ESTIMATING THE FINANCIAL COSTS OF LIGHT ROAD VEHICLES IN CANADA

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1 INTRODUCTION

Canadian passengers prefer light road vehicles to other land transportation modes. OECD statistics place Canada along with the United States at the top of the list in terms of private car use, with roughly nine out of ten passengers using private cars rather than trains or buses. As a reference, European countries average eight out of ten, and Japan six out of ten.

According to Canadian Vehicle Survey (CVS) micro data compiled by this research, in the year 2000 close to 16 million light road vehicles traveled more than 280 billion kilometres on Canadian roads. Putting the number of vehicles in perspective, the Census of Population by Statistics Canada reports a little more than 13 million Canadians employed in the year 2001, of which, more than 10 million individuals commute to work by car, truck or van. Statistics Canada and the US Department of Transportation estimate a rough one-fifth of average household expenditure in transportation of which, more than 90 percent goes towards a private vehicle.

This paper will argue that in Canada for the year 2000, the financial cost of light road vehicles could be estimated around $80 billion

[1] Views expressed in this paper benefited from numerous exchanges between the authors and the Transport Canada FCI team and the provincial FCI Task Force members during Nathalie Olds's internship at Transport Canada. However, these views do not necessarily reflect those of Transport Canada, the FCI Task Force, or the University of Ottawa.

dollars. In producing the estimates presented, this research considered differences in unit cost, intensity of vehicle use, and vehicle fleet size by geographical region, by vehicle class, and by vehicle age.

Estimating the financial cost of light road vehicles in Canada is part of a broader project called the Full Cost Investigation (FCI). The FCI was launched by Transport Canada in partnership with provincial and territorial departments of transport. Its purpose is to measure financial and social cost of transportation for various modes. It is expected that cost estimations produced by the FCI would provide the basis for efficiency comparisons across modes, the analysis of distribution issues, and appropriate public policies.

An important component of the FCI project is intermodal comparison. Many modes are specific to either intercity or intracity travel, so it is important to discriminate between intercity and intracity travel for light road vehicles. For this reason, this study also presents cost estimates for intercity and intracity travel, as well as for travel on highways. The following sections present the methodology and data sources used, the cost estimates and conclusions.

2 METHODOLOGY AND DATA SOURCES CHALLENGES

The basic methodology follows the approach taken by the FCI project. Unit cost categories are estimated as a first step, and then total cost is built up by making the necessary connections with the corresponding intensity of use estimations for similar categories, and with records of the number of vehicles registered in Canada.

The estimates are produced at a level of detail that distinguishes light vehicles by provinces and territories; by 11 classes of vehicles, by six age groups, and by the intensity of use of unpaved roads. Costs estimates were obtained by multiplying unit cost per vehicle-kilometre traveled times the number of vehicle-kilometre traveled (VKT) for each of the categories of vehicles described above. It should be noted that intensity of use given by the VKT encompasses two dimensions: the number of kilometres traveled per vehicle, and the number of vehicles.

Data sources for this study match the two variables mentioned above. The source of unit cost estimates is “Estimation of Costs of Cars and Light Trucks Use per Vehicle-Kilometre in Canada” (2006). The cost components considered by the unit cost study are fixed costs such as depreciation, insurance premiums, opportunity cost of capital, registration or licence fees, road or bridge tolls, and parking; and operating costs such as fuel including fuel taxes, maintenance, and other non-fuel operating costs.

A second basic reference in this study is the Canadian Vehicle Survey (CVS). It provides estimates of VKT classified by province, vehicle class (five relevant classes) and age (not the exact same vintage classes as the previous study) in the year 2000.

A third data source is a consolidated database of registered vehicles. It provides the number of light road vehicles that were registered in Canada in the year 2000 by province, by vehicle type, and by age, which may serve as a reference for the VKT figures from the CVS. Other data sources consulted during this research include the vehicle counts at border crossing points between Canada and the US, the International Travel Survey, and the Labour Force Information reports by Statistics Canada.

This research faced five basic challenges related to: data sources different treatment of vehicle classes and vintage, fleet size, unpaved road usage, territories data, and the US-registered vehicles use of the Canadian road network. Each of the five challenges and its solutions are being discussed in the following paragraphs.

First, only five vehicle classes in the CVS could be indirectly identified to some of the 11 vehicle classes taken from the unit cost study “Estimation of Costs of Cars and Light Trucks Use per Vehicle-Kilometre in Canada” (2006). The details of five classes of cars and three classes of vans cannot be obtained from the CVS, therefore, will either be lost or would have to be estimated. This study chose to estimate the VKT for each one of the separate vehicle classes in the unit cost study not present in the CVS (five classes of

cars and 3 classes of vans). The vehicle vintage classes presented in this study were estimated from CVS micro data.

Second, the Canadian Vehicle Survey VKT estimates were calculated using a fleet size that is not a perfect match to the registry of vehicles. The vehicle identification number (VIN) cannot be decoded for vehicles built before 1986. Therefore, the vehicle registry underestimates the older vehicles group by about one million units. This study included estimations of the missing old vehicles from the CVS vehicle counts, and made the necessary corrections to the fixed costs elements of the unit cost study, that does not seem to have included the missing old vehicles.

Third, the unit cost study includes the breakdown between paved and unpaved roads. The CVS does not offer this level of detail. Given the volume of total VKT and the *relatively* smaller difference between unit costs on paved and unpaved roads, any discussion on intensity of use for the unpaved road network becomes academic. However, this research estimated appropriate weights to be assigned to the intensity of use by paved and unpaved roads before merging it with unit cost per VKT data. In this respect the following assumptions were found to be relevant: only vehicle owners in rural areas for specific economic activities (such as farming) use the unpaved road network to a significant extent, all vehicle owners minimize the use of unpaved roads, the road network provides each location with easy and short access to paved roads, and the majority of the Canadian population lives near the national highway system.

Fourth, the unit cost study includes data on Yukon and Northwest territories when estimating the average unit cost per VKT; however it does not include Nunavut. Assuming that Nunavut roads are all unpaved, this study estimated unit cost in Nunavut based on the information available for the unpaved roads in the Northwest Territories in our unit cost source. Further refinement of this research would include adding the differences in fuel price to the unit cost in different territories. In terms of the fleet size, this study uses CVS data for estimating all vehicles in Nunavut, since this territory is not included in the registry file for the year 2000. All the VKT in

territories were based on the CVS for the year 2001, as the year 2000 data was not available.

Fifth, the CVS provides VKT data for two types of travel: travel on highways, and general travel, or travel on all roads (including highways). This means that no distinction is made between intercity and intracity travel. To differentiate between these types of travel, it is assumed that VKT on roads other than highways are traveled within a city, whereas VKT on highways are assumed to be either intercity or intracity travel. A good indicator for the type of travel on highways is the length of individual trips; short trips are most likely intracity travel, and long trips are most likely intercity. Following this reasoning, a threshold of 25 kilometres was determined using the average land area of Canadian cities, weighted by population. Intracity travel is assumed for trips on highways whose VKT are below this threshold, and intercity travel is assumed for trips on highways whose VKT are above this threshold. Having allocated VKT by travel type, it is possible to estimate costs for intercity and intracity travel, as well as for highways. It is important to note that

Last, this research estimated the cost of US-registered vehicles on Canadian roads to be close to $636 million, less than one percent of the total cost of Canadian-registered vehicles on Canadian roads for the same year. Even though more than 17 million US-registered vehicles used Canadian roads at least once in the year 2000, the majority of these vehicles visited Canada for less than 24 hours. Therefore it makes more sense to compare the daily average of 80, 697 US vehicles on Canadian roads with the 15,969,967 Canadian vehicles. Given the similarities in person-visits figures from both sides of the border, it was assumed that the Canadian vehicles travel in the US compensates for the US vehicles travel in Canada.

3 COST ESTIMATES

The total cost estimates are presented in three dimensions: by vehicle class and vintage (with an analysis of the fixed cost component included), and by province.

Table 1: Total financial cost estimates, average distance per vehicle, and fleet size by vehicle class and vintage, SOCC 6%, year 2000.

Vehicle Class	**Total Cost** Millions $	**Fleet Size** Number of vehicles	**Average distance per vehicle** Km	**Average total cost**	
				Per vehicle Dollars	**per km** Dollars
Two-seaters	365	98,360	14,150	3,707	0.25
Sub-compact	9,744	2,420,900	16,651	4,025	0.23
Compact	15,587	3,695,841	17,101	4,217	0.24
Midsize	11,136	2,433,994	16,523	4,575	0.26
Full Size	5,133	1,009,494	16,311	5,084	0.30
Station wagon	1,938	495,438	15,625	3,912	0.25
Minivan	8,698	1,382,674	20,484	6,290	0.30
Passenger Van	2,541	438,819	18,838	5,792	0.31
Cargo Van	1,605	330,777	18,250	4,852	0.26
SUV	8,507	1,121,012	20,033	7,589	0.37
Pickups	13,700	2,542,658	18,112	5,388	0.30
Sum /Average	**$ 78,954**	**15,969,967**	**17,562**	**$ 4,944**	**$ 0.27**
Vehicle Vintage (Age) Years					
0 to 2	23,949	3,058,181	23,130	7,831	0.34
3 to 5	19,351	2,959,760	21,547	6,538	0.30
6 to 8	15,103	3,085,540	18,592	4,895	0.26
9 to 11	10,842	3,090,102	14,623	3,509	0.24
12 to 14	6,518	2,232,421	12,839	2,920	0.23
15 and older	3,190	1,543,964	9,545	2,066	0.22
Sum / Average	**$ 78,954**	**15,969,967**	**17,562**	**$ 4,944**	**$ 0.27**

A separate sub section discusses the cost estimates associated to the use of roads with a posted speed limit of 80 kilometres and more, along with a brief introduction to intra-city versus inter-city travel.

Table 1 above shows the cost estimates for the year 2000 by vehicle class for a social opportunity cost of capital (SOCC) of 6 percent. Raising the SOCC to 8.6 percent increases total cost to $82.5 billion. Total cost is the product of unit costs per VKT and the VKT estimates produced by this research for each category from CVS micro data. The estimates of average cost per kilometre are consistent with the number of vehicles and VKT from the registry and the CVS intensity of use estimates for each cost category; therefore they are not simply the weighted average of the unit cost estimates by category.

From the table above some patterns could be identified from a brief inspection of cost estimates through vehicle classes. Larger size vehicles tend to have a higher cost per kilometre (for example SUVs with a cost per kilometre of $0.37) and higher intensity of use (SUVs and Minivans) as given by the average distance traveled per year. The intensity of use and the average cost per kilometre decrease sharply with vehicle age. After 12 years the average distance traveled decreases almost in half, and the cost per vehicle decreases roughly by two thirds. More detailed cost estimates for the SOCC of 8.6 percent are available in the full paper produced by the Transport Canada FCI.

The fixed component of total cost is 55 percent in average. Taking the example of a compact car, the average annualised cost per vehicle is $4,217 dollars, of which, $2,333 dollars is the average annualised fixed cost. The remaining $1,884 dollars represent the annualised operating cost, which implies an average operating cost per kilometre of 11 cents, assuming an average of 17,101 kilometres traveled per year. ***Table 2*** below shows the fixed component of total and average cost by vehicle class.

The fixed component proportion of total cost tends to be higher for new vehicles. Fixed costs represent 66 percent of the total cost of a new vehicle, and drops to close to 40 percent after 12 years of vehicle age. In terms of provincial differences, the fixed cost component of total cost tends to be high in Ontario (55 percent), and Manitoba (56 percent), and low in Prince Edward Island and Nova Scotia with 48 and 49 percent respectively.

The fixed cost component of total cost includes parking costs that were estimated to average $4 dollars per trip that parking is priced. Even though this amount may not match the reality of individuals that commute to work in downtown areas of large cities where the average daily cost is higher, it does capture the reality of individuals that do not pay for parking at all or share parking costs.

Table 2: Fixed cost component of cost estimates, and fleet size by vehicle class, SOCC 6%, year 2000.

				Average fixed cost	
Vehicle Class	**Fixed Cost** Millions $	**As % of total cost**	**Fleet Size** Number of vehicles	**per vehicle** Dollars	**per km** Dollars
Two-seaters	217	59%	98,360	2,208	0.14
Sub-compact	5,653	58%	2,420,900	2,338	0.13
Compact	8,611	55%	3,695,841	2,333	0.13
Midsize	6,240	56%	2,433,994	2,566	0.14
Full Size	3,046	59%	1,009,494	3,021	0.17
Station wagon	960	50%	495,438	1,943	0.12
Minivan	4,951	57%	1,382,674	3,587	0.17
Passenger Van	1,368	54%	438,819	3,128	0.17
Cargo Van	708	44%	330,777	2,147	0.11
SUV	5,286	62%	1,121,012	4,738	0.22
Pickups	6,596	48%	2,542,658	2,612	0.14

Sum /Average	**$ 43,636**	**55%**	**15,969,967**	**$ 2,739**	**$ 0.15**

Since the average number of passengers was found to be 1.65, the average cost per kilometre per capita oscillates around $0.17, with a maximum of $0.24 for SUVs and a minimum of $0.15 for sub-compact and compact cars.

Table 3: Cost estimates, average distance per vehicle, and fleet size by province and territory, SOCC 6%, year 2000.

Province or Territory	**Total Cost** Millions $	**Fleet Size** Number of vehicles	**Average distance per vehicle** Km	**Average total cost**	
				per vehicle Dollars	**per km** Dollars
NF[2]	1,340	229,564	20,808	5,839	0.27
PE[3]	328	68,925	18,589	4,766	0.25
Nova Scotia	2,344	483,380	17,794	4,850	0.27
New Brunswick	2,388	415,943	20,364	5,740	0.27
Quebec	15,992	3,555,545	16,972	4,498	0.26
Ontario	32,258	6,043,076	17,820	5,338	0.29
Manitoba	2,658	591,040	16,227	4,498	0.26
Saskatchewan	2,733	585,818	18,134	4,665	0.25
Alberta	9,455	1,830,569	19,411	5,165	0.26
BC[4]	9,273	2,125,183	15,486	4,363	0.28
Yukon	79	19,966	14,671	3,948	0.26
NT[5]	93	18,184	16,962	5,122	0.29

[2] Newfoundland and Labrador
[3] Prince Edward Island
[4] British Columbia
[5] Northwest Territories

Nunavut	12	2,774	14,617	4,340	0.32
Sum /Average	**$ 78,954**	**15,969,967**	**17,562**	**$ 4,944**	**$ 0.27**

The average cost per passenger tends to be high in Ontario and British Columbia at $0.18 per kilometre, while Saskatchewan and Quebec present a low cost of $0.15 and $0.16 per kilometre. The average number of passengers decreases with vehicle age, and so the average cost per kilometre per passenger. Total cost estimates by province and territory follows on ***Table 3*** above.

Vehicles registered in Ontario represent 38 percent of the fleet and 41 percent of the total cost of light vehicles in Canada. In Ontario the average cost per kilometre, average cost per vehicle, and average distance traveled per vehicle tend to be above the national average. Quebec occupies second place in terms of total cost and fleet volume, with 20 percent of the total cost, and 22 percent of the fleet. In Quebec the cost per kilometre, average cost and average distance traveled per vehicle tend to be below the national average. British Columbia and Alberta follow Quebec in that order in terms of fleet size, although Alberta's total cost is higher due to the higher average distance traveled per vehicle compared to British Columbia.

3.1 COST ESTIMATES BY TRAVEL TYPE

Examining costs by travel type provides further insight into light road vehicle use in Canada. In addition to general travel, three types of travel are explored in this study: highway, intercity, and intracity.

Table 4 presents the highway travel estimates for total and average cost, as well as for fleet size and average distance per vehicle. Highway estimates were produced using highway VKT data from the CVS and unit costs which were adjusted downward to account for the increased fuel efficiency highway driving incurs. The estimates below are for provinces only. Accordingly, the fleet size has been adjusted to exclude vehicles registered in the territories. Note that there is no adjustment to the number of vehicles within a province between highway and overall estimates. This reflects the assumption

that all light road vehicles in the Canadian fleet have the potential for all types of travel.

Table 4: Financial cost estimates, average distance per vehicle, and fleet size by vehicle class and vintage on highways, SOCC 6%, year 2000, provinces only.

				Average cost	
Vehicle Class	**Total Cost** Millions $	**Fleet Size** Number of vehicles	**Average distance per vehicle** Km	**per vehicle** Dollars	**per km** Dollars
Two-seaters	176	98,284	7,403	1,789	0.227
Sub-compact	4,702	2,417,626	8,808	1,945	0.213
Compact	7,613	3,691,219	9,148	2,063	0.218
Midsize	5,372	2,431,568	8,839	2,209	0.237
Full Size	2,497	1,008,365	8,782	2,476	0.266
Station wagon	1,005	493,833	8,970	2,034	0.223
Minivan	4,017	1,380,389	10,434	2,910	0.276
Passenger Van	1,134	437,417	9,326	2,592	0.281
Cargo Van	728	329,471	9,374	2,209	0.234
SUV	4,417	1,115,489	11,119	3,960	0.341
Pickups	6,819	2,525,382	9,986	2,700	0.269
Sum /Average	**38,479**	**15,929,043**	**9,402**	**2,416**	**0.247**
Vehicle Vintage (Age) Years					
0 to 2	11,927	3,050,507	12,458	3,910	0.316
3 to 5	9,864	2,952,298	12,044	3,341	0.277
6 to 8	6,897	3,078,688	9,431	2,240	0.236
9 to 11	4,973	3,082,662	7,494	1,613	0.217
12 to 14	3,231	2,226,496	7,116	1,451	0.202
15 and older	1,589	1,538,392	5,341	1,033	0.202

Sum / Average	**38,479**	**15,929,043**	**9,402**	**2,416**	**0.247**

As with the overall estimates presented earlier, larger vehicles have higher per kilometre costs, though they are slightly below overall per kilometre costs as their unit costs have been adjusted downward. Intensity of use is also higher in larger vehicles. Similar trends also exist when estimates are broken down by vehicle class. Again, as with general travel, highway travel results show that all costs decrease over time, as does intensity of use.

Table 5 below compares the total, average, and operating costs of the different types of travel. Total and per vehicle costs for intracity travel on highways are the lowest costs by far, but this is due to the fact that intracity trips on highways are short – less than 25km by definition. This means that intracity VKT on highways are low, resulting in low costs per vehicle. Intracity per kilometre costs on highways, however, are higher because fixed costs are distributed over a smaller distance. Note that operating costs are the same for all types of travel on highways.

Table 5: Financial cost estimates, SOCC 6%, year 2000, provinces only.

Type of Travel	**Total Cost** Millions $	**Average cost**		**Operating cost**	
		per vehicle Dollars	**per km** Dollars	**per vehicle** Dollars	**per km** Dollars
Highway	38,479	2,416	0.247	945	0.101
Intercity	30,021	1,885		732	
Intracity (Hwy)	8,458	531		212	

Table 6: Financial cost estimates, average distance per vehicle, and average passengers per vehicle, SOCC 6%, year 2000, provinces only.

Type of Travel	**Average distance per vehicle** Km	**Average number of passengers per vehicle**	**Average cost per passenger per km** Dollars	**Operating cost per passenger per km** Dollars
Highway	9,402	1.732	0.147	0.061
Intercity	7,296	1.809	0.142	0.059
Intracity (Hwy)	2,105	1.466	0.172	0.071

Table 6 compares the average distance per vehicle, the average number of passengers per vehicle, and the average and operating costs per passenger per kilometre of the different travel types. Of primary interest is the average number of passengers per vehicle. As would be expected, vehicle occupancy is highest for intercity travel and lowest for intracity travel. Highway vehicle occupancy is in the middle as it includes some of each type of travel. Average and operating costs per passenger per kilometre reflect both the trends in vehicle occupancy and the lower unit costs for highway travel.

4 CONCLUSION

This paper presented preliminary[6] financial cost estimates for the light road vehicles that used the Canadian road network in the year 2000. Based on the unit cost study "Estimation of Costs of Cars and Light Trucks Use per Vehicle-Kilometre in Canada" (20006) and the Canadian Vehicle Survey, among other sources, the total cost at a six percent social opportunity cost of capital is $78.9 billion[7] including

[6] Figures in this paper are susceptible to change as the FCI progresses towards its completion.

[7] For industry-based GDP comparisons, the economic activities related to light road vehicles transportation would have to be measured by the value of the output produced

depreciation and fuel taxes, with an average cost per vehicle of $4,944, and an average cost per kilometre of $0.27. The average distance traveled per vehicle is 17,562 kilometres. The total cost of US-registered vehicles that traveled on Canadian roads was estimated to be $ 0.6 billion, for a 0.8 percent of the total cost of Canadian-registered vehicles.

At a social opportunity cost of capital of 8.6 percent, total cost reaches $82.5 billion, with an average cost per vehicle of $ 5, 166, and average cost per kilometre of $0.28. These cost estimates include the Canadian use of the US road network, but exclude the US-vehicles use of the Canadian road network, which are assumed to compensate for each other.

The total cost of highway travel was estimated in $38,479 million of which, $30,021 million corresponds to intercity highway travel at a social opportunity cost of capital rate of six percent

Across provinces at a six percent social opportunity cost of capital, the total financial cost of light road vehicles reaches a maximum of $32.2 billion in Ontario, followed by $15.9 billion in Quebec, $9.4, and $9.3 billion in Alberta and British Columbia respectively. In Nova Scotia, New Brunswick, Manitoba, and Saskatchewan the total cost of light road vehicles falls within the range of $ 2.3 to $ 2.7 billion. Newfoundland and Prince Edward Island are the provinces with lower total cost, at $1.3 and $ 0.3 billion respectively. The total cost for Yukon, Northwest Territories and Nunavut is $0.2 billion.

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by the activity, minus the value of intermediate inputs. Notice that the main "output" related to light road vehicles are transportation services rendered by the vehicle owners to themselves, and one of the main inputs, which is fuel (taxes included) is included in our estimations.

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