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Highway Costs and Revenues in Québec: Evidence and Analysis

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1. Introduction

For the last twenty-five years, both Canada and the United States have seen their productivity growth slowed dramatically. However, it is only since the late 80's that public capital stock is mentioned as a potential factor in productivity slowdown. An alleged infrastructure shortage is now part of the agenda that the political parties of various developed countries, including Canada, have put on their agenda when seeking election or reelection. Very little academic research has focused attention on the way to identify a shortage of infrastructure investment and on the way to determine whether there was a shortage.

The aim and scope of this paper are strictly limited to answering two simple questions, by using a subset of the tangible capital stock owned by the public sector. The first is the following: does the "road industry" run a surplus or a deficit? The second question is expressed in a like manner: is the state of real net capital stock on highways and streets optimal from an intertemporal economic efficiency? The statistical computations and the economic analysis are restricted to the Province of Québec for the period 1971-1993, original data being easily available for the Ministry of Transportation and municipalities.

Section 2 assesses the nature of the expenditures and costs undertaken by the Québec Ministry of Transportation and municipalities to provide and maintain highways and streets to different classes of users. The sources of the overall revenues, collected by both types public organisations and which can be imputed as user fees are also examined. A brief analysis of the results follows. Section 3 quickly explains how the real gross and net capital stock of highways and streets are estimated for both levels of government. Various ratios are then used to appraise the potential existence of shortage in the "road industry". Section 4 focuses on the possibility of imposing user fees on highway infrastructure and its usage. Section 5 offers some concluding remarks, keeping in mind the actual context of spending cuts by the federal and provincial governments and the necessity of sustaining a steady-state rate of growth of the economy for the coming years.

2. Québec Expenditures and Revenues

The methodology adopted here to define, choose and compute revenues and expenditures and costs on highways and streets is in keeping with Prest's study[1] on highways and roads in the United Kingdom. His empirical approach has been applied by various Canadian researchers in the 70s, leading to an unproductive debate on what should be included in the revenue side[2]. As consistency is very important in this exercise, the procedure used consists of matching a specific cost item to all the revenues associated to the latter. For instance, if fines levied for various infractions commited by drivers and vehicles owners are included, appropriate police costs are also included.

2.1 Revenues

The general principle allowing the inclusion of different revenues is based on the tax incidence theory that analyzes the effects of taxes on the relative prices of goods and factors. A general consumption tax, such as a sales tax or a value added tax, that is universally levied over a period on all goods and services in the economy, is therefore not specific to some particular goods such as fuel, vehicles and auto parts, for instance. The revenues collected on these particular items shall not be part of the overall imputed revenues. As a matter of fact, the existing sales taxes in Canada do not change the relative price of the "road industry". However, selectives taxes, duties and specific fees do affect the price of the road mode in relation to other modes.

The main sources that can be assessed as "user fees" for driving a vehicle on Québec highways and streets network are the selective fuel tax, various fees imposed on vehicle owners and drivers such as vehicle registration fees, drivers' and chauffeurs' licences, for-hire motor carrier operating licence fees, fines for infractions to the Motor Vehicle Act (Code de la sécurité routière) and the Criminal Code (Code criminel), and highway tolls. Provincial revenues come from the Québec Public Accounts and municipal revenues, fines and a percentage of the property tax, from an annual publication, Municipal Finances (Finances des municipalités), a catalogue produced by the Ministry of Municipal Affairs.

Some additional comments may serve explain our imputation procedure for municipalities. As such, municipalities do not collect or impose a user fee on vehicle owners when driving on their respective infrastructure facilities. A municipality is thus considered as an economic club[3] whose financing is based on an annual lump sum tax paid by local citizens, whether they own a vehicle or not. An average of 12 percent per year, based on the relative importance of street investments in total capital outlays for the period, is

taken as a proxy for the annual lump sum fee. As a matter of fact, home and buildings owners finance it directly when local infrastructures are incorporated in the price of land or indirectly when paying an additional sectoral tax for them. Each of the respective tax components, either provincial or local, is then computed in 1986 constant dollars, by using the Canadian consumer price index.

Tables 1 and 2 present revenues received by provincial and local authorities from roads users for the 1971-1993 period. It is worth noticing that the provincial revenues collected as user fees are almost at the same level in 1993 as in 1971, whereas municipal revenues roughly doubled over the same period.

Table 1

Québec Ministry of Transportation Revenues (in constant million $)					
Year	Fuel Tax	Fees	Tolls	Fines	Total
1971	1001.3	353.6	50.5	19.7	1425.1
1972	1024.3	357.5	50.6	20.4	1452.7
1973	1062.1	394.4	55.7	23.4	1536.7
1974	985.0	290.5	56.6	24.6	1356.6
1975	954.1	437.3	56.6	28.1	1476.0
1976	902.1	385.1	60.8	29.7	1377.7
1977	879.1	370.6	60.4	34.1	1344.2
1978	797.7	386.8	59.4	36.5	1280.3
1979	729.7	366.1	55.2	31.1	1182.1
1980	733.7	326.8	55.2	31.8	1147.2
1981	1095.2	368.3	50.2	31.7	1545.4
1982	1427.6	340.7	66.2	39.3	1873.8
1983	1364.4	292.9	74.0	46.6	1777.9
1984	1115.2	295.3	65.3	34.7	1510.5
1985	1129.3	295.2	22.8	36.7	1484.0
1986	1144.7	313.5	-	45.6	1503.8
1987	1134.0	353.8	-	49.8	1571.8
1988	1127.3	325.4	-	58.3	1511.0
1989	1102.5	333.9	-	55.8	1492.2
1990	962.4	383.9	-	45.2	1391.6
1991	885.3	405.5	-	57.8	1348.7
1992	972.8	436.1	-	56.8	1466.2
1993	964.0	421.8	-	53.1	1442.7

Source: Québec Public Accounts, various years.

Table 2

Municipal Revenues (in constant million $)			
Year	Fines	Property Tax	Total
1971	43.6	285.0	328.6
1972	47.9	274.6	322.5
1973	45.1	273.5	318.6
1974	40.6	297.5	338.3
1975	42.1	251.8	293.3
1976	56.2	313.1	373.3
1977	61.2	323.2	384.4
1978	64.9	265.1	330.0
1979	54.8	243.1	297.9
1980	72.3	289.7	362.1
1981	68.6	277.0	345.6
1982	63.7	262.6	326.3
1983	59.2	312.8	338.0
1984	58.9	314.0	372.8
1985	61.6	486.1	547.7
1986	56.0	349.3	405.3
1987	75.1	384.2	459.3
1988	90.3	444.7	535.0
1989	63.2	449.7	512.9
1990	85.0	439.4	524.4
1991	83.4	393.2	476.6
1992	86.5	484.2	570.7
1993	90.6	521.0	611.6

Source: Municipal Finances catalogue, Ministry of Municipal Affairs, various years.
Note: The percentage of revenues from the property tax is equal to the relative importance of highway investments in the overall investment budget of municipalities.

2.2 Expenditures

The main components of costs and expenditures incurred by the Québec Ministry of Transportation and different municipalities in providing and maintaining their respective network are classified as either current or capital. In the first category, only police traffic expenditures are imputed and the proportion of the Québec provincial police resources that go into road surveillance is estimated at 32.5 by Québec Treasury Board analysts. For Québec municipalities, the estimated percentage, which comes from Haritos'

study[4], isset at 45. These two types of expenditures are then computed in 1986 constant dollars by the Canadian consumer price index. Miscellaneous administrative expenses, like traffic court costs related to highway offenses and expenditures incurred by the Ministry of Transportation and municipal departments of public works for managing the road industry in general, are voluntarily neglected. Too many arbitrary allocation mesures are involved for a dubious end result. Therefore, our expenditures clearly underestimate the real picture, faute de mieux!

The overall capital cost component includes the following elements: depreciation, opportunity cost of capital and maintenance expenditures on the existing infrastructure system. Provincial maintenance expenditures come directly from an unpublished official data bank collected by the Ministry of Transportation for the Statistics Canada Capital and Repair Expenditures Survey. Municipal maintenance expenditures are directly taken from the annual publication of the Ministry of Municipal Affairs, Municipal Finances. Both maintenance expenditures are computed in 1986 constant dollars by the engineering construction price index. The other two elements are obtained, after various computations, from a Statistics Canada unpublished data bank that presents, for each province and for many classes of government assets, the same content as the catalogue Fixed capital flows and stocks, 1961-1994, which describes, in an aggregate manner, the overall Canadian government assets. So, the geometric depreciation cost comes directly from the computations done by the author and the cost of capital is based on an opportunity cost of 6 percent on the end-year net capital stock. Tables 3 and 4 show expenditures and costs incurred by both provincial and local governments to preserve and maintain their respective road network.

The exclusion of the value of land from this empirical exercise is founded on a very well known principle of cost-benefit analysis[5]: road improvements change the relative value of different spatial locations. Therefore, the value of adjacent property and the pattern of land use are positively affected when a public road is built. On the other hand, the same public investment has a negative impact, because competitive existing locations are depressed due to this new availability. As we are not able to isolate those aspects of change that reflect net benefits coming from public road improvements, we choose not to take into account the value of land.

Table 3

Provincial Expenditures and Costs (in constant million $)					
Year	Deprec.	Capital	Maint.	Police	Total
1971	612.2	427.8	394.4	56.4	1490.8
1972	662.2	459.1	393.4	67.7	1582.4
1973	705.1	480.9	390.0	66.8	1642.8
1974	734.5	489.4	385.1	75.4	1684.4
1975	764.4	511.8	430.9	79.6	1786.7
1976	789.6	514.3	438.0	88.6	1830.5
1977	795.6	509.4	472.4	81.5	1858.9
1978	795.7	504.5	463.7	81.6	1845.5
1979	794.0	497.5	506.8	93.0	1891.3
1980	788.0	485.3	459.5	97.3	1830.1
1981	773.7	467.9	418.0	105.6	1765.2
1982	752.1	446.7	453.6	100.6	1753.0
1983	729.0	428.4	454.0	100.8	1712.2
1984	609.3	355.3	441.1	109.8	1515.5
1985	685.6	392.7	443.1	112.3	1633.7
1986	538.0	305.2	429.0	110.8	1383.0
1987	648.6	361.8	498.5	126.7	1635.6
1988	611.7	338.3	495.0	134.2	1600.2
1989	519.7	285.8	563.8	138.6	1507.9
1990	525.0	286.6	489.2	150.1	1450.9
1991	447.4	244.7	532.0	132.0	1356.1
1992	508.4	276.2	583.9	131.9	1507.4
1993	548.3	294.2	551.1	102.8	1495.4

Sources: Unpublished data from the Ministry of Transportation and computations done by the author.

Table 4

Municipal Expenditures and Costs (in constant million $)					
Year	Deprec.	Cap	Maint.	Police	Total
1971	193.4	133.8	145.8	156.3	629.3
1972	170.0	117.3	148.4	161.4	597.1
1973	177.6	122.0	93.3	173.3	566.2
1974	201.3	136.2	149.8	63.8	551.1
1975	170.8	114.7	138.5	76.6	500.6
1976	192.9	130.6	144.0	90.2	557.7
1977	194.0	131.9	121.7	89.7	537.3
1978	234.0	153.4	125.3	92.9	605.6
1979	230.0	144.7	126.1	85.0	585.8
1980	180.7	117.4	134.0	94.4	526.5
1981	214.6	136.2	132.8	99.4	583.0
1982	197.1	124.3	131.3	94.4	547.1
1983	241.6	150.7	154.5	94.5	641.3
1984	279.5	172.7	143.9	188.2	784.2
1985	377.4	233.1	188.2	238.9	1037.6
1986	230.3	141.9	188.7	246.8	807.7
1987	259.5	159.0	204.3	273.8	896.6
1988	283.3	173.6	221.0	252.8	930.7
1989	281.5	171.9	224.7	268.2	946.3
1990	213.5	132.6	234.5	279.2	759.8
1991	300.8	179.4	245.9	274.7	1000.8
1992	442.3	260.8	239.9	302.1	1245.1
1993	423.2	247.8	304.3	316.7	1299.0

Sources: Municipal Finances catalogue. Ministry of Municipal Affairs and computations done by the author.

2.3 General Comments

A comparison of the data on provincial revenues and expenditures reveals that the highway network users have never born, for the 1971-1981 period, the full costs incurred by the Ministry of Transportation in providing and oprating the present highway system. As a matter of fact, the expenditures and costs incurred are greater than revenues, imputed as user fees, by a large amount. By and large, the vehicles owners and highway users have received subsidies from Québec taxpayers for all these years[6]. However, since 1982, the gap between costs and revenues is now far less important than before, so that

there is a tendency for highway users to pay more and more for the services received.

On the other hand, a relatively similar scenario is observed on the municipal side, where local taxpayers still give large subsidies to vehicles owners, the discrepancy between municipal revenues and expenditures persisting over the period, at a high level. It must also be noted that the suburbs and their respective street network have expanded considerably during the 1971-1993 period. Finally, it is possible that the considered lump sum fee is too low, which implies that local citizens, who own a vehicle or not, may be willing to pay more for benefits received from the existing city streets.

Table 5, which lists the aggregated road costs and revenues, expressed in 1986 prices, and the ratios of costs over revenues for the 1971-1993 period, helps us to answer our first question on the performance of this industry: yes, the Québec "road industry" operates with a deficit and the latter is paid by taxpayers who bear an additional burden to finance road users. However, this inefficient situation differs from one level of government to another: the provincial costs/ revenues ratio (Ratio 2) has steadly decreased over time; that is not the case for the municipal costs/ revenues ratio (Ratio 3) which is still at the same level as in 1971.

Table 5

Global Revenues and Expenditures and Costs/Revenues Ratios (in constant million $)					
Year	Revenues	Costs	Ratio 1	Ratio 2	Ratio 3
1971	1753.7	2120.1	1.21	1.05	1.92
1972	1755.2	2179.5	1.24	1.09	1.85
1973	1855.3	2209.0	1.19	1.07	1.78
1974	1694.9	2235.5	1.32	1.24	1.63
1975	1769.3	2287.3	1.29	1.21	1.71
1976	1751.0	2388.2	1.36	1.33	1.49
1977	1728.6	2396.2	1.39	1.38	1.40
1978	1610.3	2451.1	1.52	1.44	1.84
1979	1480.0	2477.1	1.67	1.60	1.07
1980	1509.3	2356.6	1.56	1.60	1.45
1981	1891.0	2348.2	1.24	1.14	1.69
1982	2200.0	2300.1	1.04	0.94	1.68
1983	1811.7	2353.5	1.30	0.96	1.90
1984	1883.3	2299.7	1.22	1.00	2.10
1985	2031.7	2671.3	1.31	1.10	1.89
1986	1909.1	2190.7	1.15	0.92	1.99
1987	2031.1	2532.2	1.25	1.04	1.95
1988	2046.0	2530.9	1.24	1.06	1.74
1989	2005.1	2454.2	1.22	1.01	1.84
1990	1916.0	2210.7	1.15	1.04	1.45
1991	1825.3	2356.9	1.29	1.01	2.10
1992	2036.9	2752.5	1.35	1.03	2.18
1993	2054.3	2794.4	1.36	1.04	2.12

Note: Ratio 1: overall costs on overall revenues
Ratio 2: provincial costs on provincial revenues
Ratio 3: municipal costs on municipal revenues

3. Considerations on The Net Capital Stock

Previous Canadian studies on the same subject had to estimate with accuracy the net capital stock, compute depreciation on the gross capital stock and find an opportunity cost of capital to apply to the net capital stock. To do so, two elements are generally needed, the determination of the service life of highway and street assets and consequently how far back to go in cumulating figures of gross capital stock. We can avoid these time-consuming computations by using a preliminary disaggregated data bank on the fixed

capital flows and stocks, made available to researchers by Statistics Canada. The level of disaggregation is listed by category of assets for each province and for all its municipalities. A category called "transportation engineering construction" has, among its components, highways and roads. Because we know the annual flow of investments on the provincial and the municipal networks in constant dollars, we are able to estimate their respective real gross and net capital stock, in constant dollars[7]. We use the geometric depreciation form that fits the deterioration of flexible pavements over time in Canada[8]. As a matter of fact, their life span is around 40 to 50 years, if maintenance work and resurfacing over a given life cycle is optimal. A 6 percent opportunity cost of capital is then applied on each year-end net capital stock. These are the foundations of these relevant elements contained in Tables 3 and 4.

FIGURE 1

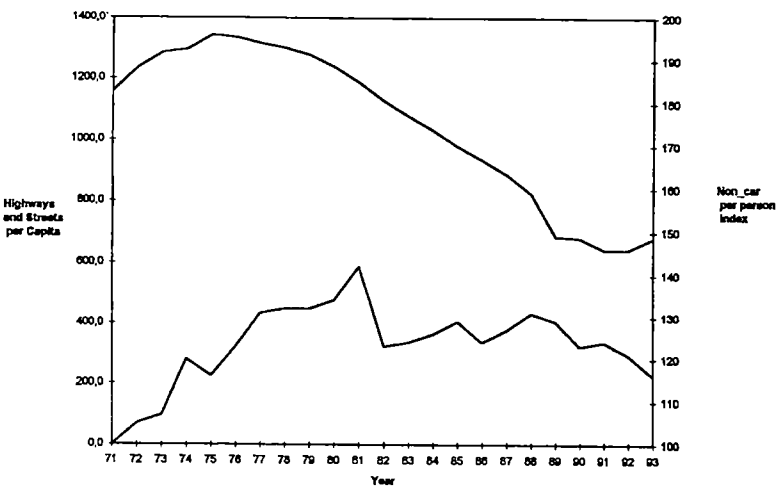

Figure 1 shows two per capita measures,one being the evolution of the net capital stock for the provincial and local governments, the second, the rate of growth of vehicles, excluding the automobile. The left-hand axis refers to the highways and streets per capita and the right-hand axis to a vehicle per capita index[9]. The net capital stock per capita rose from 1971 to 1978, then decreased sharply during the 80's and rose again since1990. The main reasons are, first of all, the near-end of building the provincial highway network; secondly, the depreciation of the previously built highways and finally, the increase in fuel tax by the government in 1981. The latter has apparently

leveled off and then slightly cut into the real number of non-automobile types of vehicles on the roads, as shown on the right-hand axis of Figure1, although both the auto park and the number of kilometres driven per capita have still increased. It is certainly not obvious from the Figure that there exists a highway shortage in Québec. More investigation is therefore required in order to give a definitive answer to our second question.

To this end, we focus on one of the four means used by Gramlich[10] in assessing the alleged shortage of infrastructure investment in the United States. Table 6 gives estimates of the percentage of pavement kilometres needing improvement and the percentage of peak hour kilometres under congested conditions for 1990 and 1994. In each case, the physical needs measure, the percentage of highway kilometres in poor condition, has declined. However, their respective levels in all categories are higher, by a factor of two, than those published by the Federal Highway Administration in 1993. On the other hand, the measures of highway congestion did rise in the four-year period from 14 percent to 20 percent, mainly on urban highways. But, by American standards, congestion observed in Québec is low and not all comparable. For instance, the level of congestion went up from 42 percent in 1987 to 47.2 percent in 1991 in the urban interstate category. In short, this needs assessment does not make a compelling case for there being a real shortage in highway and street networks. Sure, the situation described for the provincial government is border line.Therefore, our answer to the second question is the following: it may be possible that the intertemporal economic efficiency is not optimal because of underinvestments in highway infrastructure. This is a scotch verdict, for a lack of proof.

Table 6

Pavement Ratings and Peak Hour Congestion (Percentage of pavements kilometres or peak hour kilometres)		
System and Year	Needing Improvement*	Congested**
Highways		
1990	37.0	14.0
1994	22.0	20.0
National Roads		
1990	34.0	1.0
1994	24.0	2.0
Regional Roads		
1990	41.0	0
1994	26.0	0
Urban Collectors		
1990	30.0	1.0
1994	27.0	20.0
Total		
1990	33.0	6.9
1994	24.0	11.8

Source: Ministry of Transportation. 1994

* Percent of pavement kilometres rated in poor condition

** Percent of of peak hour kilometres where the peak vehicle-capacity ratio exceeds a given threshold

4. Marginal-Cost User Charges

The best way to achieve an economic efficiency in the "road industry" is to introduce user fees that will take into consideration the cost incurred by every class of road users. Because there exist important economies of scale in this particular industry, the basic component must be a variant of two-part tariffs. The latter are pricing schemes that involve a fixed fee which must be paid to get access to the highway network and then a variable fee based on usage of the network. The fixed fee has to be related to the road-wear costs caused by certain types of vehicles, mainly trucks and buses. For instance, vehicle registration fees of those configurations must therefore be determined by their weight per axle per kilometre, also called "equivalent standard axle loads" per kilometre or ESAL-kilometre. A by-product of this pricing policy is to reduce the heaviest axle weights that cause the most structural damages. For cars and light trucks, the fixed fee also has to be linked to the infrastructure costs

because the class of heavy vehicles by itself, being limited in number, cannot cover the overall initial investments and maintenance costs over a given road life cycle. By the way, both classes must also pay for the effects of weathering on pavement deterioration[11].

The variable fee must reflect the needs of each class of users when driving on the highway network. The criterion used to determine it must be founded on Ramsay's rule, the inverse of the demand price elasticity. In that context, there are in effect two different class of users and the division can easily be enforced. Each class pays a selective fuel tax that depends on its price elasticity. If the class of heavy vehicles has more substitutes than the category of car drivers because shippers can move their products by other modes, railway, ships and barges, it is thus charged a lower price. It is expected that car drivers must assume a higher price than the other class. That is actually the case in Québec, because of their low price elasticity. Mass transit and ride-sharing are in no way good substitutes.

Congestion measured by "passenger car equivalents" per kilometre or PCE-kilometre is mostly caused by cars because each of them creates an extra delay when going into the traffic stream. A peak-load pricing that takes into account estimates of vehicle operating costs and the values that people put on their time that causes an additional car to all other users will make peak-hour automobile driving less attractive on congested highways. The urban highway network is thus restored as a functioning component of the system of urban production.

A few comments must be made on the production side of the "road industry". All the components of the highway and street network have to be considered as valid assets whose usage by various classes of vehicles is determined by actual and future conditions. In short, the portfolio theory must be applied to its management. So the public manager objective should be to minimize total life-cycle cost of the network[12]. More specifically, it meansthat, at the micro level, the Ministry of Transportation has a complete inventory of its assets and it must manage its network with efficiency; secondly, it should possess relatively good estimates of the rate of growth of the demand on its main different components. This knowledge will allow public managers to act where the differential between the discounted marginal benefit and the discounted marginal cost on a given segment of the network is the largest. This optimal strategy represents the unique solution to solve the situation actually faced by the Ministry of Transportation. Adopting a different solution to please politicians, namely intervening where political benefits are equal, at the margin, to the marginal cost of public funds, only leads to an accelerated

deterioration of the network. The actual state of the infrastructure system reflects this pork-barrel philosophy.

5. Concluding Remarks

K. Small once wrote that economists' dreams can become politicians' nightmares[13]. In this particular case, the "the nightmare" consists of an unavoidably unpopular move, charging people for what has been free or for less than the opportunity cost of used resources. Our proposal for implementing charges associated both with scarce capacity and scarce durability is a natural economic response in answer to our two fundamental questions. The state of Québec public finances offers a golden opportunity to put in place a policy that shifts from reliance on fuel taxes and weight-graduated license fees to direct kilometreage charges steeply graduated with respect to axle loads. However, efficient pricing to regulate demand for highway services and efficient investment to minimize the total public and private cost of providing them should not be a way to increase taxes. Its implementation should necessarily be associated with a tax-reduction package, either on the provincial sales tax or on the personal income tax. Other short term political solutions, such as regulation to decrease the flow of traffic on some parts of the network, for instance, will postpone the adjustment process. As delayed intervention costs increase at an exponential rate, the financial burden will be higher for the taxpayers in the future. The time is now or never to break the loop!

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