C.D. Howe Institute
Commentary

www.cdhowe.org No. 248 May 2007 ISSN 0824-8001

Public Services

Congestion Relief:

Assessing the Case for Road Tolls in Canada

Robin Lindsey

In this issue...

Experience with road pricing generally — and congestion pricing specifically — is growing around the world. Research and planning in Canada should begin now on road pricing for heavily congested highways and streets.

The Study in Brief

Amid growing congestion on urban roads and aging highway infrastructure, the merits of road tolls are receiving increasing international attention. Direct road user charges in the form of electronic highway tolls, area charges, or distance-based charges are not only a tool to alleviate traffic congestion, they confront drivers with the costs of road damage and emissions.

This Commentary lays out the merits of road pricing and discusses design considerations, describes the state of play in implementing road pricing worldwide, and makes the case for road pricing in Canada. Among key conclusions:

- Congestion is a serious and growing problem in major Canadian cities as measured by the costs of travel delay, additional fuel consumption and greenhouse gas emissions. Canada's nine largest urban areas, by one estimate, face annual costs of $3 billion.
- Neither fuel taxes nor parking fees are effective in dealing with traffic congestion. Appropriately designed road-pricing schemes are the best instrument. Road-pricing's usefulness in charging for road damage, insurance, and so on are a bonus.
- Net revenues from road charges, after deducting operating costs, can be used for various purposes: to pay for road construction and maintenance, to support other modes of transport, or to reduce other distorting taxes; they can also enhance the public's acceptance of road pricing by compensating potential losers.
- Claims that road pricing hurts the poor are exaggerated. Poorer people travel less than richer people. They rely more on urban public transport, which would speed up if there were fewer cars on the road, and they would benefit if road-pricing revenues were used to enhance public transport service. Also, policymakers may choose to address equity concerns by offering discounts or exemptions.

Experience with road pricing generally — and congestion pricing specifically — is growing around the globe. Research and planning in Canada should begin now on road pricing for heavily congested urban highways and/or downtown areas.

The goal should not be to implement schemes that meet a theoretical ideal. Road-pricing programs should pass a cost-benefit test, be adaptable to changing circumstances, and not soon become technologically obsolete. Privately operated schemes have the potential to reduce implementation and operating costs and to accelerate development, and thus warrant serious consideration.

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C.D. Howe Institute Commentary© is a periodic analysis of, and commentary on, current public policy issues. Barry Norris edited the manuscript; Diane King prepared it for publication. As with all Institute publications, the views expressed here are those of the authors and do not necessarily reflect the opinions of the Institute's members or Board of Directors. Quotation with appropriate credit is permissible.

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$12.00; ISBN 0-88806-712-7
ISSN 0824-8001 (print); ISSN 1703-0765 (online)

Highway 407 stretches across Toronto from Burlington to Pickering. When the first stage opened in 1997, Highway 407 became the world's first all-electronic, barrier-free toll highway. To travel its full length during the peak period, a motorist now pays C$18.87.[1] Off-peak rates are only slightly lower. Heavy single-unit vehicles pay twice as much per kilometre as cars, and heavy multiple-unit vehicles pay three times as much. Yet, on an average workday, more than 350,000 trips are made on Highway 407. The main attraction is that it offers a (usually) free-flowing alternative to surface streets and the very heavily congested Highway 401, which runs roughly in parallel a few kilometres away.

Highway 407 is the most prominent toll road in Canada and accounts for roughly half the total traffic on all national toll roads combined. Since 1999, Highway 407 has been owned and operated by a private entity, 407 ETR Concession Company Limited. The company is not subject to direct toll regulation, and (presumably) does not set tolls with the primary objective of relieving congestion. But a handful of congestion-pricing schemes are now operating in other countries, and the idea is attracting much attention from researchers, policymakers, and the public worldwide.

Several reasons exist for the growing enthusiasm for road pricing generally, and congestion pricing specifically. Electronic tolling technology has become cheaper, it is nearly 100 percent reliable, and drivers can pay without stopping. Congestion delays and uncertainty about travel times are mounting just when reliable transport is becoming more important — both to people with harried schedules and to freight shippers with just-in-time delivery deadlines. Stop-and-go traffic contributes to emissions of local pollutants and greenhouse gases. Traditional supply and *travel demand management* policies[2] are limited in effectiveness. And road transport infrastructure is aging. Existing funding mechanisms such as the fuel tax are unlikely to yield enough revenues to pay for future maintenance, rehabilitation, and new construction — at least without large and politically unpopular increases in tax rates.[3]

I would like to thank Robin Banerjee, Yvan Guillemette, David Laidler, Barry Norris, Finn Poschmann, Bill Robson, Michael Trebilcock, and several anonymous reviewers for very useful comments on an earlier draft.

1 Toll calculated for a light vehicle equipped with a transponder entering from the Queen Elizabeth Way and exiting at Highway 7 (Brock Road), a distance of 107.2 kilometres. On February 1, 2007, the toll rate for light vehicles (weighing less than 5,000 kilograms) was set at 17.6¢ per kilometre. The peak period applies from 6:00 am to 10:00 am, and from 3:00 pm to 6:00 pm. According to a reviewer, the average trip length is 20 kilometres, for which the toll is $3.52. Only a very small fraction of users travels the full length of the highway.

2 See Box 1 for a glossary of italicized terms.

3 Reference is sometimes made to a large and unfunded transportation "infrastructure gap" that calls for additional spending. As Kitchen (2003) and Mintz and Roberts (2006, 14) point out, the idea of a "gap" implies that current expenditures fall short of some optimal amount. Determining the optimum is difficult because of the multiple tradeoffs that need to be weighed in choosing investments (Mintz 2006). Kitchen (2003) reviews a number of studies that have attempted to measure the size of the gap in Canada. He identifies various difficulties with such studies, including incomplete information about the quality of infrastructure, differences in views about appropriate quality standards, and the implicit assumption that the existing system of pricing road use will persist. If a more efficient system is eventually adopted, demand is likely to decrease — and with it the measured infrastructure gap.

As this list suggests, road pricing has been motivated not only as a tool to alleviate traffic congestion, but also as a way to face drivers with the costs they impose in road damage, emissions, and other traffic-generated *externalities*. Road pricing is also a source of revenue. Following an earlier paper of mine (Lindsey 2006, appendix A), I define road pricing to include any form of direct road user charge — highway tolls, cordon tolls, area charges, distance-based charges, and so on — imposed for any purpose.[4] I exclude indirect road charges — such as registration and licence fees, fuel taxes, and tire taxes — parking fees and parking fines, *shadow tolls*, and tradable driving permits, as well as charges on nonmotorized forms of transport. I consider, however, the virtues and limitations of fuel taxes and parking fees.

Quite a number of authoritative surveys and policy papers about road pricing have recently appeared.[5] It is impossible in this space to cover all the relevant ground,[6] so here I set myself three goals: to identify the merits of road pricing and discuss some of the design considerations, to describe the state of play in implementing road pricing worldwide, and to assess the case for road pricing in Canada. I concentrate on the potential for road pricing to alleviate traffic congestion, and consequently focus on urban rather than intercity road pricing.

I come out strongly in favour of road pricing for Canada. In brief, the main points in the argument are as follows:

- Congestion is a serious and growing problem in major Canadian cities. Selective construction and expansion of roads is warranted, but it is expensive and environmentally disruptive. Moreover, it encourages more driving as well as urban sprawl.
- As far as the price mechanism is concerned, fuel taxes are efficient as a tax on carbon-based fuel emissions. And parking fees that vary by location and time of day are the best tool for tackling congestion related to parking. But neither fuel taxes nor parking fees are effective in dealing with traffic congestion. Appropriately designed road-pricing schemes are the best instrument. Any uses of road pricing to charge for road damage, insurance, and so on are a bonus.
- Net revenues from road pricing after deducting system operating costs can be used for various purposes: to pay for road construction and maintenance, to support other modes of transport, or to reduce other distorting taxes; they can also be used to enhance the public acceptability of road pricing by compensating potential losers.
- Claims that road pricing hurts the poor are exaggerated. Poorer people travel less than richer people. And they rely more on urban public transport, which would speed up if there were fewer cars on the road, and

4 Rather than use the awkward term “road pricing” throughout the paper, I frequently refer to “tolls” or “charges” unless a particular term is appropriate for a specific form of pricing.

5 See, in particular, United Kingdom (2004); Commission for Integrated Transport (2006); Eddington (2006); Economist Intelligence Unit (2006); European Conference Ministers of Transport (2006); Partnership for New York City (2006); and United States (2006).

6 In Lindsey (2005), I review developments in Canada and the United States; in Lindsey (2006), I examine the attitudes of economists toward road pricing.

Box 1: *Glossary of Terms*

Beneficiary principle: The principle that taxes should be paid in proportion to the benefits received from public services.

Congestion, recurrent: Congestion due to regular and predictable travel patterns.

Congestion, nonrecurrent: Congestion caused by accidents, emergency road repairs, bad weather, and other unpredictable events.

Equity, horizontal and vertical: The concept of vertical equity holds that people with different incomes should pay different amounts of tax; the concept of horizontal equity holds that taxpayers with the same income should pay the same amounts of tax. Road-pricing studies have adopted the two concepts by replacing "tax" with "toll." One complication is that the amount paid in tolls depends on location and distance driven. Some scholars consequently interpret horizontal equity to mean that people living in the same neighbourhood should pay the same amount in tolls. Another complication is that the net incidence of tolls depends on the disposition of the revenues.

Externalities, external cost: An externality exists when the actions of a consumer or producer affect the utility or production possibilities of other agents who are not involved in decisionmaking about the activity and there is no market in which the effects are priced. Congestion and pollution are examples of negative externalities or external costs.

Internalization of external costs: A negative externality is internalized if the agent creating the externality is made to pay the cost. Examples include a pollution tax and a congestion toll.

Latent demand: If congestion is reduced by expanding the capacity of a link, using the link becomes more attractive. Travellers will shift onto it from other routes, other times of day, other modes, and so on. Demand materializes that was previously suppressed by the congestion, and hence hidden or latent.

Shadow toll: A toll paid by a highway authority to a private concessionaire on the basis of use. Since drivers themselves pay no toll, a shadow toll avoids the costs of toll collection.

Travel demand management (TDM): An umbrella term for a variety of policies for reducing or modifying the demand for transportation. In addition to congestion pricing, TDM includes promotion of ridesharing, telecommuting, and alternative work schedules; and enhancing the supply of alternatives to driving (or complements to alternatives) such as public transit, park-and-ride lots, and high-occupancy vehicle lanes.

they would benefit further if road-pricing revenues were used to enhance public transport service. Poorer people can continue to drive without paying tolls as long as toll-free alternative routes exist. Furthermore, rich and poor alike value the option to use congestion-free and reliable toll roads when they are especially pressed for time. Finally, equity concerns can be addressed by offering discounts or exemptions to certain groups.

- Experience with road pricing generally — and congestion pricing specifically — is growing around the globe. Research in Canada should begin now on road pricing for heavily congested urban highways and/or downtown areas. The goal should not be to implement schemes that meet the theoretical ideal, but schemes that pass a cost-benefit test, are adaptable to changing circumstances, and will not soon become technologically obsolete.

- Privately operated schemes have the potential to reduce implementation and operating costs and to accelerate development; they thus warrant serious consideration.

Congestion Costs and the Merits of Road Pricing

The Costs of Congestion

Congestion delays are generally considered to be the largest *external cost* of road traffic,[7] and congestion relief is widely viewed to be the greatest potential benefit from road pricing. It is therefore not surprising that estimates of the economy-wide costs of traffic congestion appear frequently in the literature. The most widely quoted are the Texas Transportation Institute's annual estimates for major US cities. According to the 2005 Mobility Report (Texas Transportation Institute 2005), in 2005 congestion created 3.7 billion hours of travel delay and 2.3 billion gallons of wasted fuel that cost the US economy more than US$63 billion. Estimates of the annual costs for Europe include US$38 billion for the United Kingdom and US$800 million to $1 billion for Stockholm in lost time, traffic accidents and deaths, and worsened environmental conditions (Economist Intelligence Unit 2006).[8] And according to the TD Bank Financial Group, the loss from congestion and shipment delays in the Greater Toronto Area (GTA) is some C$2 billion annually (Soberman et al. 2006).[9]

Such statistics should be treated with caution, however, for several reasons. First, the Texas Transportation Institute's calculations and some others entail comparisons of actual traffic conditions with hypothetical free-flow conditions that would be uneconomical, if not impossible, to achieve. Second, the cost of delays is often determined using a single unit value for travel time delay that ignores substantial variations across individuals, as well as possible dependency on trip duration, the severity of the congestion encountered, and whether the congestion is anticipated or not. Third, the estimates exclude the costs people incur when they avoid congestion by travelling off peak, not travelling, and so on. Fourth, the costs

7 See, for example, United States (1997, 2000) and Small and Verhoef (2007, table 3.3). Accident costs may be larger on lightly travelled roads, although the fraction of accident costs that are external to the user is difficult to estimate precisely. Many analysts count as an externality parking subsidies in the form of free off-street parking at workplaces, shops and other businesses, and residences. These subsidies induce distortions in land use and, by encouraging automobile ownership and driving, they contribute to congestion and other external costs. The estimated costs of these distortions are comparable to those of congestion and accidents. See the web site: http://www.vtpi.org/tca/tca0504.pdf.

8 In per capita terms, these costs are roughly US$210 (for the United States), US$630 (for the United Kingdom), and US$670 (for the Stockholm urban area).

9 According to a reviewer, the Ontario Ministry of Transportation came up with a similar estimate in the 1980s.

Table 1: *Costs of Congestion in Selected Canadian Cities*

Urban Area (2001 Population)	Year	At 50% Threshold	At 60% Threshold	At 70% Threshold
			(2002 C$ millions)	
Calgary (951,395)	2001	94.6	112.4	121.4
Edmonton (937,845)	2000	49.4	62.1	74.1
Hamilton (662,401)	2001	6.6	11.3	16.9
Montreal (3,426,350)	1998	701.9	854.0	986.9
Ottawa-Gatineau (1,063,664)	1995	39.6	61.5	88.6
Quebec City (682,757)	2001	37.5	52.3	68.4
Toronto (4,682,897)	2001	889.6	1,267.3	1,631.7
Vancouver (1,986,965)	2003	402.8	516.8	628.7
Winnipeg (671,274)	1992	48.4	77.2	104.0
Total, all urban areas		2,270.2	3,015.0	3,720.6

Note: The data used includes outputs from travel demand forecasting models in each urban area that vary according to the year of application.

Sources: Canada 2006, table 5; Statistics Canada, "Population and Dwelling Counts, for Census Metropolitan Areas and Census Agglomerations, 2001 and 1996 Censuses." Available at web site: http://www12.statcan.ca/english/census01/products/standard/popdwell/Table-CMA-N.cfm; accessed January 13, 2007.

of congestion are borne by drivers collectively, and only a portion of the congestion cost created by a trip is external to the driver.

These reservations notwithstanding, congestion-cost statistics are useful for measuring constituent components of the full cost of congestion and for establishing upper or lower bounds on these costs.[10] Transport Canada recently compiled the first set of statistics for Canada that quantify the costs of travel delay, additional fuel consumption, and greenhouse gas emissions for the nine largest urban areas (see Table 1).[11] Rather than taking free-flow conditions as the baseline against which to measure travel delays, the study adopts a percentage of the speed limit as a threshold below which congestion could be considered "unacceptable." Since this threshold varies across municipalities and road networks, the study undertakes calculations with thresholds of 50 percent, 60 percent, and 70 percent.

The cost of congestion for the nine urban areas computed with the 60 percent threshold is about C$3 billion.[12] Montreal and Toronto account for 70 percent of

10 Indexes might also be useful for assessing the rate of growth of congestion costs over time, and the Texas Transportation Institute annual reports indicate that the costs have been growing relatively steadily in the United States.

11 See Canada (2006). The unit values used in that study to compute the costs of travel delay vary by city and trip purpose. For work and work-related trips, they range from $24.71 per hour to $31.35 per hour; for non-work-related trips, they range from $7.63 per hour to $9.67 per hour (all in 2002 Canadian dollars). Costs of additional fuel consumption were computed using estimates of fuel consumption as a function of vehicle speed and the price of regular unleaded gasoline for each urban area. The cost of greenhouse gas emissions was taken to be $29.97 per metric ton (in 1998 Canadian dollars).

12 Travel delays account for 90 percent of the total, additional fuel consumption 7 percent, and greenhouse gas emissions the remaining 3 percent.

the total. In per capita terms, the annual cost ranges from C$17 for Hamilton to C$270 for Toronto. These costs might not seem very large — in the case of Hamilton, the cost is relatively trivial — but the figures exclude the costs of accidents, noise, local emissions, road damage, and behavioural adaptations to congestion. Moreover, the travel delay cost accounts for *recurrent congestion* but not *nonrecurrent congestion*. Given these omissions, the data in Table 1 are likely to underestimate the true cost, possibly by a considerable amount. Naturally, the cost of congestion is higher for individuals who travel extensively and for those who commute by car.

Limitations of Traditional Policy Measures to Address Congestion

During much of the 20th century, the stock response to incipient congestion was to build new roads or expand existing ones. Such a "predict-and-provide" strategy is almost universally discounted as a panacea now, although selective investments might still be worthwhile (see Eddington 2006).[13] The Achilles' heel of expanding capacity is that it makes driving more attractive, and therefore encourages more of it. *Latent demand* for the new capacity emerges as drivers shift from travelling on other routes and at off-peak times of day, switch from other modes of transport, and so on. Indeed, road investments can increase congestion costs. Spending on local roads, for example, might encourage residential development that creates more traffic, not only on the new roads, but also elsewhere on the road network.

Investing in public transport systems is another supply-side approach that has had limited success in North America. Traditional rail transit systems operate on a hub-and-spoke network. When cities were more compact and jobs were concentrated in the Central Business District (CBD), such networks served them well. But networks are ill-suited to the dispersed pattern of trips that prevails today. Rail transit and bus usage can be encouraged with low fares, but since fare elasticities of demand are typically small, cutting fares boosts ridership only modestly and it increases operating deficits.[14]

Travel demand management measures, such as bans on heavy vehicles and ridesharing, naturally have a role to play in managing traffic. But these measures also induce latent demand if they make driving easier for some groups. One policy — extensively used in the United States but to a lesser extent in Canada — is to designate High-Occupancy Vehicle (HOV) lanes. HOV lanes are effective in increasing hourly throughput measured in people only when congestion is severe and when the initial modal share of carpools is appreciable. Carpooling is relatively unattractive to most commuters because of the difficulty in finding people with compatible work schedules and the time required to collect and

13 Using US data from 1982 to 1996, Winston and Langer (2006) estimate that highway construction and maintenance expenditures yielded a very low rate of return in alleviating traffic congestion, although the expenditures might have provided safety and other benefits.

14 Fare elasticities vary from city to city, but they are generally smaller for metro rail networks than for buses, and smaller during peak than in off-peak periods. Estimated short-run elasticities often fall in the range -0.33 to -0.5. Long-run elasticities are larger, but generally less than 1 in absolute value. See Boyer (1998, 77); O'Sullivan (2003, 294); and Victoria Transport Policy Institute [n.d.].

distribute passengers. As a result, HOV lanes have been falling out of favour. As discussed in the next section, however, HOV lanes have been reinvigorated in the United States by allowing single-occupant vehicles to use them for a toll.

Fuel taxes are less vulnerable to latent demand than are command-and-control measures. And fuel taxes are (nearly) a perfect instrument for *internalizing* global warming costs caused by combustion of carbon-based fuels. But fuel taxes are a very blunt instrument for targeting congestion and other traffic-related costs that vary with location and time. In principle, municipalities or regions could use local fuel taxes as a crude way to discourage driving. But tax leakage would undermine significant tax differentials between regions. For example, residents of the Lower Mainland in British Columbia purchase more gasoline in the United States when it is appreciably cheaper there. Moreover, in the long run, gasoline taxes reduce fuel consumption more through improvements in average vehicle fleet fuel economy than through reductions in distance driven (Small and Parry 2005).

Parking fees are another pricing instrument naturally suited to dealing with congestion related to parking. Thanks to technological advances in parking meters, parking rates can be set not only by location but also by time of day, duration, and average parking occupancy rates (Shoup 2005, 383-90). And since parking fees are commonplace in most cities, they typically elicit less hostile reactions than do new tolls. Nevertheless, parking fees are a crude instrument for tackling traffic congestion. Fees do not vary with distance travelled, through traffic escapes payment, and privately owned parking space remains free (or inefficiently priced) unless regulations are introduced. Indeed, if parking fees deter traffic from using public parking space, they will encourage both through traffic and drivers who use private parking spaces.

Merits of Road Pricing

Road pricing has two basic functions: as a means of internalizing external costs and as a way to generate revenues.

Road Pricing as an Externality Charge

Pigou (1920) is credited with the general idea of using taxes to internalize external costs, and suggested that a toll could be used to reduce road congestion. Their virtue is that, unlike queues, tolls or other forms of charges make travel less attractive without social waste. Appropriately designed charges can serve many functions. Tolls based on axle loads can be used to charge heavy vehicles for road damage. Distance-based fees can be used to charge for insurance.[15] Most practically important of all, tolls can reduce traffic congestion by encouraging

15 This is called pay as you drive (PAYD) insurance. Premiums are charged in proportion to distance travelled rather than as an annual lump sum. The per kilometre rate can be conditioned on driver characteristics that are used for pricing insurance today, such as age, sex, and safety record, as well as varied by type of road travelled and time of day or night. Norwich Union, a large automobile insurance company in Britain, recently introduced PAYD policies after a successful technology trial. See http://www.norwichunion.com/pay-as-you-drive/, accessed February 24, 2007.

people to adjust all aspects of their travel behaviour: number of trips, mode of transport, destination, route, time of day, vehicle occupancy, and so on. Although drivers collectively incur the full costs of congestion delay, each driver imposes a small time delay on each of many other drivers. In heavy traffic, the aggregate cost of these small delays can amount to several times the congestion cost the driver incurs. The Pigouvian congestion toll is then correspondingly large, and the potential efficiency gains appreciable. Tolls also serve a long-run function because they provide an investment signal: high tolls indicate that capacity is scarce and that capacity expansion is correspondingly valuable; and with tolls in place, new capacity will not be swamped by latent demand.

By raising the costs of driving, tolls encourage use of public transit. As Small (2005) explains, road pricing sets off a virtuous circle of effects for public transit systems that share the right of way with cars. Transit vehicles speed up when tolls are imposed, because there are fewer cars on the road. This attracts more travellers to transit. In response, transit operators improve service by adding routes and increasing frequency. Due to economies of scale in transit operations, the cost per passenger falls, perhaps allowing the operator to lower fares. Ridership increase further, and so on.

Road pricing has some limitations, to be sure. Systems such as London's Congestion Charge have high collection costs and impose significant transactions costs on travellers. Tolls are more suited for dealing with recurrent congestion than nonrecurrent congestion — which calls for improved system management and traveller information systems. There may be little scope to modify truck flows in urban areas because of the rigidity of delivery schedules and the lack of alternative freight transport modes in many cities (Holguín-Veras 2005).[16] As noted above, parking congestion calls for parking fees. And controlling pedestrian-vehicle conflicts, inappropriately stopped taxis, double parking, and the movements of delivery vehicles requires traffic-control measures and strict enforcement of the rules.

Despite its theoretical appeal, road pricing is opposed on equity, privacy, and various other grounds. Indeed, the very idea of using taxes and user charges as instruments for internalizing externalities is controversial, as evidenced by the emergence of the "Pigou club" and "NoPigou club."[17] The Pigou Club proposes to increase the US federal gasoline tax by US$1 per gallon as a way to curb global warming, to reduce the federal deficit, and advance other goals. The NoPigou Club disagrees. Among other objections, it notes that the gas tax is too blunt an instrument to be effective in altering travel behaviour. As far as controlling congestion is concerned, this arguably applies to the fuel tax (as noted above), but not to road pricing as long as tolls are targeted at congestion. Moreover, Coase's famous argument — that externalities can be taken care of by assignment of property rights and bargaining between perpetrators and victims — does not

16 However, peak-period cargo movement fees at the Ports of Los Angeles and Long Beach have been successful at getting truckers to reschedule freight pickup and deliveries to nights and weekends. (See the web site: http://www.pierpass.org.) And because of their high opportunity costs of time truckers can benefit considerably from reductions in non-commercial vehicle traffic.

17 See the web sites: http://www.pigouclub.com and http://nopigouclub.blogspot.com.

apply to traffic congestion because, with huge numbers of individuals making frequent trips, the transactions costs would be overwhelming.

Road Pricing as a Source of Revenue

In Canada, one hears frequent calls for additional revenues to fund transport infrastructure. New sources of federal funding have indeed been developed over the past few years, including the Canada Strategic Infrastructure Fund, the Municipal Rural Infrastructure Program, the *New Deal for Cities and Communities,* and the Asia-Pacific Gateway and Corridors Initiative. In 2000, the Alberta government introduced a Fuel Tax Rebate program that grants five cents per litre of the provincial fuel tax to Edmonton and Calgary for transportation capital projects. These initiatives have some limitations — for example, the Alberta fuel tax rebate cannot be applied to neighbourhood roads. And grants (even conditional ones) for infrastructure create incentive problems and weaken accountability (see Kitchen 2006; Mintz and Roberts 2006).

As Kitchen (2006) and other have argued, municipal infrastructure should be financed on the basis of benefits received. Tolls clearly meet this requirement since those who pay the toll use the road. Traditional desiderata for revenue sources include economic efficiency, accountability, fairness, ease of administration, and stability. As Pigouvian taxes, tolls are economically efficient since they correct distortions. Whether tolls are accountable, fair, or easily administered depends on the design of the scheme, as I discuss later. As far as stability is concerned, toll revenues vary with traffic volumes and, therefore, are not recession proof. But since it is generally easier to adjust toll levels than fuel tax rates, toll revenues are arguably more resistant to recession and inflation than are fuel tax revenues.

A final point to note is that the merits of tolls as a Pigouvian externality charge do not depend on how well tolls serve as a revenue generator. Revenue generation may be a supplementary — and possibly large — source of benefits, although it is also a reason for opposition to road pricing.

State of Play Worldwide

Toll roads and bridges are commonplace around the world. But the number of facilities with congestion tolls is quite small, and the number of area-based urban road-pricing schemes is even smaller. Here I discuss the main characteristics of six prominent schemes, chosen to illustrate the variety of ways in which road pricing has been implemented and to offer templates of a sort for possible future road-pricing initiatives in Canada (for a summary of the six schemes, see Appendix Table A-1).[18]

18 Commission for Integrated Transport (2006) provides a comprehensive review of operating and planned road pricing schemes worldwide.

Highway 407 in Canada

Mylvaganam and Borins (2004) provide a fascinating account of the history of Highway 407 as well as the controversies surrounding it. The highway's goals can be described as "diverse." The concession agreement requires the concessionaire, 407 ETR Concession Company Limited, to comply with provincial safety and environmental standards, and to relieve congestion on alternative public highways. Tolls are not regulated, but if annual traffic thresholds set out in the contract are not met, the company is subject to financial penalties. Peak and off-peak rates differ only nominally according to the current schedule.[19] To what extent this pattern reflects the traffic threshold regulations and to what extent profit maximization is difficult to tell.[20]

High Occupancy Toll (HOT) Lanes in the United States

In the United States, road pricing has been spurred by federal legislation authorizing the Value Pricing Pilot Program to fund innovative road- and parking-pricing measures for alleviating congestion. The most prominent operational projects to date are High-Occupancy Toll (HOT) lanes. Hot lanes are a variant of HOV lanes in which vehicles carrying fewer people than the HOV occupancy requirement (usually two or three people) can use the lanes if they a pay a toll. Toll-free lanes run parallel to the HOT lanes a few metres away.

Six HOT lane facilities have been established to date. They feature three distinct time patterns of toll variation. Two facilities are in Texas; they are not heavily used, and employ flat (time-invariant) tolls. On State Route 91, the tolls vary hourly according to a schedule, with a goal of maintaining free-flow conditions on the HOT lanes. In contrast to Canada's Highway 407, the toll varies widely during the course of a day.[21] Tolling of the express lanes on Interstate 25 in Denver operates similarly to tolling of State Route 91. On Interstates 15 and 394, tolls are set "dynamically" every few minutes — again with the objective of maintaining a high quality of service. Revenues on the facilities are earmarked for operations, maintenance and improvements, and (in the case of I-15) for express bus service on the highway.

19 For light vehicles, the peak rate, as of February 1, 2007, was C17.6¢ per kilometre and the off-peak rate C16.8¢ per kilometre.

20 Prior to January 1, 2002, tolls were differentiated in a ratio of 10:7:4 between three periods: daytime peak, daytime off-peak, and nighttime. From January 1, 2002, to January 31, 2003, there was no time variation. On February 1, 2003, a small differential was introduced again. According to Mylvaganam and Borins (2004, 122), the purpose of the differential was to examine the sensitivity of demand to toll levels.

21 As of April 1, 2007, the toll ranged from a low of US$1.15 at night to a high of US$9.50 on Friday afternoons in the eastbound (peak) direction.

Electronic Road Pricing in Singapore

Singapore introduced electronic road pricing in 1998, after 23 years of operating a cordon scheme with paper licences. The city-state levies charges to enter restricted zones around the CBD as well as on expressways and arterial roads. Charges are generally varied every half-hour. Similar to the HOT lanes in the United States, charge levels are set to maintain target levels of service (speeds of 45-65 kilometres per hour on expressways and 20-30 on arterials), and charges are reviewed every three months. Singapore differs from the other five schemes in Table A-1 in that revenues are not earmarked for any particular purpose.

Toll Rings in Norway

In Norway, the use of tolls to help finance road infrastructure is a long tradition, and six Norwegian cities have toll rings. Until recently, the main objective of the toll rings was to raise revenue rather than to manage congestion. Bergen's toll ring was established solely as a revenue source for road construction. The Oslo and (former) Trondheim schemes — which were established a few years later — were also intended to fund infrastructure for public transport, cyclists, and pedestrians. Only the Stavanger toll varies by time of day, although the practice has been proposed for some other cities as interest in managing traffic congestion grows.

Congestion Charging in London

Ken Livingstone campaigned to become mayor of London with a manifesto to introduce congestion pricing in his first term. His efforts were successful, and in February 2003, the London Congestion Charge came into operation following investments in additional buses and changes in traffic-light sequences. The charge initially applied within a 21-square-kilometre area around the city centre between 7:00 am and 6:30 pm on weekdays. A number of vehicle categories are exempt, and residents of the charge area receive a 90 percent discount. To conform with the *Greater London Authority Act*, which enabled road pricing in London, revenues are earmarked to local transport for at least 10 years.

Transport for London's fourth annual report (2006) indicates that — despite slight reductions in average travel speeds since the previous year — the main goals of the charge continue to be met.[22] The system has evolved since its inception: methods of payment and penalties for not paying have been adjusted; in July 2005, the charge was raised from £5 to £8. In February 2007, the charging zone was expanded to include Kensington, Chelsea, and parts of the City of Westminster that were not already in the zone. And Mayor Livingstone negotiated an agreement to have revenues continue to be allocated to London Transport until at least 2017.

22 For evaluations of the congestion charge, see, for example, Litman (2005); Mackie (2005); Prud'homme and Bocarejo (2005); and Santos and Fraser (2006). Richards (2005) provides an excellent summary of the historical and institutional background to the scheme and Ken Livingstone's pivotal role in creating it.

The Trial in Stockholm

Stockholm ran a congestion charging trial from January 3 to July 31, 2006. Vehicles entering or exiting the inner city on weekdays paid a charge that varied in three bands by time of day. The effects were significant and encouraging. Traffic traversing the cordon fell by 22 percent, travel times during the morning peak dropped by nearly a third, injury accidents fell by 5 to 10 percent, emissions fell by 10 to 14 percent, and public transport usage rose by 6 percent. A September 17, 2006, referendum on making the charge permanent was approved by a narrow margin. Sweden's new Alliance government ratified the referendum, and plans to earmark charge revenues to construction of a relief ring road around the city.

Summary

All six road-pricing schemes have been quite successful despite — or possibly because of — their differences and sometimes relatively crude design. London's experience, in particular, has encouraged many cities around the world to consider road-pricing schemes of their own. Vancouver has plans to toll bridges. San Francisco has received federal funds to study an area-based congestion-pricing scheme. And several prominent institutions, including the Partnership for New York City (2006) and the Manhattan Institute (Schaller 2006), have called for studies of area-based road pricing for New York City. Some analysts believe that road pricing has gone beyond the tipping point in the United States.

Design Considerations for Road-Pricing Schemes

Designing a socially optimal road-pricing scheme is complicated because of the many factors that must be taken into account: the inability to price all roads, mispriced alternative modes, the distortion of income and excise taxes in other sectors of the economy, and so on. Here, I limit my discussion to just a few of the important considerations for system design.

Design Elements

The design of any road-pricing scheme should include considerations of what, when, and how to toll, whether exemptions should exist for certain categories of people and vehicles, how to impose and collect tolls, and how to spend the revenue thus obtained.

Tolled Infrastructure

Tolls can be either facility based or area based. Facility-based schemes include single lanes, individual roads, and sets of roads. Area-based schemes include cordons, whereby vehicles are tolled when they cross the cordon in the inbound and/or outbound direction; and area charges, which are imposed for moving into, out of, or within an area. Cordon tolls and area charges can comprise a single area, two or more disjointed areas, as in Singapore, or a system of interlocking zones within an area, as in the now-abandoned, second-generation Trondheim scheme.

Facility-based tolls make sense if congestion is localized at hot spots or on major routes. Area-based charges are better candidates if congestion is concentrated in city centres, if public transport service is good, and if the goal is to reduce emissions or to raise large amounts of revenue. Singapore's scheme (see Table A-1) features a combination of a cordon charge for restricted zones in the CBD, tolls on expressways, and tolls on arterial roads.

The appropriate structure of an area-based charge depends on the topology of the road network and the quality of public transport service, among other factors. Oslo's cordon toll has 19 toll stations, Stockholm's trial cordon had 18, but London chose not to intercept vehicle movements across the boundaries of the congestion charging zone because of the large number of entry points. Instead, cameras are used to record vehicle movements.

The choice between a cordon toll and an area charge has not been systematically examined in the literature. Since cordon tolls do not apply to trips made wholly within the charge zone, they are more favourable, *ceteris paribus*, to households and firms located in the zone. Traffic diversion and parking congestion just outside charged areas can be problems, although London and Stockholm largely managed to avoid them. Areas adjacent to a charge zone might, in fact, benefit from the reduction of traffic travelling into and out of the zone. According to Eliasson (2006), many of the benefits from the Stockholm Trial accrued to motorists who did not cross the cordon but experienced less congestion delay. The same might hold for, say, York, Mississauga, and other areas of the GTA, if a charge were levied in downtown Toronto.

Discounts and Exemptions

If a single flat charge is applied over a wide area, discounts or exemptions might be justified on efficiency grounds for individuals who usually do not travel far within the area or at peak times. (Discounts could also promote acceptability, as discussed below.) But because discounts and exemptions dilute or eliminate incentives to alter travel behaviour, they could undermine the effectiveness of a system.[23] Accounting and enforcement are also easier if all vehicles are treated equally.

Vehicle Detection and Payment Technologies

Several considerations govern the choice of vehicle detection and payment technologies: the goals of the scheme, the size of the road network, the degree of

23 According to *The Sunday Times*, about 40 percent of drivers who pay the London Congestion Charge are reimbursed by their employer (see the web site: http://driving.timesonline.co.uk/article/0,,22750-2270389,00.html). How such compensation affects the travel decisions of employees is an open question. If employers do not encourage their employees to change their commuting behaviour, employees will lack an incentive to adapt. In the long run, however, employers could respond by relocating further away from the charging area.

differentiation of charges by vehicle type, time of day, and so on. Since satellite-based systems have high fixed costs but low marginal costs, they are probably not cost effective except for charging in large cities and for intercity transport, but they make it possible to charge all roads, including residential and other low-volume streets. The ratio of collection cost to revenue varies widely across existing systems, as is evident in Table A-1. London's high costs are due partly to the multiple ways of making payments, but also to shortcomings in the procurement process (Economic Intelligence Unit 2006, 16).

Since road pricing is likely to be implemented in stages, care should be taken not to invest in incompatible technologies or technologies that will quickly become obsolete. The advantages of using interoperable technology must be balanced against the benefits of testing different technologies.

Use of Toll Revenues

A longstanding question is whether the revenues from user charges should be earmarked for a particular use. Public finance theory says that tax revenues should not be locked into any particular expenditure pattern because priorities change over time in unpredictable ways. Earmarking hampers effective budget control, and can result in shortages of revenues for some purposes and excess revenues for others. But there are several arguments for earmarking: it is consistent with the *beneficiary principle*, it facilitates long-term planning, it can prevent political abuse of funds, and, as discussed further below, it might enhance public acceptability.

Revenues from road-pricing schemes can be earmarked narrowly, such as to the highway on which the tolls are levied, or more broadly, such as to highways in the area or public transport services in the same corridor. Most existing road-pricing schemes do feature earmarking, but the practice is not common in Canada, and it is controversial. The Canada Transportation Act Review Panel, for example, recommended against allocating revenues from congestion tolls and other road user charges to road investments if expenditures on other transportation modes would yield a higher return. Heaver and Waters (2005, 795), however, advocate that revenues from the federal fuel tax be dedicated to transportation as a whole. They note the need for road repairs and the fact that the fuel tax is inconsistent with tax harmonization across sectors.

Two final points deserve mention. One is that, because revenues from congestion tolls can exceed the efficiency gains by a large multiple, revenue-allocation decisions can have larger efficiency effects than pricing decisions (Parry and Bento 2001). The other point is that earmarking schemes are undermined when funds from other sources are reduced in an offsetting way; for example, London's funding from the central government allegedly dropped after the city introduced congestion pricing (Richards 2005, 83, 214).

Public Acceptability

Analysts now widely agree that public acceptability is the largest barrier to road pricing. They also recognize that, even though road pricing can materially enhance efficiency, it is practically impossible to design a scheme that makes everyone better off. Even compensating losers by taxing gainers is generically infeasible because of the high costs of negotiating adequate compensation levels, the impracticality of dealing with individuals rather than with broad groups,[24] and adverse incentives, among other reasons (Rietveld 2003). Indeed, even where such compensation is possible, it may be unacceptable because of doubts about the possibility of making it permanent.[25]

Opposition to road pricing is nicely illustrated by an online petition to the UK government, open between December 14, 2006, and February 20, 2007, that attracted more than 1.8 million signatures. The central message on the website read:

> The idea of tracking every vehicle at all times is sinister and wrong. Road pricing is already here with the high level of taxation on fuel. The more you travel - the more tax you pay.
>
> It will be an unfair tax on those who live apart from families and poorer people who will not be able to afford the high monthly costs.
>
> Please Mr Blair - forget about road pricing and concentrate on improving our roads to reduce congestion.[26]

This message voices three common reasons for opposing road pricing: invasion of privacy, double taxation, and concern about equity.[27] Concerns about privacy have been largely overcome by anonymous electronic tolling technology, although fears are expressed about possible misuse of information from future satellite-based systems. Concerns about double taxation and equity are not as easily dismissed; I address these and a few other objections to road pricing below.

Paying for something that was previously free: In Canada, highway capital traditionally has been provided by the public sector and without direct user charges. Introduction of a toll on a previously free road understandably evokes a

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24 A general finding from polls, focus groups, and stated preference studies (for example, Small, Winston, and Yan 2006) is that attitudes toward road pricing and the likely benefits derived from it vary considerably within socioeconomic groups, such as high-income auto commuters or elderly public transit users, that appear relatively homogeneous. Making a particular group better off on average is unlikely to leave every person in the group better off.

25 Stiglitz (1998) suggests this as a reason congestion pricing has not been implemented at US airports. Since general aviation pays only nominal fees, a shift to a market system would make the subsidy to general aviation more transparent and politically untenable in the long run.

26 See the web site: http://petitions.pm.gov.uk/traveltax.

27 Two passages in the message seem perverse. Is “[t]he more you travel — the more tax you pay” — not both efficient and fair? And “forget about road pricing and concentrate on improving our roads to reduce congestion” implies that road pricing will not reduce congestion.

negative response.[28] As discussed earlier, a congestion toll can be viewed as a legitimate Pigouvian charge for creating a negative externality. It is true that, unlike a smoke-emitting factory, road users are not only the cause of the externality but also the victims (Hau 1998, 67-68). Nevertheless, economists usually argue that travellers should not automatically be compensated — either by rebating toll revenues to them or by using the revenues in ways that benefit them.

System complexity: Polls and experiments on stated preferences indicate that people dislike complex price structures — either for public transport or for driving (Bonsall and Shires 2005). This militates against varying tolls frequently by time of day or day of week, although experience with HOT lanes and Singapore's electronic road-pricing system suggest that drivers can adapt if the toll structure is clear and logical.

Loss of retail business: Retailers generally oppose road pricing on the grounds that it will hurt their business. A consensus has developed, however, that the effects are minimal if road pricing is implemented judiciously (Economic Intelligence Unit 2006, 19). Any loss of business from drivers might be offset by gains from shoppers who use other modes. Walking is made easier for everyone, with less traffic noise and fumes. Loss of business to nearby competitors could restrain some cities from implementing road pricing, but this is not a factor for dominant cities such as London or New York.

Road pricing is inequitable: The road-pricing literature generally distinguishes between *vertical equity* and *horizontal equity*. Conclusions are mixed in the papers on vertical equity. In an early and insightful analysis, Small (1983) assessed the incidence of congestion tolls on three income groups. He found that all three groups would be better off either if aggregate toll revenues were redistributed as a lump-sum transfer to everyone or if the revenues collected from each group were redistributed back to that group. In general, higher-income groups are likely to gain the most from tolls because they place the greatest value on travel time savings. Lower-income groups benefit to the extent that they use public transit, which speeds up if congestion is reduced. Empirical studies show that the mix of people who use HOT lanes is quite varied: even lower-income people do so when they are especially pressed for time.

Concern for horizontal equity is raised most frequently with respect to location. One issue is whether streets should be tolled in residential areas. Without tolls, such streets might be swamped by traffic diverting from tolled roads elsewhere, but tolling them would penalize residents. Another issue is how to set tolls on a network of toll roads or bridges. In Japan, the goal of motorway tolls is to raise money for road construction. The same toll rates are applied to all roads regardless of their construction costs or traffic volumes, so that the more expensive and less heavily used roads cross-subsidize other roads. The Japanese government sees this policy as fair and worth any loss of efficiency. Similarly, a public consultation exercise in the Netherlands in 2006 found that the public thought

28 This attitude is consistent with the endowment-effect hypothesis (see, for example, Kahneman, Knetsch, and Thaler 1990) that people value something more highly if they have, or believe they have, property rights to it. A recent Canadian example is the Fredericton-Moncton highway project. Under the public-private partnership agreement, the concessionaire was to toll a pre-existing toll-free section of the highway. This evoked strong public opposition, and the whole highway ended up toll free, with the concessionaire compensated through shadow tolls.

universal road pricing would be fair, but that selective charging on congested roads would be both unfair and ineffective (European Conference Ministers of Transport 2006).

Road pricing constitutes double taxation: In principle, this objection can be addressed by building revenue neutrality into the overall system of direct and indirect road user charges. Most existing road-pricing schemes do not feature revenue neutrality, although the Netherlands intends to modify its current road tax system and the United Kingdom has considered lowering fuel taxes as part of its planned national road pricing scheme.[29] The scope to reduce fuel taxes is greater in Europe than in Canada, where fuel taxes are much lower and concerns about climate change are growing. Licence and registration fees in Canada are also nominal, and reducing them would not go far toward achieving revenue neutrality if road pricing were widely implemented.[30] Neutrality is easier for regions, such as New York City, where traditional tolls are already in place.

Opposition to double taxation can also often be assuaged by earmarking revenues to road users.[31] In a large Internet-based survey (Ubbels and Verhoef 2006) of Dutch auto commuters, for example, fewer than 10 percent of respondents said that spending toll revenues on new roads or to reduce driving costs was "unacceptable" or "very unacceptable", while spending on the general budget was opposed by nearly 75 percent of respondents. Reducing income taxes also attracted the opposition of a third of respondents. Surprisingly, high-income motorists were somewhat less willing to use toll revenues to lower income taxes than were poorer motorists; the authors of the survey suggest the reason is that richer people value income less highly at the margin.

Guidelines for Road Pricing

Among the guidelines that have been proposed for designing road-pricing schemes are setting worthwhile objectives, choosing the right technology, managing costs, and selling the benefits to the public.[32] Some other guidelines warrant a brief discussion here.

Choose a simple scheme and explain how it works: As noted earlier, road pricing can be used to alleviate congestion, reduce emissions and road damage, generate revenues, and meet other objectives. It is natural from an optimization perspective to pursue them all. But this complicates the design and makes it more difficult to

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29 Lowering fuel taxes might be efficient in countries where they are particularly high — Small and Parry (2005) conclude that the UK tax is more than twice its optimal level.

30 In contrast to fuel taxes, licence and registration fees are fixed charges (that is, they are independent of the amount driven), so reducing them would have different efficiency and equity effects than would a fuel tax cut.

31 The lack of earmarking in Singapore is not considered an obstacle because public transport service was excellent before electronic road pricing was launched.

32 See, for example, Economic Intelligence Unit (2006); Santos and Fraser (2006); and Schaller (2006). Inadequate public information campaigns have contributed to a number of failed attempts at urban road pricing, including electronic road pricing in Hong Kong, Rekening Rijden (Bill Riding) for the Randstad area in the Netherlands, congestion metering in Cambridge and the double cordon toll in Edinburgh, and several schemes in the United States.

explain how it works. As Jones (2003) remarks, most successful schemes have focused either on congestion relief or on revenue generation combined with earmarking. Simplicity in pricing is especially important because people have to understand the pricing scheme in order to adapt optimally to it. It is also helpful to explain why the scheme is superior to — or complementary with — other measures.

Be open during the planning process and consult with the public: The process followed in developing a scheme is crucial if it is to be supported by the public (Schaller 2006). Marketing is essential. According to Berg (2003, 38) regarding the US Value Pricing Pilot Program, “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.“

Make the scheme credible: Even a well-designed scheme with clear goals might be rejected without some assurance that it will actually be carried out. Stakeholders must be convinced that tolls will be imposed fairly and will evolve as planned. And if revenues are earmarked, mechanisms must be created to guarantee that the money is channelled as intended without offsetting reductions from other sources. Credibility is enhanced if a political leader is willing to stake his or her political future on the scheme.

Establish and understand the legal framework: Interpreting the Greater London Authority Act was a challenge in designing the London Congestion Charge, while conforming to Scotland’s road user charging legislation was an obstacle in the failed attempt to launch a cordon toll in Edinburgh in 2005. In Canada, privatization of Highway 407 required passage of an enabling act (Bill 70) by the Ontario legislature, and the concession agreement had to be negotiated within legal constraints. Legal barriers are likely to be larger for pioneering schemes than for similar schemes that follow on.

Consolidate decisionmaking: Implementing area-based road pricing requires coordination of road, transit, urban planning, and other functions that are often devolved to different departments and levels of government. Evidence from existing road-pricing schemes and case studies[33] indicates that centralization of decisionmaking is desirable to internalize fiscal and investment spillovers, and to avoid problems such as excessive taxation of nonresidents and excessive taxation of transport when multiple levels of government each levy a tax. The *Greater London Authority Act* gave Mayor Ken Livingstone sufficient latitude to proceed unilaterally with some elements of the congestion charge. In Canada, urban transportation agencies with some of the same powers exist in Montreal (l’Agence métropolitaine de transport, created in 1996), Vancouver (TransLink, created in 1998), and Toronto (the Greater Toronto Transportation Authority, created in 2006).

Make road pricing part of a policy package: Selective capacity investments and travel demand management measures will continue to play an important role even if comprehensive road pricing is implemented. And supplementary measures, such as reductions in other user charges, might be needed to compensate potential

33 See, in particular, the Transport Institutions in the Policy Process (TIPP) project, funded by the European Commission (May et al. 2005).

losers. Any road or public transport improvements should be implemented in advance — as was done with bus service in London and Stockholm, and with the construction of a tunnel in Oslo.[34] Improvements should also be clearly identified with the scheme, as did not occur for public transport enhancements that Edinburgh made before a referendum on its planned cordon toll was voted down.[35]

Enhance fairness: Fairness can be enhanced by earmarking revenues and by improving travel choices. Preserving toll-free alternative routes or lanes has contributed to public acceptance of HOT lanes in the United States, and some jurisdictions, such as British Columbia, permit tolling only if an untolled alternative exists.

Postpone a plebiscite: Edinburgh's referendum on its planned cordon toll failed to pass, while Stockholm's plebiscite on continuing the congestion charge after a six-month trial was approved. Admittedly, this is scant evidence on which to propose a guideline. Yet opposition to most road-pricing schemes tends to wane after they come into operation, the traditional explanation being that attitudes improve after people experience the benefits of the schemes. In a survey of German motorists, however, Schade and Baum (2007) find empirical support for an alternative hypothesis: that people become more favourable toward road pricing if it seems inevitable, which suggests that holding a referendum after a trial than before is most likely to improve the prospects of a yes vote. But it also suggests that skipping a referendum altogether and making decisions by administrative fiat is better yet. Accountability will still be maintained insofar as citizens can vote politicians out of office if the scheme proves unpopular.

Prospects for Road Pricing in Canada

With the exception of Highway 407, all recent developments in road pricing have taken place outside Canada. What, then, can Canada learn from abroad? It is difficult to assess how other countries' experience with road pricing is transferable to Canada — particularly since all the major schemes were pioneering in some way.

The Current Situation

The possibility of introducing congestion charges is now receiving serious attention in New York City (Partnership for New York City 2006; Schaller 2006). Would a London-type scheme work? The two cities are similar in terms of population, mobility challenges, economic activity, and world profile. But New York has a disadvantage in that control over its transportation system is fragmented.[36] There are also doubts that its public transport system could handle

34 Naturally, improvements cannot be financed with road-pricing revenues before a scheme is introduced, but future revenues can be used to pay off debts on capital outlays.

35 A parallel in Canadian experience might be the personal income tax cuts that preceded introduction of the goods and services tax but were not closely linked to it (Dahlby 2005, 17).

36 New York also has an advantage in that Manhattan has only about one-tenth as many entry points as London had into its congestion charging zone (prior to the expansion in 2007).

a significant increase in ridership. Various commentators have expressed reservations that London's generally favourable experience with an area charge could be replicated either in New York City or most other cities.[37]

Unlike New York City residents, most Canadians are unfamiliar with toll roads — indeed, only 19 such roads exist in all of Canada.[38] Before Highway 407, the most recent tolled facility in the Toronto area was the Burlington Skyway bridge, whose tolls were removed in 1973. There has been a general reluctance in Canada to part from a tradition of publicly operated and toll-free roads. For example, in 2003, the British Columbia government devised a plan to privatize the Coquihalla highway on a 55-year lease, but backed down after massive opposition. In Alberta, the Public Private Partnership contract to design, build, finance, and operate part of the ring road in Edmonton prohibits "tolls or advertising to generate revenue" (Alberta 2005, 41).

There are promising signs, nevertheless. Road pricing is receiving scholarly support in Canada (see, for example, Brown et al. 2005; Kitchen 2006), and a study of transportation challenges in the Greater Toronto Area calls for "an objective assessment of alternative methods of 'road pricing' or tolls to finance GTA transportation initiatives" (Soberman et al. 2006, 53). A recent poll of Canadians that asked "How should new greenhouse-gas reduction programs be funded?" found greater support for tolls (37 percent) than for an increase in the price of gasoline (20 percent) or in income taxes (18 percent) (Laghi 2006). And — as I discuss further below — public sentiment is growing for tolling bridges in the Greater Vancouver area.

Is it better to introduce tolls on individual facilities first, or begin with an area-wide scheme? The literature on road pricing is undecided. Cities with successful area-based schemes have well-developed public transport systems that carry a large share of trips. Indeed, public transport appears to be vital — in terms of both effectiveness and public acceptability — for area-based schemes. Good public transit systems provide a reasonable alternative to driving. And public acceptability of road pricing can be materially enhanced by earmarking revenues to public transport if large numbers of people use it and stand to gain from it.

In Canada, however, even in Toronto and Montreal, the cities with the country's worst congestion, the share of commuters using public transit — 22.4 percent and 21.7 percent, respectively; see Table 2 — is far smaller than in cities such as London, Stockholm or Singapore. London's share was more than 85 percent even before the congestion charge was imposed.[39] Thus, transit use in Canadian cities seems to militate against area-based schemes.

Yet, the Canadian cases also highlight the amount of modal shifting that could take place. Toronto and Vancouver are leading candidates for some form of comprehensive road pricing, since both have serious traffic congestion problems and both have urban agencies with some power to tackle them. In Toronto, the

37 See, for example, Hensher (2003), Gray (2007), and Kahn (2007).

38 Bryan (1972) contains a detailed history of toll roads in Canada. Lindsey (2005) provides a brief update.

39 In 2004, public transport accounted for 39 percent of trips within the county of Stockholm and 64 percent of trips between the periphery and the centre (Prud'homme and Kopp 2006, table 1). In 2005, in Singapore, 52.3 percent of trips to work were by public transport (Singapore 2005).

Table 2: *How Commuters Get to Work in Selected Canadian Cities*

City	Car, Truck, Van			Public Transit	Walk	Other
	Driver	**Passenger**	**Subtotal**			
				(percent)		
Calgary	71.8	6.8	78.6	13.2	5.9	2.4
Edmonton	77.7	6.6	84.3	8.6	4.7	2.4
Hamilton	78.2	7.1	85.3	8.0	5.1	1.6
Montreal	65.6	4.8	70.4	21.7	5.9	2.0
Ottawa-Gatineau	64.6	7.4	72.0	18.5	6.8	2.7
Quebec City	76.0	5.2	81.2	9.8	7.0	2.0
Toronto	65.2	6.3	71.4	22.4	4.6	1.6
Vancouver	72.2	7.0	79.2	11.5	6.5	2.8
Winnipeg	70.0	8.4	78.4	13.2	6.1	2.3
Total, all urban areas	72.5	6.8	79.3	12.5	5.9	2.2

Source: Statistics Canada, 2001 Census, Mode of Transportation. Available at web site: http://www12.statcan.ca/english/census01; accessed December 15, 2006.

Greater Toronto Transportation Authority, which manages transportation and public transit planning within the GTA, has the responsibility "to provide leadership in the co-ordination, planning, financing and development of an integrated, multi-modal transportation network." Moreover, Ontario law makes provision for regulations "authorizing the Corporation to establish and impose fees and charges and to utilize other mechanisms for revenue generation" (Ontario 2006).

Vancouver's TransLink, set up in 1998, was the first agency in North America with authority for public transportation and roads, and responsibility for long-range transportation and land use planning.[40] It receives dedicated funding from transit fares, fuel taxes, parking taxes, and property taxes. Despite these powers, however, TransLink (and other municipal governments in British Columbia) are constrained by the *British Columbia Guidelines for Tolling*, which are worth listing in full:

> 2.1 Only major projects that result in significant increases in capacity will be subject to tolling.
>
> 2.2 Tolls will be implemented only if there are clear, demonstrable net benefits for the users of the new or improved facilities.
>
> 2.3 Tolls will be implemented only if a reasonable untolled alternative is available.

40 In January 2007, the BC government issued a report recommending a reorganization of TransLink on the grounds that its governance structure prevented it from making decisions effectively (Translink Governance Review Panel 2007).

> 2.4 The level of tolls and limits on the amount and frequency of increases will be established in advance.
>
> 2.5 Public consultation will occur in all cases where new tolls are considered.
>
> 2.6 The public will have the same rights to access tolled highways as non-tolled highways.
>
> 2.7 Tolls will be used to generate revenue for transportation projects and provide a return on the investment of the private-sector partners. (British Columbia 2003, para 2.)

These guidelines severely constrain tolling on BC highways. Yet, they are consistent with such principles and guidelines for tolling as the beneficiary principle (2.2), improving choices (2.3), selling the benefits to the public (2.5), and earmarking (2.7).

British Columbia currently plans to toll two bridges: the existing Port Mann Bridge after it is twinned, and the new Golden Ears Bridge, scheduled to open in 2009. The Greater Vancouver Regional District has long wanted to toll all bridges in the region, a move the provincial government has resisted. But the idea for comprehensive tolling has gained the support of the Consulting Engineers of BC (Boei 2006), on the grounds that tolling just one or two bridges would divert too much traffic onto other routes. According to the engineers, bridges into downtown Vancouver could also be tolled — but at a lower rate since they are less congested. Residents of Surrey and Langley, and some local politicians, are also supportive of the comprehensive tolling plan because they consider it fair (Nagel 2006).

Recommendations for Canada

It is beyond the scope of this paper to develop a blueprint for road pricing in any particular place in Canada. But the economic and engineering literature has advanced a long way since Pigou (1920), and the field now has considerable experience on which to draw. Some cities, such as Shanghai, are not even waiting until they face crippling congestion but are developing road-pricing schemes now, in order to better manage congestion as it develops (see Commission for Integrated Transport 2006). The costs of congestion in cities like Montreal, Toronto, and Vancouver are appreciable and growing, and consideration should be given soon to plans to implement some form of road pricing. I offer four brief but specific recommendations for Canadian policymakers.

Fund research: In the United States, road pricing has been spurred by the federally funded Value Pricing Pilot Program. The Bush Administration is also promoting a "congestion initiative" that includes grants to develop congestion tolling systems.[41] The Canadian federal government could follow suit by funding road-pricing research in Canada. Congestion relief should be the focus, although

41 See the web site: http://online.wsj.com/article_print/SB117064116425197878.html.

revenue generation is worth studying as a secondary objective.

Conduct experiments: The US Value Pricing Pilot Program has funded a range of experiments spanning HOT lanes, a cordon toll, truck tolls, mileage-based insurance, and GPS-measured distance-based charges. HOT lanes, of which the United States offers several successful examples, appear to be a promising model for Canada to test first.[42] HOV lanes already exist in Canada, although they are not as widespread as in the United States. The lanes are relatively cheap to build or convert, and experiments can therefore be conducted relatively quickly at low cost. HOT lanes offer motorists the choice of paying for a quicker trip or continuing to drive free at a slower pace.

Engage the private sector: In the United States, long-term toll-road concessions are rapidly becoming a popular way to fund new highway capacity. Among the potential advantages of such concessions are that they are quicker and cheaper to construct, and they contain managerial incentives to maintain highways properly over their full life-span (Poole and Samuel 2006).[43] Public-private partnerships are another mode of delivery that deserves study.

Involve apolitical individuals and professional bodies: Road-pricing schemes have a tendency to become lightning rods for opposition. Dudley and Richardson (2000, 137) claim that apolitical forums dominated by professional norms can help to legitimize controversial policy changes and bring competing interests closer together. As an example, they identify the Leitch Committee, which was appointed in 1976 to review methods of assessing trunk road investments in Britain. Along the same lines, Mylvaganam and Borins (2004, 113) argue that, by appointing external members to the board of the Ontario Transportation Capital Corporation, the Rae government may have furthered a commitment to retaining tolls on Highway 407.

Final Remarks

In developing its own road-pricing plans, Canada can draw on experience from Highway 407 and elsewhere.[44] The next steps are important: they could influence the design of the schemes that follow. Locking in technology now could forestall future options, and missteps could set back the road-pricing agenda for years. Such policy changes are driven by a combination of ideas, pressure from interest groups, government initiative, and force of circumstances. Major political decisions can result from excessive enthusiasm for a new policy. As an example, Dudley and Richardson (2000, 16) point to the universal adoption of massive road construction schemes in the years after World War II, which led to latent demand

42 Sites for HOT lane projects should be chosen with care, however, since the potential benefits are sensitive to the amount of time saved and the proportion of motorists willing to carpool (see Gómez-Ibáñez 2006; Small, Winston, and Yan 2006).

43 McFetridge (1997, 44) argues that privately operated facilities might also face less opposition than public facilities to nontraditional forms of user charges, such as tolls that vary by time.

44 As Poschmann (2003, 20) notes, Highway 407's electronic tolling technology has been proven, and both public and private sector agents in Canada have gained experience with public-private partnerships and contractual arrangements regarding risk sharing.

and environmental and other problems. Care is required to avoid ill-conceived road-pricing schemes even if their consequences are unlikely to be as serious.

This caution notwithstanding, there are good reasons to proceed with road-pricing schemes that do not meet the standard of theoretical perfection. Congestion and other traffic-related problems exact a high cost in Canadian cities, and even a rough-hewn design that follows the guidelines laid out above can yield substantial net benefits (Gillen 1997, 211). Particularly for the next steps, the difficulties of designing the best possible road-pricing system should not stand in the way of implementing helpful schemes. It can be argued, for example, that when Highway 407 began operation, an optimal scheme for the whole network would have called for low or zero tolls on the new highway to maximize congestion relief on Highway 401, Highway 7, and other roads.[45] In the view of Mylvaganam and Borins (2004), however, the policy of relatively high tolls that was actually adopted was preferable for three reasons. It has (presumably) helped to reduce urban sprawl; it reduced the Ontario government deficit; and it accelerated development of the world's first all-electronic, limited-access highway as a dramatic first step for Canada in congestion pricing.

As London mayor Ken Livingstone explained in his reasons for forging ahead with the congestion charge,

> with a scheme like this, there will never be a time when the information available is wholly complete, because the immediate effects may differ from the longer-term effects, since traffic patterns will adjust and re-adjust, and nothing is wholly predictable. I do not consider that the outstanding uncertainties would to any substantial extent be removed as a result of holding a public inquiry or commissioning further studies or consulting further on the scheme. (Quoted in Ison and Rye 2003, 228.)

If "Red Ken," the socialist mayor of London, and Swedish social democrats in Stockholm can persuade their political allies to support road pricing, surely Canadians can follow suit.[46] Attitudes do change. As Dahlby (2005, 25) remarks, "I have been very surprised over my 30-year career as an economist to discover that an opinion or policy that was at one time considered beyond the pale could, in a short time, take on the lustre of an important and obvious innovation." Public and private toll bridges, roads, and ferries were prevalent in Canada in the nineteenth century. Proponents of road pricing like me hope that toll roads will be resurrected in the twenty-first century and seem like an obvious innovation whose time should have come (again) long ago.

45 I am not aware of any estimate of optimal tolls for Highway 407. Before the highway was completed, Mekky (1995) used the EMME/2 road network software to simulate the effects of different toll rates on travel times, route diversion, and toll revenues. He assumed that the total number of trips and choice of mode were fixed, and did not evaluate the welfare effects of tolling.

46 I am grateful to a reviewer for making this point, in approximately these words.

Table A1: Characteristics of Selected Road-Pricing Schemes

	Canada: Highway 407	United States: High Occupancy Toll (HOT) Lanes	Singapore: Area Licence & Electronic Road Pricing
Inception	**1997**	**1995**	**1998**
Goals	Provincial: diverse Private: profit maximization subject to minimum traffic thresholds	Congestion relief	Congestion relief
Tolled area or infrastructure	108 kilometres of linear highway	Six projects: SR-91, I-15 in California; I-10, US 290 in Texas; I-394 in Minneapolis-St. Paul; I-25 in Colorado	Cordon charge for three restricted zones around CBD, expressways, and arterial roads; charged infrastructure progressively expanded
Toll application	Proportional to distance	Per passage	Per passage; inbound crossings of restricted zones
Technology	Detection: transponder or video Payment: online, telephone	Detection: transponder Payment: online	Detection: gantries and in-vehicle units Payment: smart cards
Time variation	Small peak/off-peak differential	I-10, US 290: flat SR-91, I-25: variable I-15, I-394: dynamic	CBD 7:30-10 am, 12-7 pm; expressways: 7:30-9:30 am; charges change in 5 or 30-min. steps; charge levels reviewed quarterly
Toll differentiation by vehicle and user characteristics	Tolls for light, heavy single unit, and heavy multiple unit in ratio 1:2:3; transponder-recorded pay C$2.15 per month, video-recorded pay C$3.50 extra per trip	I-15, I-394, I-25: high occupancy vehicles (2+ people) free SR-91, I-10, US 290: high-occupancy vehicles (3+ people) free I-10, US 290: single-occupancy vehicles prohibited on toll lanes, All: heavy goods vehicles prohibited on toll lanes SR-91: Zero-emission vehicles free	Differentiated by six vehicle types; exemption for police cars, ambulances, fire engines
Operating costs as fraction of revenues	Private; information proprietary	0.66	0.21
Earmarking of revenues	Private; revenues cover maintenance and construction	SR-91: operations, maintenance, improvements I-15: express bus service, operations I-10, US 290: operations I-394: bus service, operations I-25: operations, maintenance, enforcement	None; transport charge revenues greatly exceed expenditures on roads
Supplementary measures	Capacity expansion	SR-91: capacity expansion	Part of extensive package (multiple vehicle ownership taxes, fuel taxes, parking fees, road expansion, mass rapid rail system, buses, taxis, park & ride schemes, car cooperatives, signal timing)
Private sector involvement	Design, build, and operate agreement, financed by Ontario government; purchased in 1999 by Highway 407 International consortium	SR-91: Private from 1995 until 2003, when acquired by Orange County to bypass noncompete clause in face of rising congestion	Design and build project to implement

	Norway: Toll Rings	London: Area Congestion Pricing	Stockholm: The Stockholm Trial
Inception	**1986**	**2003**	**Jan 3 — July 31, 2006**
Goals	Initially revenue generation; amendments to Road Acts now permit demand management to enhance environmental quality, safety	Demand management: primarily congestion relief; more emphasis on pollution reduction apparent with westward expansion	Congestion relief and pollution reduction
Tolled area or infrastructure	Toll cordons in Bergen (1986), Oslo (1990), Trondheim (1991), Kristiansand, Stavanger, Namsos, and Tønsberg; Trondheim ring converted to zonal system in 1996, abandoned in 2005	Original: 21 square-kilometre charge area around city centre; extended to west in February 2007	Cordon around city centre with 18 control points
Toll application	Inbound crossings	Paid daily; includes parking on public roads	Inbound and outbound crossings
Technology	Varies by city. Detection: electronic tags, video or manual Payment: magnetic strip cards, coins	Detection: automated number plate recognition (ANPR) Payment: manual by various means	Detection: transponders and cameras; considering switch to ANPR Payment: direct by transponder from bank accounts, local shops, bank transfers
Time variation	Trondheim and Stavanger, variable; others, flat	lat charge 7:00 am to 6:30 pm on weekdays; no charge on weekends or holidays	Variable: 10, 15, or 20 Swedish kronors, depending on time of day from 6:30 am to 6:30 pm; daily maximum of 60 kronors; no charge on weekends, holidays, or day before holidays
Toll differentiation by vehicle & user characteristics	By vehicle type; discounts for passes	Exempt: various vehicle and individual categories Discounts: 90% for residents, 12.5% for fleets, various for monthly and annual payments Differentiation by vehicle emissions as of 2006	Exempt: Buses, taxis, emergency vehicles, electric and hybrid cars, traffic between Lidingö island & rest of county that spends less than 30 minutes crossing the charging zone
Operating costs as fraction of revenues	Oslo: 0.10 Bergen: 0.05	0.60	0.22
Earmarking of revenues	Formerly restricted to roads; amendments to Road Acts now permit funding of local transport, environmental quality and safety.	Revenues earmarked to local transport for minimum of 10 years	Not applicable for trial
Supplementary measures	Road and tunnel investment, public transport	Increase in bus service, retiming of traffic signals	Public transport improvements introduced August 31, 2005, before the trial
Private sector involvement	Subcontractor; public sector bears risks	Toll collection	IBM provided charging technology

Sources: Adapted from De Palma, Lindsey, and Proost (2006), with additions from Transport for London (2007) for London; Algers et al. (2006) for Stockholm, Economist Intelligence Unit (2006), and ECMT (2006).

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