Transports Québec

Economic Study

Use of Supersingle Tires by Heavy Vehicles Operating in Québec

FINAL REPORT

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Use of Supersingle Tires by Heavy Vehicles Operating in Québec

FINAL VERSION

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SUMMARY

The purpose of this study was to evaluate the costs and benefits of proposed amendments to Québec's *Vehicle Load and Size Limits Regulation* that would eliminate the 1 000 kg per axle penalty currently applied to heavy vehicles equipped with "supersingle" tires, along with the related special permit for the spring-thaw period. The analysis used data for the year 1999, expressed in 2004 dollars. It covered intercity travel within Québec, between Québec and Ontario, and between Québec and the United States. Local travel and travel to the Maritime Provinces and to Western Canada were excluded. Likewise, in assessing the costs of damage to the road network, only the primary road network in Québec was considered, and the local road network was excluded.

The proposed regulatory amendments would significantly increase the payloads that could be transported by tractor/semi-trailer combinations, particularly on intercity trips within Québec, for which the maximum payload would increase by 14% to 16%, depending on the vehicle configuration. The maximum payload would also increase for Québec-Ontario trips by vehicles less than 14.65 m long (which account for 24% of all vehicles travelling between these provinces), as well as for Québec-Ontario trips (all types combined) and for Québec-United States trips during the spring-thaw period. There would be no direct gain for 76% of Québec-Ontario trips or for cross-border trips outside the spring-thaw period.

Outside the spring-thaw period, the new amendments would allow relatively substantial reductions (14% to 29%) in the number of trips by the largest vehicles (6 axles or more) making trips within Québec. During the spring-thaw period, the reductions would be substantial for all types of trips, all markets, and all configurations (on the order of 10% to 29% for 5-axle combinations, and greater for heavier configurations).

Our economic analysis considered the following direct costs and benefits of the regulatory amendments, which would affect the loads carried by tractor/semi-trailer combinations equipped with supersingle tires, as described above:

- The direct costs, including damage to the road network, assumed by the Ministère des Transports du Québec (MTQ, the Québec transport ministry) as manager of the primary road network;
- The direct benefits in the form of reduced operating costs for the trucking industry, which the amendments would allow to transport larger payloads on full-load trips.

Under the first scenario we analyzed, in which all heavy vehicles operating in Québec switched to supersingle tires in place of conventional dual tires, the direct additional costs for maintenance of the road network administered by the MTQ would total $38.7 M/year, compared with direct operational savings of $49.0 M/year for the trucking industry, thus generating a positive direct current value of $10.3 M/year. The direct net value would be positive for 6- and 7-axle configurations, but negative for vehicles with 2 to 4, 5, and 8 or more axles. The differences in these results relate to the proportion of trips at close to maximum load and to the proportion of Québec-based carriers in each vehicle category.

We also analyzed other costs and benefits related not to the proposed regulatory amendments directly, but rather to the use of supersingle tires instead of dual tires even without these amendments. The indirect costs would consist mainly of the higher costs of purchasing and retreading supersingle tires ($7.7 M/year). The indirect benefits would be numerous. For the trucking industry, they would include a reduced number of trips, resulting from the reduced weight of tires and wheels ($6.1 M/year); reduced fuel consumption ($34.3 M); and reduced maintenance costs ($4.0 M). For society as a whole, the indirect benefits would include reduced vehicle emissions ($17.8 M/year), reduced used-tire-disposal costs ($0.4 M/year), and improved road safety ($1.4 M/year).

Overall, the direct and indirect costs and benefits in our Scenario 1 would have an aggregate net value of $66.6 M/year, for an aggregate benefit/cost ratio of 2.43:1. This ratio would be positive for all vehicle configurations. In general, the trucking industry would be better off using supersingle tires instead of conventional dual tires, which could produced a change in the industry even with no regulatory amendments. The use of supersingle tires would be positive in the aggregate for society and industry combined, with the benefits outweighing the costs for all vehicle configurations. However, for a number of configurations, the regulatory amendments would result in direct societal costs that exceeded the direct operational savings for the industry.

A large portion (more than 47%) of the incremental indirect benefits found in this economic analysis depend on the reduction in fuel consumption, and hence in fuel costs, resulting from using supersingle tires. The actual percentage reduction in fuel consumption and the actual price of fuel are therefore two factors that can significantly affect the actual results. The likely size of the reduction in fuel consumption, for which various sources provide widely varying values, should therefore be clarified. Note also that the rising price of diesel fuel tends to increase the benefits of using supersingle tires.

The overall distribution of the impacts of switching to supersingle tires among the various stakeholders is as follows: the MTQ (the Québec government ministry that manages the primary road network) would incur a recurring net cost of $38.8 M/year, the trucking industry would enjoy a recurring cost savings of $85.8 M/year, and society would enjoy environmental and safety improvements equivalent to a recurring benefit of $19.6 M/year.

In another scenario that we analyzed, we assumed that the Québec regulations affecting supersingle tires would be harmonized with the U.S. regulations for 5-axle combinations only. In this scenario, the direct benefits for the trucking industry would be slightly lower than the additional costs of maintaining the primary road network ($3.4 M/year compared with $3.7 M/year). But the other benefits would be substantial: the overall benefit/cost ratio for this scenario is 4.71:1.

Table of Contents

List of Tables

INTRODUCTION

BACKGROUND

For vehicles travelling on the Québec road network, the Québec *Vehicle Load and Size Limits Regulation* (RSQ, c. C-24.2, r.1 .02, sec. 13) imposes a reduction of 1 000 kg in the maximum axle load for each axle (excluding steering axles) equipped with only two (single) tires. This regulation was amended in 1991 to apply this load restriction to all vehicles equipped with axles with two tires, both during normal periods and during the spring-thaw period.

In Fall 2000, Michelin introduced a new type of single tire with an extra-wide tread. According to Michelin, this new tire caused no more damage to the road network than conventional dual tires. But various studies demonstrated that wide-tread tires such as Michelin's X One (455/55R22.5) are in fact more aggressive and do cause more damage to the road pavement than dual tires. The most recent of these studies recommends that vehicles using such "supersingle" tires be subject to a 10% reduction in maximum axle load.

In Québec, the load-bearing capacity of road pavements varies with seasonal climate conditions and is lowest in spring, when the roads are thawing. During the spring-thaw period, special restrictions are therefore imposed on axle loads to protect the road network from the excessive damage that can be caused by heavy traffic. The maximum load on tandem axles equipped with single tires is 16 000 kg during normal periods but is reduced to 13 500 kg during the spring-thaw period. In the United States, the trend is toward the routine use of supersingle tires, with a year-around maximum load of 15 450 kg for tandem axles.

Since 2002, Québec has allowed the use of supersingle tires with axle loads exceeding 13 500 kg (up to a maximum 15 500 kg) during the spring-thaw period, subject to the purchase of a special permit. The permit fee is $750 for a set of vehicles or $375 per unit. This fee has been calculated on the basis of the damage that loads equivalent to the U.S. standard would cause to the infrastructure of those Québec highways that provide commercial links with the United States.

This difference between Québec and U.S. regulations creates some inconveniences for certain trucking firms whose vehicles travel to the United States regularly. The Ministère des Transports du Québec (MTQ—Québec ministry of transport) is therefore considering improved harmonization of its regulations to let Québec firms optimize their operations on trips to and from the United States. The result would be to stimulate economic activity in Québec.

Against this background, and to follow up on the technical studies that have already been done, the present study was conducted to analyze this subject, taking into account safety considerations, economic considerations, impacts on roads and on the environment, and the interests of the trucking companies concerned.

PURPOSE OF THIS STUDY

The purpose of this study was to analyze the economic benefits and costs of using supersingle tires, according to various scenarios for amending the existing regulations, and thereby identify the solution that would be optimal for society as a whole. The scenarios differed as to the portion of the trucking fleet that would convert to supersingle tires and the nature of the regulatory amendments that would be adopted. Examples of the potential benefits and costs examined include the potential savings for trucking companies if the 1 000 kg penalty on axles equipped with single tires were eliminated, the social costs associated with the environmental and safety impacts of these tires, and the effects of these tires on costs for maintaining and repairing the road network.

METHODOLOGY

To document our analysis of the impacts of using supersingle tires on heavy vehicles in Québec, we consulted the manufacturers of these tires (Michelin and Bridgestone) and conducted a direct survey of the Québec trucking firms that held special permits to use these tires during the 2004 spring thaw. In total, there were seven such firms, and they held a total of 237 permits. All seven firms participated in the survey, which was conducted by telephone in December 2004. Two of this survey's main objectives were to assess these firms' perceptions about their use of supersingle tires and thereby to indirectly validate the information provided by the tire manufacturers. The topics covered included the impact of these tires on fuel consumption, safety, maintenance costs, and tire wear, as well as the truckers' interest in deregulation of the load penalties, and so on.

To simplify the analysis and the presentation of the results, we assessed the impacts of supersingle tires for the following configurations of vehicles: 2 to 4 axles, 5 axles, 6 axles, 7 axles, and 8 axles or more. To differentiate the situations for each of these configurations and for the various classes of road networks, we have presented the results of our analyses for the following markets separately: trips within Québec, trips between Québec and Ontario, and trips between Québec and the United States.

To quantitatively assess the impacts for each of these vehicle configurations and markets, we had to characterize the traffic (number of trips and distances travelled) for each of them. For this purpose, we used data that the MTQ extracted especially for this purpose from the database of responses to the roadside survey conducted by the Canadian Council of Motor Transport Administrators (CCMTA) in 1999.

We determined the distribution of trips by market and by vehicle configuration from the results of this survey. These results cover one week in the fall of 1999. To estimate the number of trips made annually, we assumed that the patterns observed in the survey for that week hold for the rest of the year as well. (Note that the survey database deals with intercity trips, because the survey was conducted at various locations on the primary road network. Strictly local trips have therefore been excluded from the calculations.)

Our economic calculations reflect the situation in Québec in 1999, and all monetary values have been expressed in constant 2004 dollars. The benefits and costs have been calculated in accordance with the principles of economic assessment and cost/benefit analysis. In other words, these benefits and costs: a) represent all of the impacts on all economic and social agents, b) have been included regardless of whether they give rise to monetary transactions (hence they include externalities), and c) have been compared to a reference situation (the *status quo*).

This reference situation or *status quo* represents the volume of trips and the markets in 1999 with the monetary units for 2004. It consists of all intercity trips made by heavy freight vehicles that operate in Québec, including the portion of these trips made outside Québec. It includes three markets: intraprovincial intercity trips (trips entirely within Québec), trips between Ontario and Québec, and trips between Québec and the United States. It does not include any other intercity trips (for example, between Québec and the Atlantic provinces or Québec and Western Canada) or any trips entirely within a given city. For this reference situation, it was assumed that the existing regulations, with the 1 000 kg axle load reduction and the special permit, remained in force.

Because the set of costs and benefits varies with the number of kilometres travelled, we were able to express our calculations in terms of a typical year, rather than the multi-year time horizon used in standard cost/benefit analyses. We therefore did not have to choose a discount rate. It should also be remembered that the purpose of this study was to estimate the impact of the proposed amendments using tools of economic analysis, and not to determine the precise results for the economy (for example, with the kind of input/output tables employed by the Institut de la statistique du Québec).

CONTENTS OF THIS REPORT

This report is divided into two chapters. Chapter 1 presents a detailed description of the assumptions and data used in our analysis, and our estimates of the economic value of each of the benefits and costs identified. Chapter 2 presents the results of these estimates for each of the scenarios that we analyzed.

Appendix A presents the meaning of some abbreviations and specific terms used in this report. Appendix B presents the questionnaire used in the survey of trucking firms that held special permits for supersingle tires in 2004. Appendix C presents the detailed calculations for our economic analysis, while Appendix D describes the detailed results for each scenario, each vehicle configuration, and each geographic market.

1 DATA AND ANALYSIS

1.1 ASSUMPTIONS

1.1.1 Assumptions Regarding Amendments to Québec Regulations

We tested two different assumptions regarding amendments to the Québec regulations that affect supersingle tires:

- Under the first assumption, the 1 000 kg load penalty per group of axles equipped with supersingle tires would be eliminated for all vehicle configurations and all times of year, and the special permit currently required during the spring-thaw period would also be eliminated;
- Under the second assumption, the Québec regulations regarding supersingle tires would be made identical to the U.S. regulations throughout the year, but for 5-axle vehicles only; in other words, the maximum allowable load for tandem axles with supersingle tires would be 15 500 kg all year around, rather than 16 000 kg during normal periods and 13 500 kg during the spring-thaw period. The maximum total loaded mass* for 5-axle vehicles equipped with supersingle tires would therefore become 36 500 kg all year around.

1.1.2 Physical Quantities

In order to quantify the various impacts of any phenomenon on society as a whole, information is needed on the quantitative characteristics of that phenomenon itself. The impacts of using supersingle tires rather than dual tires depend essentially on the total distances travelled by heavy vehicles and on the types of heavy vehicles involved. The effects on the road network also depend on the class of road. In addition, the distinction must made between: a) the number of kilometres travelled on the Québec road network, which affects the costs that Québec society incurs to maintain this network; and b) the number of kilometres travelled by Québec-based trucking firms, which determines the operating costs of these firms and a portion of which is travelled outside of Québec, especially in the case of intercity trucking and, consequently, vehicles with 5 axles or more. Our calculations therefore covered the kilometres travelled inside and outside of Québec, by class of road, vehicle configuration, and market (intraprovincial, interprovincial and cross-border).

* Official term per Québec regulations. Appears to be equivalent to “maximum gross vehicle weight”. -tr

The increase in the maximum total loaded mass for vehicles equipped with supersingle tires would result in an increase in their payloads, i.e., the weight of goods transported. The amount of this increase would depend on whether a truck was fully loaded—in other words, on whether the total load equalled the maximum allowed by the regulations before the amendments, and on whether the entire loadable volume was filled. We therefore needed to know the distribution of trips by total loaded mass and by payload. Lastly, the extent to which an increase in the payload per trip reduces the number of trips depends on the ratio between the total mass increase resulting from the amendments and the payload without the amendments, and this ratio can vary with the configuration of the vehicles. Moreover, the gain in payload varies with the destination of the goods, because of the differences among the regulations of the various jurisdictions. For example, since the maximum total loaded mass in the United States is generally lower than in Québec, the payload for this market will be less than in Québec, and the benefits from the contemplated regulatory changes will be smaller.

1.1.3 Stakeholders

The costs and benefits associated with the impacts of the proposed regulatory amendments will accrue to three main groups of economic and social agents, hereafter referred to as “stakeholders”:

- the trucking industry, chiefly as regards its operating costs;
- the government authorities—essentially the MTQ, as manager of the primary road network, and chiefly as regards its costs for maintaining and repairing this network;
- society in general, as regards externalities such as air pollution and road safety.

1.1.4 Benefits and Costs

In analyzing the impacts inherent in the use of supersingle tires, compared with conventional dual tires, we considered the following variables:

Benefits

- Increase in total loaded mass and payload if the 1 000 kg per axle penalty for heavy vehicles equipped with supersingle tires is eliminated;
- Increase in payload because of the smaller mass of supersingle tires and wheels;
- Reduction in fuel costs;
- Reduction in maintenance costs;
- Reduction in environmental costs attributable to vehicle emissions, because of reduced fuel consumption;
- Improvement in safety conditions.

Costs

- Costs of repairing additional deterioration of the road network;
- Costs of purchasing and retreading tires;
- Increase in environmental costs attributable to the disposal of used tires, because of the lesser retreadability of supersingle tires.

Transfers

- The elimination of the fees for special permits represents a benefit for industry but a cost for government and is therefore regarded as a transfer.
- The cost of damages to various users' vehicles travelling on roads that have been subject to more deterioration because of heavy vehicles equipped with supersingle tires must not be included, because the additional cost of maintaining the road network has already been included in the calculations. This means that the road network would be returned to a condition comparable to the one that it would have been in had no regulatory change occurred. To include both the costs of the incremental damage and the costs of the incremental maintenance would be double-counting.
- The reduction in insurance costs for the trucking industry has not been included in the calculations, for two reasons. First, it is hard to estimate. Second, the safety improvements for heavy vehicles have already been included in the calculations, so this too would be double-counting.

1.2 VEHICLES

1.2.1 Vehicle Fleet

According to the data compiled by the Société de l'assurance automobile du Québec (Table 1.1), in 2003, there were 112 069 heavy trucks and truck tractors on the road in Québec, and 66.1% of them had 2, 3 or 4 axles. In 1999, the number of heavy vehicles was 106 741, and vehicles with 2 to 4 axles represented 68.1% of the total fleet. From 1999 to 2003, the number of vehicles with 2 axles fell by 1.8%, while the number with 5 or more axles rose by 11.5%.

The number of axles on a heavy vehicle represents an adequate indicator of its configuration, as can be seen in Table 1.2, which is based on data from the roadside survey conducted by the CCMTA in 1999. In this survey, 84.7% of all heavy vehicles with 2 to 4 axles were straight trucks, over 97% of all vehicles with 5, 6 or 7 axles were tractors with one trailer, and 98.4% of all heavy vehicles with 8 axles or more were tractors with two trailers.

There are not many heavy vehicles equipped with supersingle tires in Québec. In total in Québec in 2004, there were 7 trucking firms with special permits for supersingle tires, operating a total of 162 tractor-trailer combinations. Vehicles with supersingle tires accounted for only 0.4% of the fleet of vehicles with 5 axles or more.

Table 1.1 Heavy vehicle fleet by number of axles, Québec, 1999-2003

Number of axles	1999	2000	2001	2002	2003
2 axles	49 980	49 587	48 760	48 664	49 097
3 axles	17 192	17 153	17 131	17 410	18 212
4 axles	5 497	5 378	5 653	6 132	6 771
5 axles	11 455	12 058	11 908	12 271	12 531
6 axles or more	22 617	23 502	23 697	24 511	25 458
Total	**106 741**	**107 678**	**107 149**	**108 988**	**112 069**

Source: SAAQ (2004), *Bilan 2003 – Accidents, parc automobile, permis de conduire, dossier statistique,* Société de l'assurance automobile du Québec, Québec City, QC, April 2004.

Table 1.2 Dominant configurations by number of axles, heavy vehicles, roadside survey, Québec, 1999

Number of axles	Straight truck	Tractor + 1 trailer	Tractor + 2 trailers
2-4	84.7%		
5		98.4%	
6		97.1%	
7		97.5%	
8 or more			98.4%

Source: GENIVAR calculations based on MTQ (2004), *Fréquence des configurations, à partir de l'enquête en bord de route de 1999*, by Kathleen Plourde, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls file.

1.2.2 Average Age of Vehicles

According to the SAAQ's data (Table 1.3), in 2002, the average age of the heavy trucks and truck tractors* on the road in Québec was 8.49 years, and nearly 32% of all trucks and truck tractors were 11 years old or older. The age of the vehicle fleet will obviously affect the replacement process and thereby encourage migration to the use of equipment with supersingle tires, to the extent that the cost of adapting vehicles currently equipped with dual tires may pose an obstacle to the adoption of this new technology for some carriers.

1.2.3 Ownership of Carriers

According to the 1999 roadside survey, 80.7% of all intercity trips by heavy vehicles were made by vehicles owned by Québec-based carriers (Table 1.4). This proportion was higher for straight trucks (87.7% among vehicles with 2 to 4 axles) and lower for vehicles with 5 axles (71.6%), a configuration for which interprovincial and cross-border trips play a larger role.

Table 1.3 Average age of heavy vehicles, Québec, 1999-2002

Age	Number	%
Less than 1 year	16 898	15.7%
1-2 years	16 724	15.6%
3-5 years	20 898	19.5%
6-10 years	24 644	22.9%
11 years or more	28 230	26.3%
Total	**107 394**	**100.0%**
Mean	**8.47 years**	

Source: GENIVAR calculations based on SAAQ (2003), *Bilan 2002 des taxis, des autobus, des camions lourds et des tracteurs routiers, dossier statistique,* Société de l'assurance automobile du Québec, Québec City, QC, April 2003.

* Literal translation. Author may actually mean "straight trucks and tractor trailers". -tr

Table 1.4 Proportion of intercity trips by heavy vehicles owned by Québec-based carriers, by configuration, Québec, 1999

Configuration	%
2 - 4 axles	87.7%
5 axles	71.6%
6 axles	80.8%
7 axles	89.9%
8 axles or more	80.5%
Mean	**80.7%**

Source: MTQ (2004), Data processed from the 1999 roadside survey by Dave Henry, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls files.

1.3 GEOGRAPHIC MARKETS AND ROAD NETWORKS

1.3.1 Number of Trips

As Table 1.5 shows, nearly one-third (31.6%) of the estimated trips were made by vehicles with 2 to 4 axles, compared with 36.2% by vehicles with 5 axles and 32.2% by vehicles with 6 axles or more. In terms of markets, nearly 60% of all trips were made entirely within Québec, compared with 23.6% for trips between Québec and Ontario and 14.2% for trips between Québec and the United States. Other trips, including trips to the Atlantic provinces or western Canada and trips in transit, represented 2.8% of the total.

The distribution of trips by geographic market differs greatly from one vehicle configuration to another. Vehicles with only 2 to 4 axles made more than 75% of their trips entirely within Québec, whereas for vehicles with 5 axles, the number of trips was divided fairly evenly among the three geographic markets. Trips by vehicles with 6 or more axles were concentrated in Québec and Ontario.

1.3.2 Average Distance per Trip

The average distance travelled per trip varies greatly from one geographic market to the next: 155 veh-km per trip within Québec, 417 veh-km per trip to Ontario, and 963 veh-km per trip to the United States. The average distance per trip for each vehicle configuration depends on its distribution of trips by geographic market. For example, 75% of all heavy vehicles with 2 to 4 axles serve the intraprovincial market, so the average distance per trip for this configuration is lower. Meanwhile, the average distance per trip for 5-axle vehicles is 591 veh-km, far higher than the overall average, because such a high proportion of these vehicles make trips to the United States.

1.3.3 Distance Travelled Annually

Vehicles with 5 axles accounted for more than half (58.5%) of the total kilometres travelled in 1999, while each of the other configurations accounted for 5 to 16%. As regards the distribution by geographic market, just about 25% of the total kilometres involved intraprovincial trips and another 25% involved trips between Québec and Ontario. Trips between Québec and the United States accounted for 37.4% of the total kilometres travelled on intercity trips.

Table 1.5 Number of trips and distances travelled, by geographic market and vehicle configuration, intercity trips by heavy vehicles, Québec, 1999

(a) Number of trips
('000 trips/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	3 205.0	1 847.6	1 350.3	1 144.2	292.4	***7 839.5***	***59.4%***
Québec - Ontario	832.0	1 233.5	531.9	340.3	173.4	***3 111.1***	***23.6%***
Québec - United States	116.8	1 539.7	150.7	25.2	40.0	***1 872.5***	***14.2%***
Other	22.2	154.8	131.8	11.4	55.4	***375.6***	***2.8%***
Total	**4 176.1**	**4 775.6**	**2 164.7**	**1 521.2**	**561.2**	**13 198.8**	**100%**
%	**31.6%**	**36.2%**	**16.4%**	**11.5%**	**4.3%**	**100%**	

(b) Average distance per trip
(veh-km/trip)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Mean
Québec - Québec	111.5	165.0	171.5	218.4	231.4	***154.5***
Québec - Ontario	122.9	515.2	565.6	493.5	529.5	***417.3***
Québec - United States	412.3	1 055.7	454.9	563.7	1 183.3	***963.3***
Other	1 043.9	1 661.7	1 317.8	819.1	876.0	***1 363.0***
Mean	**126.8**	**591.2**	**357.8**	**290.0**	**455.1**	**365.5**

(c) Distance travelled annually
(M veh-km/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	357.4	304.9	231.6	249.9	67.7	***1 211.3***	***25.1%***
Québec - Ontario	102.3	635.5	300.8	168.0	91.8	***1 298.4***	***26.9%***
Québec - United States	48.2	1 625.5	68.6	14.2	47.4	***1 803.8***	***37.4%***
Other	23.2	257.2	173.7	9.3	48.6	***512.0***	***10.6%***
Total	**531.0**	**2 823.1**	**774.7**	**441.4**	**255.4**	**4 825.5**	**100%**
%	**11.0%**	**58.5%**	**16.1%**	**9.1%**	**5.3%**	**100%**	

Source: MTQ (2004), Data processed from the 1999 roadside survey by Dave Henry, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls files.

The estimates for kilometres travelled annually based on the 1999 roadside survey and based on the SAAQ data differ greatly according to the configuration. The overall estimate based on the SAAQ data is 13.2% higher than the estimate based on the roadside survey, which may be explained by the fact that the roadside survey excludes local trips.

The roadside survey would underestimate the kilometres travelled by 2-to-4-axle vehicles by 73.5%, which represents the proportion of their trips that are local and hence use the local rather than the primary road network. For tractor-trailers (5 axles or more), the annual total kilometrage is 20.9% according to the roadside survey. This difference may be attributable to trips by tractor-trailers registered in other jurisdictions in North America. This hypothesis is consistent with the fact that 80.1% of the kilometres travelled by vehicles with 5 or more axles are travelled in geographic markets outside of Québec.

1.3.4 Road Networks Used

According to an estimate based on the 1999 roadside survey, heavy vehicles operating in Québec travelled a total of 4.8 billion veh-km that year on intercity trips. More than half of these kilometres were travelled outside of Québec, while two-thirds

of the kilometres travelled on the Québec road network during these trips were travelled on freeways and one-quarter on provincial highways (see Table 1.6).

Another 2.2 billion veh-km have been added to Table 1.6 to account for local trips, which were not covered in the roadside survey and for which an adjustment has been made on the basis of the SAAQ survey. These trips take place mostly on municipal road networks and collector roads, as well as on resource-access roads. All of the costs and benefits related to the local road network have been excluded from the present analysis.

Table 1.6 Total distance travelled, by class of road, heavy vehicles, Québec, 1999

(M veh-km/yr)

Class of road	Distance travelled	%
Local trips	**2 249.0**	
Intercity trips		
Misc. roads	30.4	**1.5%**
Regional roads	101.1	**5.0%**
Provincial roads	500.4	**24.7%**
Freeways	1 394.7	**68.8%**
Total, Québec	**2 026.7**	**100.0%**
Outside Québec	**2 798.8**	
Total	**7 074.5**	

Note: Miscellaneous roads include resource-access roads, ferry-access roads, local roads, and collector roads
Source: GENIVAR calculations from MTQ (2004), *Données traitées à partir de l'enquête en bord de route de 1999,* by Dave Henry, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls files, and from MTQ (2005), *Etude sur la sollicitation du réseau routier québécois, à partir de l'enquête en bord de route de 1999* , by Luc Denault, Ministère des Transports du Québec, Service de la Modélisation des systèmes de transport, Montréal QC, xls and jpg files.

1.4 BENEFITS AND COSTS FOR THE TRUCKING INDUSTRY

1.4.1 Elimination of Special Permits

Since 2002, Québec has let trucking firms purchase special permits entitling them to operate vehicles with supersingle tires with heavier loads during the spring-thaw period. This permit costs $750 for a set of vehicles or $375 per unit. In total, the seven firms that purchased these permits held a total of 237 permits in 2004. The fees that the trucking industry paid for these special permits totalled $88 875 that year.

1.4.2 Increased Payloads Due to Elimination of 1 000 kg Penalty

Normal (Non-Thaw) Periods

The elimination of the 1 000 kg per axle penalty for vehicles equipped with supersingle tires might result in a substantial increase in the weight of goods carried on trips where the total loaded mass equals the maximum allowed by the regulations. This increase would depend not only on the vehicle configuration but

also on the nature of the trip, because the Ontario and U.S. regulations differ from those in Québec. For example, Québec imposes different load limits during the spring-thaw period, but the Ontario and U.S. load limits are the same throughout the year.

In order to calculate the additional benefits and costs for the trucking industry for all the items discussed in sections 1.4.1 through 1.4.7, the proportion of trips for which the carrier was Québec-based was applied according to the various vehicle configurations.

The increase in payloads due to the elimination of the 1 000 kg penalty was estimated on the assumption that all of the trips made at maximum load would be optimized through an increase in the weight of goods carried, so the economic value thus calculated must be regarded as a maximum. From the percentage increase in payload allowed by the regulatory change under consideration, shown in Table 1.7, a percentage reduction in the number of trips was estimated, the results of which are shown in Table 1.8. On the basis of this percentage reduction, the savings realized were estimated by applying an average operating cost per kilometre[1] to the reduction in the number of kilometres travelled.

The 1 000 kg penalty constitutes the limiting factor for the payloads of heavy vehicles with supersingle tires for all trips entirely within Québec, both during normal periods and during the spring thaw. The increases in payload that the elimination of this penalty would allow in this geographic market during non-thaw periods would range from 14.0% for 3-axle vehicles (which account for the majority of 2-to-4 axle vehicles) to 16.3% for vehicles with 8 axles or more.

[1] CAMTECH – GENIVAR (2001), *Étude d'impact des restrictions de charge en période de dégel sur l'économie du Québec*, Camtech, Saint-Nicolas QC and Groupe conseil GENIVAR, Montréal QC, for the Ministère des Transports du Québec, Québec City, QC, 58 pages and appendixes.

Table 1.7 Percentage increase in payload allowed by proposed changes in regulations, by geographic market and vehicle configuration, heavy vehicles, Québec

	3 axles	5 axles (1)	5 axles (2)	6 axles	7 axles	8 axles or +
Normal period						
Québec - Québec	14.0%	14.5%	0.0%	15.6%	16.1%	16.3%
Québec - Ontario (a)	14.0%	14.5%	0.0%	15.6%	16.1%	16.3%
Québec - Ontario (b)		0.0%	0.0%	0.0%	7.4%	10.6%
Québec - United States	0.0%	0.0%	0.0%	0.0%		
Spring-thaw period						
Québec - Québec	17.0%	17.8%	17.8%	19.6%	19.9%	18.4%
Québec - Ontario (a)	17.0%	17.8%	17.8%	19.6%	19.9%	18.4%
Québec - Ontario (b)	0.0%	17.8%	17.8%	19.6%	19.9%	18.4%
Québec - United States	2.5%	17.8%	17.8%	19.6%		

Limiting factor

	3 axles	5 axles (1)	5 axles (2)	6 axles	7 axles	8 axles or +
Normal period						
Québec - Québec	Q	Q		Q	Q	Q
Québec - Ontario (a)	Q	Q		Q	Q	Q
Québec - Ontario (b)	O	O		O	Q	Q
Québec - United States	US	US		US		
Spring-thaw period						
Québec - Québec	Q	Q	Q	Q	Q	Q
Québec - Ontario (a)	Q	Q	Q	Q	Q	Q
Québec - Ontario (b)	O	Q	Q	Q	Q	Q
Québec - United States	US	Q	Q			

Notes: (1) Assumes elimination of 1 000 kg penalty; (2) Assumes harmonization with U.S. regulations

(a) Units less than 14.8 m (48 ft) long (b) Units more than 14.8 m (48 ft) long.

US=U.S. regulations; ST=restriction in spring-thaw period; O=Ontario regulations;

Q=Québec penalty on single tires

Sources: GENIVAR calculations based on MTQ (2004), *Guide des normes de charges et dimensions des vehicles*, Ministère des Transports du Québec, Québec City, QC, 2004 edition, 28 pages; Camtech – GENIVAR (2001), *Étude d'impact des restrictions de charge en période de dégel sur l'économie du Québec*, Camtech, Saint-Nicolas QC and GENIVAR, Montréal QC, for the Ministère des Transports du Québec, Québec City, QC, 58 pages and appendixes.

The Ontario regulations differ according to the total length of the tractor-trailer combination. The standard that applies to combinations less than 14.6 m (48 feet) long is similar to the Québec regulations, but the loads allowed for combinations more than 14.6 m (48 feet) long are more limited. For the Québec–Ontario market, during the non-thaw period, the effect of the penalty in the Québec regulations depends on the length of the tractor-trailer combination. According to one analysis of data from the 1999 roadside survey,[2] 24% of the tractor-trailer combinations travelling between Québec and Ontario are less than 14.6 m long, while 76% are more than 14.6 m long. For the first of these two categories, the potential increase in payload resulting from the elimination of the Québec penalty would range from 14.0% to 16.3%. For the second, only the heaviest configurations—those with 7 axles and those with 8 or more axles—would benefit, with payload increases of 7.4% and 10.6%, respectively.

[2] Source: MTQ (2005), Kathleen Plourde, data extracted from 1999 roadside survey.

For cross-border trips (between Québec and the United States), the U.S. regulations are more restrictive than the Québec regulations, even with the penalty.

For intercity trips entirely within Québec, it is the heaviest configurations (6 axles or more) that show the greatest potential for optimizing trips by heavy vehicles with supersingle tires during non-thaw periods. For these configurations, the proportion of trips at maximum load could range from 14.0% to 29.3%. For 5-axle configurations, only 2.6% of all intercity trips within Québec would be at maximum load.

Table 1.8 Proportion of trips at maximum load, by geographic market and vehicle configuration, heavy vehicles, Québec

	3 axles	5 axles (1)	5 axles (2)	6 axles	7 axles	8 axles or +
Normal period						
Québec - Québec	0.8%	2.6%	0.0%	14.0%	23.6%	29.3%
Québec - Ontario						
Less than 14.6 m	0.7%	3.3%	0.0%	25.8%	31.7%	0.0%
More than 14.6 m	0.0%	0.0%	0.0%	0.0%	8.3%	31.7%
Québec - United States	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Spring-thaw period						
Québec - Québec	5.8%	9.8%	9.8%	28.5%	37.5%	36.8%
Québec - Ontario						
Less than 14.6 m	2.8%	13.5%	13.5%	42.1%	44.8%	0.0%
More than 14.6 m	0.0%	12.6%	12.6%	35.0%	28.9%	44.8%
Québec - United States	0.6%	28.6%	28.6%	29.6%	0.0%	0.0%

Notes: (1) Assumes elimination of 1 000 kg penalty; (2) Assumes harmonization with U.S. regulations

Source: GENIVAR calculations based on MTQ (2004), *Données traitées à partir de l'enquête en bord de route de 1999*, by Kathleen Plourde, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls files.

The resulting cost reduction for the trucking industry would be on the order of $49.0 M for all geographic markets combined; Table 1.9 shows the breakdown. Some 72% of this economic benefit would be realized in the intraprovincial market and nearly one-quarter (24.2%) in the Ontario market. Less than half (40.0%) would be realized during the spring-thaw period. Lastly, over 87% of these savings would be realized by the heavier configurations (6 axles or more).

Spring-Thaw Period

During the spring-thaw period, the situation is very different, because Québec applies stricter load limits then, while other jurisdictions maintain the same regulations as during the rest of the year. Thus the Québec penalty on single tires becomes the limiting factor on payloads for all configurations and all markets, including 5-axle vehicles in the Ontario and U.S. markets, which account for a large proportion of all trips. For this market segment, the proportion of trips at maximum load would range from 12.6% to 28.6%. For vehicles with 6 axles or more, the proportion of trips at maximum load, essentially in the intraprovincial and Ontario markets, would range from 28.5% to 44.8%. Lastly, for straight trucks, the removal of the penalty would have little effect.

Table 1.9 Reduction in operating costs due to increased payloads resulting from the proposed regulatory amendments, all intercity trips, Québec, 1999

($ 2004)

By time of year	($'000)	%	By number of axles	($/km)	($'000)	%
Normal period	29 434	60.0%	2-4 axles	1.79 $	1 470	3.0%
Spring-thaw period	19 584	40.0%	5 axles	1.38 $	4 765	9.7%
Total	**49 018**	**100.0%**	6 axles	1.61 $	13 312	27.2%
By geographic market			7 axles	1.85 $	21 080	43.0%
Québec - Québec	35 246	71.9%	8 axles +	1.78 $	8 391	17.1%
Québec - Ontario	11 879	24.2%	**Total**		**49 018**	**100.0%**
Québec - United States	1 893	3.9%	**Harmonization w/U.S. regulations**			
Total	**49 018**	**100.0%**	5 axles		2 461	

Source: GENIVAR calculations.

1.4.3 Increased Payloads Due to Harmonization with U.S. Regulations

Normal (non-thaw) period

Under the assumption analyzed here, the Québec regulations would be amended to apply the same standard to 5-axle vehicles as the U.S. regulations do, all year around. Thus the loads allowed during non-thaw periods for heavy vehicles with single tires would be just about the same as those allowed currently by the Québec regulations including the 1 000 kg penalty. Thus, no trips made during non-thaw periods would be affected by this change in regulations.

Spring-thaw period

During the spring-thaw period, the assumption of harmonization with the U.S. regulations is equivalent to removing the 1 000 kg penalty. The effects on payloads and the trips affected would therefore be the same as described previously. The cost reduction is estimated at $2.5 M/year.

1.4.4 Increased Payloads Due to Reduced Mass of Tires and Wheels

The total mass of the tires and wheels is less on vehicles equipped with supersingle tires than on vehicles equipped with conventional dual tires. For any given maximum total load restriction imposed on heavy vehicles, this decrease in the weight of the tires and wheels can allow an increase in payload.

This increase in payload would range from 1.6% to 2.4%, depending on the configuration and the season. The annual cost savings are estimated at $6.1 M, three-quarters of which would be realized on trips within Québec and the majority of which would be realized by the heaviest configurations of vehicles. These figures are based on the same proportions of trips at maximum load as described in the preceding sections.*

1.4.5 Reduced Fuel Costs

The use of supersingle tires can reduce fuel consumption. According to information obtained from Michelin, rolling resistance accounts for 35% of a vehicle's fuel

* This is my best guess at the meaning of the French. A literal translation would read: "This is in corollary with the trips at maximum load of the preceding sections." -tr

consumption, while aerodynamic resistance accounts for 40% and mechanical factors account for 25%. When Michelin ran analyses to compare its X One supersingle tire with its XDA Energy and XT-1 conventional tires (275/80R22.5), it found that the use of supersingle tires can reduce a vehicle's rolling resistance by about 12% and thus reduce its fuel consumption by about 4%.

This impact of supersingle tires on fuel consumption also emerged from our survey of Québec trucking firms that use them. Six of the seven firms questioned in this survey stated that they had observed reductions in fuel consumption ranging from 3.5% to 12%.

For the purposes of this analysis, we have used the average percentage reduction in fuel consumption provided by supersingle tires, based on values from nine sources, which is 3.2%. The average price of diesel fuel before consumption taxes was \$0.715/L in 2004[3]. This price fluctuates widely, however, and it increased by 15% over the course of that year. As Table 1.10 shows, average fuel consumption by heavy vehicles ranges from 40 to 51 L/100 km, depending on the configuration.

Table 1.10 Reduction in cost of fuel consumption, all heavy vehicles making intercity trips in Québec, 1999

(\$ 2004)

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Reduction in consumption (%)	3.2%				
Average price of diesel	\$0.715				
Consumption (L/100 km)	40.0	45.7	49.5	50.3	50.8
Average cost (\$/km)	\$0.286	\$0.327	\$0.354	\$0.360	\$0.363
Average savings (\$/km)	\$0.009	\$0.010	\$0.011	\$0.012	\$0.012

By time of year

	(\$'000)	%
Normal period	28 333	82.7%
Spring-thaw period	5 930	17.3%
Total	**34 263**	**100.0%**
By geographic market		
Québec - Québec	12 714	37.1%
Québec - Ontario	6 118	17.9%
Québec - United States	15 431	45.0%
Total	**34 263**	**100.0%**

By number of axles

	(\$'000)	%
2-4 axles	4 258	12.4%
5 axles	19 073	55.7%
6 axles	4 980	14.5%
7 axles	4 150	12.1%
8 axles +	1 801	5.3%
Total	**34 263**	**100.0%**

Source: GENIVAR calculations based on RÉGIE DE L'ÉNERGIE DU QUÉBEC (2005), *Carburant diesel, prix moyen affiché en cents le litre, regie-energie.qc.ca/energie/petrole_tarifs* , and on CAMTECH – GENIVAR (2001), *Étude d'impact des restrictions de charge en période de dégel sur l'économie du Québec* , Camtech, Saint-Nicolas QC and Groupe conseil GENIVAR, Montréal QC, for the Ministère des Transports du Québec, Québec City, QC, 58 pages and appendixes.

Using the above figures, we calculated that for all categories of trips combined, the reduction in fuel consumption through the use of supersingle tires would result in savings on the order of \$34.3 M. The distribution of these savings depends on the distances travelled. Thus, 82.7% of these savings would be realized outside the spring-thaw period, nearly half (45.0%) would be realized on cross-border trips, and over half (55.7%) would be realized by 5-axle vehicles.

[3] Régie de l'énergie du Québec (2005), *Carburant diesel, prix moyen affiché en cents le litre*, Régie de l'énergie du Québec, Québec City, QC, regie-energie.qc.ca/energie/petrole_tarifs.html

1.4.6 Reduced Vehicle Maintenance Costs

According to the trucking firms that participated in our survey, using supersingle tires makes it easier both to inspect their vehicles and to perform maintenance on them in their garages. The actual time savings on inspections is only marginal, so we did not calculate any economic benefit of supersingle tires for inspection operations. But in maintenance operations, supersingle tires take only half as much time to service as conventional dual tires. We used these time savings to estimate the impact of supersingle tires on maintenance costs, as follows:

- Maintenance interval: 10 000 km;
- Average maintenance time, supersingle tires: 15 min per vehicle;
- Average maintenance time, dual tires: 30 min per vehicle;
- Average cost per hour: $50.

Using these values, we estimated that on average, using supersingle tires would save carriers $0.0013/veh-km in maintenance costs, or a total of $4.0 M/year. Since these savings depend on distance travelled, their distributions by time of year, vehicle configuration, and geographic market are identical to those for savings on fuel consumption.

1.4.7 Reduced Costs for Purchasing and Retreading Tires

According to Michelin, supersingle tires are subject to slightly more wear than conventional dual tires. Supersingle tires appear to wear out faster. Studies are under way to correct this situation. The majority of the trucking firms that participated in our survey said that they did not notice any glaring differences in wear between supersingle and conventional tires.

As regards retreading, at present, supersingle tires can be retreaded only once. For conventional tires, the manufacturers usually recommend two retreadings, or even three in certain applications. In practice, however, heavy-vehicle operators tend to retread even more times, to reduce their tire-replacement costs.

To estimate and compare the annual costs of replacing and retreading supersingle and conventional tires, we used the following assumptions:

- Service lives of 425 000 km for supersingle tires and 420 000 km for conventional tires;
- Supersingle tires can be retreaded once and conventional tires twice;
- Supersingle tires cost an average of $850 new and $544 for a retread;
- Conventional tires cost an average of $525 new and $248 for a retread.

Using these values, we found that annual replacement and retreading costs would be greater for supersingle tires than for conventional dual tires. The estimated cost difference for a typical year would be nearly $7.7 M, and as Table 1.11 shows, over half of these additional costs would be incurred by 5-axle vehicles.

Table 1.11 Additional costs for purchasing and retreading supersingle tires, all categories of intercity trips, heavy vehicles, Québec, 1999

($ 2004)

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Avg.cost ($/veh-km)	$0.0011	$0.0023	$0.0028	$0.0034	$0.0040	
Annual cost ($'000/yr)	526	4 122	1 242	1 222	613	**7 725**
%	6.8%	53.4%	16.1%	15.8%	7.9%	**100.0%**

Source: GENIVAR calculations based on communications with Michelin.

1.5 COSTS FOR THE MTQ (QUÉBEC TRANSPORT MINISTRY)

1.5.1 Increased Damage to the Primary Road Network

Findings from MTQ Studies

In studies conducted in 2003 and 2004, the MTQ's Direction du Laboratoire des chaussées [pavement laboratory branch] concluded that supersingle tires are more aggressive and cause more damage to road pavement than dual tires do. The last study conducted in 2004[4] recommended that vehicles using supersingle tires be subject to a 10% reduction in maximum axle load. If supersingle tires were used on the entire fleet of trucks operating in Québec, the monetary impact if there were no such 10% load restriction was estimated at $40.6 M (for all classes of roads combined).

In parallel with this study, the MTQ pavement laboratory branch conducted a more detailed analysis to differentiate the impacts by geographic market and vehicle configuration. The calculations were based on the weighted sum of the impacts on the various segments of the road network under the MTQ's jurisdiction—known as the primary road network—according to three factors that affect the unit cost per road segment: the unit cost of maintenance for a given class of road, the length of the segment, and the aging factor if supersingle tires were used without restrictions. This aging factor in turn depends on the additional percentage of aggressiveness contributed by supersingle tires for the various types of trucks, the volume for the various types of trucks, and the coefficients of aggressiveness at 20°C and at the reference temperatures for the various seasons. The trucking volumes were derived from the roadside survey that was used to determine the impacts for the industry and for society, as well as from the MTQ's traffic information system (CIR-6002) and the weighing station's data.

The total length of the road network is 26 283 km.

[4] Study conducted by the Direction du Laboratoire des chaussées [Pavement Laboratory Branch] of the Ministère des Transports du Québec, Phase II (September 2004).

Removal of 1 000 kg Penalty

The MTQ calculated the average impact per kilometre per year with regard to the increased wear on the pavement of the primary road network for the various classes of road and an average impact for the network as a whole. This average impact was then multiplied by the length of the road network. The distribution of this impact by geographic market was estimated as follows. For the intraprovincial market, the impact was determined from the total distance travelled on trips entirely within Québec. For the Québec-Ontario and Québec-U.S. markets, the number of trips was multiplied by the average distance travelled on the intraprovincial trips, so as to count only those portions of the Québec-Ontario and Québec-U.S. trips that took place within Québec's borders.

On the bases just described, it was estimated that if all trucks and truck tractors were equipped with supersingle tires, the cost of the damage to the road network, including the Québec–Québec, Québec–Ontario and Québec-United States markets, would be $38.7 M. As shown in Table 1.12, the cost during the spring thaw period would be $18.7 M, or nearly half (48.2%) of the annual figure. Trips within Québec account for slightly over half of the annual cost, compared with one-third for trips to or from Ontario and about 14% for the Québec–United States market. Including the other geographic markets (4.6% of the grand total), the total impact is estimated at $40.6 M.

Table 1.12 Additional costs of maintaining primary road network resulting from removal of 1 000 kg penalty, all intercity trips, heavy vehicles, Québec, 1999

Average cost per kilometre ($/km/yr)

Time of year	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Other seasons	$33.3	$155.2	$197.0	$181.8	$195.7	***$763.0***
Spring	$34.6	$139.1	$180.2	$164.9	$192.2	***$711.0***
All year	**$67.9**	**$294.3**	**$377.2**	**$346.8**	**$387.9**	**$1 474.1**

Annual cost ($'000/yr)

Time of year	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Other seasons	875.8	4 079.1	5 178.4	4 779.0	5 142.5	***20 054.8***
Spring	908.8	3 656.8	4 735.7	4 334.9	5 051.7	***18 687.9***
All year	**1 784.6**	**7 736.0**	**9 914.1**	**9 113.9**	**10 194.1**	**38 742.7**
	4.6%	**20.0%**	**25.6%**	**23.5%**	**26.3%**	**100.0%**

Time of year	Québec	Ontario	United States	Total	Other	Grand total
Other seasons	10 755.9	6 357.9	2 941.1	***20 054.8***	1 076.7	21 131.5
Spring	10 114.4	5 874.3	2 699.3	***18 687.9***	787.8	19 475.7
All year	**20 870.2**	**12 232.1**	**5 640.3**	**38 742.7**	**1 864.5**	**40 607.2**
	53.9%	31.6%	14.6%	**100.0%**		
	51.4%	30.1%	13.9%	95.4%	4.6%	**100.0%**

Note: The distribution of annual costs excludes other markets such as the Maritime provinces and western Canada.
Source: GENIVAR calculations based on MTQ (2005), *Effet de différents types de pneus sur les chaussées: étude économique (volet impact sur les chaussées): version préliminaire,* by Fritz Prophète, Ministère des Transports du Québec, Direction du laboratoire des chaussées, Québec City, QC, January 21, 2005.

Harmonization with U.S. Regulations for 5-Axle Combinations

The additional maintenance costs that would be incurred if the Québec regulations were harmonized with the U.S. regulations for 5-axle heavy vehicles all year around are estimated at $3.7 M/year, excluding markets other than Québec, Ontario, and the U.S. (these other markets are marginal, accounting for only 5.4% of the grand total). As Table 1.13 shows, about half of this cost comes from the Québec–United

States market. Note that since the change in maximum-load regulations would affect the spring-thaw period only, all of the impact would occur at this time of the year.

Table 1.13 Additional costs for maintaining primary road network resulting from harmonization with U.S. regulations, intercity trips, 5-axle heavy vehicles, Québec, 1999

	Average cost	Annual cost ($'000/yr)				
Time of year	($/km/yr)	Québec	Ontario	United States	Total	Other
Other seasons	$ -	0.0	0.0	0.0	***0.0***	0.0
Spring	$ -	889.3	1 072.3	1 695.3	***3 656.8***	209.4
All year	**$ -**	**889.3**	**1 072.3**	**1 695.3**	**3 656.8**	**209.4**
		24.3%	29.3%	46.4%	**100.0%**	
		23.0%	27.7%	43.8%	94.6%	5.4%

Source: GENIVAR calculations based on MTQ (2005), *Effet de différents types de pneus sur les chaussées: étude économique (volet impact sur les chaussées): version préliminaire,* by Fritz Prophète, Ministère des Transports du Québec, Direction du laboratoire des chaussées, Québec City, QC, January 21, 2005.

1.6 BENEFITS FOR SOCIETY

1.6.1 Savings from Reduced Vehicle Emissions

The combustion of fuel in the engines of heavy vehicles releases chemical compounds that contribute to air pollution. The main pollutants emitted by this fuel combustion are carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxide (NO), and hydrocarbons. By reducing heavy vehicles' fuel consumption, increased use of supersingle tires would reduce their emissions of these air pollutants as well.

These reductions would represent an economic benefit for Québec society as a whole, regardless of which carriers achieved them. To quantify this benefit, we proceeded as follows.

To estimate the amounts of these four pollutants emitted according to the volume of diesel fuel consumed by the trucking industry, we used information from a 2002 greenhouse gas study by the Ministère de l'Environnement du Québec [Québec environment ministry]. These results, expressed in grams of each pollutant per litre of diesel fuel consumed, are shown in Table 1.14.

To estimate the reduction in fuel consumption, in litres, attributable to supersingle tires, we used the percentage reduction determined previously (3.2%) and applied it to all intercity trips for all three markets, regardless of where the carriers were based.

To estimate the costs saved on each pollutant for every litre of fuel not consumed, we then multiplied the number of grams of each pollutant per litre of fuel by the monetary value associated with the elimination of 1 tonne of that pollutant. The monetary values that we used came from a study by Todd Litman, of the University of Victoria. Litman compared 37 different studies that attempted to determine the cost per tonne of various types of air pollutants. He then determined the median cost for each pollutant. It is Litman's median costs that we have used in our calculations.

Table 1.14 Value of reduction in vehicle emissions, all carriers, intercity trips, Québec, 1999

(a) Cost saved per litre of fuel not consumed, by type of pollutant

Pollutant	Amount (g/L)	Cost ($/t)	Unit cost ($/L)
Carbon monoxide (CO)	68	$1 339	0.091 $
Carbon dioxide (CO_2)	2 730	$30	0.081 $
Nitrogen oxide (NO)	9.6	$6 214	0.060 $
Hydrocarbons	9.7	$4 872	0.047 $
Total			**0.279 $**

Sources: MENVIQ (2002), *Inventaire québécois des gaz à effet de serre 1990-2000* , by Gérard Houle *et al.* , Ministère de l'Environnement du Québec, Direction des politiques du secteur industriel, Service de la qualité de l'atmosphère, Division des inventaires des émissions atmosphériques, Québec City, QC, September 2002, Annexe E. LITMAN Todd (2003), *Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications,* Victoria Transport Policy Institute, Victoria BC, 1995, revised in 2003, 300 pages, vtpi.org/tca.

(b) Cost savings from reduced vehicle emissions, by geographic market and vehicle configuration

Vehicle configuration	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Average reduction in consumption (L/100 km)	1.28	1.46	1.59	1.61	1.63	
Average cost reduction ($/M veh-km)	$3 570	$4 078	$4 417	$4 489	$4 533	
Annual cost savings ($'000/yr)	1 812.6	10 464.2	2 654.7	1 939.5	937.7	**17 808.7**
	10.2%	58.8%	14.9%	10.9%	5.3%	**100.0%**

Geographic market	Québec	Ontario	United States	Total
Annual cost savings ($'000/yr)	4 970.3	5 455.8	7 382.6	17 808.7
	27.9%	30.6%	41.5%	100.0%

Source: GENIVAR calculations from tables 1.10 and (a).

Using these values, we estimated that the environmental cost savings that supersingle tires would provide by reducing air pollution through reduced fuel consumption would total $17.8 M. A high proportion of these savings (58.8%) would be achieved by 5-axle vehicles. Since this configuration is dominated by the U.S. and Ontario markets, these markets would generate a substantial portion of these environmental cost savings.

1.6.2 Savings from Reduced Used-Tire Disposal Costs

To determine what impact the use of supersingle tires would have on used-tire disposal costs, we first had to determine the mass of the tires disposed of by Québec trucking firms each year. This mass depends on the number of used tires, as calculated previously,[*] and the average mass per used tire. In addition to the figures on the service life of tires, presented previously, our estimate of the mass of used tires that have to be disposed of assumes an average mass of 53.6 kg for one supersingle tire and 72.5 kg for conventional dual tires. According to Recyc-Québec, the cost of disposing of used tires is estimated at $0.19/kg (about $10 for one 50 kg tire).

On the basis of these figures, the annual cost of disposing of waste materials, in a context of using supersingle tires, is greater than that of conventional dual tires. [*] The use of single tires thus results in a savings of $415 900/year on disposal of waste materials.

[*] No previous calculation mentioned earlier in this report, so not clear what's being referred to. -tr

[*] Literal translation; French sentence is incorrect, because, as stated in the next sentence and confirmed in Table C.25, the estimates indicate that supersingle tires would save $415 900/year on disposal of waste materials..-tr

1.6.3 Savings from Improved Road Safety

According to Michelin,[5] the use of supersingle tires can improve safety conditions in several ways, including:

- general vehicle stability;
- traction quality and braking distances;
- frequency of blowouts and vehicle stability when blowouts occur.

The stability of a heavy vehicle depends on the height of the load and the vehicle's track. The track is measured from the centre of the ground contact area (tire footprint) on either side of the vehicle. For dual tires, the centre of the footprint is the centre of the pair of tires. When supersingle tires are installed in such a way as to maintain the same outer distance side-to-side as with dual tires, the centre of the footprint is shifted a few inches outward, which increases the vehicle's track and improves its stability.

As regards traction, the configuration of supersingle tires should improve handling, braking distances, and hydroplaning conditions.

As regards risks of blowouts, tire failures are often attributable to poor maintenance. In fact, checking and maintaining proper tire pressure is a major part of any maintenance program to reduce premature tire wear. The use of supersingle tires makes checking tire pressure much easier, because there is only one valve to check. With dual tires, the valve on the inside tire is harder to reach, and as a result, some trucks may be running with underinflated inner tires hidden behind properly inflated outer ones. Another virtue of supersingle tires is that they provide better vehicle stability if a blowout does occur.

These effects of the use of supersingle tires on safety conditions were validated in our survey of seven Québec carriers who use such tires:

- Six of the seven carriers stated that they had observed significant safety improvements in terms of vehicle stability, driver comfort, and road handling.
- The carriers stated that the frequency of blowouts and the amount of wear observed with supersingle tires were comparable to or slightly less than with conventional dual tires. Two of the carriers said that they had seen improvements in the way their vehicles handled when blowouts did occur.
- The carriers had trouble in characterizing and quantifying the impact that the use of supersingle tires might have on the frequency or severity of accidents, inasmuch as accidents directly attributable to tires are minimal.
- We were unable to locate any existing study that allows valid statistical comparisons to be made between the use of supersingle tires and the use of dual tires from a safety standpoint.

The data from the SAAQ (Québec's public auto insurance corporation) on accidents involving heavy vehicles do, however, at least let us estimate the economic cost of these accidents and hence the economic value that might be realized if the use of

[5] MICHELIN (2004), *X One – La nouvelle génération des pneus simples*, Michelin North America, July 2004, 44 pages + CD-ROM.

supersingle tires reduced their frequency. Table 1.15 shows the average annual frequencies of accidents involving heavy vehicles[6] on intercity trips in Québec. To derive these average frequencies, we took the proportion that intercity trips represented of total distance travelled, as calculated earlier, and applied it to the SAAQ's overall accident statistics. We also estimated the distribution by geographic market according to the distance travelled within Québec.

The unit cost of an accident depends on its severity. The MTQ compiles statistics on the economic costs of accidents as estimated by two different methods. The first, the "cost of human capital" method, is based on the concept of the value of lost production as reflected by the victims' gross incomes. In addition to lost production, this method also includes the costs of compensating victims and of repairing damaged property. The second method, the "willingness to pay" method, results in substantially higher values, especially for fatal accidents.

Table 1.15 Value of improved road safety, all carriers, intercity trips, Québec, 1999

Severity of accidents	Average frequency 1999-2003 (acc/yr)	Average cost ($'000/acc)	Annual cost ($'000/yr)
Fatal	114	535.7	61 178.5
Serious	340	179.3	61 033.4
Slight	1 992	20.2	40 262.2
Property damage only	10 519	11.8	124 508.7
Total	**12 965**		**286 982.8**
Reduction in accidents (per cent)	1%		
Reduction in accidents (number)	129.7		2 869.8
Percentage on primary road network	47.3%		
Reduction in accidents, primary network	**61.4**		**1 358.3**

Distribution

Vehicle configurations	$'000/yr	%	Geographic market	$'000/yr	%
2 - 4 axles	311.3	22.9%	Québec	814.1	59.9%
5 axles	512.4	37.7%	Ontario	337.4	24.8%
6 axles	234.3	17.3%	United States	206.8	15.2%
7 axles	221.6	16.3%	**Total**	**1 358.3**	**100.0%**
8 axles or more	78.7	5.8%			
Total	**1 358.3**	**100.0%**			

Source: GENIVAR calculations based on SAAQ (2004), *Bilan 2003 – Accidents, parc automobile, permis de conduire, dossier statistique,* Société de l'assurance automobile du Québec, Québec City, QC, April 2004, and on MTQ (2005), *Évaluation statistique des coûts de l'insécurité routière au Québec* , Ministère des Transports du Québec, Direction de la Sécurité et du Camionnage, Québec City, QC, Excel file.

From 1999 to 2003, there were an average of 12 963 accidents involving heavy vehicles each year in Québec, with a total of 3 334 victims. The economic value of these accidents, as estimated by the human-capital method, was close to $287 M/year. Thus, if we assumed that safety improvements brought about by the use of supersingle tires reduced the number of accidents by 1%, the economic value

[6] Heavy vehicles used to carry freight (excludes buses).

of this improvement in safety on the primary road network would be on the order of $1.4 M/year, as shown in Table 1.15.

If we further assume that these improvements would be distributed according to distance travelled within Québec, 5-axle combinations would account for 37.7% of this value and intra-Québec trips for just under 60%.

In contrast, if we instead assume a 5% reduction in accident frequency and use the willingness-to-pay method to evaluate it, the improvement in road safety has an economic value of $19.6 M.

These estimates are intended to be indicative only and will have to be validated by a more complete analysis of accident conditions involving heavy vehicles.

2 RESULTS BY SCENARIO ANALYZED

2.1 ASSUMPTIONS AND SCENARIOS ANALYZED

To estimate the costs and benefits of potential amendments to Québec regulations affecting supersingle tires, we analyzed five separate scenarios and used the *status quo* as our reference scenario. The first four scenarios were all based on the same assumption regarding the regulatory amendments, while the fifth scenario was based on a different assumption. The two assumptions and the five scenarios were as follows.

Assumption 1 for regulatory amendments: the penalty of 1 000 kg per group of axles, currently applied to supersingle tires, would be eliminated for all vehicle configurations all year around; the requirement for a special permit during the spring thaw would also be eliminated.

- **Scenario 1**: All heavy vehicles operating in Québec and serving the Québec, Ontario, or United States markets would be equipped with supersingle tires instead of dual tires;
- **Scenario 2**: All 5-axle tractor/semi-trailers carrying goods between Québec, Ontario, and the United States would be equipped with supersingle tires instead of dual tires;
- **Scenario 3**: All 5-axle tractor/semi-trailers carrying goods within Québec would be equipped with supersingle tires instead of dual tires;
- **Scenario 4**: A realistic percentage of vehicles in each category, for all three markets (Québec, Ontario, and the United States), would be equipped with supersingle tires on all axles over the long term. This percentage was calculated on the basis of the fleet of vehicles that would be replaced, according to their expected service life, at the end of a 5-year period, and it comes to 47%.

Assumption 2 for regulatory amendments: the Québec regulations would be harmonized with the U.S. regulations for 5-axle combinations only. In other words, the maximum allowable loads for vehicles using supersingle tires would be identical to those specified in the U.S. regulations, all year around: 15 500 kg for tandem axles.

- **Scenario 5:** This scenario involves 5-axle combinations only, in the Québec–Québec, Québec–Ontario, and Québec–United States markets, under Assumption 2.

2.2 OVERALL RESULTS (SCENARIO 1: ALL HEAVY VEHICLES)

The assessments of annual benefits and costs presented in sections 1.4 through 1.6 represent the results under Scenario 1, which includes all heavy vehicles. These benefits and costs are summarized in Table 2.1. As stated earlier, these results include intercity trips in three markets: trips within Québec, trips between Québec and Ontario, and trips between Québec and the United States. They therefore exclude local trips and trips serving other markets, such as the Maritime provinces and western Canada. These other markets account for 2.8% of all intercity trips.

The first section of Table 2.1 shows the direct costs and benefits of the regulatory amendments: those resulting from the increase in heavy vehicles' total loaded mass that these amendments would allow. The most obvious direct cost is the additional work that the MTQ would have to do to maintain the primary road network. This cost is estimated at $38.7 M/year. The direct benefits represent the reduction in operating costs that Québec's trucking industry would enjoy, because it would be able to carry more freight in its vehicles at maximum load. These benefits would total $49.0 M/year. The difference between these values represents a positive net direct benefit of $10.3 M/year, which means that the regulatory amendments would improve the economic efficiency of society as a whole. The ratio of benefits to costs would be 1.27 to 1. Note that some of the benefits in the form of reduced vehicle emissions should also be considered a direct impact, because the regulatory amendments will reduce the number of trips by heavy vehicles. Thus the total direct net benefit is greater than the $10.3 M cited here.

There are also other costs and benefits generated by the use of supersingle tires instead of conventional dual tires. These costs and benefits are not directly related to the proposed regulatory amendments, but the use of supersingle tires might be facilitated or stimulated by these measures.

An additional cost not directly related to the regulatory amendments is the cost of purchasing and retreading tires, which is $7.7 M/year higher for supersingle tires. This cost is absorbed by the trucking industry. There are many other benefits as well. They include, on the one hand, savings for the trucking industry from the reduced mass of tires and wheels, reduced fuel consumption, and reduced maintenance, as well as a portion of the improvements in vehicle safety. These benefits also include, on the other hand, improved environmental conditions (reduced vehicle emissions, reduced tire disposal) and improved road safety. These benefits are valued at $64.0 M, 2/3 of which goes to the trucking industry.

The overall net value of all costs and benefits totals $66.6 M/year, for a benefit/cost ratio of 2.43:1.

Table 2.1 Economic benefits and costs of using supersingle tires, by stakeholder and source–Scenario 1: All heavy vehicles, Québec, 1999

Stakeholder/source	($'000/yr)	% category	% tot.costs	% tot. ben.
Direct costs				
Ministère des Transports du Québec				
Damage to primary road network				
Normal periods	-20 054.8	*51.8%*	43.2%	
Spring-thaw period	-18 687.9	*48.2%*	40.2%	
Total	**-38 742.7**	***100.0%***	**83.4%**	
Direct benefits				
Trucking industry				
Reduction in number of trips due to regulatory amendments				
Normal periods	29 434.3	*60.0%*		26.0%
Spring-thaw period	19 583.9	*40.0%*		17.3%
Total	**49 018.2**	***100.0%***		**43.4%**
Net direct value	**10 275.5**	*21.0%*		
Direct benefit/cost ratio	**1.27**			
Indirect costs				
Trucking industry				
Purchase and replacement of tires	-7 724.9	*100.0%*	16.6%	
Total	**-7 724.9**	***100.0%***	**16.6%**	
Indirect benefits				
Trucking industry				
Reduction in number of trips due to reduced mass of tires	6 141.2	*13.8%*		5.4%
Savings on fuel	34 262.9	*77.1%*		30.3%
Savings on maintenance	4 048.7	*9.1%*		3.6%
Total	**44 452.8**	***100.0%***		**39.3%**
Society				
Reduction in vehicle emissions	17 808.7	*90.9%*		15.8%
Reduction in tire disposal	415.9	*2.1%*		0.4%
Improvements in safety	1 358.3	*6.9%*		1.2%
Total	**19 582.8**	***100.0%***		**17.3%**
Total - Indirect benefits	**64 035.6**			
Current value, indirect benefits	56 310.7			
Grand total, costs	**-46 467.6**		**100.0%**	
Grand total, benefits	**113 053.8**			**100.0%**
Net value				
Ministère des Transports du Québec	-38 831.6	*-58.3%*		
Trucking industry	85 834.9	*128.9%*		
Society	19 582.8	*29.4%*		
Total	**66 586.1**	**100.0%**		
Total benefit/cost ratio	**2.43**			

Note: Excludes local trips and trips involving other markets (Maritimes, etc.)

Source: GENIVAR calculations.

A high proportion of the benefits—47.1%--depends on the reduction in fuel consumption. The results are therefore very sensitive to the values used in estimating this parameter: the percentage reduction in fuel consumption and the price of diesel fuel. The relatively conservative value that we chose for this percentage, and the current upward pressure on fuel prices, suggest that the net value will remain largely positive. The net direct value, however, is not very sensitive to this parameter.

2.3 DISTRIBUTION OF COSTS AND BENEFITS (SCENARIO 1: ALL HEAVY VEHICLES)

2.3.1 Distribution by Stakeholder

In the distribution of costs and benefits by stakeholder, the MTQ, which maintains Québec's primary road network, absorbs a cost of $38.8 M/year (including the loss of revenues from the elimination of the special permit); the trucking industry reduces its costs by $85.8 M/year; and society at large enjoys improvements in environmental and safety conditions valued at $19.6 M/year.

2.3.2 Distribution by Vehicle Configuration

As Table 2.2 shows, the results differ widely from one vehicle configuration to another. These differences depend on a number of factors, the main ones being the damage that each configuration causes to pavement, the distance travelled, the proportion of trips made with close to the maximum allowable load, and the proportion of Québec-based carriers.

Vehicles with 2 to 4 axles account for only a small portion of the total costs and benefits, because these vehicles generally make shorter trips and cause less pavement damage. For these vehicles, the direct positive impact of supersingle tires for the trucking industry does not cover the cost of the additional damage they do to the primary road network. But the other cost reductions for industry plus the benefits for society, do more than offset these costs, in a ratio of 3.75 to 1. (It should be recalled that local trips and the local road network are not included in these calculations.)

The 5-axle configuration is an interesting case. These vehicles account for the most trips, but do not generate the greatest direct costs or benefits. One reason is that 5-axle vehicles make a smaller proportion of their trips at maximum load than larger vehicles do. Another reason is that a large share of the trips by 5-axle vehicles are made by carriers based outside Québec. The net direct value is negative (about -$3.0 M/year), with a benefit/cost ratio of 0.62 to 1.

Table 2.2 Economic benefits and costs of using supersingle tires, by vehicle configuration–Scenario 1: All heavy vehicles, Québec, 1999

Vehicle configuration	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Direct costs					
Damage to primary road network	-1 784.6	-7 736.0	-9 914.1	-9 113.9	-10 194.1
Direct benefits					
Reduction in number of trips due to regulatory amendments	1 470.5	4 764.8	13 311.9	21 079.6	8 391.3
Net direct value	**-314.1**	**-2 971.1**	**3 397.8**	**11 965.7**	**-1 802.8**
	-3.1%	-28.9%	33.1%	116.4%	-17.5%
Direct benefit/cost ratio	**0.82**	**0.62**	**1.34**	**2.31**	**0.82**
Indirect costs					
Purchase and replacement of tires	-525.7	-4 122.0	-1 242.0	-1 222.4	-612.9
Indirect benefits					
Trucking industry	5 038.2	22 043.4	7 344.6	7 494.1	2 532.5
Society	2 152.2	11 198.5	2 955.9	2 226.9	1 049.3
Net indirect value	**6 664.7**	**29 120.0**	**9 058.5**	**8 498.5**	**2 968.9**
Total net value	**6 350.6**	**26 148.8**	**12 456.3**	**20 464.3**	**1 166.1**
	9.5%	39.3%	18.7%	30.7%	1.8%
Total benefit/cost ratio	**3.75**	**3.18**	**2.12**	**2.98**	**1.11**

Source: GENIVAR calculations.

But the other, indirect benefits of using supersingle tires on 5-axle vehicles are more substantial, with a net value of $29.1 M/year. When the net figures for direct and indirect costs and benefits are summed, 5-axle vehicles account for a total net benefit of $26.1 M/year, or 39.3% of the total net value for all configurations. The total benefit/cost ratio, at 3.18 to 1, is higher than for the heavier configurations.

The 6- and 7-axle configurations generate positive net direct values, because the reduction in the cost of trips at maximum load exceeds the cost in additional pavement damage. This is especially true for 7-axle vehicles. Because the total number of trips for these configurations is less than for 5-axle vehicles, the value of the indirect benefits is also less. The total net values for 6-axle vehicles and 7-axle vehicles are $12.5 M/year and $20.5 M/year, respectively.

For vehicles with 8 or more axles, the net direct value is negative (-$1.8 M/year), but the indirect benefits offset the costs, for a total net value of $1.2 M/year.

2.3.3 Distribution by Geographic Market

The costs and benefits also vary by geographic market, as can be seen in Table 2.3. The differences here depend on the same factors mentioned earlier. The net direct value for the Québec–United States market is negative, which is consistent with the results for 5-axle vehicles, which dominate this market.

Table 2.3 Economic benefits and costs of using supersingle tires, by geographic market–Scenario 1: All heavy vehicles, Québec, 1999

Geographic market	Québec	Ontario	United States	Total
Direct costs				
Damage to primary road network	-20 870.2	-12 232.1	-5 640.3	-38 742.7
Direct benefits				
Reduction in number of trips due to regulatory amendments	35 246.4	11 879.1	1 892.6	49 018.2
Net direct value	**14 376.2**	**-353.0**	**-3 747.7**	**10 275.5**
	139.9%	-3.4%	-36.5%	***100.0%***
Direct benefit/cost ratio	**1.69**	**0.97**	**0.34**	**1.27**
Indirect costs				
Purchase and replacement of tires	-2 828.0	-1 500.7	-3 396.2	-7 724.9
Indirect benefits				
Trucking industry	18 736.4	8 166.6	17 549.8	44 452.8
Society	5 936.7	5 873.9	7 772.2	19 582.8
Net indirect value	**21 845.1**	**12 539.8**	**21 925.8**	**56 310.7**
Total net value	**36 221.3**	**12 186.7**	**18 178.1**	**66 586.1**
	54.4%	18.3%	27.3%	100.0%
Total benefit/cost ratio	**2.53**	**1.89**	**3.01**	**2.43**

Source: GENIVAR calculations.

2.4 RESULTS FOR SCENARIOS 2 TO 5

Table 2.4 presents the results for the other scenarios that we analyzed. Scenarios 2 to 4 are subsets of scenario 1, so the preceding discussion regarding 5-axle vehicles and markets outside of Québec apples to scenarios 2 and 3 as well. Scenario 4

involves applying a constant percentage to the results from scenario 1, and the benefit/cost ratios remain similar. Scenario 5 provides direct benefits that recover 93% of the costs of the additional damage to Québec's roadways.

Table 2.4 Economic benefits and costs of using supersingle tires, by geographic market–Comparison of Scenarios 2 to 5, heavy vehicles, Québec, 1999

Scenario	S2	S3	S4	S5
Direct costs				
Ministère des Transports du Québec				
Damage to primary road network				
Normal periods	-3 017.3	-4 079.1	-9 425.8	0.0
Spring-thaw period	-2 767.6	-3 656.8	-8 783.3	-3 656.8
Total	***-5 784.9***	***-7 736.0***	***-18 209.1***	***-3 656.8***
Direct benefits				
Trucking industry				
Reduction in number of trips due to regulatory amendments				
Normal periods	222.3	1 381.3	13 834.1	0.0
Spring-thaw period	2 308.8	3 383.5	9 204.4	3 383.5
Total	***2 531.0***	***4 764.8***	***23 038.5***	***3 383.5***
Net direct value	**-3 253.8**	**-2 971.1**	**4 829.5**	**-273.4**
Direct benefit/cost ratio	**0.44**	**0.62**	**1.27**	**0.93**
Indirect costs				
Trucking industry				
Purchase and replacement of tires	-3 449.0	-4 122.0	-3 630.7	-4 122.0
Total	**-3 449.0**	**-4 122.0**	**-3 630.7**	**-4 122.0**
Indirect benefits				
Trucking industry				
Reduction in number of trips due to reduced mass of tires	382.7	694.1	2 886.4	694.1
Savings on fuel	15 959.2	19 073.2	16 103.5	19 073.2
Savings on maintenance	1 904.5	2 276.1	1 902.9	2 276.1
Total	***18 246.4***	***22 043.4***	***20 892.8***	***22 043.4***
Society				
Reduction in vehicle emissions	9 220.9	10 464.2	8 370.1	10 464.2
Reduction in tire disposal	221.9	221.9	195.5	221.9
Improvements in safety	307.5	512.4	638.4	512.4
Total	***9 750.3***	***11 198.5***	***9 203.9***	***11 198.5***
Total - Indirect benefits	**27 996.7**	**33 241.9**	**30 096.7**	**33 241.9**
Current value, indirect	**24 547.7**	**29 120.0**	**26 466.0**	**29 120.0**
Grand total, costs	**-9 233.9**	**-11 858.0**	**-21 839.8**	**-7 778.8**
Grand total, benefits	**30 527.7**	**38 006.8**	**53 135.3**	**36 625.4**
Total net value	**21 293.9**	**26 148.8**	**31 295.5**	**28 846.6**
Total benefit/cost ratio	**3.31**	**3.21**	**2.43**	**4.71**

Scenario 2: 5 axles Ontario and United States Scenario 3: 5 axles Scenario 4: 'realistic' percentages

Scenario 5: Harmonization with U.S. regulations

Source: GENIVAR calculations

CONCLUSION

The purpose of this study was to evaluate the costs and the benefits (in 2004 dollars, for the year 1999) of proposed regulatory amendments that would eliminate the 1 000 kg per axle penalty currently applied to heavy vehicles equipped with supersingle tires in Québec, along with the related special permit for the spring-thaw period. Another potential amendment scenario was also analyzed, in which the Québec regulations would be harmonized with the U.S. regulations for 5-axle vehicles only, so that the maximum allowable loads would be the same during the spring-thaw period as during the rest of the year. This study considered only Québec's primary road network, which is under the jurisdiction of the MTQ (Québec's transport ministry), but not its local road network, which is controlled by Québec's municipalities.

The direct costs identified in this study consist of costs to repair damage caused to the primary road network by supersingle tires. The MTQ, as manager of this network, absorbs these costs. The direct benefits consist of the savings that supersingle tires let the trucking industry realize on its operating costs by carrying heavier payloads on trips at maximum allowable load. The direct costs total $38.7 M/year for the MTQ, compared with direct benefits of $49.0 M/year for the trucking industry, for a positive total current direct value of $10.3 M/year. The net direct value is positive for vehicles with 6 or 7 axles, but negative for those with 2 to 4 axles, 5 axles, or 8 or more axles. The differences in these results are attributable partly to differences in the proportions of trips made at close to maximum load and in the proportions of Québec-based carriers.

Other costs and benefits of using supersingle tires are not directly related to the regulatory amendments considered here, but rather to the use of these tires instead of dual tires, even with no changes in the regulations. The indirect costs basically consist of the higher costs of purchasing and retreading supersingle tires. The indirect benefits are numerous. For the trucking industry, they include reduced fuel consumption and maintenance costs. For society, they include reduced vehicle emissions, a reduced mass of used tires to dispose of, and improved highway safety. The total net value of all the direct and indirect costs and benefits equals $66.6 M/year, for an overall benefit/cost ratio of 2.43 to 1. This ratio is positive for all vehicle configurations. The additional benefits are attributable largely to reduced rates of fuel consumption.

For the main scenario that we analyzed (Scenario 1), which assumes that supersingle tires would be installed on all heavy vehicles making intercity trips wholly or partly in Québec, the overall distribution of costs and benefits would be as follows. The MTQ, which maintains Québec's primary road network, would incur a recurring net cost of $38.8 M/year. The trucking industry would enjoy recurring cost reductions of $85.8 M/year. Lastly, Québec society as a whole would enjoy improvements in environmental and safety conditions equivalent to a recurrent net gain of $19.6 M/year.

For the alternative scenario that we analyzed, which assumes that Québec regulations would be harmonized with those in the United States, the direct benefit for the industry is slightly less than the additional cost of maintaining the road network ($3.4 M/year compared with $3.7 M/year). The indirect benefits are substantial, however, because the overall benefit/cost ratio for this scenario is 4.71 to 1.

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APPENDIXES

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A ABBREVIATIONS, ACRONYMS, UNITS OF MEASUREMENT, AND GLOSSARY

A.1 ABBREVIATIONS AND ACRONYMS

AMT	Agence métropolitaine de transport (Metro. Montreal transit agency)
c.	chapter (of a Québec statute or regulation)
CCMTA	Canadian Council of Motor Transport Administrators
CO	carbon monoxide
CO_2	carbon dioxide
EPA	Environmental Protection Agency (U.S.)
HC	hydrocarbons
MRNFP	Ministère des Ressources naturelles, de la Faune et des Parcs du Québec (Québec ministry of natural resources, wildlife, and parks)
MTQ	Ministère des Transports du Québec (Québec transport ministry)
NO	nitrogen oxide
PDO	property damage only
PL	payload
RSQ	Revised Statutes of Québec
s.	section (of a Québec statute or regulation)
SAAQ	Société d'assurance automobile du Québec (Québec's public auto insurance corporation)
TLM	total loaded mass (official term per Québec regulations, equivalent to "gross vehicle weight")

A.2 UNITS OF MEASUREMENT

h	hours
ft	feet
kg	kilograms
km	kilometres
L	litres
L/100 km	litres per 100 kilometres
lb	pounds
m	metres
min	minutes

M veh-km/year	millions of vehicle-kilometres per year
t	metric tonnes
veh	vehicle
veh-km	vehicle-kilometre
wk	weeks
yr	year
$	Canadian dollars
$2004	constant 2004 dollars
$B	billions of dollars
$/h	dollars per hour
$/kg	dollars per kilogram
$/km/year	dollars per kilometre per year
$/L	dollars per litre
$M	millions of dollars
$/veh-km	dollars per vehicle-kilometre
$/yr	dollars per year

A.3 GLOSSARY

Externality: economic cost or benefit experienced by an economic agent through no action of its own but rather as the result of action by another economic agent—for example, the cost of air pollution that is experienced by society as a whole as the result of atmospheric emissions by a particular industry.

Heavy vehicle: vehicle with a net load of 3 t (3 000 kg), designed to transport freight.

Highway tractor truck: highway vehicle of 3 t (3 000 kg) or more, designed specifically for transporting freight; a highway tractor truck is registered according to the maximum number of axles that can be comprised by the tractor unit and all the trailers that it is towing.

Maximum load: maximum load that trucking regulations allow for a specified configuration of truck; in Québec, maximum loads for spring-thaw period and rest of year ("normal period") may differ.

Normal period: time of year outside the spring-thaw period.

Retreading: Process in which a tire is repaired by rebuilding of the rubber tread layer that has been worn away.

Track: distance between the centre of the tires' ground contact areas (footprints) on either side of the vehicle.

Tractor: a motor vehicle, equipped with a fifth wheel, used to haul one or two trailers or a semi-trailer and a trailer.

Trailer: highway vehicle, including a semi-trailer the front of which rests on a dolly, connected to a vehicle that hauls it by an attachment system other than a fifth wheel.

B SURVEY OF CARRIERS HOLDING SPECIAL PERMITS FOR SUPERSINGLE TIRES

Questionnaire administered by telephone to seven Québec trucking firms that held permits for use of supersingle tires during the spring-thaw period in 2004

QUESTIONNAIRE FOR TELEPHONE SURVEY OF CARRIERS

IDENTIFICATION

Company name: _____

Address: _____

Names and titles of respondents: _____

QUESTIONS

Hello. My name is ____ . I'm calling on behalf of GENIVAR Inc. Our company has been hired by the Québec transportation ministry to conduct an economic study on the use of supersingle tires on heavy vehicles in Québec. To conduct this study, we are consulting trucking firms that currently hold permits to use these tires, so that we can assess the advantages and disadvantages that they may entail. If you are willing, I'd like to ask you a few questions to get your opinion on this subject..

Q1: Has using supersingle tires let you achieve any savings on fuel consumption, compared with using dual tires?

If yes, what percentage savings have you realized?

Q2: Has using supersingle tires let you achieve any improvements in safety, compared with using dual tires? As applicable, mention any specific improvements, such as:

- vehicle response when a tire blows;
- frequency of blowouts;
- stability of trailers;
- frequency of accidents;
- cost of insurance.

Q3: Has using supersingle tires resulted in any changes (upward or downward) in your maintenance costs, compared with using dual tires?

As applicable, mention any specific changes, such as changes in:

- tire wear and frequency of tire replacements;
- purchase price / long-term cost.

Q4: Would harmonization of the maximum loads allowed with supersingle tires lead to any major changes in the structure of your operations?

As applicable, mention any specific changes, such:

- adaptation of freight logistics on the basis of new maximum loads allowed;
- optimization of trips between certain points of origin and certain destinations.

Q5: If there were a change in the regulations concerning the use of supersingle tires, what short, medium-, and long-term equipment-management strategies would you adopt?

Examples:

- convert a portion of our rolling stock in the short term;
- gradually replace our current equipment on the basis of its expected service life;
- continue using dual tires.

C DETAILED VALUES AND CALCULATIONS

Table C. 1 Constants and categories

(a) Conversion of units of measurement

International	Imperial
1 kg	2.2046 lb
1 m	3.28 pi

(b) Consumer Price Index (CPI; 1995 = 100)

	Global	Reference
1999	109.3	111.9
2004	123.4	123.1

(c) Sales tax rates

	Rate
Goods and Services Tax	7.0%
Québec Sales Tax	7.5%
Combined rate	**15.025%**

(c) Length of periods

Normal period	43 weeks
Spring-thaw period	9 weeks
Year	**52 weeks**
% spring thaw	***17.3%***

(d) Categories

Vehicle configurations
2 - 4 axles
5 axles
6 axles
7 axles
8 axles or more
Grouped configurations
2 - 4 axles
5 axles
6 axles or more
Geographic markets
Québec - Québec
Québec - Ontario
Québec - United States
Other
Québec road classes
Resource-access
Ferry link
Local
Collector
Regional
Provincial
Freeway
Types of road
Misc. roads (1)
Misc. roads (2)
Regional roads
Provincial roads
Freeways
Roads outside Québec

Note: Misc. roads (1) comprises roads used for local or regional trips that do not use the primary network covered in the 1999 roadside survey. Misc. roads (2) includes resource-access roads, roads to ferry links, local roads and collector roads for intercity trips.

Table C. 2 Number of heavy vehicles, by number of axles, Québec, 1999-2003

Number of axles	1999	2000	2001	2002	2003	Increase, '99-'03
2 axles	49 980	49 587	48 760	48 664	49 097	-1.8%
3 axles	17 192	17 153	17 131	17 410	18 212	5.9%
4 axles	5 497	5 378	5 653	6 132	6 771	23.2%
5 axles	11 455	12 058	11 908	12 271	12 531	9.4%
6 axles or more	22 617	23 502	23 697	24 511	25 458	12.6%
Total	**106 741**	**107 678**	**107 149**	**108 988**	**112 069**	**5.0%**

Source: SAAQ (2004), *Bilan 2003 – Accidents, parc automobile, permis de conduire, dossier statistique* , Société de l'assurance automobile du Québec, Québec City, QC, April 2004.

Table C. 3 Correlation between number of axles and configurations, heavy vehicles, roadside survey, Québec, 1999

Number of axles	Straight trucks	Truck and trailer	1 or 2 tractors	Tractor and 1 trailer	Tractor and 2 trailers	Total	%
2 axles	44 674		117			***44 791***	**19.2%**
3 axles	19 189	18	5 903	895		***26 005***	**11.1%**
4 axles	3 967	636	3	4 653		***9 259***	**4.0%**
5 axles	11	834		69 478	255	***70 578***	**30.2%**
6 axles		742		37 473	379	***38 594***	**16.5%**
7 axles		182		33 286	676	***34 144***	**14.6%**
8 axles or more		19		150	10 296	***10 465***	**4.5%**
Total	**67 841**	**2 431**	**6 023**	**145 935**	**11 606**	**233 836**	**100.0%**
%	**29.0%**	**1.0%**	**2.6%**	**62.4%**	**5.0%**	**100.0%**	
Percentage of dominant configuration							
2 - 4 axles	84.7%						
5 axles				98.4%			
6 axles				97.1%			
7 axles				97.5%			
8 axles or more					98.4%		

Source: GENIVAR calculations based on MTQ (2004), *Fréquence des configurations, à partir de l'enquête en bord de route de 1999* , by Kathleen Plourde, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls file.

Table C. 4 Percentages of heavy vehicles with supersingle tires, Québec, 2004

	2 - 4 axles	5 axles	Total
Permits for tractors, supersingle tires	0	162	***162***
Total fleet of vehicles, 2003	74 080	37 989	***112 069***
% supersingle tires	**0.0%**	**0.4%**	**0.1%**

Source: MTQ (2004), *Liste des détenteurs de permis lors de la période de dégel 2004* , Ministère des Transports du Québec, Québec City, QC, Excel file, and SAAQ (2003), *Bilan 2002 des taxis, des autobus, des camions lourds et des tracteurs routiers, dossier statistique* , Société de l'assurance automobile du Québec, Québec City, QC, April 2003.

Table C. 5 Age of heavy vehicles, Québec, 1998 to 2002

(a) Number of vehicles

Age	1998	1999	2000	2001	2002	Mean
Less than 1 year	13 001	14 692	12 791	9 500	34 506	***16 898***
1 year	6 534	8 753	10 707	10 108	9 900	***9 200***
2 years	5 549	6 023	8 481	10 422	7 145	***7 524***
3 years	8 785	5 222	5 858	7 919	10 077	***7 572***
4 years	6 838	8 116	4 965	5 607	10 013	***7 108***
5 years	4 685	6 266	7 769	4 730	7 641	***6 218***
6 years	3 967	4 438	5 933	7 507	5 409	***5 451***
7 years	4 106	3 754	4 186	5 688	4 552	***4 457***
8 years	5 727	3 843	3 557	3 981	7 262	***4 874***
9 years	6 208	5 267	3 478	3 371	5 460	***4 757***
10 years	8 104	5 562	4 821	3 241	3 797	***5 105***
11 years or more	32 907	34 802	35 130	35 074	3 225	***28 228***
Not specified	4	2	2	1	1	***2***
Total	**106 415**	**106 740**	**107 678**	**107 149**	**108 988**	**107 394**
Average age (years)	**8.58**	**8.50**	**8.36**	**8.40**	**8.49**	**8.47**

Source: SAAQ (2003), *Bilan 2002 des taxis, des autobus, des camions lourds et des tracteurs routiers, dossier statistique* , Société de l'Assurance automobile du Québec, Québec City, QC, April 2003.

(b) Proportion of vehicles

Age	1998	1999	2000	2001	2002	Mean
Less than 1 year	12.2%	13.8%	11.9%	8.9%	31.7%	***15.7%***
1 year	6.1%	8.2%	9.9%	9.4%	9.1%	***8.6%***
2 years	5.2%	5.6%	7.9%	9.7%	6.6%	***7.0%***
3 years	8.3%	4.9%	5.4%	7.4%	9.2%	***7.1%***
4 years	6.4%	7.6%	4.6%	5.2%	9.2%	***6.6%***
5 years	4.4%	5.9%	7.2%	4.4%	7.0%	***5.8%***
6 years	3.7%	4.2%	5.5%	7.0%	5.0%	***5.1%***
7 years	3.9%	3.5%	3.9%	5.3%	4.2%	***4.2%***
8 years	5.4%	3.6%	3.3%	3.7%	6.7%	***4.5%***
9 years	5.8%	4.9%	3.2%	3.1%	5.0%	***4.4%***
10 years	7.6%	5.2%	4.5%	3.0%	3.5%	***4.8%***
11 years or more	30.9%	32.6%	32.6%	32.7%	3.0%	***26.3%***
Not specified	0.0%	0.0%	0.0%	0.0%	0.0%	***0.0%***
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: GENIVAR calculations based on SAAQ (2003), *Bilan 2002 des taxis, des autobus, des camions lourds et des tracteurs routiers, dossier statistique,* Société de l'Assurance automobile du Québec, Québec City, QC, April 2003.

Table C. 6 Distribution of intercity trips by heavy vehicles, by carrier base, Québec, 1999

(a) Number of trips
(trips/wk)

Carriers based in:	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec	70 046	64 334	33 008	26 277	8 536	***202 201***	***80.7%***
Ontario	8 485	16 106	4 104	2 370	1 720	***32 785***	***13.1%***
United States	627	4 598	1 155	70	0	***6 450***	***2.6%***
Other	737	4 869	2 574	517	352	***9 049***	***3.6%***
Total	**79 895**	**89 907**	**40 841**	**29 234**	**10 608**	**250 485**	**100%**
%	**31.9%**	**35.9%**	**16.3%**	**11.7%**	**4.2%**	**100%**	

(b) Distribution of trips by geographic market, for each configuration
(trips/wk)

Carriers based in:	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	6 axles or +
Québec	87.7%	71.6%	80.8%	89.9%	80.5%	***80.7%***	***84.1%***
Ontario	10.6%	17.9%	10.0%	8.1%	16.2%	***13.1%***	***10.2%***
United States	0.8%	5.1%	2.8%	0.2%	0.0%	***2.6%***	***1.5%***
Other	0.9%	5.4%	6.3%	1.8%	3.3%	***3.6%***	***4.3%***
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Note: Excludes trips for which the origin or destination was unknown.
Source: MTQ (2004), *Données traitées à partir de l'enquête en bord de route de 1999* ,
by Dave Henry, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls files.

(b) Distribution of trips by geographic market, for each configuration
(trips/wk)

Number of trips, Québec carriers

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	61 321	33 534	25 878	21 706	5 623	***148 062***
Québec - Ontario	7 471	7 269	6 046	4 173	1 584	***26 543***
Québec - United States	1 617	24 913	1 721	415	770	***29 436***
Other	0	0	0	0	708	***708***
Total	**70 409**	**65 716**	**33 645**	**26 294**	**8 685**	**204 749**

Number of trips, carriers based outside Québec

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec						***0***
Québec - Ontario	8 529	16 452	4 183	2 372	1 750	***33 286***
Québec - United States	630	4 697	1 177	70	0	***6 574***
Other	741	4 974	2 624	517	358	***9 214***
Total	**9 900**	**26 123**	**7 984**	**2 959**	**2 108**	**49 074**

Number of trips, all carriers

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	61 321	33 534	25 878	21 706	5 623	***148 062***
Québec - Ontario	16 000	23 721	10 229	6 545	3 334	***59 829***
Québec - United States	2 247	29 610	2 898	485	770	***36 010***
Other	741	4 974	2 624	517	1 066	***9 921***
Total	**80 309**	**91 839**	**41 629**	**29 253**	**10 793**	**243 901**

Proportion of trips, Québec carriers

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	100.0%	100.0%	100.0%	100.0%	100.0%	***100.0%***
Québec - Ontario	46.7%	30.6%	59.1%	63.8%	47.5%	***44.4%***
Québec - United States	72.0%	84.1%	59.4%	85.6%	100.0%	***76.2%***
Other	0.0%	0.0%	0.0%	0.0%	66.4%	***1.4%***
Total	**87.7%**	**71.6%**	**80.8%**	**89.9%**	**80.5%**	**83.9%**

Source: GENIVAR calculations based on MTQ (2004), *Données traitées à partir de l'enquête en bord de route de 1999,*
by Dave Henry, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls files.

Table C. 7 Number of trips and distances travelled, by geographic market, intercity trips by heavy vehicles, Québec, 1999

Constants for following table	
Factor (a) (b)	52
Factor (b)	1 000
Factor (e)	1 000

(a) Weekly number of trips
(trips/wk)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	61 635	35 531	25 967	22 004	5 623	***150 760***	***59.4%***
Québec - Ontario	16 000	23 721	10 229	6 545	3 334	***59 829***	***23.6%***
Québec - United States	2 247	29 610	2 898	485	770	***36 010***	***14.2%***
Other	427	2 977	2 535	219	1 066	***7 224***	***2.8%***
Total	**80 309**	**91 839**	**41 629**	**29 253**	**10 793**	**253 823**	**100%**
%	**31.6%**	**36.2%**	**16.4%**	**11.5%**	**4.3%**	**100%**	

(b) Annual number of trips
('000 trips/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	3 205.0	1 847.6	1 350.3	1 144.2	292.4	***7 839.5***	***59.4%***
Québec - Ontario	832.0	1 233.5	531.9	340.3	173.4	***3 111.1***	***23.6%***
Québec - United States	116.8	1 539.7	150.7	25.2	40.0	***1 872.5***	***14.2%***
Other	22.2	154.8	131.8	11.4	55.4	***375.6***	***2.8%***
Total	**4 176.1**	**4 775.6**	**2 164.7**	**1 521.2**	**561.2**	**13 198.8**	**100%**
%	**31.6%**	**36.2%**	**16.4%**	**11.5%**	**4.3%**	**100%**	

(c) Distribution of trips by geographic market, for each configuration
('000 trips/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	76.7%	38.7%	62.4%	75.2%	52.1%	***59.4%***
Québec - Ontario	19.9%	25.8%	24.6%	22.4%	30.9%	***23.6%***
Québec - United States	2.8%	32.2%	7.0%	1.7%	7.1%	***14.2%***
Other	0.5%	3.2%	6.1%	0.7%	9.9%	***2.8%***
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

(d) Distribution of trips by configuration, for each geographic market
('000 trips/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	40.9%	23.6%	17.2%	14.6%	3.7%	***100%***
Québec - Ontario	26.7%	39.6%	17.1%	10.9%	5.6%	***100%***
Québec - United States	6.2%	82.2%	8.0%	1.3%	2.1%	***100%***
Other	5.9%	41.2%	35.1%	3.0%	14.8%	***100%***
Total	**31.6%**	**36.2%**	**16.4%**	**11.5%**	**4.3%**	**100%**

(e) Average distance travelled
(veh-km/trip)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Average
Québec - Québec	111.5	165.0	171.5	218.4	231.4	***154.5***
Québec - Ontario	122.9	515.2	565.6	493.5	529.5	***417.3***
Québec - United States	412.3	1 055.7	454.9	563.7	1 183.3	***963.3***
Other	1 043.9	1 661.7	1 317.8	819.1	876.0	***1 363.0***
Average	**126.8**	**591.2**	**357.8**	**290.0**	**455.1**	**365.5**

(f) Distance travelled per year

(M veh-km/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	357.4	304.9	231.6	249.9	67.7	***1 211.3***	***25.1%***
Québec - Ontario	102.3	635.5	300.8	168.0	91.8	***1 298.4***	***26.9%***
Québec - United States	48.2	1 625.5	68.6	14.2	47.4	***1 803.8***	***37.4%***
Other	23.2	257.2	173.7	9.3	48.6	***512.0***	***10.6%***
Total	**531.0**	**2 823.1**	**774.7**	**441.4**	**255.4**	**4 825.5**	**100%**
%	**11.0%**	**58.5%**	**16.1%**	**9.1%**	**5.3%**	**100%**	

(g) Distribution of distance travelled by geographic market, for each configuration

(M veh-km/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	67.3%	10.8%	29.9%	56.6%	26.5%	***25.1%***
Québec - Ontario	19.3%	22.5%	38.8%	38.1%	35.9%	***26.9%***
Québec - United States	9.1%	57.6%	8.8%	3.2%	18.6%	***37.4%***
Other	4.4%	9.1%	22.4%	2.1%	19.0%	***10.6%***
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

(h) Distribution of trips by configuration, for each geographic market

(M veh-km/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	29.5%	25.2%	19.1%	20.6%	5.6%	***100%***
Québec - Ontario	7.9%	48.9%	23.2%	12.9%	7.1%	***100%***
Québec - United States	2.7%	90.1%	3.8%	0.8%	2.6%	***100%***
Other	4.5%	50.2%	33.9%	1.8%	9.5%	***100%***
Total	**11.0%**	**58.5%**	**16.1%**	**9.1%**	**5.3%**	**100%**

Source: GENIVAR calculations based on MTQ (2004), *Données traitées à partir de l'enquête en bord de route de 1999*, by Dave Henry, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls files.

Table C. 8 Distances travelled per year, by vehicle configuration and road network used, intercity trips by heavy vehicles, Québec, 1999

Factor for following table
Factor 1 000 000

(a) Total distance travelled per year, by geographic market
(M veh-km/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	357.4	304.9	231.6	249.9	67.7	***1 211.3***	***25.1%***
Québec - Ontario	102.3	635.5	300.8	168.0	91.8	***1 298.4***	***26.9%***
Québec - United States	48.2	1 625.5	68.6	14.2	47.4	***1 803.8***	***37.4%***
Other	23.2	257.2	173.7	9.3	48.6	***512.0***	***10.6%***
Total	**531.0**	**2 823.1**	**774.7**	**441.4**	**255.4**	**4 825.5**	**100%**
%	**11.0%**	**58.5%**	**16.1%**	**9.1%**	**5.3%**	**100%**	

Source: MTQ (2004), *Données traitées à partir de l'enquête en bord de route de 1999,* by Dave Henry, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls files.

Factor for the following table 52
Factor for the following table 1 000 000

(b) Total distance travelled per year, by class of road, 1999
(M veh-km/yr)

Class of road	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Resource-access	0.0	0.1	0.1	0.4	0.0	***0.7***	***0.0%***
Ferry link	0.1	0.2	0.2	0.1	0.1	***0.7***	***0.0%***
Local	2.4	2.8	1.5	1.4	0.4	***8.5***	***0.4%***
Collector	5.9	6.0	4.2	3.7	0.9	***20.6***	***1.0%***
Regional	27.3	33.2	15.2	20.9	4.7	***101.1***	***5.0%***
Provincial	91.3	134.5	93.1	133.6	47.9	***500.4***	***24.7%***
Freeway	272.6	569.2	288.3	189.7	74.8	***1 394.7***	***68.8%***
Total - in Québec	**399.7**	**745.9**	**402.5**	**349.8**	**128.8**	**2 026.7**	**100%**
%	**19.7%**	**36.8%**	**19.9%**	**17.3%**	**6.4%**	**100%**	
Outside Québec	131.3	2 077.2	372.2	91.6	126.6	***2 798.8***	
Grand total	**531.0**	**2 823.1**	**774.7**	**441.4**	**255.4**	**4 825.5**	

Source: GENIVAR calculations based on MTQ (2005), *Étude sur la sollicitation du réseau routier québécois, à partir de à partir de l'enquête sur le camionnage de 1999,* by Luc Denault, Ministère des Transports du Québec, Service de la Modélisation, Montréal QC, xls and jpg files.

(c) Proportion of total distance travelled on each class of road, 1999
(M veh-km/yr)

Class of road	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Mean
Resource-access	0.0%	0.0%	0.0%	0.1%	0.0%	***0.0%***
Ferry link	0.0%	0.0%	0.0%	0.0%	0.0%	***0.0%***
Local	0.5%	0.1%	0.2%	0.3%	0.2%	***0.2%***
Collector	1.1%	0.2%	0.5%	0.8%	0.4%	***0.4%***
Regional	5.1%	1.2%	2.0%	4.7%	1.8%	***2.1%***
Provincial	17.2%	4.8%	12.0%	30.3%	18.8%	***10.4%***
Freeway	51.3%	20.2%	37.2%	43.0%	29.3%	***28.9%***
Total - in Québec	**75.3%**	**26.4%**	**52.0%**	**79.2%**	**50.4%**	**42.0%**
Outside Québec	24.7%	73.6%	48.0%	20.8%	49.6%	***58.0%***
Grand total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: GENIVAR calculations based on MTQ (2005), *Étude sur la sollicitation du réseau routier québécois, à partir de l'enquête en bord de route de 1999,* by Luc Denault, Ministère des Transports du Québec, Service de la Modélisation, Montréal QC, xls and jpg files.

Table C. 9 Distances travelled per year, by vehicle configuration, carrier ownership, and type of road, Québec, 1999

(a) Distance per year, by vehicle configuration, based on SAAQ data and roadside survey

Number of axles	Number of trucks in fleet 1999	Average kilometres per year, 1997	Estimated total distance per year, 1999 (M veh-km/yr) (1)	(2)	(3) (4)	Difference (2) - (3) or - (4)	Difference %
2 axles	49 980	25 624	1 280.7				
3 axles	17 192	31 615	543.5	2 005.8	531.0	1 474.8	73.5%
4 axles	5 497	33 029	181.6		465.5	1 540.3	76.8%
5 axles	11 455	99 366	1 138.2	3 553.3	4 294.5	-741.2	-20.9%
6 axles or more	22 617	106 782	2 415.1		2 844.6	708.8	19.9%
Total	**106 741**	**52 080**	**5 559.1**	**5 559.1**	**4 825.5**	**733.6**	**13.2%**
					3 310.1	**2 249.0**	**40.5%**

(1) Estimated from SAAQ data

(2) Aggregated from SAAQ data

(3) Aggregated from processed data from 1999 roadside survey

(4) Aggregated from processed data from 1999 roadside survey, multiplied by percentage of Québec-owned vehicles

(b) Estimated total distance per year, heavy vehicles, by carrier ownership, vehicle configuration, and type of trip, Québec, 1999

(M veh-km/yr)

2 - 4 axles

Ownership/Type of trip	Intercity	Local	Total
Québec-owned	465.5	1 540.3	***2 005.8***
Non-Québec owned	65.5	0.0	***65.5***
Total	**531.0**	**1 540.3**	**2 071.2**

5 axles

Ownership/Type of trip	Intercity	Local	Total
Québec-owned	2 844.6	708.8	***3 553.3***
Non-Québec owned	1 450.0	0.0	***1 450.0***
Total	**4 294.5**	**708.8**	**5 003.3**

Total

Ownership/Type of trip	Intercity	Local	Total
Québec-owned	3 310.1	2 249.0	***5 559.1***
Non-Québec owned	1 515.4	0.0	***1 515.4***
Total	**4 825.5**	**2 249.0**	**7 074.5**

(c) Estimated distance travelled per year, heavy vehicles, by carrier ownership, vehicle configuration, and type of road, Québec, 1999

(M veh-km/yr)

Québec-owned carriers

Type of road	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Misc. roads (1)	1 540.3	253.0	192.2	207.4	56.2	***2 249.0***
Misc. roads (2)	7.4	6.5	4.8	5.0	1.2	***24.8***
Regional roads	23.9	23.7	12.2	18.8	3.8	***82.4***
Provincial roads	80.1	96.3	75.2	120.1	38.5	***410.2***
Freeways	239.0	407.3	233.0	170.5	60.2	***1 110.1***
Roads outside Québec	115.1	1 486.3	300.8	82.4	101.8	***2 086.4***
Total	**2 005.8**	**2 273.1**	**818.3**	**604.1**	**261.7**	**5 963.0**

Non-Québec owned carriers

Type of road	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Local roads						***0.0***
Misc. roads (2)	1.0	2.6	1.1	0.6	0.3	***5.6***
Regional roads	3.4	9.4	2.9	2.1	0.9	***18.7***
Provincial roads	11.3	38.3	17.9	13.5	9.4	***90.2***
Freeways	33.6	161.9	55.3	19.2	14.6	***284.6***
Roads outside Québec	16.2	590.8	71.4	9.3	24.7	***712.4***
Total	**65.5**	**803.0**	**148.6**	**44.6**	**49.9**	**1 111.6**

All carriers

Type of road	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Local roads	1 540.3	253.0	192.2	207.4	56.2	***2 249.0***
Misc. roads (2)	8.5	9.0	5.9	5.5	1.4	***30.4***
Regional roads	27.3	33.2	15.2	20.9	4.7	***101.1***
Provincial roads	91.3	134.5	93.1	133.6	47.9	***500.4***
Freeways	272.6	569.2	288.3	189.7	74.8	***1 394.7***
Roads outside Québec	131.3	2 077.2	372.2	91.6	126.6	***2 798.8***
Total	**2 071.2**	**3 076.1**	**966.9**	**648.8**	**311.6**	**7 074.5**

Source: GENIVAR calculations based on SAAQ (2003), *Bilan 2002 des taxis, des autobus, des camions lourds et des tracteurs routiers, dossier statistique* , Société de l'Assurance automobile du Québec, Québec City, QC, April 2003 and on MTQ (2004), *Données traitées à partir de l'enquête en bord de route de 1999,* by Dave Henry, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionn Québec City, QC, xls files. GENIVAR calculations based on tables C.6 and C.8.

Table C. 10 Estimated total distance travelled per year by Québec-based carriers on intercity trips, by geographic market, vehicle configuration, and time of year, Québec, 1999

(M veh-km/yr)

(a) All year

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	377.4	297.3	225.8	243.7	66.0	***1 210.2***	***36.6%***
Québec - Ontario	50.4	189.9	173.4	104.4	42.5	***560.7***	***16.9%***
Québec - United States	36.6	1 333.7	39.7	11.9	46.2	***1 468.1***	***44.4%***
Other	1.1	22.9	38.0	0.2	9.0	***71.1***	***2.1%***
Total	**465.5**	**1 843.8**	**476.9**	**360.2**	**163.7**	**3 310.1**	**100%**
%	**14.1%**	**55.7%**	**14.4%**	**10.9%**	**4.9%**	**100%**	

(b) Normal period, excluding others

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	312.1	245.8	186.7	201.5	54.6	***1 000.7***	***37.4%***
Québec - Ontario	41.7	157.0	143.4	86.4	35.2	***463.7***	***17.3%***
Québec - United States	30.3	1 102.9	32.8	9.8	38.2	***1 214.0***	***45.3%***
Total	**384.1**	**1 505.7**	**363.0**	**297.7**	**127.9**	**2 678.4**	**100%**
%	**14.3%**	**56.2%**	**13.6%**	**11.1%**	**4.8%**	**100%**	

(c) Spring-thaw period, excluding others

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	65.3	51.5	39.1	42.2	11.4	***209.5***	***37.4%***
Québec - Ontario	8.7	32.9	30.0	18.1	7.4	***97.0***	***17.3%***
Québec - United States	6.3	230.8	6.9	2.1	8.0	***254.1***	***45.3%***
Total	**80.4**	**315.2**	**76.0**	**62.3**	**26.8**	**560.6**	**100%**
%	**14.3%**	**56.2%**	**13.6%**	**11.1%**	**4.8%**	**100%**	

Source: GENIVAR calculations based on tables C.1, C.6, and C.8

Table C. 11 Differences in maximum allowable loads, by type of tire, vehicle configuration, time of year, and jurisdiction or geographic market

Conversion factor for tractor/semi-trailer length
48 ft = 14.6 m

(a) By jurisdiction, normal (non-spring-thaw) period

	3 axles	5 axles	6 axles	7 axles	8 axles
Tare	11 000	14 000	17 500	18 300	19 500
Supersingle tires, in Québec (with 1000 kg penalty)					
Max. total loaded mass	23 250	37 500	44 500	49 500	55 500
Max. payload	12 250	23 500	27 000	31 200	36 000
Conventional dual tires, in Québec					
Max. total loaded mass	25 250	41 500	49 500	55 500	62 500
Max. payload	14 250	27 500	32 000	37 200	43 000
Difference	2 000	4 000	5 000	6 000	7 000
Diff. as % max. payload	14.0%	14.5%	15.6%	16.1%	16.3%
Ontario, less than 14.6 m (48 ft)					
Max. total loaded mass	25 250	41 500	49 500	55 500	62 500
Max. payload	14 250	27 500	32 000	37 200	43 000
Difference	2 000	4 000	5 000	6 000	7 000
Diff. as % max. payload	14.0%	14.5%	15.6%	16.1%	16.3%
Ontario, more than 14.6 m (48 ft)					
Max. total loaded mass	17 500	29 500	35 500	41 500	47 500
Tolerated total loaded mass	20 500	36 500	44 250	52 000	59 750
Max. payload	6 500	15 500	18 000	23 200	28 000
Tolerated payload	9 500	22 500	26 750	33 700	40 250
Difference, relative to tolerated payload	-2 750	-1 000	-250	2 500	4 250
Diff. as % tol. payload	-28.9%	-4.4%	-0.9%	7.4%	10.6%
United States					
Max. total loaded mass	21 000	36 500	44 250		
Max. payload	10 000	22 500	26 750		
Difference	-2 250	-1 000	-250		
Diff. as % max. payload	-22.5%	-4.4%	-0.9%		

(b) By jurisdiction, spring-thaw period

	3 axles	5 axles	6 axles	7 axles	8 axles
Tare	11 000	14 000	17 500	18 300	19 500
Supersingle tires, in Québec (with 1000 kg penalty)					
Max. total loaded mass	20 750	32 500	38 000	42 500	50 500
Max. payload	9 750	18 500	20 500	24 200	31 000
Conventional dual tires, in Québec					
Max. total loaded mass	22 750	36 500	43 000	48 500	57 500
Max. payload	11 750	22 500	25 500	30 200	38 000
Difference	2 000	4 000	5 000	6 000	7 000
Diff. as % max. payload	17.0%	17.8%	19.6%	19.9%	18.4%
Ontario, less than 14.6 m (48 ft)					
Max. total loaded mass	25 250	41 500	49 500	55 500	62 500
Max. payload	14 250	27 500	32 000	37 200	43 000
Difference	4 500	9 000	11 500	13 000	12 000
Diff. as % max. payload	31.6%	32.7%	35.9%	34.9%	27.9%
Ontario, more than 14.6 m (48 ft)					
Max. total loaded mass	17 500	29 500	35 500	41 500	47 500
Max. payload	6 500	15 500	18 000	23 200	28 000
Tolerated total loaded mass	20 500	36 500	44 250	52 000	59 750
Tolerated payload	9 500	22 500	26 750	33 700	40 250
Difference, relative to tolerated payload	-250	4 000	6 250	9 500	9 250
Diff. as % tol. payload	-2.6%	17.8%	23.4%	28.2%	23.0%
United States					
Max. total loaded mass	21 000	36 500	44 250		
Max. payload	10 000	22 500	26 750		
Difference	250	4 000	6 250		
Diff. as % max. payload	2.5%	17.8%	23.4%		

(c) Limiting factor on max. total loaded mass, by geographic market and vehicle

Geographic market	3 axles	5 axles	6 axles	7 axles	8 axles
Québec - Québec					
Normal period	Q	Q	Q	Q	Q
Spring-thaw period	Q	Q	Q	Q	Q
Québec - Ontario					
Less than 14.6 m (48 ft)					
Normal period	Q	Q	Q	Q	Q
Spring-thaw period	Q	Q	Q	Q	Q
More than 14.6 m (48 ft)					
Normal period	O	O	O	Q	Q
Spring-thaw period	O	Q	Q	Q	Q
Québec - United States					
Normal period	US	US	US	n/a	n/a
Spring-thaw period	US	Q	Q		

Note: A positive difference means that the maximum load allowed on a configuration with conventional dual tires is greater than that allowed with supersingle tires.

US: U.S. regulations
O: Ontario regulations
n/a: not applicable
ST: Québec regulations for spring-thaw period
Q: Québec penalty on single tires

(d) Maximum total loaded mass by geographic market, vehicle configuration, and time of year

	3 axles	5 axles	6 axles	7 axles	8 axles
Supersingle tires					
(with 1000 kg penalty)					
Normal period	23 250	37 500	44 500	49 500	55 500
Spring-thaw period	20 750	32 500	38 000	42 500	50 500
Québec - Québec (without penalty)					
Normal period	25 250	41 500	49 500	55 500	62 500
Spring-thaw period	22 750	36 500	43 000	48 500	57 500
Québec - Ontario					
Less than 14.6 m (48 ft)	25 250	41 500	49 500	55 500	62 500
More than 14.6 m (48 ft)	20 500	36 500	44 250	52 000	59 750
Québec - United States	21 000	36 500	44 250		

(e) Percentage difference in payload, supersingle tires vs. dual tires, by geographic market, vehicle configuration, and time of year

	3 axles	5 axles	6 axles	7 axles	8 axles
Québec - Québec					
Normal period	14.0%	14.5%	15.6%	16.1%	16.3%
Spring-thaw period	17.0%	17.8%	19.6%	19.9%	18.4%
Québec - Ontario					
Less than 14.6 m (48 ft)					
Normal period	14.0%	14.5%	15.6%	16.1%	16.3%
Spring-thaw period	17.0%	17.8%	19.6%	19.9%	18.4%
More than 14.6 m (48 ft)					
Normal period	0.0%	0.0%	0.0%	7.4%	10.6%
Spring-thaw period	0.0%	17.8%	19.6%	19.9%	18.4%
Québec - United States					
Normal period	0.0%	0.0%	0.0%		
Spring-thaw period	2.5%	17.8%	19.6%		

Note: A positive difference means that the maximum load allowed on a configuration with conventional dual tires is greater than that allowed with supersingle tires. A negative difference is reported as 0% in table (e).

Sources: MTQ (2004), *Guide des normes de charges et dimensions des vehicles*, Ministère des Transports du Québec, Québec City, QC, 2004 editoin, 28 pages; MTQ (2004), Personal communication on 2004-11-05; Camtech – GENIVAR (2001), *Étude d'impact des restrictions de charge en période de dégel sur l'économie du Québec*, Camtech, Saint-Nicolas QC and GENIVAR, Montréal QC, for the Ministère des Transports du Québec, Québec City, QC, 58 pages and appendixes.

Table C. 12 Distribution of payloads by tonnage, vehicle configuration, and geographic market, intercity trips by heavy vehicles, Québec, 1999

(a) Number of trips during one week in Fall 1999

Québec - Québec

Payload	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Less than 0.5 t	5 468	278	264	7	8
0.5 - 1 t	4 978	1 031	102	39	0
1 - 2 t	4 432	1 060	308	87	0
2 - 3 t	4 114	1 720	531	76	14
3 - 4 t	2 721	639	358	108	2
4 - 5 t	1 897	1 139	477	143	4
5 - 10 t	4 184	4 934	1 786	558	210
10 - 15 t	2 254	3 262	1 502	758	313
15 - 20 t	1 106	3 502	1 926	1 188	233
20 - 25 t	434	2 062	2 646	1 895	234
25 - 30 t	53	296	2 206	2 035	434
30 - 35 t	0	217	2 686	2 816	301
35 - 40 t	0	0	426	2 974	950
More than 40 t	0	0	124	209	902
Not applicable	26 012	14 595	10 198	8 788	2 075
No response	3 712	795	429	322	49
Total	**61 365**	**35 530**	**25 969**	**22 003**	**5 729**
Mean	**5.2**	**10.7**	**19.6**	**26.9**	**31.2**

Québec - Ontario

Payload	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Less than 0.5 t	1 487	406	54	19	0
0.5 - 1 t	945	232	53	32	0
1 - 2 t	784	704	176	63	17
2 - 3 t	564	738	238	87	1
3 - 4 t	395	946	87	81	15
4 - 5 t	389	1 277	228	81	12
5 - 10 t	833	5 202	1 033	407	73
10 - 15 t	248	3 589	920	272	44
15 - 20 t	143	3 771	1 310	689	96
20 - 25 t	71	1 817	1 531	1 193	137
25 - 30 t	3	227	1 521	689	275
30 - 35 t	0	35	655	1 193	352
35 - 40 t	0	6	170	939	766
More than 40 t	0	0	19	93	438
Not applicable	7 981	4 492	2 156	1 324	1 088
No response	2 159	280	76	49	17
Total	**16 002**	**23 722**	**10 227**	**7 211**	**3 331**
Mean	**3.4**	**11.1**	**18.7**	**24.6**	**33.0**

Québec - United States

Payload	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Less than 0.5 t	157	177	8	0	0
0.5 - 1 t	162	181	7	0	2
1 - 2 t	441	493	4	0	11
2 - 3 t	95	636	21	0	0
3 - 4 t	166	477	15	0	2
4 - 5 t	155	669	25	0	0
5 - 10 t	255	3 104	105	70	7
10 - 15 t	62	3 331	83	36	18
15 - 20 t	8	9 759	515	38	84
20 - 25 t	13	5 504	320	69	26
25 - 30 t	4	682	554	72	12
30 - 35 t	0	119	264	52	111
35 - 40 t	0	10	108	55	331
More than 40 t	0	0	1	0	91
Not applicable	668	4 342	818	91	67
No response	58	126	52	2	5
Total	**2 244**	**29 610**	**2 900**	**485**	**767**
Mean	**3.7**	**15.5**	**22.7**	**22.8**	**32.8**

Notes: Trips for which the origin or destination was unknown are excluded.

Empty runs are included in the category "Not applicable".

Source: MTQ (2004), *Données traitées à partir de l'enquête en bord de route de 1999* , by Dave Henry, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls files.

(b) Percentage of trips during one week in Fall 1999

Québec - Québec

Payload	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Less than 0.5 t	9.5%	0.8%	1.0%	0.0%	0.1%
0.5 - 1 t	8.6%	3.0%	0.4%	0.2%	0.0%
1 - 2 t	7.7%	3.1%	1.2%	0.4%	0.0%
2 - 3 t	7.1%	5.0%	2.1%	0.4%	0.2%
3 - 4 t	4.7%	1.8%	1.4%	0.5%	0.0%
4 - 5 t	3.3%	3.3%	1.9%	0.7%	0.1%
5 - 10 t	7.3%	14.2%	7.0%	2.6%	3.7%
10 - 15 t	3.9%	9.4%	5.9%	3.5%	5.5%
15 - 20 t	1.9%	10.1%	7.5%	5.5%	4.1%
20 - 25 t	0.8%	5.9%	10.4%	8.7%	4.1%
25 - 30 t	0.1%	0.9%	8.6%	9.4%	7.6%
30 - 35 t	0.0%	0.6%	10.5%	13.0%	5.3%
35 - 40 t	0.0%	0.0%	1.7%	13.7%	16.7%
More than 40 t	0.0%	0.0%	0.5%	1.0%	15.9%
Not applicable	45.1%	42.0%	39.9%	40.5%	36.5%
No response					
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Québec - Ontario

Payload	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Less than 0.5 t	10.7%	1.7%	0.5%	0.3%	0.0%
0.5 - 1 t	6.8%	1.0%	0.5%	0.4%	0.0%
1 - 2 t	5.7%	3.0%	1.7%	0.9%	0.5%
2 - 3 t	4.1%	3.1%	2.3%	1.2%	0.0%
3 - 4 t	2.9%	4.0%	0.9%	1.1%	0.5%
4 - 5 t	2.8%	5.4%	2.2%	1.1%	0.4%
5 - 10 t	6.0%	22.2%	10.2%	5.7%	2.2%
10 - 15 t	1.8%	15.3%	9.1%	3.8%	1.3%
15 - 20 t	1.0%	16.1%	12.9%	9.6%	2.9%
20 - 25 t	0.5%	7.8%	15.1%	16.7%	4.1%
25 - 30 t	0.0%	1.0%	15.0%	9.6%	8.3%
30 - 35 t	0.0%	0.1%	6.5%	16.7%	10.6%
35 - 40 t	0.0%	0.0%	1.7%	13.1%	23.1%
More than 40 t	0.0%	0.0%	0.2%	1.3%	13.2%
Not applicable	57.7%	19.2%	21.2%	18.5%	32.8%
No response					
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Québec - United States

Payload	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Less than 0.5 t	7.2%	0.6%	0.3%	0.0%	0.0%
0.5 - 1 t	7.4%	0.6%	0.2%	0.0%	0.3%
1 - 2 t	20.2%	1.7%	0.1%	0.0%	1.4%
2 - 3 t	4.3%	2.2%	0.7%	0.0%	0.0%
3 - 4 t	7.6%	1.6%	0.5%	0.0%	0.3%
4 - 5 t	7.1%	2.3%	0.9%	0.0%	0.0%
5 - 10 t	11.7%	10.5%	3.7%	14.5%	0.9%
10 - 15 t	2.8%	11.3%	2.9%	7.5%	2.4%
15 - 20 t	0.4%	33.1%	18.1%	7.9%	11.0%
20 - 25 t	0.6%	18.7%	11.2%	14.3%	3.4%
25 - 30 t	0.2%	2.3%	19.5%	14.9%	1.6%
30 - 35 t	0.0%	0.4%	9.3%	10.8%	14.6%
35 - 40 t	0.0%	0.0%	3.8%	11.4%	43.4%
More than 40 t	0.0%	0.0%	0.0%	0.0%	11.9%
Not applicable	30.6%	14.7%	28.7%	18.8%	8.8%
No response					
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: GENIVAR calculations based on MTQ (2004), *Données traitées à partir de l'enquête en bord de route de 1999*, by Dave Henry, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC

Table C. 13 Trips with payload just below the proposed minimum for single tires, by vehicle configuration and geographic market, intercity trips by heavy vehicles, Québec, 1999

Proportion of trips on the Ontario market with units less than 14.6 m long
24% Source: Kathleen Plourde, MTQ.
Proportion of trips affected 100%

(a) Proportion during normal (non-spring-thaw) period

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Québec - Québec	0.8%	2.6%	14.0%	23.6%	29.3%
Ontario, less than 14.6 m (48 ft)	0.7%	3.3%	15.4%	25.8%	31.7%
Ontario, more than 14.6 m (48 ft)	0.0%	0.0%	0.0%	8.3%	31.7%
Québec - United States	0.0%	0.0%	0.0%		

(b) Proportion during spring-thaw period

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Québec - Québec	5.8%	9.8%	28.5%	37.5%	36.8%
Ontario, less than 14.6 m (48 ft)	2.8%	13.5%	35.0%	42.1%	44.8%
Ontario, more than 14.6 m (48 ft)	0.0%	12.6%	35.0%	28.9%	44.8%
Québec - United States	0.6%	28.6%	29.6%		

(c) Number of trips made per year during normal period
('000 trips/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	20.3	40.2	156.0	223.2	70.7	***510.5***	82.8%
Québec - Ontario	1.2	8.1	16.3	35.2	45.5	***106.2***	17.2%
Québec - United States	0.0	0.0	0.0			***0.0***	0.0%
Total	**21.5**	**48.3**	**172.3**	**258.4**	**116.2**	**616.7**	**100.0%**
%	3.5%	7.8%	27.9%	41.9%	18.8%	***100.0%***	

(d) Number of trips made per year during spring-thaw period
('000 trips/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	32.3	31.4	66.6	74.2	18.6	***223.2***	67.5%
Québec - Ontario	1.0	27.3	32.2	18.9	13.5	***92.9***	28.1%
Québec - United States	0.0	7.7	6.7			***14.4***	4.4%
Total	**33.3**	**66.4**	**105.5**	**93.1**	**32.1**	**330.5**	**100.0%**
%	10.1%	20.1%	31.9%	28.2%	9.7%	***100.0%***	

(e) Annual number of trips affected, entire year
('000 trips/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	52.7	71.6	222.6	297.4	89.4	***733.7***	77.5%
Québec - Ontario	2.2	35.4	48.5	54.1	58.9	***199.1***	21.0%
Québec - United States	0.0	7.7	6.7			***14.4***	1.5%
Total	**54.8**	**114.7**	**277.8**	**351.6**	**148.3**	**947.2**	**100.0%**
%	5.8%	12.1%	29.3%	37.1%	15.7%	***100.0%***	

(f) Annual distance travelled on affected trips, normal period
(M veh-km/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	2.3	6.6	26.8	48.7	16.4	***100.8***	64.7%
Québec - Ontario	0.1	4.2	9.2	17.4	24.1	***55.0***	35.3%
Québec - United States	0.0	0.0	0.0			***0.0***	0.0%
Total	**2.4**	**10.8**	**36.0**	**66.1**	**40.4**	**155.7**	**100.0%**
%	1.5%	6.9%	23.1%	42.5%	26.0%	***100.0%***	

(g) Annual distance travelled on affected trips, spring-thaw period

(M veh-km/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	3.6	5.2	11.4	16.2	4.3	***40.7***	40.4%
Québec - Ontario	0.1	14.1	18.2	9.3	7.1	***48.9***	48.5%
Québec - United States	0.0	8.1	3.1			***11.2***	11.1%
Total	**3.7**	**27.4**	**32.7**	**25.5**	**11.4**	**100.8**	**100.0%**
%	3.7%	27.1%	32.5%	25.3%	11.3%	***100.0%***	

(h) Annual distance travelled on affected trips, entire year

(M veh-km/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	5.9	11.8	38.2	65.0	20.7	***141.5***	55.2%
Québec - Ontario	0.3	18.2	27.5	26.7	31.2	***103.9***	40.5%
Québec - United States	0.0	8.1	3.1			***11.2***	4.4%
Total	**6.1**	**38.1**	**68.7**	**91.7**	**51.9**	**256.5**	**100.0%**
%	2.4%	14.9%	26.8%	35.7%	20.2%	***100.0%***	

(i) Proportion of annual travelled distance affected, entire year

(M veh-km/yr)

Geographic market	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Moyenne
Québec - Québec	1.6%	3.9%	16.5%	26.0%	30.6%	***11.7%***
Québec - Ontario	0.3%	2.9%	9.1%	15.9%	34.0%	***8.0%***
Québec - United States	0.0%	0.5%	4.5%			***0.6%***
Moyenne	**1.2%**	**1.5%**	**11.4%**	**21.2%**	**25.1%**	**5.9%**

Source: GENIVAR calculations based on tables C.7, C.11 and C.12.

Table C. 14 Cost of permits for supersingle tires

Number of permits	237
Fee per permit	$375
Total cost	$88 875

Source: GENIVAR calculations based on MTQ (2004), *Liste des détenteurs de permis lors de la période de dégel 2004* , Ministère des Transports du Québec, Québec City, QC, doc file.

Table C. 15 Average costs of operating a heavy vehicle, by configuration, 2004

Configuration	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Cost per km in 1999	$1.63	$1.25	$1.46	$1.68	$1.62
Cost per km in 2004	$1.79	$1.38	$1.61	$1.85	$1.78

Source: GENIVAR calculations based on CAMTECH – GENIVAR (2001), *Étude d'impact des restrictions de charge en période de dégel sur l'économie du Québec* , Camtech, Saint-Nicolas QC and Groupe conseil GENIVAR, Montréal QC, for the Ministère des Transports du Québec, Québec City, QC, 58 pages and appendixes.

Table C. 16 Reductions in operating costs resulting from payload increases attributable to proposed regulatory amendments, Québec-based carriers, intercity trips, 1999

Factor in (a), (b) 1 000

(a) Reduction in distance travelled, inside and outside Québec

Normal period

('000 veh-km/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	279.1	842.9	3 615.6	6 769.9	2 292.0	***13 799.5***	81.7%
Québec - Ontario	8.4	161.6	736.4	962.4	1 219.0	***3 087.9***	18.3%
Québec - United States	0.0	0.0	0.0	0.0	0.0	***0.0***	0.0%
Total	**287.4**	**1 004.5**	**4 352.0**	**7 732.3**	**3 511.0**	**16 887.3**	**100.0%**
	1.7%	5.9%	25.8%	45.8%	20.8%	**100.0%**	

Spring-thaw period

('000 veh-km/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	524.3	781.5	1 871.2	2 687.5	671.2	***6 535.8***	55.4%
Québec - Ontario	8.1	651.7	1 766.3	985.9	526.4	***3 938.4***	33.4%
Québec - United States	0.2	1 027.3	298.7	0.0	0.0	***1 326.1***	11.2%
Total	**532.6**	**2 460.5**	**3 936.2**	**3 673.4**	**1 197.6**	**11 800.3**	**100.0%**
	4.5%	20.9%	33.4%	31.1%	10.1%	**100.0%**	

Entire year

('000 veh-km/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	803.4	1 624.4	5 486.7	9 457.5	2 963.2	***20 335.2***	70.9%
Québec - Ontario	16.5	813.3	2 502.8	1 948.3	1 745.4	***7 026.3***	24.5%
Québec - United States	0.2	1 027.3	298.7	0.0	0.0	***1 326.1***	4.6%
Total	**820.1**	**3 465.1**	**8 288.2**	**11 405.8**	**4 708.6**	**28 687.6**	**100.0%**
	2.9%	12.1%	28.9%	39.8%	16.4%	**100.0%**	

(b) Reduction in costs, inside and outside Québec

Normal period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	500.4	1 159.1	5 807.1	12 511.9	4 084.6	***24 063.1***	81.8%
Québec - Ontario	15.0	222.3	1 182.8	1 778.7	2 172.5	***5 371.2***	18.2%
Québec - United States	0.0	0.0	0.0	0.0	0.0	***0.0***	0.0%
Total	**515.4**	**1 381.3**	**6 989.9**	**14 290.5**	**6 257.1**	**29 434.3**	**100.0%**
	1.8%	4.7%	23.7%	48.6%	21.3%	**100.0%**	

Spring-thaw period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	940.2	1 074.7	3 005.4	4 967.0	1 196.1	***11 183.4***	57.1%
Québec - Ontario	14.6	896.1	2 837.0	1 822.1	938.1	***6 507.9***	33.2%
Québec - United States	0.3	1 412.6	479.7	0.0	0.0	***1 892.6***	9.7%
Total	**955.1**	**3 383.5**	**6 322.0**	**6 789.1**	**2 134.2**	**19 583.9**	**100.0%**
	4.9%	17.3%	32.3%	34.7%	10.9%	**100.0%**	

Entire year

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	1 440.6	2 233.8	8 812.4	17 478.9	5 280.8	***35 246.4***	71.9%
Québec - Ontario	29.6	1 118.4	4 019.8	3 600.7	3 110.6	***11 879.1***	24.2%
Québec - United States	0.3	1 412.6	479.7	0.0	0.0	***1 892.6***	3.9%
Total	**1 470.5**	**4 764.8**	**13 311.9**	**21 079.6**	**8 391.3**	**49 018.2**	**100.0%**
	3.0%	9.7%	27.2%	43.0%	17.1%	**100.0%**	

Source: GENIVAR calculations based on tables C.13 and C.15.

Table C. 17 Reductions in operating costs resulting from payload increases attributable to reduced mass of tires and wheels, Québec-based carriers, intercity trips, Québec, 1999

(a) Unit values

	(lb)		(kg)	
	Dual	**Single**	**Dual**	**Single**
Truck or tractor				
Tire	126.2	175.9	57.2	79.8
Wheel	50.0	70.0	22.7	31.8
Semi-trailer				
Tire	117.9	159.4	53.5	72.3
Wheel	50.0	70.0	22.7	31.8

Source: MICHELIN (2004), *X One – La nouvelle génération des pneus simples*, Michelin North America, July 2004, 44 pages and CD-ROM.

(b) Reduction in mass attributable to supersingle tires

(kg)

	3 axles	**5 axles**	**6 axles**	**7 axles**	**8 axles**
Conventional dual tires					
Truck or tractor					
Number of wheels	8	8	8	8	8
Total mass	***639.4***	***639.4***	***639.4***	***639.4***	***639.4***
Semi-trailer					
Number of wheels		8	12	16	20
Total mass		***609.3***	***913.9***	***1 218.5***	***1 523.2***
Total mass, combination	**639.4**	**1 248.7**	**1 553.3**	**1 857.9**	**2 162.6**
Supersingle tires					
Truck or tractor					
Number of wheels	4	4	4	4	4
Total mass	***446.2***	***446.2***	***446.2***	***446.2***	***446.2***
Semi-trailer					
Number of wheels		4	6	8	10
Total mass		***416.2***	***624.3***	***832.4***	***1 040.6***
Total mass, combination	**446.2**	**862.4**	**1 070.5**	**1 278.6**	**1 486.7**
Difference	**193.2**	**386.3**	**482.8**	**579.3**	**675.9**
Reduction as per cent of payload					
(normal period)	1.6%	1.6%	1.8%	1.9%	1.9%
(spring-thaw period)	2.0%	2.1%	2.4%	2.4%	2.2%

Source: GENIVAR calculations based on table (a).

(c) Reduction in distance travelled, inside and outside Québec

Normal period

('000 veh-km/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	35.2	107.3	470.0	888.6	301.7	***1 802.9***	84.6%
Québec - Ontario	1.1	22.4	99.3	204.2	0.0	***327.1***	15.4%
Québec - United States	0.0	0.0	0.0	0.0	0.0	***0.0***	0.0%
Total	**36.3**	**129.7**	**569.4**	**1 092.8**	**301.7**	**2 129.9**	**100.0%**
	1.7%	6.1%	26.7%	51.3%	14.2%	**100.0%**	

Spring-thaw period

('000 veh-km/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	73.7	119.1	266.9	346.0	0.0	***805.7***	54.3%
Québec - Ontario	1.1	99.3	251.9	126.9	0.0	***479.3***	32.3%
Québec - United States	0.1	156.6	42.6	0.0	0.0	***199.3***	13.4%
Total	**75.0**	**375.1**	**561.4**	**472.9**	**0.0**	**1 484.3**	**100.0%**
	5.1%	25.3%	37.8%	31.9%	0.0%	**100.0%**	

Entire year

('000 veh-km/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	108.9	226.5	736.9	1 234.6	301.7	***2 608.6***	72.2%
Québec - Ontario	2.2	121.7	351.3	331.2	0.0	***806.4***	22.3%
Québec - United States	0.1	156.6	42.6	0.0	0.0	***199.3***	5.5%
Total	**111.3**	**504.8**	**1 130.7**	**1 565.7**	**301.7**	**3 614.3**	**100.0%**
	3.1%	14.0%	31.3%	43.3%	8.3%	**100.0%**	

(d) Cost reductions, inside and outside Québec

Normal period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	63.1	147.6	754.9	1 642.3	537.7	***3 145.6***	84.7%
Québec - Ontario	2.0	30.8	159.6	377.5	0.0	***569.8***	15.3%
Québec - United States	0.0	0.0	0.0	0.0	0.0	***0.0***	0.0%
Total	**65.1**	**178.4**	**914.5**	**2 019.7**	**537.7**	**3 715.3**	**100.0%**
	1.8%	4.8%	24.6%	54.4%	14.5%	**100.0%**	

Spring-thaw period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	132.2	163.8	428.6	639.4	0.0	***1 364.1***	56.2%
Québec - Ontario	2.1	136.6	404.6	234.6	0.0	***777.8***	32.1%
Québec - United States	0.2	215.3	68.4	0.0	0.0	***284.0***	11.7%
Total	**134.5**	**515.8**	**901.6**	**874.0**	**0.0**	**2 425.9**	**100.0%**
	5.5%	21.3%	37.2%	36.0%	0.0%	**100.0%**	

Entire year

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	195.3	311.4	1 183.5	2 281.7	537.7	***4 509.6***	73.4%
Québec - Ontario	4.0	167.4	564.2	612.0	0.0	***1 347.6***	21.9%
Québec - United States	0.2	215.3	68.4	0.0	0.0	***284.0***	4.6%
Total	**199.6**	**694.1**	**1 816.1**	**2 893.7**	**537.7**	**6 141.2**	**100.0%**
	3.3%	11.3%	29.6%	47.1%	8.8%	**100.0%**	

Source: GENIVAR calculations based on tables C.13 and (b).

Table C. 18 Cost of fuel

Factor in (b) 100

(a) Cost of diesel

($/L)

Quarter	04-I	04-II	04-III	04-IV	2004
Price including taxes	$0.783	$0.778	$0.828	$0.904	$0.823
Price excl. GST and QST	$0.680	$0.677	$0.720	$0.786	$0.715

Sources: GENIVAR calculations based on DEPT. OF ENERGY OF NEW BRUNSWICK (2005), *New Brunswick Fuel Price Survey*, Department of Energy of New Brunswick, Fredericton NB, unpaginated.

(b) Consumption and average cost

Vehicle configurations	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Ref. price,2004 (excl.taxes)	$0.715 /L				
Consumption					
(L/100 km)	40.0	45.7	49.5	50.3	50.8
Cost ($/veh-km)	$0.286	$0.327	$0.354	$0.360	$0.363

Source: CAMTECH – GENIVAR (2001), *Étude d'impact des restrictions de charge en période de dégel sur l'économie du Québec*, Camtech, Saint-Nicolas QC and Groupe conseil GENIVAR, Montréal QC, for the Ministère des Transports du Québec, Québec City, QC, 58 pages and appendixes.

(c) Reduction in fuel consumption attributable to supersingle tires

Source	Comment	Reduction
Bridgestone (1)	From 2 to 5%	3.5%
Driversmag (2)	4% for efficient vehicles	4.0%
	10% for inefficient vehicles	
GENIVAR survey	7 respondents, omitting the extremes	3.3%
Michelin (3)	Comparison of XDA and XZA2	3.0%
Michelin (4)	Comparison of XDA Energy and XT-1*	4.2%
Michelin modified*	DOE rates applied to	
	Michelin data	2.0%
MTQ	Computer simulation	2.7%
Smart Way (5)	From 2 to 5%	3.5%
U. S. DOE (6)		2.6%
Average		**3.2%**

* Michelin assumes that rolling resistance accounts for 35% of fuel consumption.
The X-One can reduce rolling resistance by about 12%.
According to the DOE, rolling resistance accounts for only 17% of fuel consumption, which would bring the reduction in fuel consumption down to 2.0%.

Sources:

1. BRIDGESTONE (2005), *Y. Large Truck Fuel Economy*, Bridgestone Corporation, US, http://www.trucktires.com/us_eng/technical/bftechnical/fuel_economy_b.asp.
2. Cullen, David (2002), *Making less more*, Drivers Magazine, driversmag.com/ar/fleet_ making_less.
3. MICHELIN (2004), *Michelin X-One: Ever think a single tire could change an industry?*, Michelin North America, brochure.
4. MICHELIN (2004), *X One – La nouvelle génération des pneus simples*, Michelin North America, July 2004, 44 pages and CD-ROM.
5. U. S. EPA (2004), A Glance at Clean Freight Strategies: Single Wide-Based Tires, SmartWay Transport Partnership, U. S. Environmental Protection Agency, Office of Transportation and Air Quality, 1 page.
6. U. S. DOE (2005), Web site, United States Department of Energy, Washington DC, doe,gov.

(d) Reduction in fuel costs per veh-km

($/veh-km)

Vehicle configurations	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
With dual tires	$0.286	$0.327	$0.354	$0.360	$0.363
Cost reduction	$0.009	$0.010	$0.011	$0.012	$0.012

Note: excludes GST and QST.

Source: GENIVAR calculations based on tables (b) and (c).

Étude d'impact des restrictions de charge en période de dégel sur l'économie du Québec, Camtech, Saint-Nicolas QC and Groupe conseil GENI Montréal QC, for the Ministère des Transports du Québec, Québec City, QC, 58 pages and appendixes.

Table C. 19 Reduction in fuel costs, Québec-based carriers, intercity trips, Québec, 1999

Factor 1000

(a) Normal period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	2 861.3	2 575.0	2 118.7	2 323.3	635.3	***10 513.5***	37.1%
Québec - Ontario	382.3	1 644.9	1 626.8	995.7	409.5	***5 059.2***	17.9%
Québec - United States	277.5	11 552.1	372.4	113.1	444.9	***12 760.0***	45.0%
Total	**3 521.1**	**15 772.0**	**4 117.9**	**3 432.0**	**1 489.7**	**28 332.8**	**100.0%**
	12.4%	55.7%	14.5%	12.1%	5.3%	**100.0%**	

(b) Spring-thaw period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	598.9	539.0	443.4	486.3	133.0	***2 200.5***	37.1%
Québec - Ontario	80.0	344.3	340.5	208.4	85.7	***1 058.9***	17.9%
Québec - United States	58.1	2 417.9	77.9	23.7	93.1	***2 670.7***	45.0%
Total	**737.0**	**3 301.1**	**861.9**	**718.3**	**311.8**	**5 930.1**	**100.0%**
	12.4%	55.7%	14.5%	12.1%	5.3%	**100.0%**	

(c) Entire year

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	3 460.2	3 114.0	2 562.1	2 809.5	768.3	***12 714.1***	37.1%
Québec - Ontario	462.3	1 989.2	1 967.3	1 204.1	495.2	***6 118.1***	17.9%
Québec - United States	335.6	13 970.0	450.3	136.7	538.0	***15 430.7***	45.0%
Total	**4 258.1**	**19 073.2**	**4 979.8**	**4 150.4**	**1 801.4**	**34 262.9**	**100.0%**
	12.4%	55.7%	14.5%	12.1%	5.3%	**100.0%**	

Source: GENIVAR calculations based on tables C.10 and C.18.

Table C. 20 Reduction in maintenance costs, Québec-based carriers, intercity trips, Québec, 1999

Factor in (a)	60
Factor in (b)	1000

(a) Reduction in maintenance costs per kilometre travelled

		Supersingle tires	Double tires
Maintenance interval (km):		10 000	10 000
Hourly rate ($/h)	$50.00		
Maintenance time (min)		15	30
Cost per maintenance ($)		$12.50	$25.00
Cost per kilometre travelled ($/veh-km)		$0.0013	$0.0025
Average savings ($/veh-km)			**$0.0013**

Source: GENIVAR calculations based on GENIVAR survey of carriers.

(a) Normal period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	390.1	307.3	233.4	251.9	68.2	***1 250.9***	37.4%
Québec - Ontario	52.1	196.3	179.2	108.0	44.0	***579.6***	17.3%
Québec - United States	37.8	1 378.6	41.0	12.3	47.8	***1 517.5***	45.3%
Total	**480.1**	**1 882.2**	**453.7**	**372.1**	**159.9**	**3 348.0**	**100.0%**
	14.3%	56.2%	13.6%	11.1%	4.8%	**100.0%**	

(b) Spring-thaw period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	81.7	64.3	48.9	52.7	14.3	***261.8***	37.4%
Québec - Ontario	10.9	41.1	37.5	22.6	9.2	***121.3***	17.3%
Québec - United States	7.9	288.5	8.6	2.6	10.0	***317.6***	45.3%
Total	**100.5**	**393.9**	**95.0**	**77.9**	**33.5**	**700.7**	**100.0%**
	14.3%	56.2%	13.6%	11.1%	4.8%	**100.0%**	

(c) Entire year

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	471.8	371.6	282.3	304.6	82.5	***1 512.8***	37.4%
Québec - Ontario	63.0	237.4	216.8	130.6	53.2	***700.9***	17.3%
Québec - United States	45.8	1 667.1	49.6	14.8	57.8	***1 835.1***	45.3%
Total	**580.6**	**2 276.1**	**548.7**	**450.0**	**193.4**	**4 048.7**	**100.0%**
	14.3%	56.2%	13.6%	11.1%	4.8%	**100.0%**	

Source: GENIVAR calculations based on tables C.10 and (a).

Table C. 21 Additional costs of purchasing and retreading tires, Québec-based carriers, intercity trips, Québec, 1999

Factor in (c) 1 000

(a) Average cost of purchasing or retreading, per tire, by type of tire

	Service life (km)	Cost new ($)	Cost retreaded ($)	Number of times retreadable	Average cost per purchase or retread ($)
Supersingle tires	425 000	$850	$544	1	$697
Dual tires	450 000	$420	$248	2	$305

Source: GENIVAR calculations based on communication with Michelin.

(b) Average additional cost of purchasing or retreading per set of tires

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Number of tires					
Supersingle tires	4	8	10	12	14
Dual tires	8	16	20	24	28
Average cost of purchasing or retreading per set of tires ($)					
Supersingle tires	$2 788	$5 576	$6 970	$8 364	$9 758
Dual tires	$2 443	$4 885	$6 107	$7 328	$8 549
Cost of purchasing or retreading tires per kilometre travelled ($/veh-km)					
Supersingle tires	$0.0066	$0.0131	$0.0164	$0.0197	$0.0230
Dual tires	$0.0054	$0.0109	$0.0136	$0.0163	$0.0190
Additional cost	**$0.0011**	**$0.0023**	**$0.0028**	**$0.0034**	**$0.0040**

Note: Excludes the 2 front tires of the tractor or truck.

Source: GENIVAR calculations based on tables (a) and C.17.

(c) Additional cost of purchasing or retreading tires, Québec carriers, intercity trips, Québec, 1999

Normal period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	353.2	556.5	528.4	684.3	216.1	***2 338.5***	36.6%
Québec - Ontario	47.2	355.5	405.7	293.3	139.3	***1 241.0***	19.4%
Québec - United States	34.3	2 496.6	92.9	33.3	151.4	***2 808.4***	44.0%
Total	**434.7**	**3 408.6**	**1 027.0**	**1 010.8**	**506.8**	**6 387.9**	**100.0%**
	6.8%	53.4%	16.1%	15.8%	7.9%	**100.0%**	

Spring-thaw period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	73.9	116.5	110.6	143.2	45.2	***489.5***	36.6%
Québec - Ontario	9.9	74.4	84.9	61.4	29.2	***259.7***	19.4%
Québec - United States	7.2	522.5	19.4	7.0	31.7	***587.8***	44.0%
Total	**91.0**	**713.4**	**215.0**	**211.6**	**106.1**	**1 337.0**	**100.0%**
	6.8%	53.4%	16.1%	15.8%	7.9%	**100.0%**	

Entire year

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	427.2	673.0	639.0	827.5	261.4	***2 828.0***	36.6%
Québec - Ontario	57.1	429.9	490.7	354.6	168.5	***1 500.7***	19.4%
Québec - United States	41.4	3 019.1	112.3	40.3	183.0	***3 396.2***	44.0%
Total	**525.7**	**4 122.0**	**1 242.0**	**1 222.4**	**612.9**	**7 724.9**	**100.0%**
	6.8%	53.4%	16.1%	15.8%	7.9%	**100.0%**	

Source: GENIVAR calculations based on tables C.10 and (b).

Table C. 22 Additional cost of repairing and maintaining primary road network, Québec - Amendment to eliminate 1 000 kg penalty on vehicles equipped with supersingle tires

Factor in (c) 1 000

(a) Length of primary network

Class of road	Length (km)
Freeway	4 232
Provincial	8 887
Regional	5 459
Collector	7 705
Total	**26 283**

Source: MTQ (2005), *Effet de différents types de pneus sur les chaussées: étude économique (volet impact sur les chaussées): version préliminaire,* by Fritz Prophète, Ministère des Transports du Québec, Direction du laboratoire des chaussées, Québec City, QC, January 21, 2005.

(b) Average cost per km, primary network, by geographic market and vehicle configuration
($/km/yr)

Spring

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	$24.3	$33.8	$112.3	$109.3	$105.1	***$384.8***	51.9%
Québec - Ontario	$9.1	$40.8	$53.5	$52.0	$68.1	***$223.5***	30.2%
Québec - United States	$1.2	$64.5	$14.4	$3.6	$19.0	***$102.7***	13.9%
Other	$0.3	$8.0	$12.1	$3.0	$6.6	***$30.0***	4.0%
Total	**$34.9**	**$147.1**	**$192.3**	**$167.9**	**$198.8**	**$741.0**	**100.0%**
	4.7%	19.9%	26.0%	22.7%	26.8%	**100.0%**	

Rest of year

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	$23.4	$40.4	$123.0	$121.3	$101.1	***$409.2***	50.9%
Québec - Ontario	$8.7	$44.4	$58.3	$56.6	$73.9	***$241.9***	30.1%
Québec - United States	$1.2	$70.4	$15.7	$3.9	$20.7	***$111.9***	13.9%
Other	$0.2	$5.2	$12.8	$1.4	$21.4	***$41.0***	5.1%
Total	**$33.5**	**$160.4**	**$209.8**	**$183.2**	**$217.1**	**$804.0**	**100.0%**
	4.2%	20.0%	26.1%	22.8%	27.0%	**100.0%**	

Entire year

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	$47.7	$74.2	$235.3	$230.7	$206.2	***$794.1***	51.4%
Québec - Ontario	$17.8	$85.2	$111.8	$108.6	$142.0	***$465.4***	30.1%
Québec - United States	$2.4	$134.9	$30.1	$7.5	$39.7	***$214.6***	13.9%
Other	$0.5	$13.2	$24.9	$4.3	$28.0	***$70.9***	4.6%
Total	**$68.4**	**$307.5**	**$402.1**	**$351.1**	**$415.9**	**$1 545.0**	**100.0%**
	4.4%	19.9%	26.0%	22.7%	26.9%	**100.0%**	

Source: MTQ (2005), *Effet de différents types de pneus sur les chaussées: étude économique (volet impact sur les chaussées): version préliminaire,* by Fritz Prophète, Ministère des Transports du Québec, Direction du laboratoire des chaussées, Québec City, QC, January 21, 2005 and GENIVAR calculations.

(c) Annual cost, primary network, by geographic market and vehicle configuration, Québec carriers, Québec, 1999

Spring
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	638.1	889.3	2 951.1	2 873.5	2 762.4	***10 114.4***
Québec - Ontario	111.7	328.6	831.1	871.5	850.4	***2 993.3***
Québec - United States	22.7	1 426.3	224.7	81.0	499.4	***2 254.1***
Total	**772.5**	**2 644.2**	**4 006.9**	**3 826.0**	**4 112.2**	**15 361.7**

Rest of year
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	615.6	1 061.8	3 233.4	3 188.9	2 656.1	***10 755.9***
Québec - Ontario	106.8	357.6	905.7	948.6	922.8	***3 241.4***
Québec - United States	22.7	1 556.8	245.0	87.7	544.1	***2 456.3***
Total	**745.1**	**2 976.3**	**4 384.1**	**4 225.2**	**4 123.0**	**16 453.6**

Entire year
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	1 253.7	1 951.1	6 184.5	6 062.4	5 418.5	***20 870.2***
Québec - Ontario	218.5	686.2	1 736.8	1 820.1	1 773.2	***6 234.7***
Québec - United States	45.4	2 983.2	469.7	168.7	1 043.4	***4 710.4***
Total	**1 517.5**	**5 620.5**	**8 391.0**	**8 051.2**	**8 235.1**	**31 815.3**

Source: GENIVAR calculations based on tables C.6, (a) and (b).

(d) Annual cost, primary network, by geographic market and vehicle confifuration, non-Québec carriers, Québec, 1999

Spring
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	0.0	0.0	0.0	0.0	0.0	***0.0***
Québec - Ontario	127.5	743.7	575.0	495.2	939.5	***2 881.0***
Québec - United States	8.8	268.9	153.8	13.7	0.0	***445.2***
Total	**136.3**	**1 012.6**	**728.8**	**508.9**	**939.5**	**3 326.2**

Rest of year
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	0.0	0.0	0.0	0.0	0.0	***0.0***
Québec - Ontario	121.9	809.4	626.6	539.0	1 019.5	***3 116.4***
Québec - United States	8.8	293.5	167.6	14.8	0.0	***484.8***
Total	**130.7**	**1 102.9**	**794.3**	**553.8**	**1 019.5**	**3 601.2**

Entire year
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	0.0	0.0	0.0	0.0	0.0	***0.0***
Québec - Ontario	249.4	1 553.1	1 201.7	1 034.3	1 959.0	***5 997.4***
Québec - United States	17.7	562.4	321.4	28.5	0.0	***930.0***
Total	**267.1**	**2 115.5**	**1 523.1**	**1 062.7**	**1 959.0**	**6 927.4**

Source: GENIVAR calculations based on tables C.6, (a) and (b).

(e) Annual cost, primary network, by geographic market and vehicle configuration, all carriers, Québec, 1999

Spring
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	638.1	889.3	2 951.1	2 873.5	2 762.4	***10 114.4***
Québec - Ontario	239.2	1 072.3	1 406.1	1 366.7	1 789.9	***5 874.3***
Québec - United States	31.5	1 695.3	378.5	94.6	499.4	***2 699.3***
Total	**908.8**	**3 656.8**	**4 735.7**	**4 334.9**	**5 051.7**	**18 687.9**

Rest of year
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	615.6	1 061.8	3 233.4	3 188.9	2 656.1	***10 755.9***
Québec - Ontario	228.7	1 167.0	1 532.3	1 487.6	1 942.3	***6 357.9***
Québec - United States	31.5	1 850.3	412.6	102.5	544.1	***2 941.1***
Total	**875.8**	**4 079.1**	**5 178.4**	**4 779.0**	**5 142.5**	**20 054.8**

Entire year
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	1 253.7	1 951.1	6 184.5	6 062.4	5 418.5	***20 870.2***
Québec - Ontario	467.8	2 239.3	2 938.4	2 854.3	3 732.2	***12 232.1***
Québec - United States	63.1	3 545.6	791.1	197.1	1 043.4	***5 640.3***
Total	**1 784.6**	**7 736.0**	**9 914.1**	**9 113.9**	**10 194.1**	**38 742.7**

Source: GENIVAR calculations based on tables (d) and (e).

Table C. 23 Additional cost of repairing and maintaining primary road network, Québec - Amendment to harmonize Québec regulations with U.S. regulations for 5-axle vehicles all year around

(a) Average cost per km, primary network, by geographic market and vehicle configuration
($/km/yr)

Spring

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	$0.0	$33.8	$0.0	$0.0	$0.0	***$33.8***
Québec - Ontario	$0.0	$40.8	$0.0	$0.0	$0.0	***$40.8***
Québec - United States	$0.0	$64.5	$0.0	$0.0	$0.0	***$64.5***
Other	$0.0	$8.0	$0.0	$0.0	$0.0	***$8.0***
Total		**$147.1**				**$147.1**

Rest of year

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	$0.0	$0.0	$0.0	$0.0	$0.0	***$0.0***
Québec - Ontario	$0.0	$0.0	$0.0	$0.0	$0.0	***$0.0***
Québec - United States	$0.0	$0.0	$0.0	$0.0	$0.0	***$0.0***
Other	$0.0	$0.0	$0.0	$0.0	$0.0	***$0.0***
Total	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**

Entire year

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec	$0.0	$33.8	$0.0	$0.0	$0.0	***$33.8***
Québec - Ontario	$0.0	$40.8	$0.0	$0.0	$0.0	***$40.8***
Québec - United States	$0.0	$64.5	$0.0	$0.0	$0.0	***$64.5***
Other	$0.0	$8.0	$0.0	$0.0	$0.0	***$8.0***
Total	**$0.0**	**$147.1**	**$0.0**	**$0.0**	**$0.0**	**$147.1**

Note: Sum is not exactly equal to total, because of rounding.
Source: MTQ (2005), *Effet de différents types de pneus sur les chaussées: étude économique (volet impact sur les chaussées): version préliminaire,* by Fritz Prophète, Ministère des Transports du Québec, Direction du laboratoire des chaussées, Québec City, QC, January 21, 2005.

(b) Annual cost, primary network, by geographic market and vehicle configuration, Québec carriers, Québec, 1999

Spring
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec		889.3				***889.3***
Québec - Ontario		328.6				***328.6***
Québec - United States		1 426.3				***1 426.3***
Total		**2 644.2**				**2 644.2**

Rest of year
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec		0.0				***0.0***
Québec - Ontario		0.0				***0.0***
Québec - United States		0.0				***0.0***
Total		**0.0**				**0.0**

Entire year
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec		889.3				***889.3***
Québec - Ontario		328.6				***328.6***
Québec - United States		1 426.3				***1 426.3***
Total		**2 644.2**				**2 644.2**

Source: GENIVAR calculations based on tables C.6, (a) and (b).

(c) Annual cost, primary network, by geographic market and vehicle configuration, non-Québec carriers, Québec, 1999

Spring

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec		0.0				***0.0***
Québec - Ontario		743.7				***743.7***
Québec - United States		268.9				***268.9***
Total		**1 012.6**				**1 012.6**

Rest of year

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec		0.0				***0.0***
Québec - Ontario		0.0				***0.0***
Québec - United States		0.0				***0.0***
Total		**0.0**				**0.0**

Entire year

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Québec - Québec		0.0				***0.0***
Québec - Ontario		743.7				***743.7***
Québec - United States		268.9				***268.9***
Total		**1 012.6**				**1 012.6**

Source: GENIVAR calculations based on tables C.6, (a) and (b).

(e) Annual cost, primary network, by geographic market and vehicle configuration, all carriers, Québec, 1999

Spring

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	Total
Québec - Québec		889.3	***889.3***
Québec - Ontario		1 072.3	***1 072.3***
Québec - United States		1 695.3	***1 695.3***
Total		**3 656.8**	**3 656.8**

Rest of year

($'000/yr)

Geographic markets	5 axles	Total
Québec - Québec	0.0	***0.0***
Québec - Ontario	0.0	***0.0***
Québec - United States	0.0	***0.0***
Total	**0.0**	**0.0**

Entire year

($'000/yr)

Geographic markets	5 axles	Total
Québec - Québec	889.3	***889.3***
Québec - Ontario	1 072.3	***1 072.3***
Québec - United States	1 695.3	***1 695.3***
Total	**3 656.8**	**3 656.8**

Source: GENIVAR calculations based on tables (d) and (e).

Table C. 24 Value of reduction in vehicle emissions, all carriers, intercity trips, Québec, 1999

Factor in (b)	10 000
Factor in (c)	1 000

(a) Cost saved per litre of fuel not consumed, by type of pollutant

	Amount (g/L)	Cost ($/t)	Unit cost ($/L)
Carbon monoxide (CO)	68	$1 339	$0.091
Carbon dioxide (CO_2)	2 730	$29.53	$0.081
Nitrogen oxide (NO)	9.6	$6 214	$0.060
Hydrocarbons	9.7	$4 872	$0.047
Total			**$0.279**

Source: MENVIQ (2002), I*nventaire québécois des gaz à effet de serre 1990-2000*, by Gérard Houle *et al.*, Ministère de l'Environnement du Québec, Direction des politiques du secteur industriel, Service de la qualité de l'atmosphère, Division des inventaires des émissions atmosphériques, Québec City, QC, September 2002, Annexe E. LITMAN Todd (2003), *Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications*, Victoria Transport Policy Institute, Victoria BC, 1995, revised in 2003, 300 pages, vtpi.org/tca.

(b) Costs saved per million kilometres travelled

Vehicle configurations	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Fuel consumption (L/100 km)	40.0	45.7	49.5	50.3	50.8
Percentage reduction in fuel consumption	3.2%				
Reduction in fuel consumption (L/100 km)	1.28	1.46	1.59	1.61	1.63
Reduction in environmental costs ($/M veh-km)	$3 570	$4 078	$4 417	$4 489	$4 533

Source: Table C.18 and GENIVAR calculations from tables C.18 and (a).

(c) Cost savings from reduced vehicle emissions, by geographic market and vehicle configuration

Normal period
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	1 054.9	1 028.1	845.9	927.6	253.6	***4 110.1***	***27.9%***
Québec - Ontario	301.8	2 143.2	1 098.9	623.4	344.1	***4 511.5***	***30.6%***
Québec - United States	142.2	5 481.8	250.4	52.8	177.6	***6 104.8***	***41.5%***
Total	**1 498.9**	**8 653.1**	**2 195.3**	**1 603.8**	**775.4**	**14 726.4**	**100%**
%	**10.2%**	**58.8%**	**14.9%**	**10.9%**	**5.3%**	**100%**	

Spring-thaw period
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	220.8	215.2	177.0	194.1	53.1	***860.2***	***27.9%***
Québec - Ontario	63.2	448.6	230.0	130.5	72.0	***944.3***	***30.6%***
Québec - United States	29.8	1 147.4	52.4	11.0	37.2	***1 277.8***	***41.5%***
Total	**313.7**	**1 811.1**	**459.5**	**335.7**	**162.3**	**3 082.3**	**100%**
%	**10.2%**	**58.8%**	**14.9%**	**10.9%**	**5.3%**	**100%**	

Entire year
($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	1 275.6	1 243.3	1 023.0	1 121.7	306.7	***4 970.3***	***27.9%***
Québec - Ontario	365.0	2 591.7	1 329.0	753.9	416.2	***5 455.8***	***30.6%***
Québec - United States	172.0	6 629.2	302.8	63.8	214.8	***7 382.6***	***41.5%***
Total	**1 812.6**	**10 464.2**	**2 654.7**	**1 939.5**	**937.7**	**17 808.7**	**100%**
%	**10.2%**	**58.8%**	**14.9%**	**10.9%**	**5.3%**	**100%**	

Source: GENIVAR calculations based on MTQ (2004), *Données traitées à partir de l'enquête en bord de route de 1999*, by Dave Henry, Ministère des Transports du Québec, Direction de la sécurité en transport et du camionnage, Québec City, QC, xls files, and on table (b).

Table C. 25 Savings on tire recovery and recycling, Québec carriers, intercity trips, Québec, 1999

Factor in (b)	1 000 000
Factor in (c)	1 000

(a) Average cost of recovery and recycling, per tire, by type of tire

		Service life (km)	Mass per tire (kg)	Avg. cost per tire ($)
Cost of recovery ($/kg)	0.187 $			
Supersingle tires		425 000	72.5	$13.53
Dual tires		450 000	53.6	$10.00

Source: GENIVAR calculations based on communication with Michelin.

(b) Average cost of recovery and recycling for a set of tires

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +
Number of tires					
Supersingle tires	4	8	10	12	14
Dual tires	8	16	20	24	28
Average cost of recovery and recycling for a set of tires ($)					
Supersingle tires	$54.10	$108.21	$135.26	$162.31	$189.37
Dual tires	$80.00	$160.00	$200.00	$240.00	$280.00
Cost of tire recovery and recycling by distance travelled ($/M veh-km)					
Supersingle tires	$127	$255	$318	$382	$446
Dual tires	$188	$376	$471	$565	$659
Savings	**$61**	**$122**	**$152**	**$183**	**$213**

Note: Excludes the 2 front tires on the tractor or truck.

Source: GENIVAR calculations based on tables (a) and C.17.

(c) Savings on cost of recovering and recycling tires, Québec carriers, intercity trips, Québec, 1999

Normal period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	19.0	30.0	28.4	36.8	11.6	***125.9***	36.6%
Québec - Ontario	2.5	19.1	21.8	15.8	7.5	***66.8***	19.4%
Québec - United States	1.8	134.4	5.0	1.8	8.1	***151.2***	44.0%
Total	**23.4**	**183.5**	**55.3**	**54.4**	**27.3**	**343.9**	**100.0%**
	6.8%	53.4%	16.1%	15.8%	7.9%	**100.0%**	

Spring-thaw period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	4.0	6.3	6.0	7.7	2.4	***26.3***	36.6%
Québec - Ontario	0.5	4.0	4.6	3.3	1.6	***14.0***	19.4%
Québec - United States	0.4	28.1	1.0	0.4	1.7	***31.6***	44.0%
Total	**4.9**	**38.4**	**11.6**	**11.4**	**5.7**	**72.0**	**100.0%**
	6.8%	53.4%	16.1%	15.8%	7.9%	**100.0%**	

Entire year

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	23.0	36.2	34.4	44.5	14.1	***152.2***	36.6%
Québec - Ontario	3.1	23.1	26.4	19.1	9.1	***80.8***	19.4%
Québec - United States	2.2	162.5	6.0	2.2	9.9	***182.8***	44.0%
Total	**28.3**	**221.9**	**66.9**	**65.8**	**33.0**	**415.9**	**100.0%**
	6.8%	53.4%	16.1%	15.8%	7.9%	**100.0%**	

Source: GENIVAR calculations based on tables C.10 and (b).

Table C. 26 Number and severity of accidents, heavy vehicles, Québec, 1999-2003

(a) Number of accidents, by degree of severity

Severity	1999	2000	2001	2002	2003	Mean, 1999-2003
Fatal	122	123	99	125	102	***114***
Serious	352	317	322	332	379	***340***
Slight	1 882	2 017	1 871	2 070	2 119	***1 992***
Property damage only	11 855	10 915	9 723	9 343	10 757	***10 519***
Total	**14 211**	**13 372**	**12 015**	**11 870**	**13 357**	**12 965**

(b) Number of victims, by severity of accidents

Severity	1999	2000	2001	2002	2003	Mean 1999-2003
Fatal	141	141	108	132	108	***126***
Serious	427	403	403	409	467	***422***
Slight	2 686	2 757	2 615	2 902	2 971	***2 786***
Total	**3 254**	**3 301**	**3 126**	**3 443**	**3 546**	**3 334**

(c) Mean number of victims per accident, by degree of severity

Severity	1999	2000	2001	2002	2003	Mean 1999-2003
Fatal	1.16	1.15	1.09	1.06	1.06	1.10
Serious	1.21	1.27	1.25	1.23	1.23	1.24
Slight	1.43	1.37	1.40	1.40	1.40	1.40
Avg., all bodily injuries	**1.38**	**1.34**	**1.36**	**1.36**	**1.36**	**1.36**

Source: SAAQ (2004), *Bilan 2003 – Accidents, parc automobile, permis de conduire, dossier statistique*, Société de l'assurance automobile du Québec, Québec City, QC, April 2004.

Table C. 27 Costs of highway accidents, heavy vehicles, Québec, 1999-2003 averages

Factor in (a)	1 000 000
Factor in (b)	1 000
Factor in (d)	1 000
Percentage reduction	1%

(a) Annual cost of accidents, heavy vehicles, by severity of accident
($ 2004/yr)

	Human Capital Method			Willingness To Pay Method		
Severity	Average cost per accident ($)	Annual cost ($M)	% of annual cost	Average cost per accident ($)	Annual cost ($M)	% of annual cost
Fatal	$535 714	61.2	21.3%	$3 673 727	419.5	50.7%
Serious injuries	$179 299	61.0	21.3%	$607 489	206.8	25.0%
Slight injuries	$20 214	40.3	14.0%	$61 116	121.7	14.7%
Property damage only	$11 837	124.5	43.4%	$7 601	**80.0**	9.7%
Total		**287.0**	**100%**		**828.0**	**100%**

Source: MTQ (2005), *Évaluation statistique des coûts de l'insécurité routière au Québec*, Ministère des Transports du Québec, Direction de la Sécurité et du Camionnage, Québec City, QC, Excel file.

(b) Kilometres travelled per year in Québec, heavy vehicles, by geographic market and vehicle configuration, all carriers, Québec, 1999

(M veh-km/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Local market	1 540.3	253.0	192.2	207.4	56.2	***2 249.0***	***52.7%***
Québec - Québec	357.4	304.9	231.6	249.9	67.7	***1 211.3***	***28.4%***
Québec - Ontario	92.8	203.5	91.2	74.3	40.1	***502.0***	***11.8%***
Québec - United States	13.0	254.1	25.8	5.5	9.3	***307.7***	***7.2%***
Total	**2 003.4**	**1 015.4**	**540.8**	**537.1**	**173.2**	**4 270.0**	**100.0%**
	46.9%	23.8%	12.7%	12.6%	4.1%	**100.0%**	

Note: For each vehicle configuration, the average distance travelled in Québec is assumed to be the same for the Québec-Ontario and Québec-United States markets as for the Québec-Québec market.

Source: GENIVAR calculations based on tables C.7 and C.9.

(c) Cost of highway accidents, heavy vehicles, intercity trips, by geographic market and vehicle configuration, all carriers, Québec, annual average for 1999-2003

($M 2004)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	24.0	20.5	15.6	16.8	4.5	***81.4***	59.9%
Québec - Ontario	6.2	13.7	6.1	5.0	2.7	***33.7***	24.8%
Québec - United States	0.9	17.1	1.7	0.4	0.6	***20.7***	15.2%
Total	**31.1**	**51.2**	**23.4**	**22.2**	**7.9**	**135.8**	**100.0%**
	22.9%	37.7%	17.3%	16.3%	5.8%	**100.0%**	

Source: GENIVAR calculations based on tables (a) and (b).

(d) Reduction in costs of highway accidents, heavy vehicles, intercity trips, Québec, annual average for 1999-2003

Normal period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	198.6	169.4	128.7	138.9	37.6	***673.2***	59.9%
Québec - Ontario	51.6	113.1	50.7	41.3	22.3	***279.0***	24.8%
Québec - United States	7.2	141.2	14.4	3.1	5.1	***171.0***	15.2%
Total	**257.4**	**423.7**	**193.8**	**183.3**	**65.0**	**1 123.2**	**100.0%**
	22.9%	37.7%	17.3%	16.3%	5.8%	**100.0%**	

Spring-thaw period

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	41.6	35.5	26.9	29.1	7.9	***140.9***	59.9%
Québec - Ontario	10.8	23.7	10.6	8.6	4.7	***58.4***	24.8%
Québec - United States	1.5	29.6	3.0	0.6	1.1	***35.8***	15.2%
Total	**53.9**	**88.7**	**40.6**	**38.4**	**13.6**	**235.1**	**100.0%**
	22.9%	37.7%	17.3%	16.3%	5.8%	**100.0%**	

Entire year

($'000/yr)

Geographic markets	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total	%
Québec - Québec	240.2	204.9	155.6	168.0	45.5	***814.1***	59.9%
Québec - Ontario	62.3	136.8	61.3	50.0	27.0	***337.4***	24.8%
Québec - United States	8.8	170.7	17.4	3.7	6.2	***206.8***	15.2%
Total	**311.3**	**512.4**	**234.3**	**221.6**	**78.7**	**1 358.3**	**100.0%**
	22.9%	37.7%	17.3%	16.3%	5.8%	**100.0%**	

Source: GENIVAR calculations based on tables C.1 and (c).

D ECONOMIC BENEFITS AND COSTS OF USING SUPERSINGLE TIRES

Table D. 1 Economic benefits and costs of using supersingle tires – Assumption 1: 1 000 kg per axle penalty eliminated – Scenario 1: All heavy vehicles, by configuration, season, and geographic market, Québec, 1999

(a) Normal (non-spring-thaw) period

($'000/yr)

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Ministère des Transports du Québec						
Damage to primary road network						
Québec - Québec	-615.6	-1 061.8	-3 233.4	-3 188.9	-2 656.1	***-10 755.9***
Québec - Ontario	-228.7	-1 167.0	-1 532.3	-1 487.6	-1 942.3	***-6 357.9***
Québec - United States	-31.5	-1 850.3	-412.6	-102.5	-544.1	***-2 941.1***
Total	***-875.8***	***-4 079.1***	***-5 178.4***	***-4 779.0***	***-5 142.5***	***-20 054.8***
Elimination of special permits						
Québec - Québec	***-615.6***	***-1 061.8***	***-3 233.4***	***-3 188.9***	***-2 656.1***	***-10 755.9***
Québec - Ontario	***-228.7***	***-1 167.0***	***-1 532.3***	***-1 487.6***	***-1 942.3***	***-6 357.9***
Québec - United States	***-31.5***	***-1 850.3***	***-412.6***	***-102.5***	***-544.1***	***-2 941.1***
Total	**-875.8**	**-4 079.1**	**-5 178.4**	**-4 779.0**	**-5 142.5**	**-20 054.8**
Trucking industry						
Reduction in number of trips, due to regulatory amendments						
Québec - Québec	500.4	1 159.1	5 807.1	12 511.9	4 084.6	***24 063.1***
Québec - Ontario	15.0	222.3	1 182.8	1 778.7	2 172.5	***5 371.2***
Québec - United States	0.0	0.0	0.0	0.0	0.0	***0.0***
Total	***515.4***	***1 381.3***	***6 989.9***	***14 290.5***	***6 257.1***	***29 434.3***
Reduction in number of trips, due to reduced wheel mass						
Québec - Québec	63.1	147.6	754.9	1 642.3	537.7	***3 145.6***
Québec - Ontario	2.0	30.8	159.6	377.5	0.0	***569.8***
Québec - United States	0.0	0.0	0.0	0.0	0.0	***0.0***
Total	***65.1***	***178.4***	***914.5***	***2 019.7***	***537.7***	***3 715.3***
Savings on fuel						
Québec - Québec	2 861.3	2 575.0	2 118.7	2 323.3	635.3	***10 513.5***
Québec - Ontario	382.3	1 644.9	1 626.8	995.7	409.5	***5 059.2***
Québec - United States	277.5	11 552.1	372.4	113.1	444.9	***12 760.0***
Total	***3 521.1***	***15 772.0***	***4 117.9***	***3 432.0***	***1 489.7***	***28 332.8***
Savings on maintenance						
Québec - Québec	390.1	307.3	233.4	251.9	68.2	***1 250.9***
Québec - Ontario	52.1	196.3	179.2	108.0	44.0	***579.6***
Québec - United States	37.8	1 378.6	41.0	12.3	47.8	***1 517.5***
Total	***480.1***	***1 882.2***	***453.7***	***372.1***	***159.9***	***3 348.0***
Elimination of special permits						
Purchase and replacement of tires						
Québec - Québec	-353.2	-556.5	-528.4	-684.3	-216.1	***-2 338.5***
Québec - Ontario	-47.2	-355.5	-405.7	-293.3	-139.3	***-1 241.0***
Québec - United States	-34.3	-2 496.6	-92.9	-33.3	-151.4	***-2 808.4***
Total	***-434.7***	***-3 408.6***	***-1 027.0***	***-1 010.8***	***-506.8***	***-6 387.9***
Québec - Québec	***3 461.7***	***3 632.5***	***8 385.7***	***16 045.0***	***5 109.6***	***36 634.6***
Québec - Ontario	***404.2***	***1 738.7***	***2 742.7***	***2 966.5***	***2 486.6***	***10 338.8***
Québec - United States	***281.1***	***10 434.1***	***320.5***	***92.0***	***341.3***	***11 469.1***
Total	**4 147.0**	**15 805.4**	**11 449.0**	**19 103.6**	**7 937.5**	**58 442.5**
Society as a whole						
Reduction in vehicle emissions						
Québec - Québec	1 054.9	1 028.1	845.9	927.6	253.6	***4 110.1***
Québec - Ontario	301.8	2 143.2	1 098.9	623.4	344.1	***4 511.5***
Québec - United States	142.2	5 481.8	250.4	52.8	177.6	***6 104.8***
Total	***1 498.9***	***8 653.1***	***2 195.3***	***1 603.8***	***775.4***	***14 726.4***
Reduction in tire disposal						
Québec - Québec	19.0	30.0	28.4	36.8	11.6	***125.9***
Québec - Ontario	2.5	19.1	21.8	15.8	7.5	***66.8***
Québec - United States	1.8	134.4	5.0	1.8	8.1	***151.2***
Total	***23.4***	***183.5***	***55.3***	***54.4***	***27.3***	***343.9***
Improvements in safety						
Québec - Québec	198.6	169.4	128.7	138.9	37.6	***673.2***
Québec - Ontario	51.6	113.1	50.7	41.3	22.3	***279.0***
Québec - United States	7.2	141.2	14.4	3.1	5.1	***171.0***
Total	***257.4***	***423.7***	***193.8***	***183.3***	***65.0***	***1 123.2***
Québec - Québec	***1 272.5***	***1 227.5***	***1 003.0***	***1 103.3***	***302.9***	***4 909.2***
Québec - Ontario	***355.9***	***2 275.4***	***1 171.5***	***680.5***	***373.9***	***4 857.3***
Québec - United States	***151.3***	***5 757.4***	***269.8***	***57.6***	***190.9***	***6 427.0***
Total	**1 779.7**	**9 260.3**	**2 444.3**	**1 841.5**	**867.7**	**16 193.5**
Québec - Québec	***4 118.6***	***3 798.2***	***6 155.3***	***13 959.4***	***2 756.4***	***30 787.9***
Québec - Ontario	***531.4***	***2 847.2***	***2 381.9***	***2 159.4***	***918.2***	***8 838.2***
Québec - United States	***400.9***	***14 341.2***	***177.7***	***47.2***	***-11.9***	***14 955.0***
GRAND TOTAL	**5 050.9**	**20 986.5**	**8 714.9**	**16 166.0**	**3 662.8**	**54 581.1**
Benefits	6 361.4	28 474.2	14 920.3	21 955.9	9 312.1	***81 023.8***
Costs	-1 310.5	-7 487.7	-6 205.4	-5 789.8	-5 649.3	***-26 442.7***
Net value	**5 050.9**	**20 986.5**	**8 714.9**	**16 166.0**	**3 662.8**	**54 581.1**
Benefit/cost ratio	**4.9**	**3.8**	**2.4**	**3.8**	**1.6**	**3.1**

(b) Spring-thaw period

($'000/yr)

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Ministère des Transports du Québec						
Damage to primary road network						
Québec - Québec	-638.1	-889.3	-2 951.1	-2 873.5	-2 762.4	***-10 114.4***
Québec - Ontario	-239.2	-1 072.3	-1 406.1	-1 366.7	-1 789.9	***-5 874.3***
Québec - United States	-31.5	-1 695.3	-378.5	-94.6	-499.4	***-2 699.3***
Total	***-908.8***	***-3 656.8***	***-4 735.7***	***-4 334.9***	***-5 051.7***	***-18 687.9***
Elimination of special permits		***-88.9***				***-88.9***
Québec - Québec	***-638.1***	***-978.1***	***-2 951.1***	***-2 873.5***	***-2 762.4***	***-10 203.3***
Québec - Ontario	***-239.2***	***-1 072.3***	***-1 406.1***	***-1 366.7***	***-1 789.9***	***-5 874.3***
Québec - United States	***-31.5***	***-1 695.3***	***-378.5***	***-94.6***	***-499.4***	***-2 699.3***
Total	**-908.8**	**-3 745.7**	**-4 735.7**	**-4 334.9**	**-5 051.7**	**-18 776.8**
Trucking industry						
Reduction in number of trips, due to regulatory amendments						
Québec - Québec	940.2	1 074.7	3 005.4	4 967.0	1 196.1	***11 183.4***
Québec - Ontario	14.6	896.1	2 837.0	1 822.1	938.1	***6 507.9***
Québec - United States	0.3	1 412.6	479.7	0.0	0.0	***1 892.6***
Total	***955.1***	***3 383.5***	***6 322.0***	***6 789.1***	***2 134.2***	***19 583.9***
Reduction in number of trips, due to reduced wheel mass						
Québec - Québec	132.2	163.8	428.6	639.4	0.0	***1 364.1***
Québec - Ontario	2.1	136.6	404.6	234.6	0.0	***777.8***
Québec - United States	0.2	215.3	68.4	0.0	0.0	***284.0***
Total	***134.5***	***515.8***	***901.6***	***874.0***	***0.0***	***2 425.9***
Savings on fuel						
Québec - Québec	598.9	539.0	443.4	486.3	133.0	***2 200.5***
Québec - Ontario	80.0	344.3	340.5	208.4	85.7	***1 058.9***
Québec - United States	58.1	2 417.9	77.9	23.7	93.1	***2 670.7***
Total	***737.0***	***3 301.1***	***861.9***	***718.3***	***311.8***	***5 930.1***
Savings on maintenance						
Québec - Québec	81.7	64.3	48.9	52.7	14.3	***261.8***
Québec - Ontario	10.9	41.1	37.5	22.6	9.2	***121.3***
Québec - United States	7.9	288.5	8.6	2.6	10.0	***317.6***
Total	***100.5***	***393.9***	***95.0***	***77.9***	***33.5***	***700.7***
Elimination of special permits		***88.9***				***88.9***
Purchase and replacement of tires						
Québec - Québec	-73.9	-116.5	-110.6	-143.2	-45.2	***-489.5***
Québec - Ontario	-9.9	-74.4	-84.9	-61.4	-29.2	***-259.7***
Québec - United States	-7.2	-522.5	-19.4	-7.0	-31.7	***-587.8***
Total	***-91.0***	***-713.4***	***-215.0***	***-211.6***	***-106.1***	***-1 337.0***
Québec - Québec	***1 679.0***	***1 814.2***	***3 815.7***	***6 002.1***	***1 298.1***	***14 609.1***
Québec - Ontario	***97.7***	***1 343.7***	***3 534.7***	***2 226.3***	***1 003.8***	***8 206.1***
Québec - United States	***59.4***	***3 811.9***	***615.2***	***19.3***	***71.4***	***4 577.1***
Total	**1 836.0**	**6 969.8**	**7 965.5**	**8 247.7**	**2 373.4**	**27 392.4**
Society as a whole						
Reduction in vehicle emissions						
Québec - Québec	220.8	215.2	177.0	194.1	53.1	***860.2***
Québec - Ontario	63.2	448.6	230.0	130.5	72.0	***944.3***
Québec - United States	29.8	1 147.4	52.4	11.0	37.2	***1 277.8***
Total	***313.7***	***1 811.1***	***459.5***	***335.7***	***162.3***	***3 082.3***
Reduction in tire disposal						
Québec - Québec	4.0	6.3	6.0	7.7	2.4	***26.3***
Québec - Ontario	0.5	4.0	4.6	3.3	1.6	***14.0***
Québec - United States	0.4	28.1	1.0	0.4	1.7	***31.6***
Total	***4.9***	***38.4***	***11.6***	***11.4***	***5.7***	***72.0***
Improvements in safety						
Québec - Québec	41.6	35.5	26.9	29.1	7.9	***140.9***
Québec - Ontario	10.8	23.7	10.6	8.6	4.7	***58.4***
Québec - United States	1.5	29.6	3.0	0.6	1.1	***35.8***
Total	***53.9***	***88.7***	***40.6***	***38.4***	***13.6***	***235.1***
Québec - Québec	***266.3***	***256.9***	***209.9***	***230.9***	***63.4***	***1 027.5***
Québec - Ontario	***74.5***	***476.2***	***245.2***	***142.4***	***78.3***	***1 016.6***
Québec - United States	***31.7***	***1 205.0***	***56.5***	***12.1***	***40.0***	***1 345.2***
Total	**372.5**	**1 938.2**	**511.6**	**385.4**	**181.6**	**6 308.5**
Québec - Québec	***1 307.2***	***1 093.0***	***1 074.6***	***3 359.5***	***-1 400.9***	***5 433.4***
Québec - Ontario	***-67.0***	***747.6***	***2 373.7***	***1 002.0***	***-707.8***	***3 348.5***
Québec - United States	***59.5***	***3 321.7***	***293.2***	***-63.3***	***-388.0***	***3 223.1***
GRAND TOTAL	**1 299.7**	**5 162.3**	**3 741.5**	**4 298.2**	**-2 496.7**	**14 924.2**
Benefits	2 299.5	9 532.5	8 692.1	8 844.7	2 661.1	***32 029.9***
Costs	-999.8	-4 459.1	-4 950.6	-4 546.4	-5 157.8	***-20 113.8***
Net value	**1 299.7**	**5 162.3**	**3 741.5**	**4 298.2**	**-2 496.7**	**14 924.2**
Benefit/cost ratio	**2.3**	**2.1**	**1.8**	**1.9**	**0.5**	**1.6**

(c) Entire year

($'000/yr)

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Ministère des Transports du Québec						
Damage to primary road network						
Québec - Québec	-1 253.7	-1 951.1	-6 184.5	-6 062.4	-5 418.5	***-20 870.2***
Québec - Ontario	-467.8	-2 239.3	-2 938.4	-2 854.3	-3 732.2	***-12 232.1***
Québec - United States	-63.1	-3 545.6	-791.1	-197.1	-1 043.4	***-5 640.3***
Total	***-1 784.6***	***-7 736.0***	***-9 914.1***	***-9 113.9***	***-10 194.1***	***-38 742.7***
Elimination of special permits		***-88.9***				***-88.9***
Québec - Québec	***-1 253.7***	***-2 040.0***	***-6 184.5***	***-6 062.4***	***-5 418.5***	***-20 959.1***
Québec - Ontario	***-467.8***	***-2 239.3***	***-2 938.4***	***-2 854.3***	***-3 732.2***	***-12 232.1***
Québec - United States	***-63.1***	***-3 545.6***	***-791.1***	***-197.1***	***-1 043.4***	***-5 640.3***
Total	**-1 784.6**	**-7 824.9**	**-9 914.1**	**-9 113.9**	**-10 194.1**	**-38 831.6**
Trucking industry						
Reduction in number of trips, due to regulatory amendments						
Québec - Québec	1 440.6	2 233.8	8 812.4	17 478.9	5 280.8	***35 246.4***
Québec - Ontario	29.6	1 118.4	4 019.8	3 600.7	3 110.6	***11 879.1***
Québec - United States	0.3	1 412.6	479.7	0.0	0.0	***1 892.6***
Total	***1 470.5***	***4 764.8***	***13 311.9***	***21 079.6***	***8 391.3***	***49 018.2***
Reduction in number of trips, due to reduced wheel mass						
Québec - Québec	195.3	311.4	1 183.5	2 281.7	537.7	***4 509.6***
Québec - Ontario	4.0	167.4	564.2	612.0	0.0	***1 347.6***
Québec - United States	0.2	215.3	68.4	0.0	0.0	***284.0***
Total	***199.6***	***694.1***	***1 816.1***	***2 893.7***	***537.7***	***6 141.2***
Savings on fuel						
Québec - Québec	3 460.2	3 114.0	2 562.1	2 809.5	768.3	***12 714.1***
Québec - Ontario	462.3	1 989.2	1 967.3	1 204.1	495.2	***6 118.1***
Québec - United States	335.6	13 970.0	450.3	136.7	538.0	***15 430.7***
Total	***4 258.1***	***19 073.2***	***4 979.8***	***4 150.4***	***1 801.4***	***34 262.9***
Savings on maintenance						
Québec - Québec	471.8	371.6	282.3	304.6	82.5	***1 512.8***
Québec - Ontario	63.0	237.4	216.8	130.6	53.2	***700.9***
Québec - United States	45.8	1 667.1	49.6	14.8	57.8	***1 835.1***
Total	***580.6***	***2 276.1***	***548.7***	***450.0***	***193.4***	***4 048.7***
Elimination of special permits		***88.9***				***88.9***
Purchase and replacement of tires						
Québec - Québec	-427.2	-673.0	-639.0	-827.5	-261.4	***-2 828.0***
Québec - Ontario	-57.1	-429.9	-490.7	-354.6	-168.5	***-1 500.7***
Québec - United States	-41.4	-3 019.1	-112.3	-40.3	-183.0	***-3 396.2***
Total	***-525.7***	***-4 122.0***	***-1 242.0***	***-1 222.4***	***-612.9***	***-7 724.9***
Québec - Québec	***5 140.7***	***5 446.7***	***12 201.4***	***22 047.2***	***6 407.8***	***51 243.7***
Québec - Ontario	***501.9***	***3 082.4***	***6 277.4***	***5 192.8***	***3 490.5***	***18 544.9***
Québec - United States	***340.5***	***14 246.0***	***935.8***	***111.3***	***412.7***	***16 046.2***
Total	**5 983.1**	**22 775.2**	**19 414.5**	**27 351.3**	**10 310.9**	**85 834.9**
Society as a whole						
Reduction in vehicle emissions						
Québec - Québec	1 275.6	1 243.3	1 023.0	1 121.7	306.7	***4 970.3***
Québec - Ontario	365.0	2 591.7	1 329.0	753.9	416.2	***5 455.8***
Québec - United States	172.0	6 629.2	302.8	63.8	214.8	***7 382.6***
Total	***1 812.6***	***10 464.2***	***2 654.7***	***1 939.5***	***937.7***	***17 808.7***
Reduction in tire disposal						
Québec - Québec	23.0	36.2	34.4	44.5	14.1	***152.2***
Québec - Ontario	3.1	23.1	26.4	19.1	9.1	***80.8***
Québec - United States	2.2	162.5	6.0	2.2	9.9	***182.8***
Total	***28.3***	***221.9***	***66.9***	***65.8***	***33.0***	***415.9***
Improvements in safety						
Québec - Québec	240.2	204.9	155.6	168.0	45.5	***814.1***
Québec - Ontario	62.3	136.8	61.3	50.0	27.0	***337.4***
Québec - United States	8.8	170.7	17.4	3.7	6.2	***206.8***
Total	***311.3***	***512.4***	***234.3***	***221.6***	***78.7***	***1 358.3***
Québec - Québec	***1 538.8***	***1 484.4***	***1 213.0***	***1 334.2***	***366.3***	***5 936.7***
Québec - Ontario	***430.4***	***2 751.7***	***1 416.7***	***823.0***	***452.2***	***5 873.9***
Québec - United States	***183.0***	***6 962.4***	***326.2***	***69.7***	***230.9***	***7 772.2***
Total	**2 152.2**	**11 198.5**	**2 955.9**	**2 226.9**	**1 049.3**	**19 582.8**
Québec - Québec	***5 425.8***	***4 891.2***	***7 229.8***	***17 319.0***	***1 355.5***	***36 221.3***
Québec - Ontario	***464.5***	***3 594.8***	***4 755.6***	***3 161.4***	***210.5***	***12 186.7***
Québec - United States	***460.4***	***17 662.9***	***470.9***	***-16.1***	***-399.9***	***18 178.1***
GRAND TOTAL	**6 350.6**	**26 148.8**	**12 456.3**	**20 464.3**	**1 166.1**	**66 586.1**
Benefits	8 660.9	38 006.8	23 612.4	30 800.5	11 973.2	***113 053.8***
Costs	-2 310.3	-11 946.8	-11 156.1	-10 336.3	-10 807.1	***-46 556.5***
Net value	**6 350.6**	**26 148.8**	**12 456.3**	**20 464.3**	**1 166.1**	**66 586.1**
Benefit/cost ratio	**3.75**	**3.18**	**2.12**	**2.98**	**1.11**	**2.43**

Table D. 2 Economic benefits and costs of using supersingle tires – Assumption 1: 1 000 kg per axle penalty eliminated, all year around – Scenario 1: All heavy vehicles operating in Québec, by configuration, 1999

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Ministère des Transports du Québec						
Damage to primary road network						
Normal period	-875.8	-4 079.1	-5 178.4	-4 779.0	-5 142.5	***-20 054.8***
Spring-thaw period	-908.8	-3 656.8	-4 735.7	-4 334.9	-5 051.7	***-18 687.9***
Elimination of special permits		-88.9				***-88.9***
Total	**-1 784.6**	**-7 824.9**	**-9 914.1**	**-9 113.9**	**-10 194.1**	**-38 831.6**
Trucking industry						
Reduction in number of trips						
Due to regulatory amendments						
Normal period	515.4	1 381.3	6 989.9	14 290.5	6 257.1	***29 434.3***
Spring-thaw period	955.1	3 383.5	6 322.0	6 789.1	2 134.2	***19 583.9***
Due to reduced wheel mass	199.6	694.1	1 816.1	2 893.7	537.7	***6 141.2***
Savings on fuel	4 258.1	19 073.2	4 979.8	4 150.4	1 801.4	***34 262.9***
Savings on maintenance	580.6	2 276.1	548.7	450.0	193.4	***4 048.7***
Elimination of special permits		88.9				***88.9***
Purchase and replacement of tires	-525.7	-4 122.0	-1 242.0	-1 222.4	-612.9	***-7 724.9***
Total	**5 983.1**	**22 775.2**	**19 414.5**	**27 351.3**	**10 310.9**	**85 834.9**
Society						
Reduction in vehicle emissions	1 812.6	10 464.2	2 654.7	1 939.5	937.7	***17 808.7***
Reduction in tire disposal	28.3	221.9	66.9	65.8	33.0	***415.9***
Improvements in safety	311.3	512.4	234.3	221.6	78.7	***1 358.3***
Total	**2 152.2**	**11 198.5**	**2 955.9**	**2 226.9**	**1 049.3**	**19 582.8**
GRAND TOTAL	**6 350.6**	**26 148.8**	**12 456.3**	**20 464.3**	**1 166.1**	**66 586.1**
Benefits	8 660.9	38 006.8	23 612.4	30 800.5	11 973.2	***113 053.8***
Costs	-2 310.3	-11 946.8	-11 156.1	-10 336.3	-10 807.1	***-46 556.5***
Net value	**6 350.6**	**26 148.8**	**12 456.3**	**20 464.3**	**1 166.1**	**66 586.1**
Benefit/cost ratio	**3.75**	**3.18**	**2.12**	**2.98**	**1.11**	**2.43**

Table D. 3 Economic benefits and costs of using supersingle tires – Assumption 1: 1 000 kg per axle penalty eliminated, all year around – Scenario 2: 5-axle vehicles, Ontario and U.S. markets, 1999

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Ministère des Transports du Québec						
Damage to primary road network						
Normal period		-3 017.3				***-3 017.3***
Spring-thaw period		-2 767.6				***-2 767.6***
Elimination of special permits		-88.9				***-88.9***
Total		**-5 873.8**				**-5 873.8**
Trucking industry						
Reduction in number of trips						
Due to increased payloads						
Normal period		222.3				***222.3***
Spring-thaw period		2 308.8				***2 308.8***
Due to reduced wheel mass		382.7				***382.7***
Savings on fuel		15 959.2				***15 959.2***
Savings on maintenance		1 904.5				***1 904.5***
Elimination of special permits		88.9				***88.9***
Purchase and replacement of tires		-3 449.0				***-3 449.0***
Total		**17 417.3**				**17 417.3**
Society as a whole						
Reduction in vehicle emissions		9 220.9				***9 220.9***
Reduction in tire disposal		221.9				***221.9***
Improvements in safety		307.5				***307.5***
Total		**9 750.3**				**9 750.3**
GRAND TOTAL		**21 293.9**				**21 293.9**
Benefits		30 616.6				***30 616.6***
Costs		-9 322.8				***-9 322.8***
Net value		**21 293.9**				**21 293.9**
Benefit/cost ratio		**3.28**				**3.28**

Table D. 4 Economic benefits and costs of using supersingle tires – Assumption 1: 1 000 kg per axle penalty eliminated, all year around – Scenario 3: All 5-axle vehicles operating in Québec, 1999

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Ministère des Transports du Québec						
Damage to primary road network						
Normal period		-4 079.1				***-4 079.1***
Spring-thaw period		-3 656.8				***-3 656.8***
Elimination of special permits		-88.9				***-88.9***
Total		**-7 824.9**				-7 824.9
Trucking industry						
Reduction in number of trips						
Due to increased payloads						
Normal period		1 381.3				***1 381.3***
Spring-thaw period		3 383.5				***3 383.5***
Due to reduced wheel mass		694.1				***694.1***
Savings on fuel		19 073.2				***19 073.2***
Savings on maintenance		2 276.1				***2 276.1***
Elimination of special permits		88.9				***88.9***
Purchase and replacement of tires		-4 122.0				***-4 122.0***
Total		**22 775.2**				22 775.2
Society as a whole						
Reduction in vehicle emissions		10 464.2				***10 464.2***
Reduction in tire disposal		221.9				***221.9***
Improvements in safety		512.4				***512.4***
Total		**11 198.5**				11 198.5
GRAND TOTAL		**26 148.8**				26 148.8
Benefits		38 095.6				***38 095.6***
Costs		-11 946.8				***-11 946.8***
Net value		**26 148.8**				26 148.8
Benefit/cost ratio		**3.19**				3.19

Table D. 5 Economic benefits and costs of using supersingle tires – Assumption 1: 1 000 kg per axle penalty eliminated, all year around – Scenario 4: Realistic percentage of heavy vehicles operating in Québec, 1999

%	47%					
	2 - 4 axles	**5 axles**	**6 axles**	**7 axles**	**8 axles or +**	**Total**
Ministère des Transports du Québec						
Damage to primary road network						
Normal period	-411.6	-1 917.2	-2 433.8	-2 246.1	-2 417.0	***-9 425.8***
Spring-thaw period	-427.1	-1 718.7	-2 225.8	-2 037.4	-2 374.3	***-8 783.3***
Elimination of special permits	0.0	-88.9	0.0	0.0	0.0	***-88.9***
Total	**-838.8**	**-3 724.8**	**-4 659.6**	**-4 283.5**	**-4 791.2**	-18 297.9
Trucking industry						
Reduction in number of trips						
Due to increased payloads						
Normal period	242.3	649.2	3 285.2	6 716.6	2 940.8	***13 834.1***
Spring-thaw period	448.9	1 590.2	2 971.4	3 190.9	1 003.1	***9 204.4***
Due to reduced wheel mass	93.8	326.2	853.6	1 360.0	252.7	***2 886.4***
Savings on fuel	2 001.3	8 964.4	2 340.5	1 950.7	846.7	***16 103.5***
Savings on maintenance	272.9	1 069.8	257.9	211.5	90.9	***1 902.9***
Elimination of special permits	0.0	41.8	0.0	0.0	0.0	***41.8***
Purchase and replacement of tires	-247.1	-1 937.3	-583.7	-574.5	-288.1	***-3 630.7***
Total	**2 812.0**	**10 704.3**	**9 124.8**	**12 855.1**	**4 846.1**	40 342.4
Society as a whole						
Reduction in vehicle emissions	851.9	4 918.2	1 247.7	911.5	440.7	***8 370.1***
Reduction in tire disposal	13.3	104.3	31.4	30.9	15.5	***195.5***
Improvements in safety	146.3	240.8	110.1	104.2	37.0	***638.4***
Total	**1 011.5**	**5 263.3**	**1 389.3**	**1 046.6**	**493.2**	9 203.9
GRAND TOTAL	**2 984.8**	**12 242.8**	**5 854.5**	**9 618.2**	**548.1**	31 248.4
Benefits	4 070.6	17 904.9	11 097.8	14 476.2	5 627.4	***53 177.0***
Costs	-1 085.8	-5 662.1	-5 243.3	-4 858.0	-5 079.3	***-21 928.7***
Net value	**2 984.8**	**12 242.8**	**5 854.5**	**9 618.2**	**548.1**	31 248.4
Benefit/cost ratio	**3.75**	**3.16**	**2.12**	**2.98**	**1.11**	2.43

Table D. 6 Economic benefits and costs of using supersingle tires – Assumption 2: Québec regulations harmonized with U.S. regulations –Scenario 5: 5-axle heavy vehicles, by geographic market, Québec, 1999

(a) Normal (non-spring-thaw) period

($'000/yr)

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Ministère des Transports du Québec						
Damage to primary road network						
Québec - Québec		0.0				***0.0***
Québec - Ontario		0.0				***0.0***
Québec - United States		0.0				***0.0***
Total		***0.0***				***0.0***
Elimination of special permits						
Québec - Québec		***0.0***				***0.0***
Québec - Ontario		***0.0***				***0.0***
Québec - United States		***0.0***				***0.0***
Total		**0.0**				**0.0**
Trucking industry						
Reduction in number of trips, due to regulatory amendments						
Québec - Québec		0.0				***0.0***
Québec - Ontario		0.0				***0.0***
Québec - United States		0.0				***0.0***
Total		***0.0***				***0.0***
Reduction in number of trips, due to reduced wheel mass						
Québec - Québec		147.6				***147.6***
Québec - Ontario		30.8				***30.8***
Québec - United States		0.0				***0.0***
Total		***178.4***				***178.4***
Savings on fuel						
Québec - Québec		2 575.0				***2 575.0***
Québec - Ontario		1 644.9				***1 644.9***
Québec - United States		11 552.1				***11 552.1***
Total		***15 772.0***				***15 772.0***
Savings on maintenance						
Québec - Québec		307.3				***307.3***
Québec - Ontario		196.3				***196.3***
Québec - United States		1 378.6				***1 378.6***
Total		***1 882.2***				***1 882.2***
Elimination of special permits		***88.9***				
Purchase and replacement of tires						
Québec - Québec		-556.5				***-556.5***
Québec - Ontario		-355.5				***-355.5***
Québec - United States		-2 496.6				***-2 496.6***
Total		***-3 408.6***				***-3 408.6***
Québec - Québec		***2 562.3***				***2 562.3***
Québec - Ontario		***1 516.5***				***1 516.5***
Québec - United States		***10 434.1***				***10 434.1***
Total		**14 512.9**				**14 512.9**
Society as a whole						
Reduction in vehicle emissions						
Québec - Québec		1 028.1				***1 028.1***
Québec - Ontario		2 143.2				***2 143.2***
Québec - United States		5 481.8				***5 481.8***
Total		***8 653.1***				***8 653.1***
Reduction in tire disposal						
Québec - Québec		30.0				***30.0***
Québec - Ontario		19.1				***19.1***
Québec - United States		134.4				***134.4***
Total		***183.5***				***183.5***
Improvements in safety						
Québec - Québec		169.4				***169.4***
Québec - Ontario		113.1				***113.1***
Québec - United States		141.2				***141.2***
Total		***423.7***				***423.7***
Québec - Québec		***1 227.5***				***1 227.5***
Québec - Ontario		***2 275.4***				***2 275.4***
Québec - United States		***5 757.4***				***5 757.4***
Total		**9 260.3**				**9 260.3**
Québec - Québec		***3 789.8***				***3 789.8***
Québec - Ontario		***3 791.9***				***3 791.9***
Québec - United States		***16 191.5***				***16 191.5***
GRAND TOTAL		**23 773.2**				**23 773.2**
Benefits		27 092.9				***27 092.9***
Costs		-3 408.6				***-3 408.6***
Net value		**23 773.2**				**23 773.2**
Benefit/cost ratio		**7.95**				**7.95**

(b) Spring-thaw period

($'000/yr)

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Ministère des Transports du Québec						
Damage to primary road network						
Québec - Québec		-889.3				***-889.3***
Québec - Ontario		-1 072.3				***-1 072.3***
Québec - United States		-1 695.3				***-1 695.3***
Total		***-3 656.8***				***-3 656.8***
Elimination of special permits		***-88.9***				***-88.9***
Québec - Québec		***-978.1***				***-978.1***
Québec - Ontario		***-1 072.3***				***-1 072.3***
Québec - United States		***-1 695.3***				***-1 695.3***
Total		**-3 745.7**				**-3 745.7**
Trucking industry						
Reduction in number of trips, due to regulatory amendments						
Québec - Québec		1 074.7				***1 074.7***
Québec - Ontario		896.1				***896.1***
Québec - United States		1 412.6				***1 412.6***
Total		***3 383.5***				***3 383.5***
Reduction in number of trips, due to reduced wheel mass						
Québec - Québec		163.8				***163.8***
Québec - Ontario		136.6				***136.6***
Québec - United States		215.3				***215.3***
Total		***515.8***				***515.8***
Savings on fuel						
Québec - Québec		539.0				***539.0***
Québec - Ontario		344.3				***344.3***
Québec - United States		2 417.9				***2 417.9***
Total		***3 301.1***				***3 301.1***
Savings on maintenance						
Québec - Québec		64.3				***64.3***
Québec - Ontario		41.1				***41.1***
Québec - United States		288.5				***288.5***
Total		***393.9***				***393.9***
Elimination of special permits		***88.9***				***88.9***
Purchase and replacement of tires						
Québec - Québec		-116.5				***-116.5***
Québec - Ontario		-74.4				***-74.4***
Québec - United States		-522.5				***-522.5***
Total		***-713.4***				***-713.4***
Québec - Québec		***1 814.2***				***1 814.2***
Québec - Ontario		***1 343.7***				***1 343.7***
Québec - United States		***3 811.9***				***3 811.9***
Total		**6 969.8**				**6 969.8**
Society as a whole						
Reduction in vehicle emissions						
Québec - Québec		215.2				***215.2***
Québec - Ontario		448.6				***448.6***
Québec - United States		1 147.4				***1 147.4***
Total		***1 811.1***				***1 811.1***
Reduction in tire disposal						
Québec - Québec		6.3				***6.3***
Québec - Ontario		4.0				***4.0***
Québec - United States		28.1				***28.1***
Total		***38.4***				***38.4***
Improvements in safety						
Québec - Québec		35.5				***35.5***
Québec - Ontario		23.7				***23.7***
Québec - United States		29.6				***29.6***
Total		***88.7***				***88.7***
Québec - Québec		***256.9***				***256.9***
Québec - Ontario		***476.2***				***476.2***
Québec - United States		***1 205.0***				***1 205.0***
Total		**1 938.2**				**3 699.0**
Québec - Québec		***1 093.0***				***1 093.0***
Québec - Ontario		***747.6***				***747.6***
Québec - United States		***3 321.7***				***3 321.7***
GRAND TOTAL		**5 162.3**				**6 923.1**
Benefits		9 532.5				***9 532.5***
Costs		-4 459.1				***-4 459.1***
Net value		**5 162.3**				**6 923.1**
Benefit/cost ratio		**2.14**				**2.14**

(c) Entire year

($'000/yr)

	2 - 4 axles	5 axles	6 axles	7 axles	8 axles or +	Total
Ministère des Transports du Québec						
Damage to primary road network						
Québec - Québec		-889.3				***-889.3***
Québec - Ontario		-1 072.3				***-1 072.3***
Québec - United States		-1 695.3				***-1 695.3***
Total		***-3 656.8***				***-3 656.8***
Elimination of special permits		***-88.9***				***-88.9***
Québec - Québec		***-978.1***				***-978.1***
Québec - Ontario		***-1 072.3***				***-1 072.3***
Québec - United States		***-1 695.3***				***-1 695.3***
Total		**-3 745.7**				**-3 745.7**
Trucking industry						
Reduction in number of trips, due to regulatory amendments						
Québec - Québec		1 074.7				***1 074.7***
Québec - Ontario		896.1				***896.1***
Québec - United States		1 412.6				***1 412.6***
Total		***3 383.5***				***3 383.5***
Reduction in number of trips, due to reduced wheel mass						
Québec - Québec		311.4				***311.4***
Québec - Ontario		167.4				***167.4***
Québec - United States		215.3				***215.3***
Total		***694.1***				***694.1***
Savings on fuel						
Québec - Québec		3 114.0				***3 114.0***
Québec - Ontario		1 989.2				***1 989.2***
Québec - United States		13 970.0				***13 970.0***
Total		***19 073.2***				***19 073.2***
Savings on maintenance						
Québec - Québec		371.6				***371.6***
Québec - Ontario		237.4				***237.4***
Québec - United States		1 667.1				***1 667.1***
Total		***2 276.1***				***2 276.1***
Elimination of special permits		***0.0***				***0.0***
Purchase and replacement of tires						
Québec - Québec		-673.0				***-673.0***
Québec - Ontario		-429.9				***-429.9***
Québec - United States		-3 019.1				***-3 019.1***
Total		***-4 122.0***				***-4 122.0***
Québec - Québec		***4 198.8***				***4 198.8***
Québec - Ontario		***2 860.1***				***2 860.1***
Québec - United States		***14 246.0***				***14 246.0***
Total		**21 304.9**				**21 304.9**
Society as a whole						
Reduction in vehicle emissions						
Québec - Québec		1 243.3				***1 243.3***
Québec - Ontario		2 591.7				***2 591.7***
Québec - United States		6 629.2				***6 629.2***
Total		***10 464.2***				***10 464.2***
Reduction in tire disposal						
Québec - Québec		36.2				***36.2***
Québec - Ontario		23.1				***23.1***
Québec - United States		162.5				***162.5***
Total		***221.9***				***221.9***
Improvements in safety						
Québec - Québec		204.9				***204.9***
Québec - Ontario		136.8				***136.8***
Québec - United States		170.7				***170.7***
Total		***512.4***				***512.4***
Québec - Québec		***1 484.4***				***1 484.4***
Québec - Ontario		***2 751.7***				***2 751.7***
Québec - United States		***6 962.4***				***6 962.4***
Total		**11 198.5**				**11 198.5**
Québec - Québec		***4 705.1***				***4 705.1***
Québec - Ontario		***4 539.4***				***4 539.4***
Québec - United States		***19 513.2***				***19 513.2***
GRAND TOTAL		**28 757.7**				**28 757.7**
Benefits		36 625.4				***36 625.4***
Costs		-7 867.7				***-7 867.7***
Net value		**28 757.7**				**28 757.7**
Benefit/cost ratio		**4.66**				**4.66**