Road pricing issues and experiences in the US and Canada

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1 INTRODUCTION

For some years the European Union has been studying the application of marginal-cost-based pricing in transportation, as evidenced by its Green and White Papers and by the series of research projects that it has sponsored. By comparison, the United States and Canada have not maintained a comparable effort at a central government level. Nevertheless, the two countries are acutely aware of flaws in the way that transportation is currently priced, and have shown interest in policy reform. As far as pricing roads the US is funding congestion pricing demonstration projects through its Value Pricing Pilot Program.[1] And Canada has recently completed a thorough review of the Canada Transportation Act that addresses 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 developments — as well as to examine the history of road pricing in the two countries — with the aim of drawing lessons for the phasing and packaging of urban and interurban road pricing reform that may be useful for the European Union. Canada and the US are broadly similar to the EU in many respects including standards of living and system of government. As in the EU, financing, regulation and operation of transportation facilities is divided between multiple levels of government: federal, state (US) or provincial (Canada), regional and municipal. There are also some differences. Despite heavy subsidies to North American urban transit systems, the automobile is more dominant than in Europe. Roads are generally more modern, 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 — although ironically interurban private roads are less prevalent than in some European countries.

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. National transportation policy in Canada has arguably been more influenced by employment and regional equity objectives. Unlike in the US, most fuel tax revenue is not earmarked for spending on roads. Also unlike the US, Canada has ratified the Kyoto Protocol and therefore has a strong incentive to reduce travel powered by carbon-based fuels.

To help relate the paper to current European research on the phased implementation of marginal-cost-based pricing, it is useful to draw on some of the conceptual framework developed in the ongoing MC-ICAM project (http://www.mcicam.net). Project MC-ICAM identifies three types of barriers to pricing reform:

- Technological and practical barriers such as the time and expense required to develop and install electronic toll collection technology, and the difficulties of computing optimal tolls and conveying them in an intelligible way to users.
- Legal and institutional barriers such as freedom of mobility, rights to privacy, and constraints on charging for road use by private-sector operators.

[1] The Program is summarised in US DOT (2002) and reviewed in Sullivan (2002).

- Acceptability barriers. Both the public and politicians have opposed road pricing as a form of double taxation, inequitable to the poor, and on various other grounds.

In the MC-ICAM framework, barriers to road pricing impose constraints on what roads can be priced and how, on the degree to which charges can be differentiated by user group, on how revenues can be spent, and on the use of supplementary non-price measures. Barriers and constraints are key to the formulation of an implementation path for pricing. Following Niskanen *et al*. (2003, Section 3.2) an implementation path can be defined compactly as a sequence of constrained second-best optima involving the use of packages of policy instruments that leads to (or towards) a specified first-best optimum, in which the underlying barriers and their implied constraints are typically — but not inevitably — relaxed or eliminated.

This notion of an implementation path, and the classification of barriers, will feature in the analysis of the paper. The next section reviews the history of road pricing in the US, with an emphasis on recent developments. Section 3 provides a similar treatment for Canada, and makes some comparisons with the US. Section 4 summarises the main lessons and unresolved questions regarding the long-run prospects of road pricing.

2 ROAD PRICING IN THE UNITED STATES

User-based road transport taxes were pioneered by the state of Oregon in 1919 with a one-cent per gallon gasoline tax. Within 20 years all states had a gas tax (Jones and Bekmez, 2001). In 1956 the US Highway Trust Fund was established to finance the federal share of the Interstate highway network and to support other federal-aid highway projects. Revenues for the Fund are derived from taxes on fuel, tires, truck sales and heavy-vehicle use. Tax rates are linked to vehicle characteristics. However, the most recent 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%.[2] The Fund has also been criticised on the grounds that its geographical distribution formulas guarantee states revenues regardless of need, and inflate demand.

2.1 Toll roads prior to Value Pricing

Toll roads have a long and checkered history in the US.[3] The first toll road was a Pennsylvania turnpike chartered in 1792. Private toll roads were widespread in the 19th century, but they rarely made money and disappeared as canals and railroads increasingly drew away long-distance traffic. Following World War II there was a short boom in public toll roads, but it ended when the Highway Trust Fund was created.

At various times, states and local governments found toll financing of roads attractive for diverse reasons:

[2] Samuel *et al*. (2002:7).

[3] See Klein (1990), Klein and Fielding (1992), US DOT (2001) and Levinson (2002: Chap. 2).

- As a way to accelerate road construction.
- As a supplementary source of funding during times of financial stringency.
- To avoid expenditure constraints imposed by the revenue-sharing formulas of the Highway Trust Fund.
- As a way to adhere to the user-pays principle by raising money from immediate beneficiaries, including outsiders who were not subject to local taxes.
- More recently: as a result of reductions in current and expected future fuel tax revenues, and as a way to curb demand in light of growing environmental and space constraints on construction of new roads.

This list reveals that economic considerations have factored heavily in toll financing decisions. Currently, the United States has several hundred toll facilities. As of January 1, 2001, there were 8,030 km of toll roads, bridges and tunnels, of which 7,606 km was tolled inside the US. Electronic toll collection was used on 157 facilities.[4] Some facilities differentiate tolls by vehicle and other characteristics, and some offer alternative means of payment. For example, the Maine Turnpike (http://www.maineturnpike.com) offers three types of accounts: for commercial users, for commuters and other frequent individual users, and for occasional users.

2.2 Value Pricing Pilot 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; Arrillaga, 1993).

Road pricing has now gained appreciable 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 to fund innovative road and parking pricing measures for alleviating congestion, and permitted tolling on Interstate highways. Five types of projects are eligible: (1) cordon tolls and other "areawide" projects, (2) bridges and other single facilities, (3) single or multiple traffic lanes on given facilities, (4) pre-project studies and market tests, and (5) pilot tests of innovative approaches.

About thirty projects have been funded to date, with a wide range of public-private mix. A list can be found on the Value Pricing website (http://www.valuepricing.org). The summary of projects below follows the categorisation in Value Pricing Pilot Program (2002).

2.2.1 Pricing on existing free roads

Despite the conventional wisdom that in the early stages of road pricing tolls are politically acceptable only when introduced on new facilities, about a third (eleven) of

[4] US DOT (2001). These figures update those in Nix (2001:32).

the funded Value Pricing projects include pricing on existing roads that were toll free. Five of the projects involve High-Occupancy Toll (HOT) lanes that permit vehicles carrying fewer people than the High-Occupancy Vehicle (HOV) lane minimum (usually 2 or 3) to use the HOV lanes for a fee (or a surcharge over the existing HOV fee).

One project (Highway pricing with dynamic ridesharing in Alameda County, California) includes a feasibility study of so-called Fast And Intertwined Regular (FAIR) lanes. FAIR lanes involve conversion of some freeway lanes to toll lanes, while leaving other lanes free (Decorla-Souza, 2000). Drivers who travel on the free lanes receive credits that are paid for by revenues from the toll lanes. Credits can be used either for future trips on the toll lanes or other purposes (transit, parking, *etc.*).

Only one of the eleven projects involves areawide tolling. This is a cordon pricing project in 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.

Another project, "Financing infrastructure through value pricing," is described in two short documents (Oregon Department of Transportation, 2002a,b) that appear to define a two-stage implementation path for road pricing.[5] For this reason the project will be summarised in a bit of detail.

Oregon Department of Transportation (2002a) lists several options for pricing and allocation of funds (paraphrased here):

Pricing strategy
1. Area pricing. Within a defined area; most likely the Portland Metropolitan Area.
2. Cordon pricing. For access to a defined area.
3. Facility pricing. On individual freeways.
4. Network pricing. For a freeway system with potential differentiation of tolls on each freeway.

Pricing technology
1. Complex Global Positioning System (GPS). Enables peak hour pricing by highway and street segment.
2. Simple GPS. Enables peak hour pricing only by area, with equal rates for all roads within the area.
3. Automatic Vehicle Identification (AVI). Requires installation of infrastructure on each priced road, but allow tolls to vary by time and location.

Method for allocation of funds
1. To the roadway on which the revenues are generated.
2. To modernisation of state, city or county roadways based on Vehicle Miles Traveled (VMT) data for each category of roadways.
3. To the state.
4. To "the Highway [Trust] Fund for distribution to the state, cities and counties."

[5] Neither document refers explicitly to an implementation path; it is the author's inference.

Short-run recommendations (Oregon Department of Transportation, 2002a)

For pricing strategy, facility pricing (option 3) is recommended for the short run on the grounds that it is the only feasible distance-based alternative at the phase-in stage of road pricing. Cordon pricing is downgraded because of anticipated distortions to the spatial pattern of economic growth.[6] Network pricing is also downgraded because of numerous alternative routes outside the freeway system in the area that would permit undesirable traffic diversion. For the pricing technology an AVI-based system (option 3) is preferred as being the simplest, although it appears to be of limited use if/when a GPS-based system is later implemented. Options for allocation of funds are ranked, without explanation, in the order listed above. The Highway Trust Fund may be ranked last because the tolled area would get the least amount of money back under this scheme.

Long-run recommendations (Oregon Department of Transportation, 2002b)

For the long run the preferred pricing strategy is area pricing (option 1) and the preferred pricing technology is simple GPS with fees collected at the fuel pump (option 2). Though no explanation is provided, collection at the pump may be preferred because the infrastructure is already in place and drivers have to patronise it. The document notes the prohibitive cost of retrofitting vehicles with new GPS or odometer-based devices. It recommends that installation of such devices be mandated in new vehicles that are sold in the state. However, by law pricing with the devices could not be initiated until (almost?) all passenger vehicles that travel (regularly?) in the congested area are equipped — a process that would take over 20 years. The preferred allocation of funds changes (again without explanation) from Option 1 to Option 2 (state, city or county roadways).

Two features of the inferred implementation path are worth highlighting. One is the long time lag required to implement the preferred pricing technology — a lag caused by the confluence of a legal and a technological/practical barrier. Second, the preferred pricing strategy, pricing technology, and allocation of funds all change from short to long run, a feature of the implementation path that might cause significant adjustment costs.

2.2.2 Pricing on new lanes

Six Value Pricing projects are listed in this category. The oldest, which concluded in December 2002 and is now considered an "established" facility, are the HOT lanes on State Route 91 (SR-91) in Orange County, California (http://www.91expresslanes.com). SR-91 was the first site of congestion pricing in the United States, was privately operated until recently (see below) and has been well studied (http://ceenve.calpoly.edu/sullivan/sr91). Two features are worth mentioning here. One is the extent of time variation in tolls: in hourly intervals; by multiples of 5 cents within a range from $1.00 to $4.75; with different time patterns in morning and evening peaks;

[6] Author's interpretation of the document.

and with different schedules on different days of the week. The extent of time variation belies the idea that acceptability constraints will preclude fine time variation of tolls in the early stages of road pricing.

The other notable feature of SR-91 is that on January 3, 2003, it reverted to public ownership and is now operated by the Orange County Transportation Authority (http://www.octa.net/news/late/011003.asp). This happened because of a "non-compete" clause in the private contract that precluded capacity improvements to the Freeway until 2030, and was resulting in growing congestion on the untolled lanes that run parallel to the HOT lanes. According to the OCTA website, plans are being made to revise operations and maintenance and make "improvements". Furthermore, "OCTA will look at immediately lowering tolls on the Express Lanes to maximise traffic flow rather than profit, and may allow 3+ carpoolers to use the lanes for free". (Currently they pay half price.) And new legislation "stipulates that toll revenue can only be spent on general toll road operating expenses, ongoing maintenance to the lanes, and improvements in the 91 Freeway corridor." Finally, the current operator, Cofiroute, will be retained and "all customer support and billing services related to the FasTrak system will remain in place."

The SR-91 experience is significant in that the "non-compete" clause, which was included to engender private-sector participation, proved to be the undoing of private operation within less than a decade. SR-91 runs in a corridor that has been experiencing rapid traffic growth and has no good substitute. It remains to be seen whether the SR-91 experience is an isolated case, or whether changes in institutional arrangements will occur on other facilities.

The other established Value Pricing project that involved new traffic lanes is Interstate 15 (I-15) north of San Diego (http://argo.sandag.org/fastrak). By law, I-15 is required to maintain a level of service of at least *C* on the tolled Express Lanes.[7] This is done by varying tolls in close to real-time (every six minutes) in response to changes in incoming traffic flows. The facility publishes a schedule that shows average toll levels by time of day. The normal maximum is $4.00, but tolls may be raised up to $8.00 in the event of severe traffic congestion. As far as tolling, the major difference between I-15 and SR-91 is that I-15 varies tolls dynamically or responsively in order to provide a predictable *travel time*, whereas SR-91 follows a fixed schedule in order to minimise uncertainty about *payment*.

2.2.3 Pricing on toll roads

Seven projects are listed in this category. A majority involve implementation of time-varying tolls on turnpikes or other existing toll roads.

[7] I-15 therefore adjusts tolls to assure at least a minimum level of service. As discussed in Section 3, this contrasts with the practice on Highway 407 north of Toronto.

2.2.4 Pricing of parking and vehicle use

As noted in Section 2.2.1, only one Value Pricing project involves areawide tolling. However, road pricing on an areawide basis can be realised using other measures including pricing of parking and variabilization of vehicle costs.

Cashing out free parking

One Value Pricing project (Parking cash-out and pricing, King County Metro in Washington State) investigates cashing out of free parking. Approximately 90% of commuters who drive to work in the US do not pay for parking — in large part because employers provide parking free. One solution, long recommended by Shoup (*e.g.* Shoup, 1997; see also DeCorla-Souza, 1994) is to offer commuters cash, transit passes or an another alternative to free parking with comparable value. Like other measures to increase parking prices, the effectiveness of cashing-out varies with the road network and with the distribution of trips. Parking fees are seen to be more effective in the San Francisco Bay area than in Los Angeles where much of the traffic passes through, and (through latent demand effects) could weaken the potential congestion relief from a reduction in driving by commuters.

Variabilization of auto costs

Registration fees, license fees, insurance and other fixed costs account for a large fraction of the total costs of driving, but do not factor in marginal private costs. Variabilization of costs involves measures to convert fixed costs to variable costs, possibly on a revenue-neutral basis (DeCorla-Souza, 2002; Greenberg, 2003). Unlike road investments, variabilization does not require large expenditures, and unlike facility-based tolling it is not susceptible to undesired traffic diversion because its effects are areawide.

One Value Pricing project (Variabilization of Fixed Auto Costs, Minneapolis-St. Paul) explores the conversion of fixed vehicle lease costs and registration taxes & fees to mileage-based charges. Another project (Mileage-based insurance/FAIR lanes in Atlanta, Georgia) explores 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, although not directly as a function of congestion levels. But the per-kilometre premium rate can by conditioned on driver characteristics such as age, sex, and safety record that are used for pricing insurance today. And it is superior to "pay at the pump" insurance proposals under which costs would vary (inappropriately for insurance purposes) with vehicle fuel efficiency, but would be independent of driver characteristics as well as traffic congestion.[8]

[8] Two recent theoretical studies outside the Value Pricing program come out in favour of variabilization. Edlin (2002) 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 cost-effectiveness for improving air quality and reducing traffic fatalities.

2.3 Other pricing proposals

Various methods for pricing roads more efficiently have been suggested in recent years. Attention is limited here to toll truckways: an idea that shows promise and could have far-reaching impacts on freight transportation. As proposed by Samuel *et al*. (2002), toll truckways would be established along Interstate rights-of-way in lanes separated from other traffic. 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 in proportion to distance travelled by truckway. Size and weight regulations would also be relaxed to permit trucking companies to use larger and more economical vehicles. The cost savings would constitute a real resource saving, and would boost willingness to pay to use truckways.

According to Samuel *et al*. (2002), toll truckways would have several advantages: (a) lane separation would enhance both auto and truck safety, (b) truckways would be self-financing under a wide range of scenarios, and (c) states would gain more from reductions in construction and maintenance costs than they would lose in fuel tax revenues. But in order for toll truckways to come about, several policy changes would be required as noted in Section 2.4.1 below.

2.4 Lessons from the US on phasing and packaging of road pricing

From recent developments in the US it is possible to make some inferences (albeit tentative) about how road pricing should, or will, be phased in. The barriers framework of MC-ICAM will be used.

2.4.1 Barriers to road pricing

(a) *Technological and practical barriers*

Pricing technology

Traditional ways of collecting tolls have high administration costs and can impose long waits on drivers (Friedman and Waldfogel, 1995).[9] But with the advent of electronic tolling and other technologies there are no significant technical barriers to more direct and efficient charges for either road use or other costs of driving such as parking and insurance. To be sure, tolling the whole US interurban road network might never be economical if it required wayside infrastructure. But with GPS-based technology such infrastructure is unnecessary.

[9] Boronico and Siegel (1998) recount that service time on the New Jersey Parkway rose dramatically in 1988 when the toll was raised from $0.25 to $0.35 and drivers had to pay with more than one coin.

Urban form

It has been argued (*e.g.* Niskanen *et al*., 2003) that road pricing is both more urgently needed and more acceptable in large cities than in other regions. This may be true of Europe, where area licenses and toll rings around urban centres feature prominently.[10] But most of the Value Pricing projects are not concentrated in large cities, and only one (cordon pricing in Fort Myers) involves areawide tolling.[11] The majority are limited-scale projects and address local congestion hot spots.[12] The extent of urban sprawl and dispersal of congestion in the US is one factor that may help to explain the difference with Europe.[13] As discussed in Section 3, the situation in Canada is similar to the US. According to one expert, compared to North America "[t]he urban form in European cities may adapt better to a congestion charge."[14] This would suggest that road pricing may be more spatially concentrated, and perhaps also extensive, in Europe than in North America.

Interoperability

Unlike commodities such as currencies or computer operating systems that have strong positive network effects, toll roads don't have to use identical technology. Still, there are some economies of scale with respect to the fixed costs of ETC systems and smartcards. And it is cheaper and more convenient for users if they can use one system for all their transactions.

Problems in calculation

The difficulties of computing (second-best) optimal prices in the real world of myriad 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, auto travel is subject to various other price distortions that

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[10] Singapore's former Area Licensing Scheme (1975-1988) was also area-based. Its current Electronic Road Pricing system (http://www.lta.gov.sg) is a hybrid of tolling on expressways and three restricted zones that is probably best classified as network pricing.

[11] Furthermore, one of the HOT lanes projects (Regional Study and HOT lanes on I-25/US-36 in Colorado) is described as "the first such facility that penetrates the core of a major city [Denver]"; see Value Pricing Pilot Program (2002:4).

[12] So-called queue jumps that allow drivers to circumvent bottlenecks are an example. A Value Pricing project in Lee Country, Florida, is studying elevated facilities that "jump" over congested intersections. Being relatively cheap, queue jumps are affordable for areas with smaller populations.

[13] As Levinson (2002, Chap. 1) notes, smaller jurisdictions are less able to tax non-residents than are larger jurisdictions, and have a stronger incentive to choose toll financing for roads. If this effect is stronger in the US than Europe, perhaps because of greater mobility in the US, then this would provide another explanation.

[14] Mario Bozzo, associate director of IBI Group, quoted in Freeman and Lewington (2003).

are larger in total: unpaid parking, infrastructure costs and the heavy reliance on fixed costs that leave automobile travel severely underpriced at the margin. 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 certainly more accurate for the US than for European countries, particularly those with lower levels of auto ownership or high fuel taxes such as Britain. This would appear to suggest that road pricing may actually be *easier* to implement in the US than in Europe, in contrast to what is argued above regarding urban form.

(b) *Legal and institutional barriers*

Parking pricing

Two entrenched practices cause parking to be underpriced in the US. First, as noted in Section 2.2.4 most auto commuters do not pay for parking because their employers provide it free. Cashing-out of free parking is one solution that appears to require government intervention. Second, minimum parking requirements inflate the supply of parking and leave it underpriced at the margin. Shoup (1999) argues convincingly that parking requirements in the US are arbitrary, vary greatly from city to city, and are often extremely onerous on developers. He recommends in-lieu fees that allow developers to pay a fee in lieu of providing parking.

Regulatory changes

As noted earlier, tolls were prohibited on Interstate highways until ISTEA, and then only as an exception. The creation of toll truckways on Interstates as envisaged by Samuel *et al*. (2002) would necessitate further relaxation, as well as three other changes: (i) provision of truck rights-of-way along existing corridors "on the federal-aid system", (ii) relaxation of truck size and weight regulations, and (iii) procedures to issue rebates on federal and state truck user taxes.

Samuel *et al*. (2002) identify three possible stages in the implementation of truckways. The first would be to extend the territory in which longer combination vehicles (LCVs) are permitted in the US. The second would be to harmonise US, Canadian and Mexican best-practice standards as required under the 1994 North American Free Trade Agreement. In the third stage new types of LCVs would be developed, and perhaps also new road technology that would remove some of the burden of driving from drivers.

Samuel *et al*. (2002) comment favourably on Canadian regulatory policy, and note (p.12) that in contrast to the case in 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 emphasising. 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 that go well beyond pricing are required as a package.

Private sector involvement

Private roads have played a prominent role in the US and elsewhere in the world. There are several arguments in favour of private roads. The profit motive provides a compelling incentive to control costs. Private operators may have a greater commitment than public operators to price congestion. And private roads serve as a benchmark for evaluating the efficiency of public sector toll road counterparts.

These advantages notwithstanding, in most (all?) cases regulations have been introduced to curb monopoly power. In North America two regulatory models have been employed[15]. One is rate-of-return regulation as introduced by California in 1989, and applied to State Route 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 in Toronto (see Section 3), provides users with more assurance about future toll levels.

Comparison with the nineteenth century

New roads typically serve relatively few individuals, but are often paid for by many. As Levinson (2002:4) points out, the uneven incidence can be alleviated by a package deal whereby many roads serving diverse communities are approved at once. This approach was workable in the turnpike era when the road network was immature, but it is hardly viable today. Another nineteenth century "advantage" of having a sparse road network was that "non-compete" clauses were generally unnecessary because the threat of competition seemed slim (Klein and Fielding, 1992). But as noted above, a "non-compete" clause was granted to State Route 91 which led to its recent reversion to public status.

[15] As noted by Samuel *et al*. (2002:28).

Time frame for legislation

Legal approval of road pricing may be easier to obtain either if it is implemented only temporarily to address a particular problem (*e.g.* as with the toll rings in Norway to fund new infrastructure) or if it is subject to periodic review. In fact, re-examination is automatic at the US federal level through the process of Reauthorization. And as Sullivan (2002) points out, funding for the Value Pricing program has been reduced. Still, because it is intended as start-up money for demonstration projects, continued funding for Value Pricing in perpetuity is not expected.

(c) *Acceptability related barriers*

Equity

A long-standing objection to road pricing is that it will make poorer households worse off. To an extent, this concern has been addressed by implementing pricing on new traffic lanes and facilities, and letting travellers choose between quicker but more expensive trips and remaining on pre-existing free alternatives that may now be less congested. Moreover, even unemployed individuals and off-peak commuters occasionally experience the need to travel during the peak, as had been documented for SR-91. Road pricing lets these individuals travel quickly when their value of time is high (Svadlenak and Jones, 1998). Furthermore, transponders can be programmed to allow discounted or free travel for the needy.

Time variation

A common view is that — at least in the early stages of road pricing — prices should vary infrequently or not at all. But most of the Value Pricing projects do involve at least a peak/off-peak time differential, and SR-91 features up to 11 changes and 9 distinct toll levels per day. Furthermore, focus groups were strongly opposed to responsive pricing on Interstate 15 before it began operation (Godbe Research & Analysis, 1997). But responsive pricing is now accepted, and it has achieved a better balance between peak and off-peak periods (Supernak *et al*., 2003). Indeed, Sullivan (2002:3) 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 responsive pricing because they value highly reliable travel times (Lam and Small, 2001).

2.4.2 Long-run prospects for road pricing in the US

A number of US academics have predicted that road pricing will never be widespread in the US (*e.g.* Giuliano, 1992; Gillen, 1997; Small and Gómez-Ibáñez, 1999; Meyer, 1999). Even Robert Poole — a strong advocate of free markets and the founder of the Reason Foundation (http://www.rppi.org) — asserts (Poole, 2003) that state authorities and capital markets will need to gain more experience and confidence with private sector financing and operation before a wholesale turnover of existing public highways to the private sector can occur. And Taylor (2002) views pricing of roads and parking as best strategies for congestion relief only in the long run, with new technologies and capacity expansion more appropriate for the nearer term. A cautiously optimistic view is

that road pricing may eventually be applied on much of the US road network, but implementation is likely to be interrupted by surprises and setbacks and to be influenced by economic factors such as the business cycle.[16]

3 ROAD PRICING IN CANADA[17]

3.1 Current funding of roads and tolled facilities

In Canada roads are mostly paid for with general tax revenues and property taxes. Road users in aggregate receive a small subsidy[18], while transit and other modes are heavily subsidised. The extent of user-pays varies by province as a function of traffic volumes and road construction costs (Nix, 2001:5).

During the nineteenth century many toll bridges, roads, and ferries in Canada were owned and operated by municipalities and private companies (Bryan, 1972). Most were subsequently abolished by provincial governments. The 1950s saw a brief revival of tolled facilities as a supplementary source of revenue for road construction. But high interest rates, financial disappointments, and insufficient traffic volumes contributed to the demise of the movement.

The motives for road tolls in Canada and the US overlap, although they are weaker in Canada in the following respects:

- There is a greater commitment to public funding in Canada, not only for roads but also for public transport (CTAR 2001b:216).
- Traffic volumes and congestion are lower.
- 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.
- Canada lacks formal mechanisms for road funding on a scale comparable to the US Highway Trust Fund and no legislation similar to ISTEA or TEA-21 has been passed.

Currently only 385 km of toll roads are operational in Canada, compared to about 8,000 km in the US. A majority of the 19 tolled facilities are bridges or tunnels linking

[16] For example the Value Pricing project "Pricing of parking and vehicle use" for Seattle notes that "Target audiences and interests have shifted due to the economic downturn in the region" (Value Pricing Pilot Program, 2002:27).

[17] The review here draws heavily on Lake *et al*. (1999), Canada Transportation Act Review Panel (2001a,b) and especially Nix (2001), as well as on Nix (2002) and Ojah and Prentice (2002).

[18] According to Transport Canada (2001, Table 3-5) for 2000/2001 spending by all levels of government on roads amounted to CDN 13,176 million, equal to 73.7% of total spending on transport. Revenues from road users were CDN 12,665 million.

Ontario and the US. Ownership, operations and institutional structures of the facilities vary considerably. The prevalence of tolling at border crossings is consistent with the use of tolls to extract revenues from nonresidents. A handful of large new facilities have been built by diverse mechanisms. The Coquihalla highway in British Columbia which opened in 1986 is wholly public. By contrast, Highway 407 north of Toronto is currently private.

Highway 407, the world's only all-electronic open access toll highway, began operating as a toll road in 1997. It was politically viable in part because of its proximity to a toll-free (and heavily congested) alternative: Highway 401 to the south. Highway 407 was a design, build, and operate agreement with a private consortium, but financed by the province. It went private in 1999 when it was purchased by the international consortium that currently operates it.

Tolls on Highway 407 depend on distance, time of day, vehicle class and presence of a transponder. Unlike State Route 91 in California, which is subject to rate-of-return regulation, tolls on Highway 407 are regulated directly. The regulations stipulate that tolls can be raised only if a *minimum* traffic level is met. This contrasts with Interstate 15, 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.

For reasons unknown, on January 1, 2002, Highway 407 temporarily eliminated time-of-day pricing. The new flat rate was set at a level above the previous peak toll, presumably because of rapid growth in traffic volume. On February 1, 2003, limited variation was re-introduced, but with only two periods rather than the former three, and with much smaller percentage differences.[19]

Of the 19 tolled facilities in Canada, electronic tolls are collected on only five (Nix, 2002). Some facilities also allow smartcards, although it is necessary for vehicles to stop when paying. All facilities differentiate charges by vehicle type and size, but (in sharp contrast to the US Value Pricing projects) only Highway 407 changes 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]

[19] Throughout Highway 407's history the toll rate per kilometre for single-unit trucks has been double the automobile rate, and the rate for multiple unit trucks triple the automobile rate.

[20] A guarantee of free alternatives appears to have long been Canadian policy, if only implicitly. According to Bryan (1972:47), 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". And legislation passed in Québec permits toll facilities where an alternative un-tolled route exists (Nix 2001:9). See also Section 3.4.1(b) below regarding British Columbia.

3.2 Road funds and urban transportation agencies

3.2.1 Road funds

All ten provinces in Canada have at some time employed earmarked taxes. But currently most fuel tax revenues and other user charges are added to the general account, and most spending on roads comes from general tax revenues and property taxes. There have been recent efforts to create provincial road funds. But these have either been short-lived, or failed to be fully self-financing from user charges with users' approval of spending decisions.[21] The closest to a fully operational fund, Saskatchewan's permit fees for large trucks (Nix, 2001:52), is relatively narrow in its scope.

3.2.2 Urban transportation agencies

A recent innovation in Canada is the establishment of urban transportation agencies in Montreal (L'Agence métropolitaine de transport) and Vancouver (TransLink), the second and third largest cities. 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.

In addition to these agencies, major cities in Canada have planning agencies. Calgary's recent experience is instructive. The City has been experiencing rapid growth, and is suffering from congestion and transportation-related environmental problems. The most recent Transportation Plan (City of Calgary, Transportation Planning, 1995) identifies as policy instruments parking supply, locations of new jobs, "user pay" and travel demand management — particularly for the downtown core. Calgary has considered road pricing, but it is not part of existing long-range implementation plans.[22] One practical barrier is that transit is at capacity during the peak, and a need is seen for expansion to accommodate any modal diversion from the auto that road pricing might induce.

3.3 Federal policy recommendations

Transportation policy in Canada has been the subject of three major federal studies in the last decade: the 1992 Royal Commission on National Passenger Transportation, the 1993 National Transportation Act Review Commission, and the Canada Transportation Act Review of 2001.

[21] See Nix (2001:14, Section 5) and CTAR (2001a:186).

[22] Personal communication with Mac Logan, Manager of Transportation Planning, City of Calgary, April 14, 2003.

3.3.1 The 1992 Royal Commission

The 1992 Royal Commission made a number of recommendations, including [23]

- Travellers pay the full costs of their trips.
- Decision making to be assigned to the level of government closest to the people and most able to exercise authority efficiently.
- All modes to be taxed and regulated equally.
- Fuel tax revenue to be used for transportation.
- Weight-distance taxes for trucks.
- Conventional tolling systems to be considered for new or expanded limited-access highways.
- *Gradual* development of a road pricing framework (emphasis added).

These recommendations are broadly consistent with those of the European Union, as well as (with one exception) the recommendations of the Canada Transportation Act Review Panel in 2001.

3.3.2 The Canada Transportation Act Review

The Canada Transportation Act Review (CTAR) Panel investigated three, not necessarily mutually exclusive, financing arrangements for roads: road funds, urban transportation agencies and toll roads.

Road funds

The CTAR Panel identified three competing models for a Canadian road fund: the US Highway Trust Fund, New Zealand's Transfund, and a fund as envisaged by the World Bank. The first two have been criticised. As noted earlier, the US Fund entails geographical distribution formulas that create distortions (Nix, 2001: Section 5.2). And New Zealand's fund is a hybrid system in that only part of user fees go to the fund, and only part of the revenue come from user charges (Newbery and Santos, 1999).

The CTAR Panel departed from the 1992 Royal Commission's position in recommending that congestion and other road charges should not necessarily be allocated to road investment if expenditures on other transport modes would yield a higher return.[24] This recommendation applies both in the short term with respect to fuel tax revenues, and the longer term for funding from the proposed road funds.

Urban transportation agencies

The CTAR Panel saw the two main roles of urban transportation agencies as promoting charges that reflect costs according to user class, and promoting spending decisions that yield the highest returns on funds (CTAR, 2001c). It also saw merit in self-financing not-for-profit agencies such as those that now manage airports and other transport

[23] As summarised in Lake *et al*. (1999:59).

[24] CTAR (2001b, Recommendation 12.3).

facilities in Canada. But it also perceived a need to adapt such agencies to account for characteristics of roads, including network "interrelationships" and the traditional Canadian practice of providing road access without explicit cost recovery except for the most remote communities.

3.4 Lessons from Canada on phasing and packaging of road pricing

3.4.1 Barriers to road pricing

(a) *Technological and practical barriers*

Most of the considerations regarding technological and practical barriers to road pricing in the US (Section 2.4.1) also apply to Canada. Interoperability of user charging technology is desirable not only between provinces and territories in Canada but also between Canada and the US — particularly given the growing volume of cross-border trucking traffic that has been spurred by the Canada-US and North American Free Trade Agreements.[25] However, there are differences between the countries and it is unrealistic to expect seamless integration.[26]

(b) *Legal and institutional barriers*

From experience with road pricing in the US it is evident that the private sector will play a prominent role in that country. The matter is not as clear for Canada, in part because of its stronger tradition of state provision of public and semi-public goods. According to Nix (2001:58) recent enthusiasm for a commercial approach to roads 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."

Early in 2003, the BC Ministry of Transportation set out guidelines for tolling of facilities that have private sector involvement in financing, delivery or management (BC Ministry of Transportation, 2003). The guidelines (paraphrased here) include:

- Only major projects that result in significant increases in capacity will be subject to tolling.
- Tolls will be implemented only if there are clear, demonstrable net benefits for the users.

[25] According to Transport Canada (2002:142), from 1990 to 2000 international for-hire trucking traffic in Canada grew from 30% of total trucking traffic to over 48%.

[26] This caveat also applies to Intelligent Transportation Systems. As Alberta Infrastructure (2000:C1) remarks, "Canada faces unique challenges when it comes to ITS. Distinct features such as our large land mass, dispersed population, climate, existing ITS, use of the metric system, communication requirements (including infrastructure and bilingualism), and organizational relationships, will all affect how ITS becomes integrated into our transportation systems provincially, nationally and internationally."

- Tolls will be implemented only if a reasonable untolled alternative is available. The public has a right to a basic level of toll-free access.
- The level of tolls and limits on the amount and frequency of increases will be established in advance. This is intended to provide certainty to the public.
- Tolls will be used to generate revenue for transportation projects.[27]

These guidelines are generally consistent with the user-pays principle, and appear to be designed to gain political acceptability.

(c) *Acceptability related barriers*

Government policy in Canada has been driven not only by efficiency, but also by other goals that sometimes conflict with efficiency. One such goal is alleviation of regional disparities. Transportation costs create geographical price differentials that cause real income differences between regions and this has been a motive for subsidising transport to remote regions in Canada, particularly by air. Transportation costs may account for part of the shortfall in income per capita between Atlantic Canada (the Maritimes) and Central Canada. Indeed, the Maritimes has been particularly supportive of treating roads as public goods, and resistant to toll facilities on grounds of double taxation and regional inequity (Nix, 2001:18).[28]

Several points indicate that in Canada an increase in the cost of road transport would be regressive (Lake *et al*., 1999:32):

- The percentage of total household expenditures on transport falls with income.[29]
- Remote areas are dependent on trucking, and would suffer disproportionately from a rise in the cost of road transport.
- Local roads and services are funded primarily by regressive property and sales taxes.
- Lower-income households have older and more polluting vehicles, and they often have rigid work hours that prevent them from avoiding peak-period tolls.

The response in Canada to the introduction of road pricing in London on February 17, 2003, reveals diverging opinions on road pricing. On February 25, Transport Minister David Collenette spoke in favour of road tolls in large Canadian cities. His statement was supported by transit advocates, but criticised by municipal and provincial government leaders (Lewington, 2003). The mayors of Toronto and Vancouver were soundly against it (Freeman and Lewington, 2003). But a provincial commission in Québec had just proposed expansion of an existing bridge in Montreal and a $2 toll for

[27] It is not clear from the wording whether "projects" are limited to highways.

[28] Another regional equity consideration is that road pricing could induce modal shifts that harm certain firms or industries that located on the basis of historical freight rates (Lake *et al*., 1999:79).

[29] This is according to a 1996 Statistics Canada survey of family expenditures, which appears to be the most recent available. Lake *et al*. remark (footnote 23) that in contrast, spending on private transport rises strongly as a percentage of total income in the EU.

using it at rush hour. The fact that Montreal is on an island and has heavily congested bridges suggests that tolls may stand a better chance there than in other major Canadian cities.

3.4.2 Long-run prospects for road pricing in Canada

Compared to the US, the prospect of extensive road pricing in the form of tolls appears to be weaker in Canada. Stronger preferences for public funding are one factor. Another is that traffic volumes on most of the road network are insufficient to justify tolling, at least for the purpose of congestion pricing (Nix, 2001:34).

If this assessment proves to be wrong, and tolling does become widespread, the question then arises whether roads would be self-financing. Lake *et al*. (1999) address the issue of cost recovery with the following remarks (paraphrased here):

- Canada's overall road system is probably subject to increasing returns to scale which would imply less than full cost recovery under marginal-cost pricing. (p.36)
- Attempting to recover the cost of each link "would likely give rise to substantial disparities" and also high administration and enforcement costs. (p.45)
- "Even assuming [full recovery] … it is most unlikely that an efficient road pricing regime would see each provincial and municipal service provider even approximately recover its individual cost". (p. 112)
- Many US cost allocation procedures may be transferable to Canada. But the freeze-thaw pavement damage is much more significant in Canada.[30] (p.123)

Climate change is another factor that distinguishes Canada from the US because whereas the US has not ratified the Kyoto Protocol, Canada did so in December, 2002. It is an open question whether the two countries will stick 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 will be a strong impetus to reduce automobile travel. This will presumably mean a reduction in the base for fuel taxes. But is also means less expenditure in the long run on construction and maintenance of roads. Moreover, global warming could facilitate transport in Canada because it would ameliorate the adverse effects of the dominant winter, and provide further savings on road maintenance. Overall, this leaves the net implications of climate change for financing roads ambiguous.

4 CONCLUDING REMARKS

Experience with road pricing in the US and Canada provides both lessons and questions regarding the phasing and packaging of road pricing reform:

- States and provinces vary widely in their use of tolling, and how it is implemented. The differences are attributable to a number of factors including jurisdiction size,

[30] Environmental factors are responsible for 50% of road damage on high-volume roads, and 80% on low-volume roads (Andrey and Snow, 1997:424).

urban structure and road network geometry, traffic volumes and history of toll roads. Decentralisation of policy to states, provinces and smaller jurisdictions has two advantages: it allows them to adopt measures suitable to their individual circumstances, and it allows different experiments to be run so that jurisdictions in the same and other countries can learn from each other.

- Partly by design, and partly by necessity, an incremental approach has been taken to road pricing. Facility-based pricing has been the rule rather than areawide systems such as toll rings, although projects for cashing out free parking and variabilization of insurance will — if later implemented on a large scale — have areawide impacts. It is unlikely that either the US or Canada will consciously plan and carry out a unified implementation path for comprehensive marginal-cost based pricing.

- The private sector has played an important role in road pricing. While it is debatable how much private sector participation has saved in costs, it is clear that it has enabled much more rapid construction of new facilities such as State Route 91 in Orange County, California, and Highway 407 in Canada.

- In some jurisdictions budget balance requirements and/or public acceptability constraints mean that introduction of new user charges must be orchestrated with changes in registration and other fixed vehicle charges, property and business taxes. A need is also seen for packaging road pricing with Travel Demand Management (TDM) policies, and investments in transit — particularly to provide adequate capacity to accommodate significant modal diversion from private vehicles.

- Interoperability of electronic toll collection technology as well as information technology is important not only between states and between provinces, but also between Canada and the US.

- There appears to be ample scope for differentiated pricing. Some US states levy weight-distance taxes on trucks. Most of the active Value Pricing Pilot projects employ time-of-day pricing. On Interstate 15 in California, tolls are adjusted dynamically to regulate incoming traffic flows so as to maintain a high level of service. And one of the mileage-based insurance projects will experiment with premium rates based on risk factors such as time-of-day, congestion levels, speed and acceleration. Basing charges on the characteristics of individuals (as opposed to vehicles) is controversial in the US and Canada (and also in Europe). But GPS technology makes it possible, and it has been suggested as a (further) dimension for risk-adjusted insurance rates. Value of service pricing is also possible. For example, under Saskatchewan's "Transportation Partnership Policy" the cost of permits to operate large and more efficient trucks is based partly on the expected benefits to operators.

- Canada appears to have less potential for widespread road pricing than does the US. Canada has proportionally fewer roads with sufficient traffic volumes to warrant tolling, let alone to be self-financing. But Canada has ratified the Kyoto Protocol, whereas the US has not. If Canada follows through with its commitment, there will be a strong impetus to reduce automobile travel by road pricing and/or other means.

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