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Build It and Will They Drive? Modelling Light-Duty Vehicle Travel Demand

At a Glance

- Building roads at a rate that matches driving age population growth does not generate additional demand for travel on the road network in Canada. It is only when construction surpasses that rate of growth that a weak “induced-travel effect” is apparent.
- As a result, road network capacity expansion is part of a comprehensive strategy to improve the efficiency of the transportation network.
- If the goal is to reduce carbon emissions from road use, policy-makers should implement measures to increase urban density and consider socio-economic tools, such as congestion charges, that have a stronger effect on personal vehicle use than limiting road and highway construction.

INTRODUCTION

Transportation network planners currently face an unenviable challenge. They must continue to increase transportation network capacity for the purpose of reducing congestion and improving mobility in a society that, while dominated by internal combustion personal vehicles, is facing a carbon-constrained future. (See Table 1.)

This challenge is especially difficult in the Canadian context. Canada is a vast country with low population density and great distances between markets. Even within urban areas, efforts to make public transit an efficient, effective mode of transportation are hampered by societal perceptions, suburban sprawl and the low cost of operating personal vehicles.

Table 1
Canadian Greenhouse Gas Emissions and Sources, 2004

Origins of Greenhouse Gas Emissions: Canada	Emissions	
	Mt of CO2 eq.	Per cent
Electricity and Heat Generation	130	17.2
Fossil Fuels	79	10.4
Residential	43	5.7
Commercial and Institutional	37.9	5
Mining	15.4	2
Other Stationary	54.7	7.2
Domestic Aviation	7.8	1
Railways	6	0.8
Gasoline Automobiles*	49.4	6.5
Light-Duty Gasoline Trucks*	43.6	5.8
Heavy-Duty Diesel Vehicles	44.9	5.9
Off-Road diesel	20	2.6
Other Transportation	18.3	2.4
Fugitives (including coal mining, natural gas, oil, venting and flaring)	66.5	8.8
Industrial Processes	54.3	7.2
Agriculture	55	7.3
Waste	29	3.8
Totals (may not add due to rounding)	758	100

*Indicates the emissions from the light-duty vehicles investigated in this analysis.

Source: Environment Canada.

Many transportation experts argue that the only way to achieve a sustainable transportation network is to increase the density of new and existing communities. Increasing the density, they argue, improves the ability of citizens to satisfy their transportation demand through less greenhouse-gas-intensive alternative methods of transportation such as walking, cycling and public transit. Expanding the existing road network capacity is not an option, they assert, because it only perpetuates existing greenhouse gas (GHG) emission trends and, at best, is a short-run solution to transportation network congestion. Increases in highway capacity, they contend, lead directly to increased road network travel demand. Any congestion relief and reduction in greenhouse gas emissions via higher average travel speeds and time savings are soon negated because of the induced travel effect. Indeed, transportation experts have produced numerous econometric models suggesting exactly this. The consensus in the literature is that for every 1 per cent increase in road network capacity, there is a corresponding increase in the short run of 0.2 to 0.6 per cent in vehicle kilometres traveled. In the long run, this per cent increase rises to 0.6 to 1.0.¹

Induced Travel

Sometimes referred to as “induced demand,” induced travel is the increment of new vehicle traffic (measured in this analysis by vehicle-kilometres traveled per person of driving age) that would not have occurred without capacity improvements (measured in this analysis by increases in lane-kilometres per person of driving age).

Source: Patricia L. Mokhtarian et al., “Revisiting the Notion of Induced Traffic Through a Matched-Pairs Study,” *Transportation*, Vol. 29 (2002), pp. 193–220.

Is this true for Canada? Is there more to this story? How do socio-economic factors contribute to vehicle-kilometres traveled per capita in Canada?

This briefing begins by detailing the inputs and results of the modelling exercise. It continues by considering the implications for policy development, and concludes with a discussion of how socio-economic policy, such as fuel taxes, user charging and increased urban density, could influence light-duty vehicle use.

METHODOLOGY AND DATA SOURCES

To start, The Conference Board of Canada constructed an econometric model to investigate the travel demand for Canada’s road network. This model is unique in Canada for two reasons. First, it is the only Canadian model to incorporate socio-economic variables in the exercise. Second, it is the first model to utilize the Canadian Vehicle Survey, a new Statistics Canada data collection tool. (See box “The Canadian Vehicle Survey.”)

Is there evidence of induced travel in Canada? Is there more to the story?

This modelling exercise focuses on identifying the explanatory variables to past Canadian travel demand in order to test how socio-economic factors, such as the price of gasoline and the number of vehicles per person, influence behavior. (A complete listing of data sources is included as the appendix.)

The Canadian Vehicle Survey

"Canadian transport activity statistics were inadequate due to the lack of any routine measurement of road vehicle activity. While road vehicles dominate passenger travel and freight traffic, no measures of total vehicle-kilometres or passenger-kilometres were available.

"The Canadian Vehicle Survey (CVS) was developed at the request of Transport Canada to fill this data gap. The survey provides annual and quarterly estimates of the amount of road travel, broken down by types of vehicles and characteristics, such as age and sex of driver, time of day and season. The results will be the prime source of road vehicle use information for researchers and interested members of the public.

"The CVS is a voluntary vehicle-based survey that provides annual and quarterly estimates of road vehicle activity (vehicle-kilometres and passenger-kilometres) of vehicles registered in Canada. Quarterly samples of vehicles are drawn from vehicle registration lists provided by the provincial and territorial governments.

"Survey collection began on February 1, 1999. Only eight provincial/territorial vehicle registration lists were received in time to be included in the sample at that time, but over the remainder of 1999, the other lists were received. Starting October 1, 1999, vehicles from all provinces and territories were included in the survey."

Source: Canadian Vehicle Survey: Annual 2000.

Definition of Travel Demand

For the purposes of this analysis, travel demand is defined as kilometres per person of driving age. This imposes a one-for-one relationship between population growth and total driving demand. When testing various functional forms for the equation, population was often used as a dependent variable, and its coefficient was consistently close to one. Thus, it is not inconsistent to impose this relationship on the equations. Given this structure, the socio-economic determinants of demand are also placed on a per capita basis where appropriate.

income were tested on both a per capita and aggregate basis. Similar rigour was incorporated in the measures of prices, demographics and vehicle-specific data.

In addition to testing the effectiveness of different socio-economic variables, alternate functional forms for the travel demand equation were considered. These included various transformations to both the independent and dependent variables, such as growth rates, and differences. In the end, the equation presented here was found to be the most robust.

The results are striking.

SOCIO-ECONOMIC VARIABLES

Economic studies that test the theory of induced travel with respect to capacity expansions in the road network tend to focus on arterial sections of the network and do not include regional socio-economic variables in the assessment. For some, this approach neglects the significant contribution of the most visible cost of driving—the price of gasoline—to the decision to drive a vehicle. Theoretically, one would also expect other socio-economic factors such as population density, income, prices of vehicles and fuel, demographics and vehicle-specific data to influence road-network travel demand along with network capacity. This Conference Board exercise tests that theory.

Many different measures within each of the five socio-economic groupings listed in the previous paragraph were collected and tested during the construction of the model. For example, comparable and complementary data sets such as single and multiple housing starts, housing stock and the share of the population living in urban centres were all tested within the analysis as proxies for population density. With respect to measures of income, data sets such as real personal income and real disposable

DETERMINANTS OF TRAVEL DEMAND

In Canada, the single largest determinant of travel demand is population density—represented in this modelling exercise by the share of Canadians residing in urban regions. The results tell us that as population density increases (i.e., **the share of Canadians residing in urban areas increases**), travel demand on a per capita basis decreases. The most likely explanation for this result is that the higher density of urban development locates residents closer to the places they work and the services they demand. Whether this service is a hospital, the grocery store or the regional airport, people living in urban areas have fewer kilometres to travel before their need is met.

This rationale is supported by the significant difference in coefficients for light trucks versus cars. For this indicator, the percentage decrease in travel demand for trucks is over two times greater than that for cars. Light trucks have been historically associated with a rural lifestyle. However, over the past twenty years the rate of truck ownership in urban settings has increased dramatically, as minivans and sport utility vehicles gained in popularity.

Light-Duty Vehicle Definitions

In this study, the term “light-duty vehicle” represents vehicles used predominantly for passenger transport. It includes all cars, minivans, sport-utility vehicles and pick-up trucks less than 4.5 tonnes (gross vehicle weight).

As a result, the share of light trucks being used in an urban environment has increased much more quickly than the share of the population in urban areas. This effective shift in truck ownership from rural to urban residents—combined with the different travel demands of urban truck owners—results in the population density variable having a larger coefficient for light trucks than for cars.

The second-largest determinant of travel demand in Canada is a function of wealth, namely the number of **vehicles per person of driving age**. The fundamental premise is that as Canadians become more affluent, luxury items such as cars become more affordable. Similarly, the demand for travel increases as the number and scope of leisure activities increase. Our analysis demonstrates that in the case of cars, for every 1 per cent increase in the number of vehicles per person of driving age in Canada, there is a corresponding 1.01 per cent increase in per capita travel demand. The magnitude is slightly larger for light trucks.

Fundamentally, the greater access one has to a vehicle, the more one will use that vehicle for travel. However, this logic has trouble explaining the magnitude of the indicator, namely that it is too small for this simple explanation. Indeed, factors that temper the growth in travel demand as a result of greater access to vehicles include the following:

- There is an already relatively high level of vehicle ownership per person of driving age.
- A large proportion of travel demand is fixed.
- Not all trips with the “new” vehicle will be “new” trips.
- The “new” vehicle may raise the number of vehicles per person of driving age past one-to-one in a given family, leading to travel demand from drivers being split between multiple vehicles.

The vehicles per person of driving age variable also serves an additional purpose in these equations. Since there has been a considerable shift in the vehicle fleet from cars towards light trucks, the total truck kilometres driven has grown much faster than that of cars. The incorporation

of changing fleet characteristics in the model serves as a control for the impact of vehicle choice on per capita travel demand.

The third-largest determinant of travel demand is **population growth**, and is implied by the structure of the equations themselves. Because travel demand is estimated on a per person of driving age basis, a 1 per cent increase in the population of driving age will result in a 1 per cent increase in the total kilometres driven. This implies that each new driver exhibits the same behaviour as the average current driver.

The fourth-largest determinant of travel demand per capita in Canada is **real per capita disposable income**. It is also related to wealth, but it is more of a short-run indicator compared with vehicles per person, which is much less variable. Whereas the decision to purchase a vehicle is fundamentally rooted in current income and expected future income, the decision to drive the vehicle is more a function of current discretionary income, that is, money not previously allocated to rent, mortgage, car payments, investments, etc. The availability of this money is what determines whether one will go to the movies tonight, travel to visit friends or family for the weekend, or take other discretionary trips. For every 1 per cent increase in real per capita disposable income, per capita travel demand in Canada increases by approximately 0.7 per cent.

As Canadians become more affluent, luxury items such as cars become more affordable. Similarly, the demand for travel increases as the number and scope of leisure activities increase.

The next socio-economic indicator that was found to explain current travel demand is a measure of **past driving habits**. While at first glance it may seem that including this variable in the model amounts to double counting, this indicator is a measure of the “stickiness” of travel demand. Many factors change slowly in an individual’s life—factors such as place of residence, place of employment, proximity to family and friends, availability of services, and lifestyle choices (including children, shopping habits and leisure activities). This variable captures what could be considered fixed travel demand, that is,

travel demand that exists regardless of price or availability of roads. This variable also serves to represent individual preferences with respect to travel demand. Individual tastes such as enjoying a Sunday drive or choosing to commute via personal vehicle for comfort, accessibility or business needs are difficult to collect in neat data points. Using a lagged variable is common practice in econometrics to “capture all the variables one cannot otherwise capture.”

Lastly, to account for alternative travel choice, the model includes **the price of gasoline relative to the price of local transit**. (See Table 2.) This is a visible short- to medium-run cost of driving that influences choice on a daily and monthly basis.

INDUCED TRAVEL—TESTING FOR THE EFFECT OF CAPACITY ADDITIONS

The purpose of this modelling exercise is to test the hypothesis that increases in **lane-kilometres per capita**, independent of any other influences, lead directly to induced travel. In other words, physical improvements to the road network, which result in freer-flowing traffic and reduced travel times, induce individuals to drive more.

The model does find a weak relationship. It finds that for every 1 per cent increase in lane-kilometres, there is a 0.49 per cent increase in vehicle-kilometres traveled by light trucks and a 0.26 per cent increase in vehicle-kilometres traveled by cars, which is in the range of what had been predicted by previous research. However, the significance of these estimated coefficients is weak. They fail to meet established standards for inclusion in an econometric model (falling just outside the 80 per cent confidence interval for cars and the 90 per cent confidence interval for light trucks).

There is no statistically significant relationship between lane-kilometres and vehicle-kilometres per capita in Canada.

It is also important to note that the demand variable considered in this analysis is lane-kilometres per person of driving age. Thus, if road building continues at a pace that matches the rate of population growth, no induced

Table 2
Estimated Coefficients of Independent Variables in Light-Duty Vehicle Travel Demand

Explanatory Variable	Coefficient Value ¹ :	
	Light Trucks	Cars
The share of Canada's population living in urban areas	-4.984	-2.413
Vehicles per person of driving age	1.097	1.010
Real per capita disposable income	0.721	0.705
Vehicle-kilometres traveled per person of driving age (lagged one period)	0.163	0.220
The price of gasoline relative to the price of local transit	-0.195	-0.080
The lane-kilometres of road network per person of driving age	0.490	0.267

¹ The listed coefficient values correspond with the elasticity of travel demand relative to the explanatory variables. Elasticity is an economic term to measure the responsiveness of one variable to another. In this model, elasticity equals the per cent change in travel demand (the dependent variable) divided by the per cent change in a given independent variable. Unless noted, all variables used in the regression meet a 90% confidence interval.

Source: The Conference Board of Canada.

travel is to be expected. It is only when construction surpasses the rate of population growth that an argument, albeit weak, for an induced travel effect is apparent.

IMPLICATIONS FOR POLICY DEVELOPMENT

The results of this Conference Board of Canada model suggest that, since there is at best only a weak correlation between the number of lane kilometres of road and the number of vehicle kilometres driven, simply restricting the physical capacity of the road and highway network is not an effective policy for mitigating greenhouse gas emissions from the road transportation sector. Instead, socio-economic policies designed to influence individual behaviour (such as adjusting fuel taxes or land-use policy designed to increase the density of cities) are much stronger tools for mitigating travel demand and the resulting greenhouse gas emissions from light-duty vehicles than is restricting the physical capacity of road and highway infrastructure.

What this result implies is that a “no-build” roads and highways policy will continue to increase congestion and the amount of “wasted”² greenhouse gas emissions from cars and light trucks. At the same time, however, the model doesn’t suggest that continuing to build road

networks—and, by extension, facilitating urban sprawl—as Canada has in the past is an effective strategy for limiting greenhouse gases from the transportation sector either. For example, urban planners must consider the opportunity cost of the “business as usual” strategy of suburban development. There is a limited area of land available for cities to provide the services their citizens demand. When land is allocated to transportation network expansion it cannot be used for other purposes, such as recreation, housing or commerce.

THE COSTS OF CONGESTION

Transport Canada recently completed an assessment of the costs of congestion in Canada’s nine largest cities.³ One of the four specific purposes of the research was to “estimate the socio-economic costs of *urban congestion* per se and the impact of congestion on the quality of life of Canadians and on the economy.”⁴ To that end, three types of costs were aggregated to identify the total cost to Canada of peak-period congestion:

- the cost of time lost due to delay
- the cost of wasted fuel
- the cost of GHG emissions.

The results of Transport Canada’s efforts show that the costs of congestion in Canada’s major urban centres total somewhere between \$2.3 and \$3.7 billion dollars per year, depending on the congestion threshold used.⁵ The cost of time lost to passengers and drivers represents over 80 per cent of this total.⁶ And this estimate must be considered conservative. (See box “Conservative Estimates of Congestion Costs in Canada’s Urban Areas.”)

Conservative Estimates of Congestion Costs in Canada’s Urban Areas

“The estimates of congestion and its costs must be considered as *conservative*, for two reasons: First, reflecting the available data and modelling tools, they address only peak period congestion—but not off-peak congestion, which is known to occur in many urban areas.

“Second, the estimates only account for congestion on auto travelers (data on truck travel being available only for a small number of urban areas; and none of the models accounts for other vehicles in the traffic mix [such as taxis, emergency vehicles and light-duty vehicles that are used for commercial activity]).”

Source: Transport Canada, Sustainable Development Branch Contract No.T8080-01-1593. *Costs of Congestion in Canada’s Transportation Sector: Final Report* (March 2005). Submitted by Delcan in association with ADEC and iTrans, pp. 126–127.

A secondary conclusion that Transport Canada reached was that “(t)hese results are consistent with findings in other countries and ... the magnitude of the results suggests that there is a large potential for productivity improvement in travel in urban areas.”⁷ For example, the Texas Transportation Institute’s *2005 Urban Mobility Report* states that in the United States in 2003: the annual delay per peak traveler was 47 hours, the total hours of delay were 3.7 billion, the “wasted” fuel totalled 2.3 billion gallons (8.71 billion litres) and the cost of congestion was US\$63.1 billion in nominal dollars.⁸ In an attempt to develop comparable numbers from the Transport Canada study, the Conference Board estimated annual hours of delay per peak traveler to be 55 hours, and the total hours of delay to be 261 million at the most conservative of congestion thresholds—50 per cent (i.e., when vehicles are traveling at less than 50 per cent of the posted limit). As previously stated, the cost of congestion developed by Transport Canada at this threshold is CDN\$2.3 billion.

DATA LIMITATIONS AND MODELLING ASSUMPTIONS

As mentioned previously, this analysis of travel demand is the first of its kind completed in Canada. In many respects, it was a challenging task to collect enough information to create suitable data sets. The largest and most important challenge in this analysis was to develop a usable inventory of lane-kilometres in Canada. Unfortunately, data on this variable is only available from Transport Canada for the years up to and including 1989, 1991, 1995 and 2005. This required the Conference Board to infill data for most of the 1990s and 2000s. The second major challenge was to infill vehicle-kilometres traveled for the years 1989–1994 and 1996–1999. At the same time, however, it is the incorporation of new data for this variable that makes this modeling exercise unique—the Canadian Vehicle Survey provides the best information on Canadian travel habits from 1999 to present. Other estimations and assumptions in the analysis are:

- Fleet size—the size of the Canadian car and Canadian light truck fleet had to be estimated based on sales data and assumed scrappage rates.
- Light truck sales—this information was not available from Statistics Canada in the required gross vehicle weight breakdown, so sales were estimated using data from a private sector organization, WARDS.

- Scrappage rates—with little alternative, scrappage rates are held constant throughout the analysis for each age and vehicle type breakdown based on data from 1999.

Where possible, the estimated data was checked against independent sources such as Statistics Canada, Natural Resources Canada and Transport Canada, as well as private sources, such as DesRosiers Automotive Consultants and R.L. Polk, to ensure accuracy. These comparisons, combined with the system established to ensure internal consistency, provide a measure of confidence in the data's accuracy and robustness.

GREENHOUSE GAS REDUCTION STRATEGIES

Given the result of the modelling—which tells us that the availability of physical capacity on the road network is an insignificant determinant of travel demand—what tools are available to policy-makers if the goal is to reduce greenhouse gas emissions from personal vehicles? Our model suggests that socio-economic policy tools are most likely to deliver that result.

The analysis suggests per capita driving demand is most sensitive to shifts in population from rural to urban settings. Urbanization is an ongoing trend in Canada (see box “Canadian Population Trends”), and this trend provides a natural damper on travel demand growth as people increasingly live closer to the goods and services they demand. However, the drawback of the modelling result is clear—population migration occurs very slowly relative to the other determinants of travel demand. Therefore despite the large impact this variable has on travel demand, as evidenced by its large coefficient value, it has a small influence on total kilometres driven per capita.

Policy-makers will find it difficult to take direct action on the next two strongest drivers of travel demand. Canada is a market-based economy; therefore, directly limiting the number of cars per capita or actively dampening personal disposable income growth are non-starters. Instead policy-makers would need to indirectly influence consumer behaviour—that is, alter how people make their spending decisions. Currently, the price of owning and operating a vehicle does not account for all of the socio-economic costs. Adjusting the price to more accurately

Canadian Population Trends

The share of the population in Canada's 27 metro areas has been gradually rising over time. It stood at 61 per cent in 1980 and is currently at 65.4 per cent, which equals a growth rate of about 0.2 per cent each year over the past 25 years. This pace of change tends to correlate with economic growth. When job creation is good, people move to the cities. But when it is not, the share tends to flatten out. For example, job creation slowed in the early 1990s and the share of population in metro areas was unchanged between 1990 and 1993. In contrast, between 1999 and 2005, when job creation was relatively strong, the share increased by an average of 0.3 per cent per year.

Sources: The Conference Board of Canada; Statistics Canada.

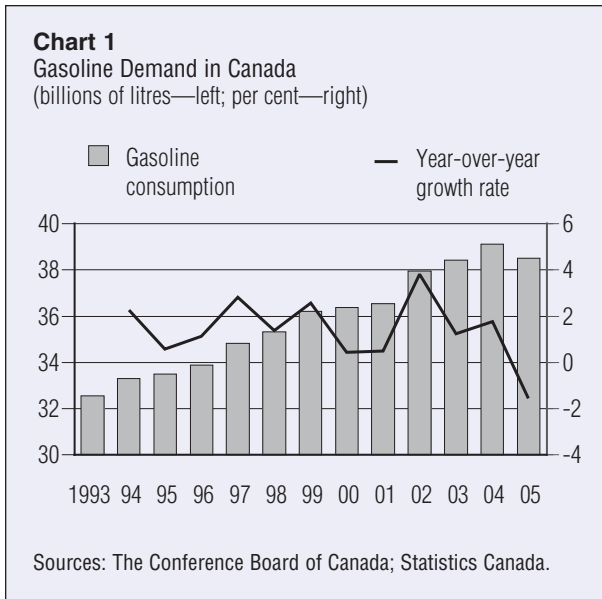
capture these costs is one potential tool to influence consumer behavior.

This brings us to the last variable examined in the equation, the price of gasoline relative to mass transit. As discussed previously, this indicator acts as a proxy for the most visible short-run cost of personal vehicle transportation. And this is something policy-makers can leverage.

SOCIO-ECONOMIC TOOLS

One way that policy-makers can alter the cost of personal vehicle transportation is to increase the rate of taxation on a unit of fuel. This stimulates a number of actions from individuals. As reported widely in the summer of 2006, rising fuel prices (albeit not related to taxation) are forcing Canadian consumers to reconsider their driving habits on a daily basis. Gasoline demand actually slipped in 2005 versus 2004. (See Chart 1.) In a market economy, price is the most effective method to influence demand. One of the drawbacks to this tool, however, is the potential impact on fixed- and low-income residents. They have less ability to adapt to upward shifts in price. The other drawback to this approach is the complex jurisdictional arrangement with respect to fuel tax collection and allocation in Canada. As noted in the Canada Transportation Act Review Panel's report *Vision and Balance* (2001), provincial and territorial governments argue that the federal government's disproportionate revenues and spending is unjustifiable—and this situation has yet to change.

A second socio-economic tool that can be used more effectively is road pricing—that is, charging users the full-cost of their transportation choice. This approach would require users—not taxpayers broadly—to cover the



combined costs of infrastructure provision and social externalities.⁹ As *Vision and Balance* notes,

An efficient scheme to charge for road use ... would vary by type of vehicle, type of road, time of day and season. Annual licence fees might be higher than currently, to cover fixed costs. (T)he most obvious components of (variable) charges would be axle-weight-kilometre charges for trucks, eventually differentiated by class of road, and congestion charges per kilometre for all vehicles in urban areas, differentiated by the amount of road space they use.¹⁰

From an economics perspective, achieving this type of user-charging in all transportation modes is ideal because all the costs of transportation demand are captured within the price of each mode. It is an approach that rewards consumers for low-impact transportation choices and ensures that the individual's optimal transportation choice contributes to the most efficient operation of the existing transportation network. Some of the most likely effects of road pricing include: car-pooling, shifts in demand to off-peak times, increased demand for fuel-efficient vehicles, increased demand for urban transit, increased demand for intercity buses and a shift in freight traffic among road, marine and rail transportation.¹¹ Additionally, *Vision and Balance* contends that full-cost pricing would eventually allow governments to eliminate general subsidies to mass transit systems, as the relatively

lower social costs would be evident to users. These lower costs should increase ridership and influence urban development patterns.

There are some barriers, however, that will need to be addressed prior to implementing such a system in Canada. First, as witnessed in this analysis, the information required to accurately determine the value of transportation externalities does not exist in Canada. Second, societal perceptions with respect to road-pricing must change in Canada. (Consider the recent attempts at tolling new highways in New Brunswick and Ontario.) Third, significant technology development is required to be able to undertake such a complex pricing adjustment.

Full-cost user pricing rewards consumers for low-impact transportation choices.

Despite these barriers, however, one jurisdiction that has recently begun to actively use price to optimize its existing transportation network is London, England. Faced with debilitating congestion in its central business district, London's solution is to charge motorists (currently £8 per day) to drive or park in the charging zone. Charging began in February of 2003. And Transport for London's *Central London Congestion Charging Impacts Monitoring: Fourth Annual Report* notes that:

- Reductions in congestion inside the charging zone since 2003 average 25 per cent.
- Public transport continues to successfully accommodate displaced car users, and bus service continues to benefit from significantly improved reliability and ongoing investment. The provisional 2005–2006 net revenue from congestion charging is 122 million pounds, and is being spent largely on improved bus service within London.
- [Reductions in the number of] road traffic accidents and reductions to emissions of key traffic pollutants in and around the charging zone continue to be apparent, alongside favourable “background” trends in both of these indicators.
- Economic trend data and comparative analyses continue to demonstrate that there are no significant net impacts from the scheme on the central London economy.¹²

The program has been so successful that a “western extension” of the charging zone will begin operation on February 19, 2007.¹³ Elsewhere, Stockholm and Singapore have road pricing of this type in their central business districts, and Germany and Austria have implemented distance-based pricing for truck transport.

INFRASTRUCTURE IMPROVEMENT

The socio-economic tools mentioned above have a discernable impact on the short-run cost of driving—and thus, they reduce travel demand and GHG emissions. Improvements to physical infrastructure are also very effective at improving traffic flow and eliminating “wasted” GHGs. Given the absence of induced travel if lane-kilometres grow at the same rate as the population of driving age, expanding the capacity of the road network becomes part of a comprehensive strategy to improve the efficiency of the transportation network. More specifically, eliminating traffic bottlenecks in the network via lane additions,¹⁴ mass transit links and road pricing substantially reduces tailpipe emissions and time spent idling in congestion.

Given the absence of induced travel, expanding the road network becomes part of a comprehensive strategy to enhance mobility.

The service derived from the transportation network is mobility for citizens and businesses. Mobility is an enabler of economic growth, similar to monetary policy or public education. Congestion is a constraint to economic growth, the same as limited access to capital or raw materials. Personal decisions such as the location of the home relative to the place of employment and business investment decisions considering supply chain logistics are made based on the expectation that current levels of mobility will be maintained. This can be accomplished with an integrated approach to capacity additions in all modes of transportation in the network, not simply just expanding road capacity to satisfy the expanding footprint of cities.

While it is not realistic to consider directly changing the population distribution (i.e., urban versus rural), wealth and income of Canadians to reduce their travel demand, policy tools are available that have the ability to change

the coefficients of those determinants over time. To build upon the already decreased travel demand of urban residents, actively reducing suburban sprawl could be pursued. In one scenario, municipal planning policy could limit the supply of land for greenfield suburban development. This effectively raises the price of real estate for that type of development and makes more central real estate relatively more attractive for development, thus enhancing the density of the region. With respect to wealth, policy-makers could raise taxes on the purchase of new cars (either fixed rate or graduated based on fuel economy) or raise the fixed costs of car ownership such as licensing and registration fees. Similarly, the variable costs of car use can be adjusted via fuel taxes or road pricing. This would have both a direct impact on modal choice and an indirect impact by altering the share of personal disposable income allocated to satisfying personal transportation demand.

All of these socio-economic tools (and this list is not exhaustive) will raise the relative price of personal vehicle use. However, policy-makers must always be conscious of the impacts of these tools on mobility. Consonant with the use of these tools, viable and efficient alternatives to personal vehicle use must be available if policy-makers are not to constrain mobility and, by extension, economic growth.

Theoretically, there exists an optimal stock of transportation infrastructure, the modal mix of which varies from region to region depending on factors such as regional density, economic structure, wealth and income. At the same time, this concept of optimal stock does not preclude the existence of congestion. Analogous to the existence of waiting times for non-essential medical services, congestion on the transportation network is a signal that the network is operating at capacity, as opposed

Concrete Pavement and GHG Reductions

If Highway 20 between Montreal and Quebec City were entirely built from concrete rather than asphalt, and assuming a resulting 4 per cent fuel savings, the 2,290,000 trucks circulating annually on this portion of highway would save 74.3 tonnes of carbon dioxide emissions per day, or 27,106 tonnes of carbon dioxide every year. Already on this same highway, there are 12 kilometres of Portland cement concrete pavement, which provides annual carbon dioxide emission savings of 5.78 tonnes per day and 2,111 tonnes per year.

Source: Tim Smith and Robb Jolly, “Concrete Pavement: A Sustainable Choice.” (Presented at the *8th International Conference on Concrete Pavements*, Colorado Springs, Colorado, August 14–18, 2005.) p. 14.

to having been overbuilt. So, given that some level of congestion on the transportation network is acceptable (this level will vary depending on the tolerance of the region and the signals policy-makers want to send to motorists), one might consider the growth rate of population over 15 years of age to be the optimal rate of capacity addition to maintain current economic growth. The main objective is to service the mobility needs of people and the economy at an acceptable level. This does not mean a complete elimination of congestion, rather it means providing adequate infrastructure to deliver mobility at the targeted level of congestion as determined by policy-makers.

It should be remembered that the most direct way to reduce greenhouse gas emissions from vehicles is to improve fuel efficiency. This could be accomplished in two different ways. First, policy-makers could regulate new fuel efficiency standards for all vehicles sold in the marketplace, whether through increasing the stringency of Company Average Fuel Consumption¹⁵ standards or by developing a whole new framework. Second, one of the determinants of fuel efficiency is rolling resistance. Though more relevant to tractor-trailer units than personal vehicles, rigid (concrete) pavements distribute the mass of the vehicle over a broader area than flexible (asphalt) pavements thereby reducing the flexibility in the pavement. This reduces rolling resistance and provides the greatest fuel efficiency of all pavement types.¹⁶

THE PATH FORWARD FOR CANADA

For well over a decade, climate change and greenhouse gas emissions have been relatively high on Canada's federal government agenda. Unfortunately, few concrete actions have been taken to date to mitigate emission levels from any source. In the meantime, despite averaging about 1.5 per cent growth in lane-kilometres per year on the road network,¹⁷ traffic congestion and alternative transportation continue to be important issues in politics at all levels. In search of solutions, some municipalities are undertaking massive public transit investment (Ottawa, Vancouver) while others have embarked on major road network upgrades (Calgary, Saskatoon).

Road Network Capacity in Canada

The net increase in highway kilometres was very small through the 1980s. In 1980, the number of highway kilometres was 874,000. By 1989, this figure stood at 880,000. Building began to accelerate after this, reaching 902,000 kilometres by 1995 (averaging annual growth of 0.4 per cent) and 1.042 million kilometres by 2005 (averaging annual growth of 1.5 per cent). However, it should be noted that, on a per capita basis, the current rate of building is only slightly ahead of the pace of growth in the population over age 15.

- In 1980, there were 46.2 metres of highway per person of driving age.
- By 1995, there were only 38.7 metres of highway per person of driving age.
- In 2005, this figure stood at 39.3 metres.

Sources: The Conference Board of Canada; Transport Canada.

This Conference Board of Canada analysis, and many sustainable development publications¹⁸, suggest that a multi-pronged approach to addressing the fundamental socio-economic determinants of travel demand is required to improve the economic and environmental performance of transportation networks. Continuing "business as usual" practices will only serve to exacerbate the costs of congestion on the economy in terms of the value of time lost, and on the environment in terms of total emissions.

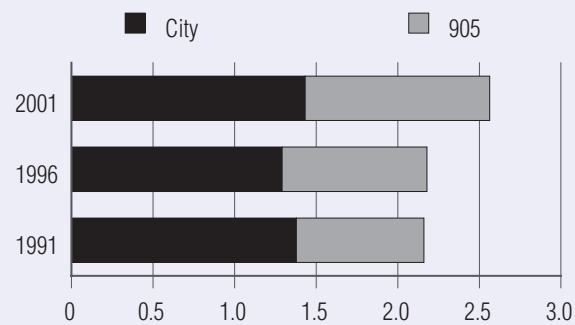
Addressing the fundamental socio-economic determinants of travel demand is required to improve the economic and environmental performance of transportation networks.

Furthermore, the argument can be made that by restricting optimal transportation investment patterns, policy-makers distort private sector investment choice. This manifests itself in property values and influences the vibrancy and use of an urban central business district (CBD). As congestion on the transportation network increases to unpalatable levels, property values close to the CBD increase to capture the value of time saved commuting. Concurrently, property values far from the municipal core are much lower, internalizing the costs of

Chart 2

Employment in the City of Toronto and the 905 Area Code (millions of jobs)

A Canadian example of this distortion of investment choice away from CBDs can be found in Toronto. In the period from 1991–2001, employment growth in the 905 area code including Mississauga, Pickering, Oakville, Markham and others outpaced that of the city proper by a factor of 10.



Sources: Statistics Canada; City of Toronto.

commuting to the CBD. At some point, the prohibitive cost of real estate reaches the point where businesses strategically relocate to suburban areas. (See Chart 2.) If left unchecked, the result of these investment choices is an urban area whose core economic activities are distributed broadly. This results in a situation where mass transit is unable to adequately service citizens' mobility demands and personal vehicles dominate modal choice for all types of trips. If policy-makers actively maintain incentives to locate core economic activities in a CBD, travel demand

to the core should continue to support investment in mass transit, raise ridership levels and enable urban planners to strategically plan future transportation investment. The goal is to deliver a network in which congestion charging and road pricing are able to play a key role in mitigating personal vehicle travel demand because walking, cycling, car pooling and mass transit are viable, efficient and reliable transportation options.

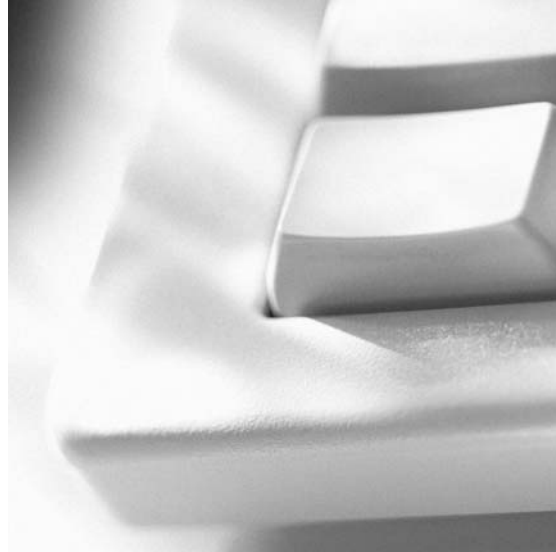
Technical solutions at the vehicle level must also be pursued in partnership with jurisdictions that have similar policy goals. The most likely partners in this context are the Northeastern U.S. states, California and European nations. While Canada itself is a relatively small player in the global automotive marketplace, joining with any one or all of these likely partners will capture a much larger portion of global auto sales.

Mitigating greenhouse gas emissions from the transportation sector requires a combination of policy tools. And in contrast to the findings of international studies, our modelling results indicate that restricting the physical capacity of the road network is not an effective approach for Canada. At the same time, Canadian policy-makers and urban planners must invest today in transportation infrastructure with a keen eye to the future. This will make it possible to design a system capable of fully capturing the benefits of congestion charging and road pricing, while enhancing personal mobility via efficient and reliable mass transit, cycling routes and pedestrian options.

- 1 Lewis M. Fulton et al., "A Statistical Analysis of Induced Travel Effects in the U.S. Mid-Atlantic Region," *Journal of Transportation and Statistics* (April 2000).
- Fotis G. Stathopoulos and Robert B. Noland, "Induced Travel and Emissions from Traffic Flow Improvement Projects," *Transportation Research Record* 1842, paper no. 03-2092.
- Robert B. Noland and Lewison L. Len, "A Review of the Evidence for Induced Travel and Changes in Transportation and Environmental Policy in the United States and the United Kingdom," *Transportation Research D*, 7(1), pp. 1–26.
- 2 "Wasted" in this context refers to consuming energy without doing work. A vehicle idling in congestion is doing exactly this: it is consuming gasoline and emitting greenhouse gases but is not moving the passengers closer to their destination. If, under free-flow conditions, a trip would average 10 litres of gasoline but in congestion averages 20 litres, then 10 litres of gasoline and approximately 25 kilograms of carbon dioxide equivalent is wasted.
- 3 From east to west the cities are: Québec City, Montréal, Ottawa-Gatineau, Toronto, Hamilton, Winnipeg, Calgary, Edmonton and Vancouver.
- 4 Transport Canada, Sustainable Development Branch, Contract No. T8080-01-1593, *Costs of Congestion in Canada's Transportation Sector: Final Report* (March 2005). Submitted by Delcan in association with ADEC and iTrans.
- 5 Transport Canada used three different speed threshold ratings of 50 per cent, 60 per cent and 70 per cent for determining when congestion occurred on the road. These ratings represent the average speed of traffic relative to the free-flow conditions. For example, a roadway has a posted speed limit of 60 km/h but is experiencing an average vehicle speed of 33 km/h. The measure of congestion at the 60 per cent threshold would be the delays between the threshold of 36k/h and the actual speed of 33k/h. Under these same average speed conditions, the roadway is uncongested at the 50 per cent threshold. In order to be congested at the 50 per cent level, the average vehicle speed would have to be less than 30 km/h.
- 6 Transport Canada, Sustainable Development Branch, Contract No. T8080-01-1593, *Costs of Congestion in Canada's Transportation Sector: Final Report* (March 2005). Submitted by Delcan in association with ADEC and iTrans. p. 125.
- 7 *Ibid.*, p. 125.
- 8 David Schrandk and Tim Lomax, *The 2005 Urban Mobility Report*, Texas Transportation Institute, The Texas A&M University System, (May 2005). <http://mobility.tamu.edu>.
- 9 The full-cost user charge on fixed- and low-income Canadians must be considered in the design of the charging system. Various methods such as tax credits and discounting can be used to manage potential financial constraints on their mobility.
- 10 Canada Transportation Act Review Panel, *Vision and Balance: Canada Transportation Act Review* (Ottawa: June 2001), p. 183.
- 11 *Ibid.*, p. 183.
- 12 Transport for London, *Central London Congestion Charging Impacts Monitoring: Fourth Annual Report* [online]. Overview, [cited August 2006]. www.tfl.gov.uk/tfl/cc/london/cc_publications-library.shtml#reports, p. 2.
- 13 www.tfl.gov.uk/tfl/cc-ex/ [accessed September 2006].
- 14 American Highway User's Alliance, *Unclogging America's Arteries: Effective Relief for Highway Bottlenecks 1999-2004* (February 2004), pp. 70–71. www.highways.org.
- 15 This program is a voluntary measure governed by a memorandum of understanding with the automobile industry, but is backed by the Fuel Consumption Standards Act. This act remains unproclaimed, but is available for proclamation if manufacturers fail to deliver agreed performance. This would replace the voluntary agreement with regulated standards [cited September 21, 2006]. www.tc.gc.ca/programs/environment/fuelpgm/menu.htm.
- 16 Tim Smith and Robb Jolly, "Concrete Pavement: A Sustainable Choice", *The 8th International Conference on Concrete Pavements*. Conference held at Colorado Springs, Colorado, August 14–18, 2005.
- G.W. Taylor Consulting in collaboration with Dr. Patrick Farrell and Anne Woodside, *Additional Analysis of the Effect of Pavement Structure on Truck Fuel Consumption* (August 2002). Prepared for Government of Canada Action Plan 2000 on Climate Change Concrete Roads Advisory Committee.
- 17 The Conference Board of Canada; Transport Canada.
- 18 World Business Council for Sustainable Development, *Mobility 2030: Meeting the Challenges to Sustainability* [online], The Sustainable Mobility Project, Overview 2004 [cited September 2006]. www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=NjA5NA.
- L.C. Wadhwa, *Enhancing Urban Sustainability Through Integrated Transport Planning in Three Largest Australian Cities*, WIT Transactions on The Built Environment, Vol. 77 (WIT Press, 2005).
- Tracy Wolf and Jena Carter, *Growing with Less Greenhouse Gases*, (National Governors Association Center for Best Practices, 2002), [online]. [cited September 2006]. www.nga.org/portal/site/nga/menuitem.9123e83a1f6786440ddcbeeb501010a0/?vgnextoid=1a92303cb0b32010VgnVCM1000001a01010aRCRD.

APPENDIX

Data Sources		
Input	Source	Notes
Vehicle scrappage rates	Natural Resources Canada; Champagne Model	Vehicle scrappage rates are used to estimate the size of the fleet.
Vehicle sales	Statistics Canada	Provides monthly sales data.
Fleet size	Statistics Canada; Natural Resources Canada	Applying scrappage rates to a historical data set of new vehicle sales estimates the size of the operational fleet.
Consumer Price Index	History; Statistics Canada Forecast; The Conference Board of Canada	
Share of population in urban areas	History; Statistics Canada Forecast; The Conference Board of Canada	
Vehicle-kilometres traveled	Canadian Vehicle Survey (2000-2005); National Personal Vehicle Use Survey (1995); Fuel Consumption Survey (1982-1989)	These three sets of data were harmonized by creating kilometres traveled per vehicle data points from each set. The fleet estimates generated from the sales data were then applied to estimate total vehicle-kilometres traveled. Significant data gaps in the 1990s.
Lane-kilometres	Transport Canada Annual Report (1996 and 2005)	Significant data gaps in the 1990s.



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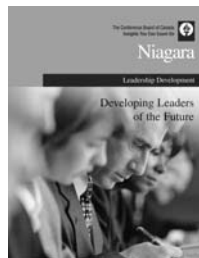
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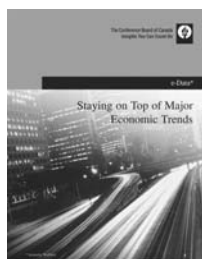
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Build It and Will They Drive? Modelling Light-Duty Vehicle Travel Demand

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