European Transport \ Trasporti Europei n. 31 (2005): 46-66

Recent developments and current policy issues in road pricing in the US and Canada

Robin Lindsey [1*]

[1] *Department of Economics, University of Alberta, Edmonton, Alberta, CANADA T6G 2H4*

Abstract

The United States and Canada lag Europe and Singapore in implementing road pricing on a large scale. But the two countries have shown interest in tolling roads as a way to curb congestion and to generate revenues. The US is funding congestion pricing demonstration projects through its Value Pricing Pilot Program, and Canada has examined new ways to charge for road use and to finance road construction and maintenance. This paper reviews the current state of road pricing and funding in the two countries. The prospects for extensive road pricing appear to be brighter in the US than in Canada.

Keywords: Road pricing; Congestion; Earmarking; US Highway Trust Fund; Fuel taxes.

1. Introduction

For over a decade the European Union has been studying the application of marginal-cost-based pricing in transportation, and has issued Green and White Papers as well as sponsored a series of research projects. The United States and Canada have not made a comparable effort. Nevertheless, the two countries are acutely aware of flaws in the way that transportation is currently priced and funded, and they have shown interest in policy reform. As far as pricing roads the US has been funding congestion pricing demonstration projects through its Value Pricing Pilot Program since 1998. And in 2001, Canada completed a thorough review of the Canada Transportation Act that addressed the case for new ways to charge for road use and to finance road construction and maintenance.

The purpose of this paper is to summarise these and other developments, and to identify both the challenges and the prospects for wide-scale implementation of road pricing in the two countries. Europe is chosen as the main reference for comparison since many readers of this journal will be Europeans, and because there are interesting similarities and differences between the two continents. The US and Canada have standards of living and systems of government that are similar to the EU. As in the EU,

* Corresponding author: Robin Lindsey (rlindsey@ualberta.ca)

financing, regulation and operation of transportation facilities are divided between multiple levels of government: federal, state (US) or provincial (Canada), regional and municipal. And the political and acceptability barriers to road pricing are broadly similar. There are also some differences. Despite heavy subsidies to North American urban transit systems, the automobile is more dominant than in Europe. Urban sprawl is greater, and traffic congestion is less concentrated in urban centres. Particularly in the US, there is less trust in government and more reliance on the private sector generally. Yet private-sector involvement in road pricing has been much less than in the EU. And neither the US nor Canada has yet established either networks of interurban toll roads or large-scale urban road pricing schemes such as those found in Europe.

The US and Canada differ in some respects. There is a stronger commitment to public funding of transport in Canada, evident also in other sectors such as education and health care. But the US federal government is more active in funding urban transport projects, and in using transport investments to pursue economic development and national security goals. The US also earmarks a majority of federal fuel tax revenues to roads, whereas Canada does not. Finally, whereas the US has not ratified the Kyoto Protocol, Canada has done so and has an onus to reduce consumption of carbon-based fuels.

The next section reviews in some detail the current state of policy and practice of road pricing in the US. Section 3 provides a parallel, but briefer, summary for Canada. Section 4 addresses some of the major issues concerning the evolution of road pricing in the two countries. Concluding remarks are offered in Section 5.

2. Road pricing in the United States

Toll roads have a long and checkered history in the US going back to the late 1700s.[1] Private roads were widespread in the 1800s, but they rarely made money and disappeared as canals and railroads came to dominate long-distance traffic. From time to time, state and local governments found toll financing of roads attractive as a way to accelerate road construction, as a supplementary source of funding during periods of financial stringency[2], and as a way to raise money from immediate beneficiaries, including non-resident travelers who were not subject to local taxes.

Currently the US has several hundred tolled facilities. As of January 1, 2003, there were 8,440 km of toll roads, bridges and tunnels, of which 8,097 km comprised tolled sections of roads inside the US (about 9% of total highway mileage). Electronic toll collection was used on 229 facilities.[3] Some facilities differentiate tolls by vehicle and other characteristics, some offer alternative means of payment, and a modest fraction feature time-of-day toll variations.

[1] See Klein and Fielding (1992) and Levinson (2002, Chap. 2).

[2] According to Shoup (2005, p.553, fn 56), financial stringency may also have been a motivating factor in installing parking meters during the Great Depression.

[3] US Department of Transportation (2003). The numbers reported in the text are derived by counting each section or location of road as a separate facility if it is listed separately in the US DOT (2003) tables.

Growing support for road pricing

For a number of reasons support for road pricing has been growing in the US.

Increasing severity of congestion. According to the Texas Transportation Institute (2005), in 2003 the cost of congestion-induced time delays and extra fuel consumption amounted to $63.1 billion in 85 major US urban areas. In Los Angeles, the most congested city, the annual delay per traveler was 93 hours, and average travel time during peak periods was 75% longer than travel time under free-flow conditions.[4] These figures have grown relatively steadily since at least 1982.

Improved tolling technology. Conventional tollbooths have high administration costs and can impose long waits on drivers. But with electronic toll collection and smartcards now commonplace, and Global Position System (GPS) technology coming in, there are no significant technical barriers to direct and differentiated charges for road use.

Limitations of traditional supply and demand policies. Building new roads is constrained by tight public budgets, lack of space and environmental concerns. Public transport systems are very expensive, and ill-suited to the decentralised urban structure and diverse trip patterns that characterise most US cities. And travel-demand management strategies, though numerous, have a limited potential to control automobile use (Meyer, 1999).

Limitations of existing funding mechanisms. Road construction and maintenance in the US is funded primarily by indirect user charges rather than tolls. All 50 states have gasoline taxes. Federal funding is provided through the Highway Trust Fund (HTF), which was established in 1956 to finance the federal share of the Interstate highway network and to support other federal-aid highway projects. Revenues for the HTF are derived from taxes on fuel, tires, truck sales and heavy-vehicle use. The HTF and the primary reliance for funding on fuel and other indirect taxes have come under attack on several scores[5]:

1. Although tax rates are linked to vehicle characteristics, a Highway Cost Allocation study (US DOT, 1997, 2000) concluded that heavy combination trucks pay only about 80% of their costs, whereas automobiles and other light vehicles cover 110%. The system therefore does not adhere to the user pays principle as far as major user groups.
2. Although the HTF was established as an earmarked fund for roads, only a portion (roughly 65%-75%) of the money is now actually spent on road projects.
3. Money in the HTF is allocated according to geographical distribution formulas that guarantee states revenues regardless of whether the revenues can be put to good use, and that inflate demand for spending.
4. Despite the popularity of fuel-inefficient Sports Utility Vehicles (SUVs), the average fuel efficiency of the vehicle fleet in the US will probably improve in the future. Coupled with the growth of alternative-fuel vehicles, this will dampen gasoline consumption. State and federal fuel tax rates are difficult to increase, and the recent hike in world oil prices is likely to make it all the harder. Maintenance

[4] Texas Transportation Institute (2005, Table 1).
[5] See, for example, Orski (2005) and Roth (2005).

expenditures, meanwhile, are rising as the Interstate Highway system ages and rising traffic levels impose more wear and tear on roads of all types.

Due to these and other problems, the HTF is increasingly seen as both inappropriate and inadequate to continue as the primary highway funding mechanism.

Value Pricing Pilot Program projects

During the 1970s the US federal government attempted unsuccessfully to initiate congestion pricing demonstration projects in several cities. Fears of adverse impacts on businesses and the poor, and insufficient efforts to gain constituency support, were largely responsible for the failure (Elliott, 1986; Higgins, 1986). But road pricing has since gained momentum thanks to two breakthrough pieces of federal legislation: the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, and the Transportation Equity Act for the 21st Century (TEA-21) of 1998. TEA-21 authorised the Value Pricing Pilot Program (VPPP)[6] to fund innovative road and parking pricing measures for alleviating congestion, and permitted limited tolling on Interstate highways. Table 1 lists the projects that have been funded to date.

Table 1: US Value Pricing Pilot Program projects in operation and under development.

	Project category	***Operational***	***Under development***
1	New lanes	2 HOT lanes	6 HOT lanes 2 managed lanes 1 queue jump
2	Previously toll-free roads	4 HOT lanes	4 conversion HOV to HOT lanes 4 FAIR lanes 1 cordon toll
3	Existing or new toll roads, bridges and tunnels	4 variable tolls	4 variable tolls 1 variable pricing 1 discount truck tolls
4	Parking and vehicle use	1 car sharing 1 cash-out of free parking 1 cash out of cars	1 mileage-based insurance 1 variabilisation of fixed auto costs 1 financing infrastructure 1 GPS-based pricing
	Total	13	28

Sources: DeCorla-Souza (2004), Value Pricing Pilot Program (2005) and Congestion Pricing Listserv.

All of the operational projects in the first two categories feature *High-Occupancy Toll* (HOT) lanes. HOT lanes are a variant of *High Occupancy Vehicle* (HOV) lanes that allow vehicles carrying fewer people than the HOV occupancy requirement (usually 2 or 3 people) to use the lanes if they pay a toll (or a surcharge over the existing HOV fee). General-purpose toll-free lanes run parallel to the HOT lanes.

[6] Value Pricing Pilot Program (2005). See also Transportation Research Board (2003) and DeCorla-Souza (2004).

Table 2 provides information on the five HOT lane facilities that are currently in operation. The HOT lanes on State Route 91 (SR-91) were built in 1995 before the VPPP was launched. The lanes were privately operated until 2003 (see Section 4). Tolls vary hourly according to a schedule that depends on day of week, with a goal of maintaining free-flow conditions on the HOT lanes. A number of studies have examined how the tolls affect ridesharing, lane and departure-time choices of users.[7]

Table 2: Operational High Occupancy Toll (HOT) lane projects.

Facility	***Launch date***	***Location***	***Time variation***	***Differentiation by vehicle & occupancy***	***Use of revenues***
State Route 91 (SR-91)	1995	Orange County, CA	Variable (scheduled) Range: $1.05-$7.75	HOV3+ free	Operations, maintenance, corridor improvements
Interstate 15 (I-15)	1997	San Diego County, CA	Dynamic (6 min. changes) Range: $0.25-$8.00	HOV2+ free	Express bus service & operations
Interstate 10 (I-10, Katy Freeway)	1998	Houston, Texas	Flat $2 during peak	HOV3+ free SOVs prohibited on toll lanes	Operations
Northwest Freeway (US 290)	2000			As I-10, except lanes available only during morning peak	
I-394	2005	Minneapolis-St. Paul	Dynamic (3 min. changes) Range: $0.25-$8.00	HOV2+ free	Capital costs, operations, improvements, bus transit

Sources: Appiah and Burris (2005), Burris and Stockton (2004), DeCorla-Souza (2004), Munnich and Loveland (2005).

Interstate 15 (I-15) was the first facility on which pre-existing HOV lanes were converted to HOT status. By law, I-15 is required to maintain a level of service of *C* or better on the HOT lanes. This is accomplished by varying tolls "dynamically" as often as every six minutes. A schedule is published that shows average toll levels by time of day. The normal maximum toll is $4, but tolls may be raised up to $8 in the event of severe traffic congestion. Drivers who plan to use the HOT lanes therefore face uncertainty about how much they will pay, but they are (nearly) guaranteed a congestion-free trip. By contrast, on SR-91 the toll paid is predictable but travel time can vary with unexpected demand or capacity fluctuations.

The two HOT lane projects in Houston, Texas, carry very low traffic volumes compared to SR-91 and I-15, and the tolls remain "flat" at $2 rather than varying over time. The most recent project, I-394 in Minneapolis, involved a conversion of existing HOV lanes to HOT lanes and construction of new tolled lanes, and is therefore tallied in

[7] See, for example, Lam and Small (2001) and Brownstone and Small (2005).

both Categories 1 and 2 of Table 1. As on I-15, tolls vary dynamically with the goal of maintaining free-flow conditions on the tolled lanes.

Category 1 in Table 1 also includes managed lanes and queue jumps. The term *managed lanes* refers to demand management, and the concept encompasses various facility types: HOV lanes, HOT lanes, Single Occupancy Vehicle (SOV) express lanes, special use lanes and truck lanes. *Queue jumps* are elevated roads that allow drivers to avoid congested intersections by "jumping" over them. Being relatively cheap, queue jumps are affordable for areas with small populations.

Fast And Intertwined Regular (FAIR) lanes in Category 2 entail conversion of some freeway lanes to toll lanes, while leaving other lanes free (Decorla-Souza, 2004). Toll-lane revenues are used to give drivers on the free lanes credits that can be used either for future trips on the toll lanes or other purposes (transit, parking, *etc.*). FAIR lanes are designed to enhance acceptability by allocating toll revenues directly to users of the freeway in a revenue-neutral way.

One project in Category 2 features a cordon toll around Fort Myers Beach, Florida: an island community where additional roadways are not practical and where the limited number of access points makes cordon pricing viable. A cordon toll was proposed for New York City by the mayor, Michael Bloomberg, but withdrawn in the face of opposition.[8]

The third project category in Table 1 covers toll roads, bridges and tunnels. Unlike with HOT lanes, all lanes on these facilities are tolled. A majority involve variable (i.e. time-varying) tolls.[9] The fourth and final category in Table 1 encompasses a wide range of usage and area-based pricing schemes. A common motivation underlying these schemes is that the existing system of transport prices in the US is biased in favour of auto travel in two ways. First, auto usage is underpriced or unpriced on average. For example, fuel taxes do not cover environmental and other external costs of driving. Also, 91% of commuters drive to work and 95% of auto commuters park free at work.[10] Second, a large fraction of the total costs of driving are fixed charges (vehicle depreciation, insurance, registration, licensing fees, etc.) that do not vary with usage and contribute to the underpricing of driving at the margin.

The project on cashing-out free parking in Category 4 offers commuters cash, transit passes or another alternative to free parking with comparable value.[11] Mileage-based insurance is being studied in the form of *Pay As You Drive* (PAYD) insurance premiums that are paid in proportion to distance travelled. PAYD insurance is a form of road pricing because it charges for road use. The per-kilometre premium rate can be conditioned on driver characteristics that are used for pricing insurance today, such as age, sex, and safety record. PAYD insurance is superior to "pay at the pump" insurance

[8] A new proposal for a peak-period charge in Manhattan was made in November, 2005, by the city's major business association (http://nytimes.com/2005/11/11/nyregion/11traffic.html). In an attempt to forestall further opposition, several roadways would remain free.

[9] For details see DeCorla-Souza (2004, pp.295-301).

[10] Shoup (2005, p.267 and Appendix B). The supply of parking in the US is also artificially inflated by minimum parking requirements, which according to Shoup (2005) are often arbitrary, vary greatly from city to city, and can be extremely onerous on developers.

[11] The advantages of cashing-out free parking (especially in the US) are explained by Shoup (2005, pp.262-266). Shoup also describes (pp. 383-390) high-technology parking meters that can adjust parking rates by time of day and expected parking occupancy rates in the neighbourhood. Such meters have been installed in a few US cities, but they are far more prevalent in European cities where parking space is scarcer, and the need for efficient rationing more pressing.

proposals under which costs would vary (inappropriately for insurance purposes) with vehicle fuel efficiency, but would be independent of driver characteristics.[12]

Arguably the most ambitious of the VPPP projects is Oregon's GPS- and distance-based pricing proposal. The long run plan is to charge for all driving within the state, with charges proportional to distance traveled and varying by type of road and time of day. Travel would be monitored by GPS and payments would be paid at the pump when the vehicle is refuelled.[13] State fuel taxes would be refunded. The project faces a number of stumbling blocks including the cost of installing fuel-pump infrastructure and on-board vehicle equipment, the need for a long transition period to deal with vehicles that lack GPS or odometer-based devices and that would be too costly to retrofit, the shift of burden away from fuel-inefficient vehicles, lack of agreement on whether revenues should be spent on highways or other modes, and privacy concerns related to GPS.

Summary of US developments

The HOT lane projects have been the biggest success of the VPPP so far. A number of reasons can be offered. First, the projects have relatively small set-up and operating costs. Second, three of the projects (SR-91, I-15 and I-394) are designed to minimise congestion. This goal is readily explained and motivated to politicians and the public. It can be verified by examining loop-detector data on traffic flows and speeds, and the benefits are readily visible both to users of the lanes and those who drive on the parallel toll-free lanes just a few metres away. Third, availability of the toll-free lanes enhances acceptability by giving drivers a choice whether to pay for an essentially identical trip in terms of route. Contrary to the view that toll lanes will be used only by the rich as "Lexus Lanes", lower-income and unemployed individuals and off-peak commuters occasionally use them when they are especially pressed for time. Fourth, revenues are earmarked, either for operations or public transport alternatives. Fifth, environmentalists have come to see congestion pricing generally, and HOT lanes in particular, as a way to improve air quality by keeping traffic moving smoothly.[14]

It is of some interest that the five existing HOT lane projects differ in terms of whether the lanes are new or converted from HOV lanes, vehicle occupancy requirements, the extent of time variation of tolls, and the allocation of revenues (cf. Table 2). This suggests either that there is some flexibility in the design of successful schemes or, alternatively, that the design needs to be tailored to the particular circumstances of the facility in question. A number of other HOT lane projects are

[12] Two recent theoretical studies have come out in favour of variabilisation. Edlin (2003) has determined that, by pricing congestion through a percentage tax on per-mile premiums, sizeable (and comparable) benefits would result from reductions in congestion and accident costs. Greenberg (2003) proposes a 10% federal subsidy to states, insurance companies and other companies for converting taxes and other fixed auto costs to a per-kilometre basis. He finds that the subsidy compares well with most existing policies in terms of cost-effectiveness for improving air quality and reducing traffic fatalities.

[13] For details see Forkenbrock (2004) and Whitty *et al*. (2005).

[14] A sixth possible benefit of HOT lanes is that by maintaining free-flowing conditions they actually support higher traffic throughput per lane than toll-free lanes. This has been confirmed from traffic counts on SR-91 (Poole and Orski, 2003, p.6) but the idea that congestion pricing can increase throughput in general is controversial. See, for example, postings to the Congestion Pricing Forum listserv between September 28 and October 12, 2005.

under development, and new projects are frequently being announced. One factor working in favour of HOV-to-HOT lane conversion projects is that most HOV lanes are underutilised in the US and can accommodate a large percentage increase in vehicle loads before speeds begin to deteriorate.[15] Most other countries do not have this "slack", and therefore cannot expect to replicate US success with HOT lanes.

The HOT lane and other VPPP projects provide several lessons that may carry over to other road-pricing initiatives. One is that new tolls are politically feasible if the locations and designs of the schemes are chosen carefully. A second is that variable and even dynamic pricing is acceptable. Focus groups were strongly opposed to dynamic pricing on I-15 before it began operation (Godbe Research & Analysis, 1997). But dynamic pricing is now accepted, and it has achieved a better balance between peak and off-peak periods. Indeed, Sullivan (2002, p.3) remarks that "There appear to be no differences in consumers' acceptance or ability to comprehend any of these current systems, regardless of their complexity." In part, drivers may accept dynamic pricing because they value highly reliable travel times. A third lesson is that effective marketing of new schemes to the public is vital. As Berg (2003, p.38) notes:

> "If value pricing is to be implemented, it has to be seen as the logical solution arrived at through public participation, not something that has been developed in isolation by 'experts'. Just as new products are introduced with marketing campaigns, new public policies need to be 'marketed' to the public."

This lesson is echoed by European experience (e.g. Schade and Schlag, 2003).

The new life imparted to road pricing by the ISTEA and TEA-21 legislation has been extended with passage, in August 2005, of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)[16] which authorises the Federal highway and transit programs for 2005-2009. In addition to continuing the VPPP, SAFETEA-LU includes existing or new programs that permit tolls to be collected for the purpose of constructing, reconstructing or rehabilitating Interstate highways. It includes a new Express Lanes Demonstration Program to permit tolling for congestion relief, emissions reductions, and building new Interstate lanes to reduce congestion. The Act also creates two commissions to assess the adequacy of the Highway Trust Fund to provide long-term transportation funding, and to consider supplementary or alternative revenue sources besides the fuel tax.[17]

3. Road pricing in Canada

The history of toll roads in Canada broadly resembles that in the US: early enthusiasm, followed by retrenchment and sporadic implementation thereafter. During the nineteenth century many toll bridges, roads, and ferries were owned and operated by municipalities and private companies (Bryan, 1972). Most were subsequently abolished

[15] Safirova *et al*. (2004) convincingly demonstrate this using a simulation model for Washington, D.C.
[16] See US Department of Transport (2005).
[17] See http://trb.org/news/blurb_detail.asp?id=4795, accessed October 30, 2005.

by provincial governments. Currently, there are only 19 operational tolled facilities comprising 385 km of toll roads in Canada, compared to over 8,000 km in the US.[18]

Ownership, operations and institutional structures of the facilities vary considerably. A majority are bridges or tunnels linking Ontario and the US. The prevalence of tolling at border crossings is consistent with the use of tolls to extract revenues from nonresidents. Three large facilities have been built by diverse mechanisms. The Coquihalla highway, which opened in 1986 and traverses 115 km of mountainous terrain between Hope and Merritt in British Columbia, is public. By contrast, Highway 407 in Toronto was publicly funded, but it is now owned and operated by a consortium, Highway 407 International. The Confederation Bridge which links Prince Edward Island to the mainland was financed, designed, built and operated privately. Tolls are levied, but most of the debt is being repaid from government subsidies rather than toll revenues.

Of the 19 tolled facilities, electronic tolls are collected on only five (Nix, 2002). All facilities differentiate charges by vehicle type and size.[19] But in contrast to the VPPP projects, only Highway 407 charges by time of day. Freedom of mobility is respected in that, except for non-local trucks on Highway 104 in Nova Scotia, no user is forced to take a toll road.[20] Highway 407 is by far the most heavily used facility. When it began operating as a toll road in 1997, it was the world's first all-electronic open access toll highway.[21] Tolling was facilitated politically by proximity to Highway 401: a toll-free and heavily congested alternative running roughly in parallel a few kilometres to the south.

Tolling roads in Canada has been spurred by factors similar to those in the US, although the impetus is not as strong for several reasons. First, there is a greater commitment to public funding in Canada, not only for roads but also for public transport. Second, traffic volumes and congestion are lower. And third, because of the size of Canada's provinces and their "linear" configuration from east-to-west, the provinces are generally better able than are US states to tax non-resident users while they are in transit, and correspondingly less reliant on tolls for revenue.

Roads in Canada are mostly paid for with general tax revenues and property taxes. Road users in aggregate approximately pay their way[22], whereas transit and other modes are heavily subsidised. The extent of user-pays varies by province as a function of

[18] A major bridge across the Fraser River in Vancouver is scheduled to open in 2008. Tolls will be collected electronically, and will vary by vehicle type and method of payment, but not time of day. See http://www.translink.bc.ca/goldenearsbridge/project_information/funding.asp, accessed November 19, 2005.

[19] An axle-based system was introduced on the Confederation Bridge on January 1, 2006. Prior to this, tolls were based on rates for the ferry service that the bridge replaced. See http://www.confederationbridge.com/images/New_Toll_Structure.pdf, accessed November 18, 2005.

[20] Canadian policy has generally supported the availability of toll-free alternatives. According to Bryan (1972, p.47), during the brief revival of tolling in the 1950s "… it was generally accepted in principle that there ought to be an alternative to any toll route". Legislation passed in Québec permits toll facilities where an alternative un-tolled route exists (Nix 2001, p.9). And British Columbia's guidelines for tolling stipulate that "Tolls will be implemented only if a reasonable untolled alternative is available." See British Columbia Ministry of Transport (2003, para. 2.3).

[21] Mylvaganam and Borins (2004) provide an insightful history of the toll road.

[22] According to Transport Canada (2004, Table 3-5) for 2003/2004 spending by all levels of government on roads amounted to CDN 13,647 million, equal to 69.4% of total spending on transport. Revenues from road users were CDN 13,989 million. In the three previous years, spending exceeded revenues by small margins.

traffic volumes and road construction costs (Nix, 2001, p.5). Canada lacks formal mechanisms for road funding on a scale comparable to the US Highway Trust Fund, and no legislation similar to ISTEA, TEA-21 or SAFETEA-LU has been passed. Only about 7% of federal fuel tax revenues are spent on roads and highways. And until recently the federal government provided almost no funds for urban transport. But under the *New Deal for Cities and Communities,* the government has allocated $5 billion in federal gasoline excise tax funding to cities over a five-year period.[23]

Federal policy recommendations

Transportation policy in Canada has been reviewed by three major federal studies in the last 15 years: the 1992 Royal Commission on National Passenger Transportation, the 1993 National Transportation Act Review Commission, and the Canada Transportation Act Review (CTAR) of 2001. In general these studies supported the subsidiarity principle, the user pays principle, and recognition of environmental costs in transport pricing. In addition to toll roads, the CTAR Panel investigated road funds and urban transportation agencies as financing arrangements for roads. All ten Canadian provinces have at some time employed earmarked taxes. But currently most fuel tax revenues and other user charges are added to the general account. There have been attempts to create provincial road funds. But these funds were either short-lived, or failed to be fully self-financing from user charges.[24] The federal government has recently created several infrastructure funds, but the amounts are modest and none of the funds are earmarked specifically for roads. Urban transportation agencies have been established in Montreal and Vancouver, the second and third largest cities in Canada.[25] These agencies have mandates that include public transit as well as roads, and powers to raise revenues through new charges on motorists. This gives them multiple objectives, as well as multiple instruments to assemble policy packages.

Climate change

Climate change is a factor that distinguishes Canada from the US. Only Canada has ratified the Kyoto Protocol, and Canada could be affected more strongly by global warming because of its northern latitudes. It is an open question whether the two countries will adhere to their current positions, and if so whether greener policies will be pursued more vigorously north of the 49th parallel. If Canada does follow through with its Kyoto commitment, there may be a concerted attempt to reduce consumption of fossil fuels for transport. The implications for road pricing are ambiguous. Because greenhouse gas emissions can be effectively targeted with a carbon tax, tolls or other usage-based charges do not appear to be required on this score. Moreover, with global warming there may be less damage to roads from the freeze-thaw cycle, and correspondingly less expenditure on road maintenance. However, reductions in fuel

[23] http://www.infrastructure.gc.ca/ndcc/index_e.shtml, accessed November 20, 2005.
[24] See Nix (2001, p.14, Section 5) and CTAR (2001a, p.186).
[25] The two agencies are L'Agence métropolitaine de transport (http://www.amt.qc.ca) created in 1996, and TransLink (http://www.translink.bc.ca) created in 1998. Both agencies were created before the CTAR was conducted.

consumption will reduce the base for fuel taxes, and consequently increase the need for other revenue sources.

4. Some questions about road pricing in the US and Canada

A number of questions and issues regarding road pricing have come to the fore in recent years. Attention is limited here to a few questions of concern to the US and Canada.

Design of road pricing schemes

An overarching question that has been addressed in European-Union funded research[26], and is currently under debate in the UK, is how to phase in road pricing over time. An implementation path has several dimensions: the numbers of steps or phases, the design at each step, the speed of progression from step to step, and the ultimate form and extent of road pricing. Since road pricing in the US and Canada has not yet progressed very far, discussion is focused here on the design of schemes rather than on the time dimension of implementation.

Road pricing schemes can be categorised as facility-based, area-based or network-based. Facility-based schemes include HOT lanes and individual highways. Toll cordons, area licenses and urban parking-fee structures are types of area-based schemes. Network-based schemes include highway networks, and systems that encompass all road travel such as GPS-based distance pricing. As Section 2 explains, most of the VPPP projects are facility-based. The prospects for area-based and network-based schemes in the US and Canada are briefly assessed here.

Area-based schemes

Fort Myers Beach in Florida is the only urban area in the US or Canada with a cordon toll, and no area charges have been implemented or initiated anywhere. To be sure, several schemes have recently been proposed. As noted in Section 2, a cordon toll was proposed for New York City and withdrawn, and a revised scheme has been put forward. The San Francisco County Transportation Authority has applied for a federal grant to study an area charge similar to that in London.[27] A toll for driving into downtown Boston during the morning peak was recommended by a city councillor.[28]

[26] See in particular the MC-ICAM project (http://europa.eu.int/comm/dgs/energy_transport/rtd/5/index_en.htm) accessed November 19, 2005.

[27] http://www.sfgate.com/cgi-bin/article.cgi?file=/c/a/2005/06/04/CONGESTION.TMP. Accessed November 19, 2005.

[28] http://www.boston.com/news/globe/editorial_opinion/oped/articles/2005/04/01/blocking_traffic/ Accessed November 19, 2005.

And TransLink, Vancouver's urban transportation agency, drew up a plan for tolls in 2004 but abandoned it after the *New Deal for Cities and Communities* was announced.[29]

These and other area-based road-pricing proposals have met various criticisms:

- travel patterns are dispersed in most North American cities. Congestion is not concentrated in city centres, and any charge schemes for downtown areas would have limited effectiveness[30];
- motorists will divert around charge areas, resulting in displacement rather than suppression of congestion;
- public transport capacity is inadequate to accommodate a significant modal shift away from driving;
- business and commercial activity would be displaced to toll-free locations;
- those who would pay the charge (viz. suburban residents who work in the city) outnumber those who would benefit (viz. city-centre residents); and
- state or provincial legislation would be required, and various horizontal or vertical agreements between government departments would have to be made.

London's area charge appears to have been successful because these difficulties were avoided (Litman, 2005). Few cities in North America seem as well-suited. This is not to say that area charges will not work anywhere, but one should not assume that positive experiences in one jurisdiction will necessarily be repeated elsewhere.

Network-based schemes

Four types of toll-road networks have recently been approved or recommended for the US. One, proposed by Poole and Orski (2003), are urban networks of HOT lanes and Bus Rapid Transit. These networks would comprise interconnected limited-access freeway lanes that are converted from HOV lanes and designed for relatively long-haul travel. Dynamic tolls would be levied on all vehicles except buses, and the revenues would be used to fund network construction on an incremental basis.

A second type of toll-road network for intercity travel has been launched in Texas. The Trans-Texas Corridor project (http://www.texastollways.com) already comprises more than 20 ventures. The long-range plan calls for 1,560 lane-km of new toll lanes on existing or new expressways. Construction of the lanes would be financed by private investors, who would be repaid from toll revenues. To exploit scale economies and revenue opportunities new highway corridors would be built that are wide enough to accommodate railway tracks as well as gas lines and other utilities.

A third type of toll-road network for trucks has been proposed by Samuel *et al*. (2002). Toll truckways would be established along Interstate rights-of-way in lanes separated from other traffic to enhance safety. The truckways could be owned and operated either privately or by the states. Tolls would be based on distance and conditioned on truck characteristics such as axle loads. To avoid double taxation, state and federal fuel taxes would be rebated. Size and weight regulations would also be

[29] http://www.tricitynews.com/portals-code/listcgi?paper=74&cat=23&id=502071&more, article dated October 2, 2005.

[30] According to Richardson and Bae (2004) differences between the US and Europe in land-use and travel patterns have been diminishing over time.

relaxed to permit trucking companies to use larger, more economical, vehicles. Samuel *et al*. (2002) claim that toll truckways would be self-financing under a wide range of scenarios, and that states would gain more from reductions in construction and maintenance costs than they would lose in fuel tax revenues. To take full advantage of the technology it would need to be harmonised with Canada and Mexico, as required under the 1994 North American Free Trade Agreement. Harmonisation would be especially desirable for Canada given the large volume of cross-border trucking traffic between Canada and the US.[31]

The fourth type of road-pricing scheme, *credit-based congestion pricing* (CBCP), has been proposed by Kockelman and Kalmanje (2005). CBCP adds revenue neutrality to congestion pricing by giving each resident of a prescribed area a monthly allowance of travel credits equal to the average amount spent on tolls by residents (after deducting administrative costs) in the previous month. Individuals who drive less than average can either save the credit for future travel or exchange it for cash. Only those who travel more than average incur an out-of-pocket expense. Kalmanje and Kockelman (2004) conducted simulations of CBCP on the Austin, Texas, road network and found that it greatly increased the proportion of residents who benefit from pricing.

Networks of toll roads have some attractive properties. They embody scale economies for users similar to airline and public transit networks in that travel is possible between many origins and destinations. There are also likely to be scale economies in toll collection costs for both users and operators. And political approval might even be easier to gain than for single facilities insofar as spatial equity is promoted by providing a common type of service across multiple regions. Nevertheless, toll-road networks face design challenges and obstacles.

One issue is how to set tolls. Differences between links in construction costs and congestion levels would appear to call for differences in tolls to satisfy the user pays and efficient pricing principles. If tolls are set dynamically – as Poole and Orski (2003) recommend for urban networks – toll differences might be accepted. However, there are advantages in the Japanese Revenue Pooling System, established in 1972, whereby all routes have the same tolls regardless of construction costs and traffic levels.[32] The rationale offered for this system is that it minimises confusion for drivers and is seen to be fair. Furthermore, full cost recovery from toll revenues is unlikely to be possible for especially costly links that are nevertheless vital parts of the network. A system of common tolls may also forestall local governments from exploiting tolls as a cash cow – a danger that Heaver and Waters (2005, p.796) warn about in the Canadian context.

A second concern about toll-road networks that also arises with facility-based tolling is route diversion. This is perceived to be a problem, or potential problem, for small states that can be circumvented by using highways in neighbouring states. Levying tolls on Interstate highways or major urban arterials may also induce traffic to divert onto two-lane roads or residential streets, and exacerbate congestion as well as compromise safety.

Toll-road networks will face regulatory hurdles. In the case of toll truckways several policy changes would be required (Samuel *et al.*, 2002): (i) further relaxation of prohibitions on tolls on Interstate highways, (ii) provision of truck rights-of-way along

[31] According to Transport Canada (2004, p.61), in 2003 approximately 63% of Canada-US trade was transported by truck.

[32] See World Bank (http://www.worldbank.org/transport/roads/toll_rds.htm) Annex 9, accessed November 20, 2005. Cross-financing of intercity concession motorways is also practiced in France.

existing corridors "on the federal-aid system", (iii) relaxation of truck size and weight regulations, and (iv) procedures to issue rebates on federal and state truck user taxes. In this regard Samuel *et al*. (2002) comment favourably on Canadian regulatory policy, and note (p.12) that, in contrast to the US:

> "Canadian trucking has benefited from its federal government acting as a facilitator rather than as a decisionmaker about truck sizes and weights. Provincial governments take final responsibility for the difficult trade-off decisions about which roads are designated for what class of heavy vehicles…"

Two points are worth noting. One is that both the subsidiarity principle and harmonisation – central concepts in European Union transport policy reform – also matter in North America. As far as subsidiarity there are advantages in having a number of jurisdictions (*e.g*. states in the US, or provinces in Canada) experimenting independently with ways to provide roads, particularly in light of rapid technological change. The second point is that to make toll truckways possible, let alone to realise their full potential, multiple regulatory changes are required that go well beyond pricing.

Scheme complexity

The difficulties of designing second-best policies in the real world of myriad economic distortions are well known, and opinions differ on what approach to take. Delucchi (2000) maintains that getting the price right may be impractical or impossible because of difficulties in estimating demand elasticities, externality costs, *etc*. But in a comment on Delucchi (2000), Litman and Greenberg (2000) argue that, besides road congestion and non-market externalities, various other price distortions apply to auto travel that are larger in total: unpaid parking, infrastructure costs and the heavy reliance on fixed costs that leave automobile travel severely underpriced at the margin (recall Section 2). Estimates from US studies cited by Litman and Greenberg (2000) indicate that efficient pricing would increase variable vehicle expenses by 200-500% over current levels. With respect to the implications for pricing policy they remark (p.7):

> "The conceptual test of additional vehicle use charges need not be the theoretical ideal based on Marginal Social Cost, but rather, it simply needs to be better than existing taxes and fees. This is a far easier standard to meet."

In their view, politics in the US are such that auto usage will always be underpriced, so that there is little risk in taking initial steps towards raising prices by whatever means. This assessment is almost surely more accurate for the US than for European countries, particularly those with lower levels of auto ownership and/or high fuel taxes such as Britain.

Earmarking of toll revenues

A longstanding question that goes beyond transportation is whether revenues from user charges should be earmarked for specific purposes. Practice varies widely. As

noted in Section 2, earmarking is the rule for VPPP projects, and the US Highway Trust Fund is earmarked in principle if not in practice. Earmarking is less common in Canada. Simple economic theory suggests that use of revenues should be kept flexible because the relative merits of different spending patterns change over time in ways that cannot be foreseen. However, earmarking can also be defended as a means of compensating losers, as well as a way to prevent politicians from misallocating funds.

Many recent studies of road pricing support earmarking as necessary to gain political or public approval. But earmarking has been opposed by some authoritative sources. The National Research Council committee on congestion pricing disagreed with the spending constraints written into the ISTEA legislation that enabled the VPPP. The US National Research Council Committee noted that voters might approve spending revenues for other purposes, and local governments should have the latitude to comply with their wishes.[33] Similarly, the Canada Transportation Act Review (CTAR) Panel recommended that congestion and other road charges should not be allocated to road investments if expenditures on other transport modes would yield a higher return.[34] However, Heaver and Waters (2005, p.795) recommend that revenues from the Canadian federal fuel tax *should* be dedicated to transport as a whole. Amongst other reasons they point out the pressing need for funds to rehabilitate road infrastructure, and the fact that the fuel tax is inconsistent with harmonisation of tax rates across economic sectors.

Policy towards environmental costs of driving

It is generally, but not universally, argued that drivers should pay for the environmental externalities they generate, but also that environmental charges should be levied on all economic sectors rather than just transportation. Fuel taxes are potentially effective for internalising climate change costs, but rather crude for addressing the health and other costs of local emissions. Tolls are being touted in the US primarily as a tool for pricing congestion rather than environmental externalities. One question that looms in the future is how to tackle environmental costs through fiscal measures if road pricing becomes widespread as either a supplement or a replacement for fuel taxes. One concern with Oregon's proposed distance-based toll, which would replace fuel taxes, is that it would penalise fuel-efficient vehicles unless toll rates are conditioned on vehicle characteristics.

Another, more immediate problem, is how to treat vehicles with non-conventional fuels that are rapidly gaining in popularity. Some states and cities already provide incentives in the form of tax credits, exemptions from emissions-testing and even free parking. And with passage of the SAFETEA-LU Act, states can now grant free access to HOV and HOT lanes not only to electric and alternative-powered vehicles, but also to hybrid vehicles. These privileges have raised objections from owners of regular vehicles, and are also opposed on efficiency grounds since they undermine the primary goal of HOV and HOT lanes to combat congestion.

[33] Transportation Research Board (1994, p.73).

[34] CTAR (2001b, Recommendation 12.3). This recommendation applies both in the short term with respect to fuel tax revenues, and in the longer term with respect to any road funds that might be established.

Scope for private-sector involvement

The private sector plays a leading role in toll-road development in Europe, Australia and other parts of the world, in part because this is facilitated by government policy (Orski, 2005). Relatively speaking, the private sector has had a low profile in the US and Canada. Nevertheless, more than 50 urban toll roads have been developed in the US, most of them in the last 30 years (Poole, 2005a). Prominent examples include State Route 91, the Dulles Greenway in North Virginia, and the Chicago Skyway. In addition to Texas, where public-private partnerships (PPPs) are blooming, laws enabling PPPs in transportation projects have been passed in over 20 other states. And the federal government is encouraging private-sector involvement through its Special Experimental Project initiative (SEP-15). Amongst various projects under consideration are a series of new HOT lanes on the Capital Beltway in Washington, D.C. In Canada, Highway 407 is the only privately operated urban road – albeit a very profitable one with over 300,000 average daily trips on workdays.

From a public-sector perspective the main goal in harnessing the private sector is to attract private funding and/or operation of tolled facilities while avoiding both heavy subsidisation and exploitation of monopoly power. One challenge is that start-up projects are inherently risky because costs are high, highway infrastructure is sunk and long-lived, and willingness to pay is uncertain (Poole, 2005a). A public financing option was chosen for Highway 407 because Canadian companies were seen to be risk averse, and would demand a provincial guarantee (Mylvaganam and Borins, 2004, p.39). Proposals to build a corridor from Lewis County in Washington State to Canada, and a system of express toll lanes for Minneapolis-St. Paul, were cancelled after studies concluded that they could not be self-financing from user fees.

To reduce risks, governments have granted protection against competition.[35] A "non-compete" clause was included in the contract for SR-91which precluded capacity improvements to the freeway until 2030. But rapid traffic growth in the corridor led to severe congestion on the untolled lanes, and in 2003 the Orange County Transportation Authority took over the highway. According to Poole (2005b), the California Department of Transport (Caltrans) agreed to the non-compete clause because there was no precedent for SR-91 in the US, and it was not realised that some commuters are willing to pay appreciable tolls to save travel time. Current practice is less generous with respect to protection from competition.

To contain monopoly power, two regulatory models have been employed in North America. One form is rate-of-return regulation, which was applied to SR-91. This model allows operators to implement time-of-day pricing relatively freely. The second model is toll regulation, with maximum tolls determined by traffic levels and an inflation index. This model, which is applied on Highway 407, is designed to provide users with more assurance about future toll levels. The regulations for Highway 407 stipulate that tolls can be raised only if a *minimum*[36] traffic level is met, and capacity expansion is required if flow exceeds 1,700 vehicles per lane-hour for more than 125 hours in a calendar year.

[35] Private highways generally face less competition in European countries than in North America because a larger fraction of public highways is tolled.

[36] See Mylvaganam and Borins (2004, pp.95-96). Interestingly, this policy contrasts with Interstate 15 (a public operated facility), which is required by law to maintain level of service *C* and is therefore constrained (on a real time basis) by a *ceiling* on traffic volume.

Besides competition clauses and regulations, another design question in privatising roads is whether to grant concessions only for individual roads or for networks. Both approaches are taken internationally (Estache *et al*., 2000). One consideration is the trade off between the disadvantage of networks in conveying greater monopoly power, and the advantage that the operator will internalise the complementarity in demand between links. The Ontario provincial government may be at a bargaining disadvantage vis à vis the incumbent operator, Highway 407 International, if Highway 407 is ever extended because the new segment would be less valuable to a new contractor than to the incumbent.[37]

Yet another consideration is foreign involvement. Most toll-road projects in the US and Canada involve large foreign partners because of their experience and ability to absorb risks (Orski, 2005). One potential drawback is illustrated by an ongoing dispute over toll regulations between Highway 407 International and the Ontario government. A Spanish firm holds an interest in the consortium, and the Spanish government threatened to disrupt free-trade negotiations unless the problem was resolved.[38]

On balance, the future for private-sector engagement in highway financing and operation appears to be relatively bright in the US. The picture is not as clear for Canada. According to Nix (2001, p.58) recent enthusiasm for a commercial approach to roads in Canada is driven by fiscal restraints and "does not appear to have been driven by any reliance on economic principles or regard to the recommendations of Commissions." There appears to be a reluctance in Canada to part from a tradition of publicly operated and toll-free roads. In 2003, the British Columbia provincial government formulated a plan to privatise the Coquihalla highway on a 55-year lease. But it backed down in the face of massive opposition. As another example, a PPP contract to Design, Build, Finance and Operate part of a ring road in Edmonton, Alberta, was recently signed that "does not allow tolls or advertising to generate revenue".[39]

5. Long-run prospects for road pricing

A number of experts have predicted that road pricing will never be widespread in the US.[40] Arnott (2005) also sounds a cautionary note, identifying as his main concerns that congestion pricing may not reduce congestion very much, that tolling may exacerbate other distortions, and that implementation will be impeded by political barriers and high infrastructure and administration costs.

The brief review of evidence in this article indicates that the prospects for extensive road pricing in Canada in the near future are slim. Strong preferences for public funding are one factor. Another is that traffic volumes on most Canadian roads are insufficient to justify tolls, at least for the purpose of congestion pricing. Recent experience with the Value Pricing Pilot Program suggests, however, a more positive assessment for the US.

[37] Mylvaganam and Borins (2004, p.125).
[38] Mylvaganam and Borins (2004, p.96 ff).
[39] Alberta Infrastructure (2005, p.41).
[40] See for example Giuliano (1992), Gillen (1997), Small and Gómez-Ibáñez (1999), Meyer (1999) and Downs (2004).

Several VPPP projects have been surprisingly successful, and public support for road pricing has gained momentum. A strength of the VPPP, which it shares with the American economy at large, is its experimental and varied approach that facilitates identification of winning (and losing) strategies at relatively low cost. One of the lessons is that resistance to road pricing can be overcome by careful design of schemes and extensive marketing campaigns that engage the public. Another is that sophisticated dynamic congestion pricing is technologically feasible and politically acceptable. A third encouraging trend in the US is growth in private-sector involvement with road pricing.

It has been argued that congestion is less localised in North America than in Europe, and that consequently road pricing is less cost effective on the western side of the Atlantic. However, to the extent that auto travel is underpriced in North America compared to Europe, the case for road pricing may actually be stronger. A cautiously optimistic view is that road pricing may eventually be applied on much of the US road network, although implementation is likely to be punctuated by setbacks, and to be influenced by economic factors such as the business cycle and budgetary pressures on governments. In 1994 the National Research Council-sponsored congestion pricing study panel wrote[41]

> "The risks associated with congestion pricing and the nature of policy development in a pluralistic society imply that this policy will progress in small steps. Given that congestion pricing represents a substantial change from the current operation of the road system, such small steps are appropriate. If individual projects succeed, they will help convince policy makers and the public of the benefits of congestion pricing. This process will take time, however; thus it may be many more years before congestion pricing would be applied throughout a metropolitan area in this country. Whether congestion pricing will evolve to this level will depend on how it is implemented, how well it works, and how much motorists and voters come to accept it. Only time, experimentation, and careful evaluation will tell."

Although these words were written over a decade ago, they still sum up rather well the state of road pricing today.

References

Alberta Infrastructure (2005) "Alberta Infrastructure and Transportation Annual Report 2004-2005", Alberta Infrastructure and Transportation.

Appiah, J. and Burris, M. W. (2005) "QuickRide User Response to Different HOT Lane Operating Scenarios", *84th Annual Meeting of the Transportation Research Board*, Washington, DC.

Arnott, R. A. (2005) "City Tolls — One Element of an Effective Policy Cocktail", *Dice Report: Journal of Institutional Comparisons* 3 (3): 5-11, http://www.cesifo-group.de/portal/page?_pageid=36,34692&_dad=portal&_schema=PORTAL, accessed November 20, 2005.

[41] Transportation Research Board (1994, p.103).

Berg, J. T. (2003) "Listening to the Public: Assessing Public Opinion about Value Pricing", State and Local Government Program, Hubert H. Humphrey Institute of Public Affairs.

British Columbia Ministry of Transport (2003) "Guidelines for Tolling", http://www.th.gov.bc.ca/publications/reports_and_studies/tolling/index.htm, accessed November 20, 2005.

Brownstone, D. and Small, K. A. (2005) "Valuing Time and Reliability: Assessing the Evidence from Road Pricing Demonstrations," *Transportation Research Part A* 39(4), pp. 279-293.

Bryan, N. (1972) "More Taxes and More Traffic", *Canadian Tax Papers,* No. 55, Canadian Tax Foundation, Toronto.

Burris, M. W. and Stockton, B. R. (2004) "HOT Lanes in Houston - Six Years of Experience", *Journal of Public Transportation* 7(3), pp. 1-18.

Canada Transportation Act Review Panel (2001a) "Vision and Balance," Canada Transportation Act Review: Final Report, Chapter 10: Paying for Roads, pp. 175-198 (http://www.reviewcta-examenltc.gc.ca/english/pages/final/ch10e.htm), accessed November 20, 2005.

Canada Transportation Act Review Panel (2001b), "Vision and Balance," Canada Transportation Act Review: Final Report, Chapter 12: The National Interest in Urban Transportation, pp. 215-229 (http://www.reviewcta-examenltc.gc.ca/english/pages/final/ch12e.htm), accessed November 20, 2005.

Congestion Pricing Listserv (http://www.hhh.umn.edu/centers/slp/projects/conpric/news/listser.htm).

Decorla-Souza, P. (2004) "Recent U.S. Experience: Pilot Projects", In: Santos, G. (ed) *Road Pricing: Theory and Evidence*, Research in Transportation Economics 9, Elsevier Science, Amsterdam, pp. 283-308.

Delucchi, M. (2000) "Should We Try to Get the Prices Right?," *Access* 16, Spring, pp. 14-21.

Downs, A. (2004) *Still Stuck in Traffic: Coping with Peak-Hour Traffic Congestion*, Brookings Institution Press, Washington, D.C.

Edlin, A. (2003) "Per-mile Premiums for Auto Insurance", In: Arnott, R., Greenwald, B., Kanbur, R. and Nalebuff, B. (eds) *Economics for an Imperfect World: Essays In Honor of Joseph Stiglitz*, MIT Press, Cambridge.

Elliott, W. (1986) "Fumbling Toward the Edge of History: California's Quest For a Road-Pricing Experiment", *Transportation Research A* 20A(2), pp. 151-156.

Estache, A., Romero, M. and Strong, J. (2000) "Toll Roads", In: Estache, A. and de Rus, G. (eds) *Privatization and Regulation of Transport Infrastructure: Guidelines for Policymakers and Regulators*, The World Bank, Washington, D.C.

Forkenbrock, D. J. (2004) "Mileage-based Road User Charge Concept", *Transportation Research Record* 1864, pp. 1-8.

Gillen, D. W. (1997) "Efficient Use and Provision of Transportation Infrastructure with Imperfect Pricing: Second Best Rules," In: Greene, D. L., Jones, D. W. and Delucchi, M. A. (eds), *The Full Costs and Benefits of Transportation*, Springer-Verlag, Berlin, pp. 193-218.

Giuliano, G. (1992) "An Assessment of the Political Acceptability of Congestion Pricing", *Transportation* 19, pp. 335-358.

Godbe Research & Analysis (1997) "I-15 ExpressPass Focus Groups Conducted for the San Diego Association of Governments," (http://fastrak.sandag.org/pdfs/godbe.pdf), accessed October 31, 2005.

Greenberg, A. (2003), "Comparing the Benefits of Mileage and Usage Pricing Incentives with other Government Transportation Expenditures," *82nd Annual Meeting of the Transportation Research Board*, Washington, DC.

Heaver, T. D. and Waters, W. G. II. (2005) "Transportation Policy in Canada", In: Button, K. J. and Hensher, D. A. (eds), *Handbook of Transport Strategy, Policy and Institutions* 6, Elsevier, Amsterdam, pp. 779-801.

Higgins, T. J. (1986) "Road Pricing: Attempts in the United States," *Transportation Research A* 20A(2), pp. 145-150.

Interstate 15, http://argo.sandag.org/fastrak, accessed October 30, 2005.

Kalmanje, S. and Kockelman, K. M. (2004) "Credit-based Congestion Pricing: Travel, Land Value, and Welfare Impacts", *Transportation Research Record* 1864, pp. 45-53.

Klein, D. B. and Fielding, G. J. (1992) "Private Toll Roads: Learning from the Nineteenth Century", *Transportation Quarterly* 46(3), pp. 321-341.

Kockelman, K. M. and Kalmanje, S. (2005) "Credit-based Congestion Pricing: A Proposed Policy and the Public's Response", *Transportation Research A* 39A, pp. 671-690.

Lam, T. C. and Small, K. A. (2001) "The Value of Time and Reliability: Measurement from a Value Pricing Experiment", *Transportation Research E* 37E, pp. 231-251.

Levinson, D. M. (2002) *Financing Transportation Networks*, Edward Elgar, Cheltenham.

Litman, T. (2005) "London Congestion Pricing – Implications for Other Cities", *Dice Report: Journal of Institutional Comparisons* 3(3): pp. 17-21, http://www.cesifo-group.de/portal/page?_pageid=36,34692&_dad=portal&_schema=PORTAL, accessed November 20, 2005.

Litman, T. and Greenberg, A. (2000) "Response to Mark Delucchi's 'Should We Try to Get the Prices Right?" (http://www.vtpi.org).

Meyer, M. D. (1999) "Demand Management as an Element of Transportation Policy: Using Carrots and Sticks to Influence Travel Behavior," *Transportation Research A* 33A, pp. 575-599.

Munnich, L. W. Jr. and Loveland, J. D. (2005) "Value Pricing and Public Outreach: Minnesota's Lessons Learned", *84th Annual Meeting of the Transportation Research Board*, Washington, DC.

Mylvaganam, C. and Borins, S. (2004) *If you Build it ... Business, Government and Ontario's Electronic Toll Highway*, University of Toronto Centre for Public Management, Toronto: University of Toronto Press.

Nix, F. P. (2001) "Alternative Road Financing Arrangements," Research conducted for the Canadian Transportation Act Review (http://www.reviewcta-examenltc.gc.ca/CTAReview/CTAReview/english/reports/nix.pdf), accessed November 20, 2005.

Nix, F. P. (2002) "Toll Roads in Canada", *Proceedings of the 37 Annual Conference of the Canadian Transportation Research Forum*, University of Saskatchewan, pp. 134-148.

Orski, K. (2005) "Going beyond the Interstate Highway System", Innovation Briefs 16(2), March/April – 16(3), May/June.

Poole, R. W. Jr. (2005a) "The Orange County Toll Roads: Largely successful", Reason Foundation, Policy Brief 38 (http://www.reason.org/pb38.pdf), accessed November 20, 2005.

Poole, R. W. Jr. (2005b) "Orange County's 91 Express Lanes: A Transportation and Financial Success, Despite Political Problems", Reason Foundation, Policy Brief 39 (http://www.reason.org/pb39.pdf), accessed November 20, 2005.

Poole, R. W., Jr. and Orski, C. K. (2003) "HOT Networks: A new Plan for Congestion Relief and Better Transit", *Reason Public Policy Institute* Policy Study No. 305 (http://www.reason.org/ps305.pdf), accessed November 20, 2005.

Richardson, H. W. and Bae, C-H. C. (eds) (2004) *Urban Sprawl in Western Europe and the United States*, Ashgate, Aldershot, England.

Roth, G. (2005) "Liberating the Roads: Reforming U.S. Highway Policy", *Policy Analysis*, Cato Institute, March 17, p.538.

Safirova, E., Gillingham, K., Parry, I. W. H., Nelson, P., Harrington, W. and Mason, D. (2004) "Welfare and Distributional Effects of HOT Lanes and Other Road Pricing Policies in Metropolitan Washington DC", In: Santos, G. (ed), *Road Pricing: Theory and Evidence*, Elsevier Science, pp. 179-206.

Samuel, P., Poole, R. W. Jr. and Holguin-Veras, J. (2002) "Toll Truckways: A New Path Toward Safer and More Efficient Freight Transportation", *Reason Public Policy Institute* Policy Study No. 294 (http://www.reason.org/ps294.pdf), accessed November 20, 2005.

Schade, J. and Schlag, B. (eds) (2003) *Acceptability of Transport Pricing Strategies*, Elsevier, Amsterdam.

Shoup, D. C. (2005) *The High Cost of Free Parking*, APA Planners Press, Chicago, Illinois and Washington, D.C.

Small, K. A. and Gómez-Ibáñez, J. (1999) "Urban Transportation", In: Cheshire, P. and Mills, E.S. (eds) *Handbook of Regional and Urban Economics* 3, North-Holland, Amsterdam, pp. 1937-1999.

State Route 91, http://www.91expresslanes.com, accessed October 30, 2005.

Sullivan, E. C. (2002) "Implementing Value Pricing for U.S. Roadways," *IMPRINT-EUROPE Seminar Two*, "Implementing reform on transport pricing," Brussels, May 14-15.

Texas Transportation Institute (2005) "The 2005 Urban Mobility Report", (http://tti.tamu.edu/documents/mobility_report_2005.pdf), accessed November 7, 2005.

Transport Canada (2004), Transportation in Canada 2004: Annual Report, Ottawa (http://www.tc.gc.ca/pol/en/report/anre2004/toc_e.htm), accessed November 20, 2005.

Transportation Research Board (1994) "Special Report 242: Curbing Gridlock Peak-Period Fees to Relieve Traffic Congestion", *National Research Council*, Washington D.C.

Transportation Research Board (2003) "Road Value Pricing: Traveler Response to Transport System Changes", *Transit Cooperative Research Program* Report 95, Transportation Research Board (http://gulliver.trb.org/publications/tcrp/tcrp_rpt_95c14.pdf), accessed November 20, 2005.

US Department of Transport (2005), Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users, http://www.fhwa.dot.gov/safetealu/index.htm, accessed October 30, 2005.

US Department of Transportation (1997) *Federal Highway Cost Allocation Study*, Washington, DC: US Department of Transportation.

US Department of Transportation (2000) *Addendum to Federal Highway Cost Allocation Study*, Washington, DC: US Department of Transportation.

US Department of Transportation (2003) "Toll Facilities in the United States, Bridges - Roads - Tunnels – Ferries", Office of Highway Policy Information, Federal Highway Administration, Publication No: FHWA-PL-04-017, Washington, DC. (http://www.fhwa.dot.gov/ohim/pdf/Toll03.pdf), accessed November 20, 2005.

Value Pricing Pilot Program (2005) http://www.hhh.umn.edu/centers/slp/projects/conpric/, accessed November 20, 2005.

Whitty, J., Porter, J. D., Svadlenak, J., Kim, D. S., Larsen, N. C., Vergara, H. A., Sexton, C. B. and Capps, D. F. (2005) "Development and Performance Evaluation of a Vehicle-Miles-Traveled Revenue Collection System", *84th Annual Meeting of the Transportation Research Board*, Washington, DC.

Acknowledgements

An earlier version of this paper was prepared for the IMPRINT-EUROPE Fourth Seminar "Implementing Pricing Policies in Transport: Phasing and Packaging," Katholik University of Leuven, Belgium, May 13, 2003 (http://www.imprint-eu.org/public/Papers/IMPRINT4_lindsey-v2.pdf). This version incorporates updated material that was presented at the 2nd Kuhmo conference on "Road Pricing: Is it needed? Is it possible? Is it inevitable?", Kuhmo, Finland, July 14, 2005. I would like to thank participants at both the Leuven and Kuhmo meetings for insightful questions and comments. I am also grateful to Joseph Schulman and an anonymous referee for comments and corrections. Finally, thanks for financial support are due to the European Commission (project MC-ICAM: Implementation of Marginal Cost Pricing in Transport – Integrated Conceptual and Applied Model Analysis) and to the Social Sciences and Humanities Research Council of Canada (project "Road pricing in urban areas").