed by the government with the in exchange for completing the 785 km road from Thailand to Singapore. The Indonesian government had built 318 km of toll roads and four bridges by 1990. As with Malaysia, firms with government connections were given the authority to build private joint-venture toll roads, where the government provided the right-of-way and the firm did construction. Thailand has constructed public toll roads in and around Bangkok, and in 1989 signed a concession with a private firm to complete a beltway around the capital and construct spokes. Tolls are to be shared between the public and private roads.

Economists have long suggested widespread road pricing as a solution to the financing and congestion problems. However, comprehensive pricing has only been carried out in a few areas and to a limited extent. These experiments have all operated with the government acting as a central planner, dictating road prices to users.

The best example may be in Hong Kong, where in the 1980's a full-fledged test of road pricing technology was implemented (Hau 1992). A sample of 2500 vehicles tested electronic road pricing. Each vehicle was fitted with an electronic license plate, and tolls were collected at 18 sites buried in the ground. While the system was technically successful, it failed the political test when it was perceived to be just another tax (despite

government protestations that it would be revenue neutral) and enabled “big brother” to monitor travel, particular concerns with the transfer of Hong Kong to the People’s Republic of China in 1997.

Singapore has had an area licensing scheme since 1975 (Hau 1992, McCarthy and Tay 1993), where in order to enter the downtown cordon, cars must possess a license, which can be read as the cars travel at full speed. The program did significantly reduce vehicle travel into the cordon, though off-peak traffic increased. Hau (1992) concludes that the government is using the area licensing scheme as a traffic management device rather than a revenue generator. McCarthy and Tay (1993) argue that the toll is too high, and that tolled “peak” period congestion is now lower than the untolled “off-peak”. They suggest that presence of congestion is insufficient grounds for imposing a toll, and that the congestion externality needs to be estimated explicitly.

Bergen, Norway has established a ring around the central business district and imposed tolls on the traffic crossing of that ring. Bergen allows the purchase of a seasonal pass which has zero marginal effect, as there is no immediate out-of-pocket charge, no delay, and no incentive not to travel after the pass is purchased. Traffic did decline somewhat after the program was put in place. The revenue was used to finance construction and expansion of the toll system. This system has been adopted by Oslo and Trondheim, and considered by many other cities. The tolls use electronic as well as manual collection, and provide volume discounts for frequent users (PRA 1996). The extent to which volume discounts increase automobile travel is not yet known.

## **5. SUMMARY AND CONCLUSIONS**

Both push and pull factors created the pressure to charter turnpikes. Pull factors include a modest advance in technology - the increased use of wheeled vehicles, along with the economic factors promoting more longer distance trade. The push factors were the difficulties in the existing system which utilized statute labor for maintaining roads. Toll roads have come in four eras. The first, which lasted from the 1700’s and peaked in the early-to-mid 1800’s, saw turnpikes under the control of local companies and trusts chartered by states or Parliament.

The difference between the American and British experience during the first era is instructive. In Britain, turnpikes were quasi-governmental organizations which sold bonds to fund construction. In the United States, turnpikes were owned and built by private companies, granted charters by the state to sell stock, and raise tolls on given roads. Turnpike authorities were permitted to lay out roads and negotiate with property owners whose property they needed to take; legal procedures were implemented when this was a

problem. On both continents, the turnpike authority's obligations were similar, to maintain roads at an acceptable standard. In Britain, turnpikes were viewed as local public goods, with some club aspects, built by the community for the good of the community because no private individuals would build it themselves under the then current economic and legal circumstances. In America, turnpikes were privately provided. However, the motivations in the United States include both the case of voluntary provision of public goods - with profits foregone, and the attempt to undertake a profitable enterprise. Free riders were present in both America and England: first, shunpikes enabled the skirting of tolls; second, many classes of trips which crossed the toll gate were exempt; third, trips remaining within the toll cordon paid no tolls and raised no revenue, though they imposed costs on the turnpike authority. Local residents in Britain and some American towns subsidized the roads through annual taxes, or through municipal subscription to an unprofitable road, and even through use of required contribution of local labor on occasion, but whether these subsidies covered the full private cost of travel by local residents is doubtful. As the competition from canals and rail diverted long-distance trips, toll revenue declined, even if local traffic did not, leading to the bankruptcy and abandonment of turnpikes in the United States and disturnpiking and public takeover of the quasi-autonomous trusts in Britain. Because more trips were local to the larger government level (states in the U.S. or counties in England), and revenue could be raised from multiple sources, tolls were removed.

A brief second wave came about with the automobile and the first significant deployment of smooth paved roads. However, in the U.S. most roads were financed by states, and later the federal government, by means of a gas tax. With the relatively slow speed of highway travel, most trips remained within states; through trips were not as significant as later in the twentieth century. However, a number of parkways featuring the property of excludability, were toll financed.

A third and significant wave of toll financing arrived with the deployment of grade-separated highways. As both vehicles and highways improved, trips of longer distances could be made in the same time and trip lengths increased. This in turn implied more trips between states, and the emergence of the free-rider problem when the basis over which roads were financed (taxes or tolls) did not coincide with those who used the system. Since financing was at the state level, turnpikes were effective for collecting revenue from all users and mitigating the potential free-rider problem. But when national financing became dominant, the definition of "local" changed to include everyone, and the revenue mechanism with lower collection costs (the gas tax) was preferred to tolls. As a result, new toll roads stopped being built in the U.S., though international experience varies. Furthermore, unlike earlier roads, grade-separated roads are easily excludable, that is, the

number of entrances is limited and tolls can be cost-effectively assessed at each. The same is not true of roads without grade separations.

Finally, upon completion of the interstate (intercity grade-separated highway) system in the U.S., new road financing has largely become a local problem again, and new toll roads are being constructed, including some private roads. Because of the length of trips, and because of the ease with which tolls can be collected on these excludable roads, as well as a reduction in toll collection transaction costs on both the government and traveler side with electronic toll collection, tolls are again a feasible option. New road pricing proposals depend on electronic toll collection. Further, cordon tolls are being placed around a number of cities internationally, which will collect revenue from non-local residents for traveling on urban streets. The cordons establish excludability for use of a network from outside, though not for any particular link once the network is entered. In places where cordons can easily be established, such as river crossings and ring roads, this is a feasible option for localities wishing to switch the road financing burden to suburban residents. Ironically, the attempts of localities subject to obsolete political boundaries to finance infrastructure for the “wrong” reason - the offloading of costs on non-residents - creates opportunities to achieve a more efficient infrastructure pricing and financing system.

From the evidence here, two key conditions are required to bring about more widespread use of toll financing emerge. First, a decentralization of the authority for road operation to the point where a significant number of the trips are non-local to the relevant decision-making authority would foster a willingness to use tolls, following the traditional saying “don’t tax you, don’t tax me, tax the fellow behind the tree”. Second, a decline in transaction costs to the point where they are equal or lower than the costs of other revenue streams is necessary, where transaction costs include both delay to users and collection costs for operators. These two factors should shift beliefs about the utility of imposing tolls, as they are designed to toll someone else (not the individual making the decision to support them) and they raise at least as much revenue at the same amount or less inconvenience.

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## 7. REFERENCES

- Albert, William. 1979. "Popular Opposition to Turnpike Trusts in Early Eighteenth Century England" *Journal of Transport History* 2:5:1: 1-17 (Feb. 1979)
- Albert William. 1972. *The Turnpike Road System in England: 1663-1840* Cambridge University Press, Cambridge UK
- Baer, Christopher T., Daniel B. Klein, and John Majewski. 1993. "From Trunk to Branch: Toll Roads in New York, 1800-1860." *Essays in Economic and Business History*, Vol. XI, 1993, pp. 191-209 (University of California Transportation Center No.121 Aug. 1992).
- Bobrick, Benson. 1986. *Labyrinths of Iron: Subways in History, Myth, Art, Technology, and War*. Henry Holt. New York.
- Buchanan, B.J. 1990. "The Turnpike Roads: A Classic Trap?" *Journal of Transport History*. 3:11:2:60-72 (Sept. 1990).
- Caro, Robert. 1974. *The Power Broker*. Alfred Knopf Publishers, New York.
- Chu, Xuehau and Gordon Fielding. *Electronic Road Pricing in Southern California: Policy Obstacles to Congestion Pricing*. University of California Transportation Center No.189.
- Copeland, John. 1963. "An Essex Turnpike Gate." *Journal of Transport History*. 1:6:2:87-94 (Nov. 1963).
- Cornes, Richard and Todd Sandler. 1996. *The Theory of Externalities, Public Goods, and Club Goods*. Cambridge University Press, Cambridge UK
- Cupper, Dan. 1990. "The Road to the Future." *American Heritage* May/June 1990 103-111
- Deakin, Elizabeth. 1989. *Toll Roads: A New Direction for U.S. Highways? Built Environment* Vol. 15 Nos. 3/4 185-194. (University of California Transportation Center No. 56 reprint).
- Dilts, James D. 1992. *The Great Road: The Building of the Baltimore and Ohio, The Nation's First Railroad, 1828-1853*. Stanford University Press, Stanford CA.
- Duckham, Baron F. 1984. "Road Administration in South Wales: The Carmarthenshire Roads Board, 1845-89." *Journal of Transport History* 3:5:1:45-65 (Mar. 1984)
- Durrenberger, Joseph. 1931. *Turnpikes: A Study of the Toll Road Movement in the Middle Atlantic States and Maryland*. Valdosta Georgia. University Microfilms, Ann Arbor Michigan
- Fielding, Gordon J., and Daniel B. Klein. 1992. *Toll Roads: Learning from the Nineteenth Century*, *Transportation Quarterly*, July 1992, 321-341
- Fielding, Gordon J., and Daniel B. Klein. 1993. *High Occupancy Toll Lanes: Phasing in Congestion Pricing a Lane at a Time*. Reason Foundation Policy Study No. 170 November 1993. (University of California Transportation Center No. 179 reprint).
- Fielding, Gordon J., and Daniel B. Klein. 1993. *How to Franchise Highways*. *Journal of Transport Economics and Policy*. May 1993. pp. 113-130. (University of California Transportation Center No. 134 reprint).
- Flink, James J. 1990. *The Automobile Age*. MIT Press. Cambridge MA.

- Gifford, Jonathan. 1983. An Analysis of the Federal Role in the Planning, Design, and Deployment of Rural Roads, Toll Roads, and Urban Freeways (Dissertation UCB-ITS-DS-83-2) Institute of Transportation Studies, University of California, Berkeley CA
- Gillen, David W. 1995. *Efficient Use and Provision of Transportation Infrastructure with Imperfect Pricing*. Paper prepared for “Measuring the Full Social Costs and Benefits of Transportation”, Beckman Center, University of California at Irvine, July 6-8, 1995
- Goddard, Stephen B. 1994. *Getting There: The Epic Struggle Between Road and Rail in the American Century*. Basic Books. New York.
- Gomez-Ibanez, Jose and John Meyer. 1993. *Going Private: The International Experience with Transport Privatization*. Brookings Institute: Washington, DC.
- Goodrich, Carter. 1960. *Government Promotion of American Canals and Railroads: 1800-1890*. Greenwood Press Publishers. Westport CT
- Gray, Ralph D. 1967. *The National Waterway*. University of Illinois Press, Urbana
- Guensler, Randall and Daniel Sperling. 1994. Congestion Pricing and Motor Vehicle Emissions: An Initial Review. *Curbing Gridlock: Peak Period Fees to Relieve Traffic Congestion* TRB Special Report 242, Vol. 2. (1994) pp. 356-379. (University of California Transportation Center No. 229 reprint)
- Hau, Timothy D. 1991. *Economic Fundamentals of Road Pricing: A Diagrammatic Analysis*. The World Bank Washington DC
- Hau, Timothy D. 1992. *Congestion Charging Mechanisms: An Evaluation of Current Practice*. The World Bank Washington DC.
- Hilton, George W. and John F. Due. 1960. *The Electric Interurban Railways in America*. Stanford University Press. Stanford CA.
- Hood, Clifton. 1993. *722 Miles: The Building of the Subways and How They Transformed New York*. Simon and Schuster. New York.
- Hughes, Mervyn. 1964. “Telford, Parnell, and the Great Irish Road.” *Journal of Transport History* 1:6:4 199-209 (Nov. 1964).
- Johansson, Borje, Charlie Karlsson, Lars Westin, editors. 1993. *Patterns of a Network Economy*. Springer-Verlag: Berlin.
- Klein, Daniel B. 1990. The Voluntary Provision of Public Goods? The Turnpike Companies of Early America. *Economic Inquiry*. March 1990. (University of California Transportation Center No. 18 reprint March 1990).
- Klein, Daniel B. and Chi Yin. 1994. “Use, Esteem and Profit in Voluntary Provision: Toll Roads in California, 1850-1902”, *Economic Inquiry*, 34, October 1996, pp. 678-692. (The Private Provision of Frontier Infrastructure: Toll Roads in California 1850-1902. University of California Transportation Center No. 238. preprint)
- Klein, Daniel B. and John Majewski. 1994. Plank Road Fever in Ante-bellum America: New York State Origins. *New York History*. January 1994. 39-65. (University of California Transportation Center No. 243 reprint) and (Promoters and Investors in Ante-bellum America: The Spread of Plank Road Fever. University of California Transportation Center No. 75 preprint, June 1991.)
- Lansberry, H.C.F. 1965. “James McAdam and the St. Albans Turnpike Trust.” *Journal of Transport History* 1:7:2 120-127 (Nov. 1965).

- Linowes, David F. 1988. *Privatization: Toward More Effective Government*. University of Illinois Press. Chicago.
- Lo, Hong K., Mark D. Hickman, Maura Walstad. 1996. An Evaluation Taxonomy for Congestion Pricing. UCB-ITS-PRR-96-10. University of California at Berkeley.
- Majewski, John, Christopher Baer, and Daniel B. Klein. 1991. Market and Community in Ante-bellum America: The Plank Roads of New York. University of California Transportation Center No. 47, August 1991.
- Majewski, John, Christopher Baer, and Daniel B. Klein. 1993. Responding to Relative Decline: The Plank Road Boom of Ante-bellum New York. *The Journal of Economic History*. March 1993 53,1:106-122. (University of California Transportation Center No. 267 reprint).
- Martin, Albro. 1992. *Railroads Triumphant: The Growth, Rejection, and Rebirth of a Vital American Force*. Oxford University Press. Oxford, England.
- McCarthy, Patrick and Richard Tay. 1993. Economic Efficiency vs. Traffic Restraint: A Note on Singapore's Area License Scheme. *Journal of Urban Economics* 34 96-100.
- McShane, Clay. 1994. *Down the Asphalt Path: The Automobile and the American City*. Columbia University Press. New York.
- Monroe, Elizabeth. 1992. "Charles River Bridge v. Warren Bridge" in Hall, Kermit (ed.) The Oxford Companion to the Supreme Court. Oxford University Press, Oxford UK, p135-6.
- Olson, Mancur. 1965. *The Logic of Collective Action: Public Goods and the Theory of Groups*: Harvard University Press, Cambridge MA
- Owen, Wilfred and Dearing, Charles L. 1951. *Toll Roads and the Problems of Highway Modernization*. Washington DC, The Brookings Institution 1951.
- Pawson, Eric. 1977. *Transport and Economy: The Turnpike Roads of Eighteenth Century Britain*. Academic Press New York
- Payne, Peter L. 1956. "The Bermondsey, Rothermithe and Deptford Turnpike Trust: 1776-1810." *Journal of Transport History* 1:2:3: 132-143 (May 1956).
- Phillips, A.D.M. and B.J. Turten. 1987. "Staffordshire Turnpike Trusts and Traffic in the Early Nineteenth Century". *Journal of Transport History* 3:8:2: 126-146 (Sept. 87)
- Public Roads Administration (Norway). 1996. *The Automatic Toll Ring in Trondheim*. Directorate of Public Roads. Oslo
- Rae, John. 1971. *The Road and Car in American Life*. MIT Press. Cambridge, MA.
- Reason Foundation. 1994. *Eighth Annual Report on Privatization*. Los Angeles, CA.
- Rose, A. 1953. *Historical American Highways - Public Roads of the Past*. American Association of State Highway Officials. Washington DC
- Roth, Gabriel. 1996. *Roads in a Market Economy*. Avebury Technical Press. Aldershot UK
- Schaevitz, Robert C. 1991. Private Sector Role in U.S. Toll Road Financing - Issues and Outlook. *Transportation Research Record* 1197:1-8
- Smerk, George M. 1991. *The Federal Role in Urban Mass Transportation*. Indiana University Press. Bloomington, IN.

- Small, Ken, Clifford Winston, Carol Evans. 1989. *Road Work*. Brookings Institution. Washington DC
- Smith Adam. 1776. *An Inquiry into the Nature and Causes of the Wealth of Nations*. Liberty Press Indianapolis IN
- Smith, Henry Ladd. 1991. *Airways: The History of Commercial Aviation in the United States*. Smithsonian Institution Press Washington DC.
- Transportation Research Board. 1994. *Curbing Gridlock: Peak Period Fees to Relieve Traffic Congestion: Special Report 242*. Washington DC
- United States Department of Transportation. 1976. *America's Highways: 1776-1976*. Federal Highway Administration, Government Printing Office Washington DC
- Wright, John W. ed. 1990. *Universal Almanac*. Andrews and McMeel. Kansas City.
- Warner, Sam Bass. 1962. *Streetcar Suburbs*. Harvard University Press. Cambridge MA
- Webb, Sidney and Beatrice Webb. 1913. *English Local Government: The Story of the King's Highway*. Longmans, Green and Co. London.
- Webster's II New Riverside Dictionary. 1984. Riverside Publishing Company New York.
- Whitt, J. Allen. 1982. *Urban Elites and Mass Transportation: The Dialectics of Power*. Princeton University Press. Princeton, NJ.

## 8. TABLES AND FIGURES

Table 1: Turnpike Incorporation in the United States, 1792-1845

State	1792-1800	1801-10	1811-20	1821-30	1831-40	1841-45	Total
New Hampshire	4	45	5	1	4	0	59
Vermont	9	19	15	7	4	3	57
Massachusetts	9	80	8	16	1	1	115
Rhode Island	3	13	8	13	3	1	41
Connecticut	23	37	16	24	13	0	113
New York	13	126	133	75	83	27	457
Pennsylvania	5	39	101	59	101	37	342
New Jersey	0	22	22	3	3	0	50
Virginia	0	6	7	8	25	0	46
Maryland	3	9	33	12	14	7	78
Ohio	0	2	14	12	114	62	204
Total	69	398	362	230	365	138	1562

source Fielding and Klein (1992)

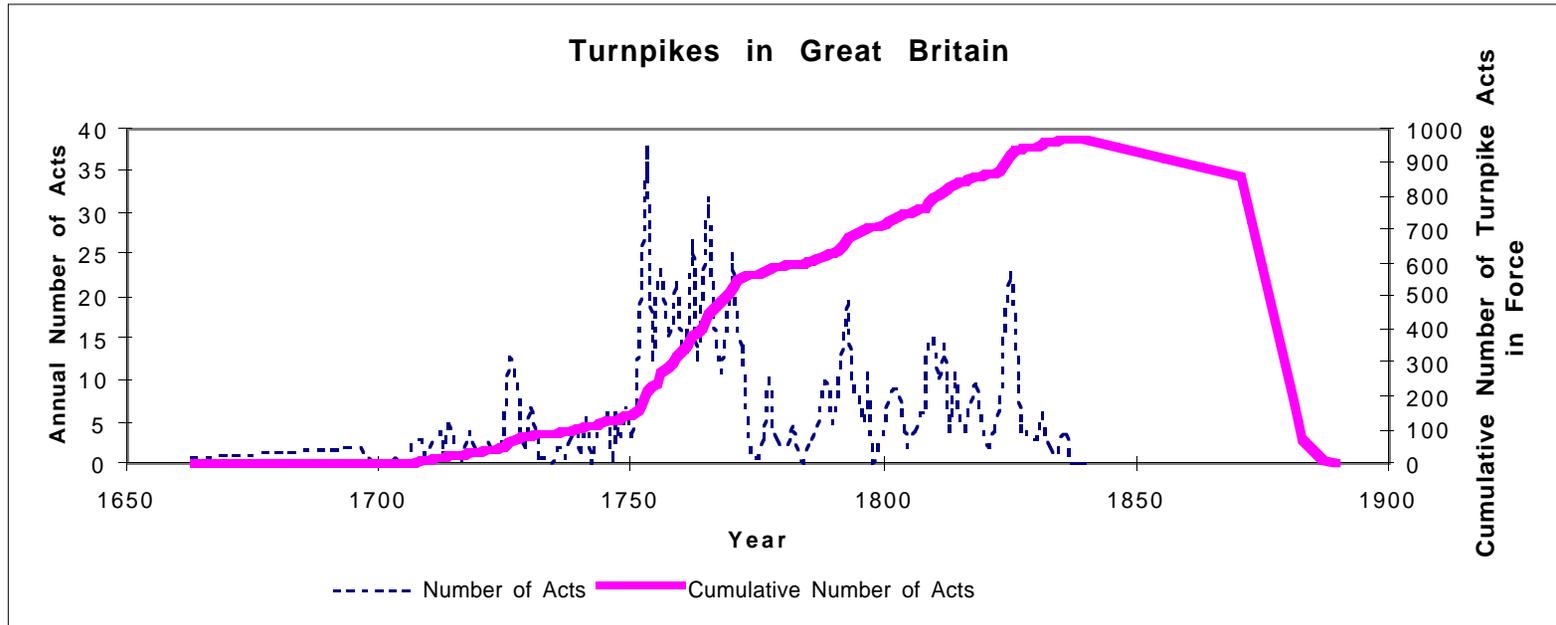
Table 2: Miles of Toll Highways in Operation in 1963

State	Mileage in Use	Kilometers in Use	Cost (thousands)	Period Built
Colorado	17.3	29	\$6,237	1952
Connecticut	1939.9	3233	502,092	1940-59
Delaware	11.2	19	30,000	1963
Florida	206.6	344	171,783	1950-64
Georgia	11.1	19	3,150	1924
Illinois	185.3	309	445,623	1958-59
Indiana	156.9	262	280,000	1956
Kansas	240.9	401	179,500	1956-59
Kentucky	204.7	341	185,500	1956-64
Maine	112.2	187	79,406	1955-57
Maryland	42.3	70	74,000	1963
Massachusetts	124.4	207	239,000	1957
New Hampshire	77.2	129	43,524	1950-57
New Jersey	309.2	515	821,200	1952-57
New York	628.8	1048	1,130,951	1926-60
Ohio	241.0	402	326,000	1955
Oklahoma	174.3	290	106,714	1953-57
Pennsylvania	469.3	782	539,664	1940-57
Texas	30.1	50	58,500	1957
Virginia	34.6	58	75,150	1958
West Virginia	86.3	144	133,000	1954
Totals	3557.6	5929	5430994	1940-64

source Rae 1971 after Bureau of Public Road data

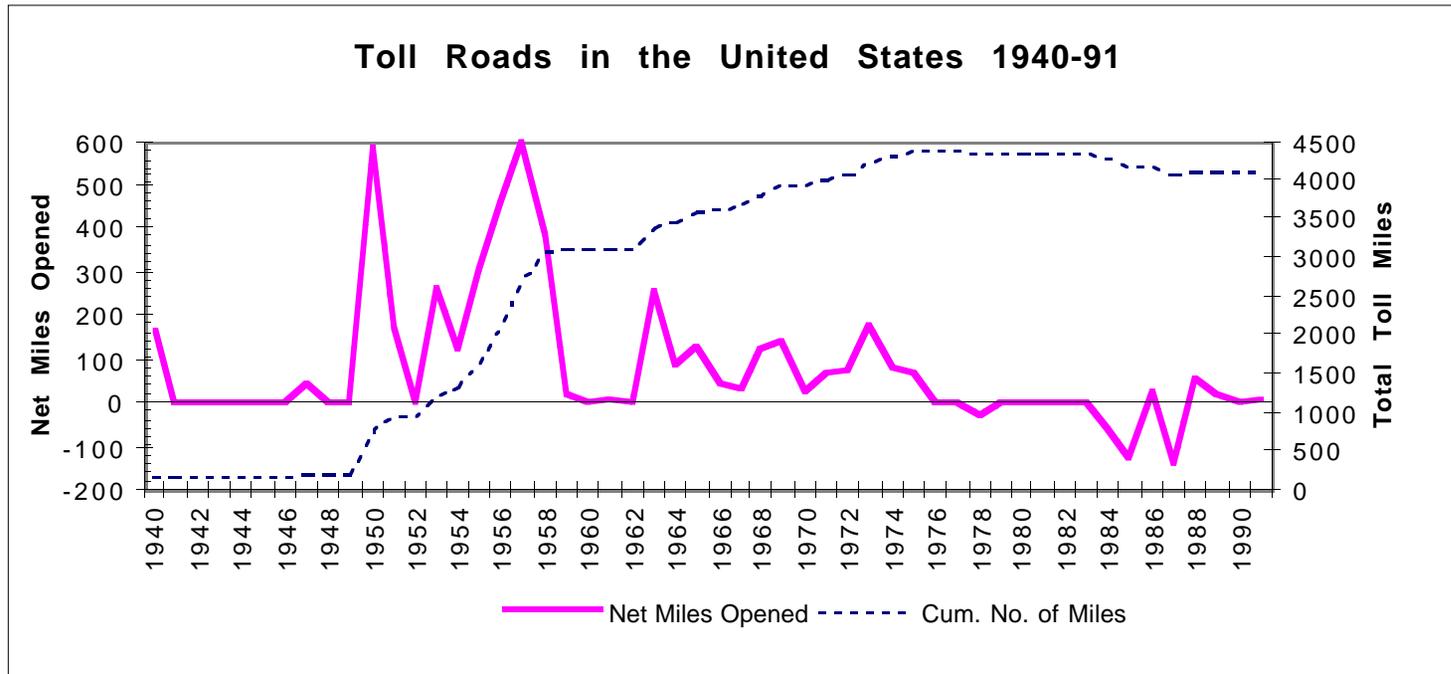
FIGURES

Figure 1



source, Pawson (1977), Webb (1913)

Figure 2:



source Gomez-Ibanez (1993)

## 9. END NOTE

1. To demonstrate the point that intercity roads in western states carry more local (in-state) traffic than in eastern states, we can look at trip length distributions between the various areas. While trips are on average slightly longer in western than in eastern states, the difference is not significant compared with their size differences.

Travel Distance in Miles (km), All Trips

Region	Mean	Std. Dev.	N
Northeast	10.8 (18.1)	39.7 (66.2)	24591
Northcentral	10.5 (17.6)	41.2 (68.6)	24175
South	10.9 (18.1)	40.2 (67.0)	28756
West	11.5 (19.2)	50.8 (84.7)	16248

source: 1990/91 Nationwide Personal Transportation Survey (FHWA 1991)