INSTITUT C.D. HOWE INSTITUTE
Essential Policy Intelligence | Conseils indispensables sur les politiques

e-brief August 31, 2011

THE URBAN ISSUES SERIES

Congestive Traffic Failure: The Case for High-Occupancy and Express Toll Lanes in Canadian Cities

By
Benjamin Dachis

ESSENTIAL POLICY INTELLIGENCE

- Congestion on Canadian highways is having a significant negative economic impact on major Canadian cities. Rather than face the political challenge of introducing road tolls to discourage traffic, governments have chosen to build carpool lanes on urban highways, despite evidence that these lanes have limited effectiveness in curbing congestion.
- Governments should instead convert existing and planned carpool lanes to high-occupancy toll (HOT) lanes, giving drivers a choice of whether to use them or free lanes. This would improve travel time reliability, increase highway capacity and potentially reduce congestion on un-tolled lanes.
- For three of Canada's largest urban areas, HOT lanes, which usually let high occupancy vehicles travel for free and charge a toll to other drivers, and express toll lanes could generate total annual revenue of more than $1 billion, which could be used to support transportation investments.
- Policymakers in major Canadian cities need realistic options for reducing the economic cost of congestion and increasing revenue for transportation infrastructure: converting carpool to HOT lanes would fit those needs.

Canada's urban highways are choked with congestion because road access is free and scarce road space is occupied by drivers who wait, albeit grumpily, in traffic as a recent Statistics Canada (2011) survey shows. Provincial and municipal governments mostly have been unwilling to solve the congestion problem by putting a price on highway use. They have instead built carpool lanes, despite evidence that carpool lanes have limited effectiveness in curbing overall congestion.[1]

1 Ontario's high-occupancy vehicle (HOV) policy mentions easing traffic congestion as the main purpose of carpool lanes (Ontario 2007).

Table 1: Automobile Drivers' Traffic Congestion Costs per year in Canada's Five Largest Urban Areas

City	Total Cost (millions – 2002 dollars)	Cost per capita ($)
Toronto and Hamilton	2,518	473
Montreal	1,390	405
Vancouver	927	466
Calgary	211	222
Ottawa-Gatineau	172	164
Five largest cities	**5,218**	**410**

Source: Calculated in Lindsey (2009) from Transport Canada (2006a, 2006b).

High-occupancy toll (HOT) lanes require drivers to pay tolls to use designated carpool lanes, although they normally allow high-occupancy vehicles to travel for free. HOT lanes have proven politically acceptable in the United States where they have resulted in faster and more predictable driving times. Converting carpool lanes to HOT lanes also would:

- have relatively low implementation costs;
- potentially increase capacity and travel speed on the highway as a whole;
- maintain a free option in adjacent lanes for drivers not willing to pay a toll;
- provide reliable express bus routes; and,
- raise revenues for transportation investments.

The Ineffectual Response to Congestion Thus Far

The economic burden of traffic congestion – wasted time and fuel – costs automobile drivers in the five largest Canadian urban areas billions of dollars per year (Table 1), with the highest costs in the Greater Toronto and Hamilton area (GTHA).[2]

Some jurisdictions have addressed highway traffic problems by introducing high-occupancy vehicle (HOV, also known as carpool) lanes. HOV lanes are designed to reduce traffic flows by restricting their usage to passenger vehicles with two or sometimes three or more people. Ontario plans to add 450 kilometres of HOV lanes on most of its 400-series major highways in the GTHA area over the next two decades (Ontario 2007). Meanwhile, British Columbia is expanding the number of HOV lanes on Highway 1 in the Vancouver area.[3]

However, instead of improving traffic flows, HOV lanes can decrease overall highway capacity relative to general purpose lanes, because many HOV lanes are underutilized during peak periods while adjacent general purpose lanes are congested. In addition to some lanes being underutilized at times, many other HOV lanes are over-utilized and congested themselves during peak periods (Kwon and Varaiya 2008).[4] Despite there being more people in carpooling vehicles, maintaining free-

2 The economic burden from congestion includes lost time from longer travel times and the additional cost of wasted time due to less reliable travel times requiring people to include contingency time in their travel. This congestion cost does not include the economic costs of delayed commercial vehicles or freight, or costs associated with automobile or public transit passengers, accidents, noise, road damage, distortions to driving behaviour, and off-peak period congestion. See Transport Canada (2006a, 2006b) for more details.

3 Montreal has HOV lanes on some of its highways that could easily become HOT lanes. Other Canadian cities have HOV lanes on major local roads, but these are not amenable to HOT lane conversion.

4 Further, most HOV trips are not work-related trips and many carpoolers would have driven together anyway, thus HOV lanes often do not change driver behaviour (Poole and Balaker 2005). Additionally, because HOV lanes are usually only one lane, one slow vehicle can slow down all drivers unable to pass. The same problem applies to HOT lanes, but it can be resolved by creating multiple HOT or express lanes. Exclusive bus lanes, such as on the median shoulder of a major Toronto highway (City of Toronto 2010), are also underutilized in most hours and could be converted to HOT lanes with additional expansion.

flow traffic conditions – such as through variable tolls – is more effective at increasing the number of people able to use a highway than is adding HOV lanes (Kwon and Varaiya 2008).

Governments could better confront their traffic problems if they converted existing and planned HOV lanes into HOT lanes. HOT lanes are usually a single, barrier-separated lane that HOVs can access for free, but are also available to single-occupant vehicle drivers who pay a toll. In most HOT systems, the toll increases in periods of high demand to maintain constant free-flow conditions. HOT lanes exist in nine US major urban areas, and more are proposed.[5] They have been most effective when implemented regionally, rather than locally, to ensure reliable travel times over the duration of an individual's trip.

Drivers pay for tolls with a transponder or photo-recognition of licence plates. With HOT lanes, cars enter and exit at prescribed points on the highway where toll rates are clearly posted. The tolling authority records the distance travelled for later billing. Enforcement officials visually identify carpooling vehicles, which do not receive a bill.[6] Another approach involves tolled express lanes that are adjacent to free lanes. Under this scheme, all vehicles, including HOVs, pay to use the dedicated express lane.

Benefits of HOT Lanes

With HOT lanes present, free lanes may remain congested. However, drivers move between HOT and free lanes based on how they value the time spent on a particular trip, maximizing each driver's usage of highway space.

Total hourly volume of highway lane traffic is maximized at a certain speed. When the number of drivers wanting to use the highway increases, average vehicle speed slows and total highway capacity falls (Figure 1). Highway operators can increase tolls to prevent degradation of capacity due to excess demand. Dynamic pricing enables a toll lane to carry more vehicles per hour than a HOV lane or a congested general-purpose lane. Thus, in addition to improving the allocation of highway capacity by driver value of time, HOT lanes increase the amount of highway capacity.

This increased capacity on one HOT lane relative to a HOV lane can potentially reduce congestion in adjacent free lanes, increase overall highway capacity (Poole and Orski 2000) and, as projected in one study for San Francisco, increase average peak period speeds in general-purpose lanes by 20 percent (Metropolitan Transportation Commission 2007).[7] If currently congested or slow-moving HOV lanes were converted to HOT lanes, they could have their minimum HOV thresholds increased to three or more individuals per vehicle to ensure free-flowing travel. Otherwise, no single-occupant vehicle driver would be willing to pay a toll to traveled in the lane.[8] With the introduction of HOT lanes and a mandatory minimum of three people per HOV, vehicles with two people would be more likely to travel in free general-purpose lanes.

HOT lanes do not necessarily favour only those who can afford to pay the toll since these lanes are available for public transit, which moves faster in HOT lanes (Schweitzer and Taylor 2008; Poole and Balaker 2005). Furthermore, Shaw et al. (2011) found that the value of travel time for urgent trips is higher for lower-income drivers than for middle-income drivers, meaning they are more likely to pay to use the HOT lane. As well, the majority of HOT lane users, both high- and low-income, use HOT lanes only on occasion (Gilroy and Pelletier 2007), mostly when their trips are urgent.

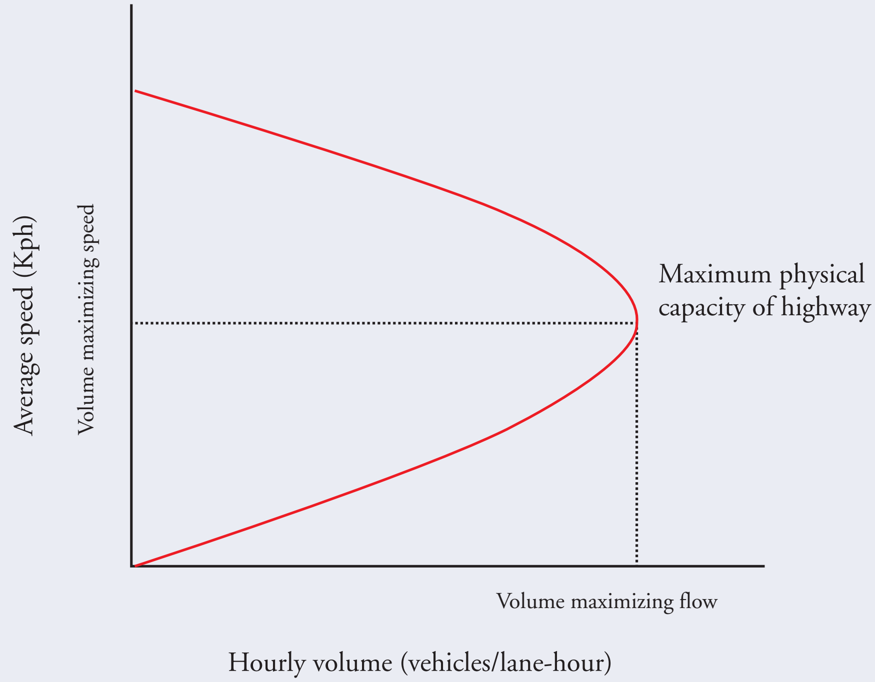
5 HOT lanes are currently in place in California (I-670 near San Francisco, SR-91 near Los Angeles and I-15 in San Diego), Colorado (I-25 in Denver), Florida (I-95 in Miami), Minnesota (I-35W and I-394 in Minneapolis), Texas (I-10 in Houston), Utah (I-15 in Salt Lake City) and Washington (SR-167 near Seattle).

6 Sullivan and Burris (2006) find that on California's SR-91, 19 percent of drivers were HOVs with two or more people (HOV 2+) and 7.4 percent were HOVs with three or more people (HOV 3+). Most new HOT lanes require three people in a vehicle for free access. Some HOT systems provide discounts to HOVs, rather than full toll exemption. Poole (2011) suggests that HOV vehicles pre-register for exemption from tolls on HOT lanes, which can lessen the onus of enforcing exemptions.

7 Sullivan (1998) finds that the introduction of HOT lanes also reduces congestion levels on adjacent arterial roads as drivers choose to take the less congested highway.

8 Uncongested HOV lanes may remain 2+ until such time when they become overcrowded.

Figure 1: Average Highway Speed and Traffic Volume



Note: Graph is a stylized representation of previous studies of traffic volume and travel speed. Source: Kim (2000).

Surveys of drivers on highways with HOT lanes find that most users of both free and tolled lanes approve road tolls and that approval ratings increase as drivers become more familiar with the benefits of HOT lanes (Sullivan 1998). In a survey of drivers in the Greater Toronto and Hamilton Area (GTHA), Finkleman (2010) found that more than 75 percent of drivers would be willing to pay to avoid congestion during high-urgency trips.[9]

Putting HOT Lanes into Practice: Application to Canadian Cities

Provincial and municipal governments in Canada's largest cities could easily transform existing and proposed HOV and bus lanes into HOT lanes. (For a simple estimate of potential HOT and express toll lane revenues and HOT lane infrastructure costs in the GTHA, Calgary and the Vancouver area see Box 1.)[10] Although there are many highways in Montreal amenable to HOT lanes, the most appealing road pricing option for Montreal is a cordon, where tolls are levied on bridge and tunnel traffic entering the city (Lindsey 2008).[11]

9 In a synthesis of US and international survey results, Zmud (2008) finds that 73 percent of respondents favoured HOT lanes and 62 percent favoured express toll lanes.

10 British Columbia road toll legislation (article 2.3 of the *British Columbia Guidelines for Tolling*) requires that a "reasonable un-tolled alternative" be available for any proposed road toll, and can only be applied on major projects that result in significant increases in highway capacity (Lindsey 2007). Calgary does not currently have plans for HOV lanes, but existing highways could be expanded to accommodate new HOT lanes. Lindsey (2008) argues that a cordon toll on vehicles entering Vancouver by bridge and tunnel would also be an appealing option for road tolling, but that Toronto's existing road network does not lend itself easily to a similar proposal, even though it may be an efficient option.

11 Lindsey (2008) estimates such Montreal tolls would raise between $180 and $300 million annually and finds even higher estimates of net revenues and economic benefits when road tolls are used to reduce existing, distortionary taxes levied to finance transportation infrastructure.

Box 1: Estimating Potential Toll Revenues

I have calculated potential toll revenues using detailed hourly estimates of traffic volumes by each highway segment for a sample of days in 2009, which accounts for heavier flows in one direction at different times of the day (Poole and Orski 2003). For each segment, I define peak periods as hours when hourly traffic volume is more than 70 percent of the recorded maximum hourly traffic volume of that segment. Off-peak periods are hours with less than 70 percent of maximum volume.

I assume peak tolls equal to the peak rate tolls on the 407 ETR (22.95 cents per kilometre). Using the methodology in Poole and Orski (2003), I also assume off-peak tolls are half the peak amount (11.48 cents per kilometre) to ensure that 1,100 paying vehicles will use the HOT lane every hour. However, when volume is less than 50 percent of the maximum hourly volume, I assume that no drivers are willing to pay tolls at such low traffic volumes because the HOT lanes would be no different than adjacent free lanes, and thus that no revenues are collected during these times.

I assume a maximum HOT lane capacity of 1,600 passenger vehicles per hour because this number provides room for other vehicles, such as buses, to use the lane. I otherwise assume that the number of vehicles in the HOT lane is the same as in existing general-purpose lanes. For passenger vehicles, I also assume that the HOT lanes are still freely accessible to 2+ HOVs, which I assume to be one-quarter of passenger vehicles, as has historically been the case on HOT lanes on State Route 91, a major east-west Los Angeles area freeway. The responsiveness of drivers to using a toll lane will depend on the extent and values of time saved, which will in turn depend on individual circumstances.

I calculate only gross revenue from HOT lanes. A major US HOT lane, State Route 91 in Los Angeles, has operating expenses totaling 27 percent of gross revenues. Meanwhile, a large proposed HOT network in San Francisco has forecasted maintenance and operations expenses of between 14 percent and 20 percent of gross revenues (Metropolitan Transportation Commission 2007). The largest determinant of whether HOT lanes are net revenue positive is the cost of construction. Poole and Orski (2003) estimate that each HOV lane-kilometre added to an existing highway costs US$4.6 million to build. Converting existing or planned and funded HOV lanes to HOT lanes has a minimal incremental cost, while building new HOT lanes is considerably more expensive. A high-end estimate of capital costs of converting HOVs to HOTs, including a 40 percent to 60 percent cost contingency, puts the conversion cost at US$1.8 million per kilometre (Metropolitan Transportation Commission 2007). On this basis, Ontario's long-term plan to construct additional HOV lanes on GTHA highways would likely cost approximately $2 billion, but converting those plans into a HOT network could cost, using high-end cost estimates, an additional US$800 million.

For the GTHA, I provide two road-pricing scenarios (Table 2):

1. HOT conversion of existing and planned HOV lanes on all GTHA 400-series highways (excluding Highway 427 in Toronto and the segments of Highway 401 in the GTHA without existing plans for HOV lane additions) and an exclusive bus-lane on the Don Valley Parkway that could be expanded to a HOT lane; and
2. Establishment of HOT lanes on the western part of Toronto's Gardiner expressway, and express toll lanes on the eastern part of the Gardiner expressway and the inside express lanes on the 401, leaving the collector lanes remain un-tolled.

Total revenue from converting proposed and existing HOV lanes into HOT lanes in the GTHA, as Table 2 shows, could be nearly $300 million per year. A toll on the 401 express lanes and eastern Gardiner expressway could collect a further $630 million annually. Together, total GTHA-wide revenues from HOT and express toll lane revenues could total $926 million annually, providing a large share of the funding needed for planned GTHA transportation expansion, even after operating and maintenance expenses are taken into account.[12]

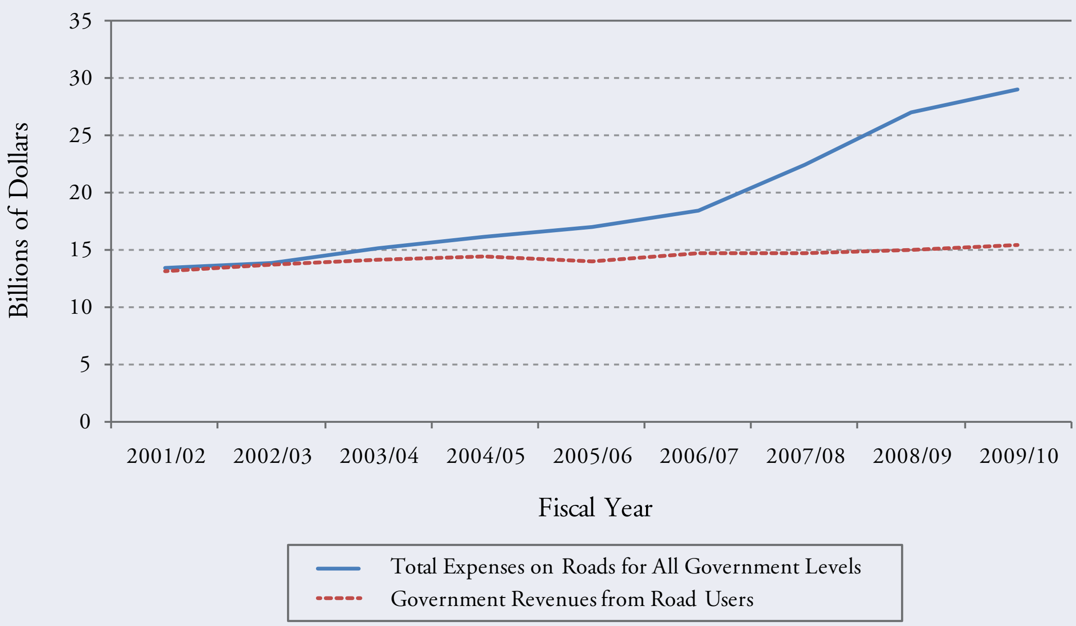
12 Allocating revenues from HOT lanes to transit does occur in other cities. For example, 50 percent of net revenues from the Minneapolis HOT network are dedicated to transit spending (DeCorla-Souza 2009). The extent to which revenues from HOT lanes can be applied to transit expansion will likely depend on whether HOT lanes are privately operated. Private operators will set tolls at a higher level to maximize profits compared to a publicly operated toll road likely to be priced to maximize volume.

Table 2: Predicted Total Annual Revenues from Road Pricing Scenarios

	Total Lane-km of Toll Roads	Total Gross Revenues *($ millions)*
Greater Toronto and Hamilton Area: Scenario 1 Existing and planned HOV to HOT conversion	432	294
Greater Toronto and Hamilton Area: Scenario 2 401 and Gardiner express toll lanes	441	632
Total Greater Toronto and Hamilton Area	***873***	***926***
Calgary: Deerfoot Trail only	87	40
Vancouver: Trans-Canada Highway existing and proposed HOV lanes	74	81

Source: Author's calculations from Poole and Orski (2003), Finkleman (2010), British Columbia (1999) and from City of Calgary, British Columbia Ministry of Transportation and Ontario Ministry of Transportation 2009 average hourly vehicle volumes.

Figure 2: Total Government Revenues and Expenses Related to Road and Highway Usage



Source: Transport Canada (2011).

Meanwhile in Calgary, total annual estimated HOT revenues from the city's section of the Deerfoot Trail could be approximately $40 million per year and total revenues in the Greater Vancouver Area from a HOT system using existing or proposed HOVs could generate approximately $80 million per year.[13] In sum, HOT lanes or express toll lanes could raise more than $1 billion in three of Canada's largest cities.

Opponents of toll highways call them "double taxation" of drivers because both the tolls and part of their government taxes go to build, repair and maintain roads. However, HOT lane revenues could bring the price that drivers pay for infrastructure closer to the actual cost of construction and maintenance of roads. Gas taxes, vehicle licences and other revenues from drivers, which do little to curb congestion, only covered 53 percent of roadway expenses across Canada during the 2009/2010 fiscal year (See Figure 2).

Where the Rubber hits the Road: Implementing Road Pricing in Canadian Cities

The political dilemma of pricing what were previously free lanes has hitherto stymied road toll proposals. By preserving a non-toll option, HOT and express lanes provide the solution. They can achieve the benefits of road pricing, while still being politically palatable, since drivers have the choice to drive for free in adjacent lanes. Although not a panacea for all congestion problems, incrementally introducing HOT lanes can improve utilization of existing or planned high-occupancy vehicle lanes and lead to more comprehensive road pricing once drivers see the benefits first hand. HOT lanes are Canada's best opportunity to reduce highway congestion, provide funding for transportation infrastructure and introduce drivers to the benefits of road pricing.

13 I estimate that total revenue of converting only existing Greater Vancouver Area HOV lanes to HOT lanes would be approximately $37 million per year. Converting recently built HOV lanes on other Greater Vancouver Area highways would yield additional revenues. The only planned tolls on the upcoming expansion along Highway 1 in Vancouver will be on the new Port Mann Bridge, currently planned at approximately $3 per crossing, and will not be related to reducing congestion.

References

British Columbia. 1999. "High Occupancy Vehicle Lanes (HOV) Evaluation." Ministry of Transportation. Available at: http://www.th.gov.bc.ca/publications/reports_and_studies/hovsummary/summary.htm.

City of Toronto. 2010. "GO Transit Bus Bypass Lanes on the Don Valley Parkway." Report from General Manager, Transportation Services. Available at http://www.toronto.ca/legdocs/mmis/2010/pw/bgrd/backgroundfile-29798.pdf.

DeCorla-Souza, Patrick. 2009. "Gaining Public Acceptance for Road Pricing: Experience in the United States." Transportation Futures Workshop. Toronto, November 12-13. Available at http://www.transportfutures.ca/past-events/workshop-2009/presentations.

Finkleman, Jeremy. 2010. "The HOT-Solution? An Examination of the Desirability for High-Occupancy/Toll (HOT) Lanes in the Greater Toronto Area." University of Waterloo Masters of Arts in Planning Thesis. Available at http://uwspace.uwaterloo.ca/handle/10012/5151.

Gilroy, Leonard, and Amy Pelletier. 2007. "HOT Lanes: Frequently Asked Questions." *Reason Foundation* Policy Brief 59. March. Available at http://reason.org/news/show/1002865.html.

Kim, Eugene J. 2000. "HOT Lanes: A Comparative Evaluation of Costs, Benefits, and Performance." University of California Los Angeles PhD Dissertation. Available at http://www.uctc.net/research/diss055.pd.

Kwon, Jaimyoung, and Pravin Varaiya. 2008. "Effectiveness of California's High-Occupancy Vehicle (HOV) system." *Transportation Research Part* C 16 (1): 98-115. Available at http://paleale.eecs.berkeley.edu/~varaiya/transp.html.

Lindsey, Robin. 2007. *Congestion Relief: Assessing the Case for Road Tolls in Canada*. Commentary 248. Toronto: C.D. Howe Institute. May.

————————. 2008. "Prospects for Urban Road Pricing in Canada." Brookings-Wharton Papers on Urban Affairs. Available at http://www.jstor.org/stable/25609552.

———————. 2009. "Road Pricing 101 and Public Acceptance Issues." Presentation at Transport Futures 2009: Road Pricing & Public Acceptance, November 12-13.

Metropolitan Transportation Commission in cooperation with Caltrans Consultant assistance by PB Americas, Inc. and ECONorthwest. 2007. "Bay Area High-Occupancy/Toll (HOT) Network Study Final Report." September. Available at: http://www.vta.org/expresslanes/pdf/mtc_hot_lanes_study_final.pdf.

Ontario. 2007. "Summary of the Plan for the 400-Series Highways in the Greater Golden Horseshoe." Ministry of Transportation." Available at: http://www.mto.gov.on.ca/english/traveller/hov/summary2007.shtml.

Poole, Robert W., and C. Kenneth Orski. 2000. "HOT Lanes: A Better Way to Attack Urban Highway Congestion." *Regulation* 23 (1). Available at http://www.cato.org/pubs/regulation/regv23n1/poole.pdf.

————————————————————. 2003. "HOT Networks: A New Plan for Congestion Relief and Better Transit." *Reason Foundation* Policy Study 305. February. Available at http://reason.org/news/show/127685.html.

Poole, Jr., Robert W., and Ted Balaker. 2005. "Virtual Exclusive Busways: Improving Urban Transit while Relieving Congestion." *Reason Foundation* Policy Study 337. September. Available at http://reason.org/files/f74f4436cd5e98624899baf1c02c384f.pdf.

Poole, Jr., Robert W. 2011. "Automating HOT Lanes Enforcement," *Reason Foundation* Policy Study 390. February. Available at http://reason.org/files/automating_hot_lanes_enforcement.pdf.

Schweitzer, Lisa, and Brian D. Taylor. 2008. "Just pricing: the distributional effects of congestion pricing and sales taxes." *Transportation* 35 (6). Available at http://ideas.repec.org/a/kap/transp/v35y2008i6p797-812.html.

Shaw, W. D., et al. 2011. "Variation in the value of travel time savings and its impact on the benefits of managed lanes." *Transportation Planning and Technology*. March 15. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1808035.

Statistics Canada. 2011. "Canadian Social Trends." 11-008-XWE, No.92. August 24.

Sullivan, Edward. 1998. "Evaluating the Impacts of the SR-91 Variable-Toll Express Lane Facility Final Report." May. Available at http://ceenve3.civeng.calpoly.edu/sullivan/SR91/final_rpt/finalrep_full.pdf.

Sullivan, Edward, and Mark Burris. 2006. "Benefit-Cost Analysis of Variable Pricing Projects: SR-91 Express Lanes." *Journal of Transportation Engineering* 132 (3). Available at http://cedb.asce.org/cgi/WWWdisplay.cgi?150962.

Transport Canada. 2006a. *The Cost of Urban Congestion in Canada*. Ottawa: Transport Canada, Environmental Affairs. March 22. Available at http://www.tc.gc.ca/eng/mediaroom/releases-nat-2006-06-h006e-2353.htm.

————————. 2006b. *Costs of Non-Recurrent Congestion in Canada Final Report*. Transport Canada Economic Analysis TP 14664E, December 11.

————————. 2011. "Transportation in Canada 2010." Economic Analysis Directorate Policy Group. May. Available at http://www.tc.gc.ca/eng/policy/report-aca-anre2010-index-2700.htm.

Zmud, Johanna. 2008. "The public supports pricing If … A synthesis of public opinion studies on tolling and road pricing." International Bridge, Tunnel and Turnpike Association *Tollways*. Winter. Available at http://www.ibtta.org/files/PDFs/win08_Zmud.pdf.

This *e-brief* is a publication of the C.D. Howe Institute.

Benjamin Dachis is a Policy Analyst at the C.D. Howe Institute.

This *e-brief* is available at www.cdhowe.org.