Université de Montréal

Rapport de recherche

Assessing the impact of the Canadian tax credit for public transit passes

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Introduction

The government of Canada announced in the 2006 budget that it was introducing a Public Transit Tax credit (PTTC) for individuals purchasing monthly transit passes. The stated aim of this budgetary measure was to create an "incentive to use public transit (which) will help ease traffic congestion and improve the environment"(Canada Budget 2006). It was officially put in place the 1st of July 2006 and seems quite popular among taxpayers since it was claimed by almost a million and a half taxpayers two years after its implementation (Canada, 2012)

Given that it has now been six years since the tax-credit is implemented we find it necessary to question its impact. Did it effectively create an incentive to use public transport instead of car is the main question of our study. We do not discuss the benefits of privileging public transport versus private transport since it seems reasonable to us in a perspective of lowering carbon emissions and congestion. Our interest relies on the broader question of how to convince people to use public transport? Changing transportation behaviour implies obvious comfort cost for users, they lose the independence and the comfort the seat a car provides. Is the PTTC sufficient to encourage people to switch? Is the fiscal policy a useful tool for transportation position? We do not here pretend to answer all those questions but contribute to the debate using two type of studies. First we will determine if there was a significative change in public transit ridership due to the introduction of this tax credit, which corresponds to analyze the macro-demand for public transport. Second we will study the tax credit's impact on household expenses for public transport that is, we try to assess the impact of the tax credit at a micro-level. It is important to note that, due to its recent introduction, we cannot conclude about the long term impact of this policy, however we may find some good insights on the importance of it.

Section one provides the reader with an introduction to the debate of policy tools to encourage public transport use. Section two contextualizes the debate in the Canadian framework with a presentation of the PTTC. Section three describes the methodology of our study and section four gives the results.

Section 1: Literature review

Encouraging the use of public transit facilities has been a constant preoccupation of governments given the rise in urbanisation. Transportation demand management strategies all insists on the importance of promoting shared transport option, especially for peak time hours. Shared transport can help reduce traffic and thus facilitate commuting between city centers and residential areas. Another reason to encourage public transport is the environmental benefits it provides to society. We will first review the different forms of interventions and organization through the world and in Canada and then get insights of the determinants of public transport demand.

Government intervention and organization of public transport

A popular justification for government intervention in public transport is that it helps reducing the externality provoked by congestion. Solow (Solow, 1973) showed that the efficient mount of land to be used for transportation is a decreasing function of the distance to the city center: that is in practical term it would be efficient to build 9 lane highway in the middle of a city center! However this model does not take into account rigidities that could arise in the construction of new roads and railways, it is harder to be a Baron Haussmann (who implemented Paris' 'grands boulevards') or a Robert Moses (commonly referred as the master builder of New York City) today. If roads are not infinitely expandable, growth in use will cause congestion and thus each new driver will impose an external cost on others if there is no toll system (Solow, 1973). We could thus see a bus as an instrument to lower each driver's burden since it will help lower traffic and so lower congestion. If we push this argument to the extreme, an efficient bus service could help maintaining the status of public good we generally attribute to a road.

Another justification for government intervention in transport is the reduction in pollution it implies. Transport is a major contributor to gas emission; a note released by the European Federation of Transport and Environment estimates at almost 30% the contribution of transport to co2 emissions ("CO2 emissions from transport in the EU27 ", 2010). Although transit systems emit polluting gases, the individual contribution to the emissions per capita is significantly lower. Indeed, in a study of emissions in 84 cities, Kenworthy found that the share of public transport in total CO2 emissions per capita was under 50% for 80 cities and under 20% for 66 cities of its sample (Kenworthy, 2003). The international association of public transport records that the highest per-capita emissions are found in the cities were public transport is the least popular (UITP, 2011).

Considering the recent rise in oil and thus fuel prices, public transport seems more and more a viable solution to lower individuals' dependency on cars. But investments in order to make it a reliable option to cars are high. Mass transit systems should be fast and offers numerous destinations within the city. Traditionally economists concluded that it implies very high fixed cost and increasing return to scale ending up in natural monopolies, justifying government interventions for those systems. However recent research and

successful private public partnerships (PPP) put in doubt this belief (Berechman, 1993). Tokyo is the best example of PPP where there are three public operators and eight private. Routes are unique but as operators' station are near each other, they indeed compete to move people from point A to point B. Buses and trolleys are found to be less demanding in fixed investments and there exist numerous cities in the world where they are operated by private companies, the best known case is England where services have been deregulated in 1986 (Romilly, 2001) and it is common to see public buses run by cooperatives of bus drivers (known as 'Gremios') in South American countries. In Canadian metropolis, transit is provided by municipal operators when the borders of the city correspond to the area where population is living. In metropolis where administrative borders are not representative of population dispersion, it is often the case that there exist two separate municipal transit agencies which serve their respective cities and some connection points. The exception is the region of Vancouver where transit is provided by a provincial authority. We should also note that there exist Canadian municipalities where service is provided by private operators (Thompson MB, Corner Brook NL for instance).

Even if transit is mainly a local preoccupation it is not unusual to see the intervention of central governments in those matters which takes different forms worldwide. Transit system can be owned by central governments as it is the case in New York, Paris or Vancouver. However the main form of intervention from central government is by funding transit system in form of subsidies and investments. In Canada, provincial and municipal contribution to transit systems (through subsidies or emitting special debt for public transit operators) amounts to 37% of total operating costs, whereas passenger revenues represent 46,5%, (CUTA, 2011a). Federal and provincial governments are also main contributors to the capital expenditures of transit systems in Canada, federal and provincial contribution both accounts for a little bit more than 70% of capital expenditures. There are great differences in provinces ranging from 92% central government funding in Saskatchewan to 0% funding in Newfoundland and Labrador (CUTA, 2011a).

Finally, a less direct way of supporting public transport is by lowering the cost of travelling through tax relief for transit system user. This is the option chosen by the Canadian federal government throughout the tax credit for transit passes. The Canadian scheme is unique in the sense that only individuals can claim the tax credit. Similar tax relief policies in the USA, Holland or Ireland are such that both the employers and the employees receive a financial incentive in form of tax deduction under the condition that the employer provides the transit pass to the employee (Potter et al, 2006). In the US (IRS, 2011) and in Ireland (Citizens Information, 2009) employees receive a tax free voucher for public transportation and employers can claim this voucher as a salary which increases payroll and so lower total taxes. In the USA employers can even declare as a transportation fringe benefit the fact that employees use their bicycle to commute and car-sharing if organized through the employers (IRS, 2011). Indeed before the implementation of the tax credit for transit passes CUTA was supporting such a scheme similar to the American one for Canada (CUTA, 2005). Those policies are in line with the recommendation of the transit cooperative

research program (TRCP report 87) which insists on the necessity to integrate the employers in the effort of transport demand management Those tax relief actions are often more specifically aimed at commuters choosing to use transit system to go and leave work rather than just users of the transit system.

What influences the demand for public transport?

Taylor and Fink (Taylor & Fink, 2003) distinguished two kinds of analysis in transit literature. The first using survey data aims at describing transit for particular system. This literature insists on the importance of preferences and constraints with respect to travel options (fare, perception of service quality and quantity...) and neglects external factors which lead to the formation of those preferences. The second approach does exactly the contrary by insisting on those external factors (socio-economic factors, government policies, geographic factors). Some effort has been made to reconcile both approach but we can also note that the data available will also greatly influence the choices made by authors.

The first interest for public regulator is the incidence of fare on ridership as they are generally regulated by government agencies. Theoretically an increase in fare has two effects: a revenue effect and a substitution effect. The substitution effect to be considered here is that increasing the absolute cost of public transit will also lower the relative cost of using private car and thus it could lead to an increase in car use. If the direction of the change in ridership is known precaution should be the rule in assessing how big this change is. Most studies conclude that there is low fare elasticity even if they are quite variable if we consider different factors (city versus rural transport, peak and off peak demand, and purpose of the trip...) (Balcombe et al., 2004). This calls for a better understanding of non-price factors.

As we saw before, price does not seem to be the major determinant of the use of public transport. In fact the level of transit is much more affected by the choices that have been made on an urban level and by the demographic composition of population. Urban design has long been used as an explicative factor; the problem is that there is not a clear measure of it, especially in macro-measures. People move mainly from their residences to work and commercial zones; if those three zones are well differentiated it is straightforward to picture that the distance between those three zones is relevant for the analysis. However, in cities where the three zones are mixed up, it is not the distance but also the density which becomes relevant (Balcombe et al., 2004).

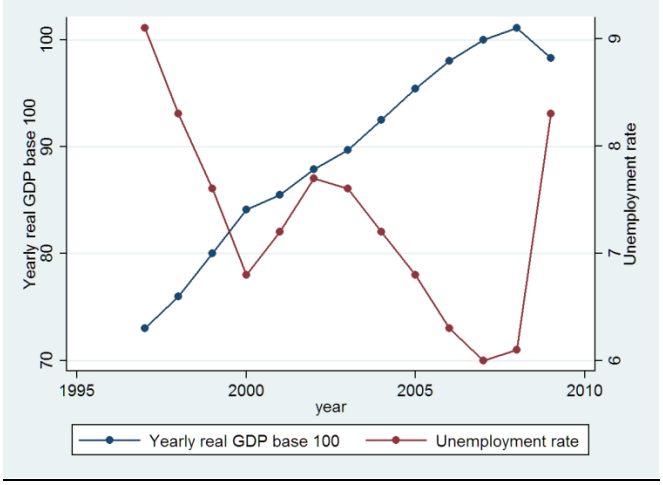
Last factor to take account for are economic factors and policies. As most trips are due to everyday commuting it makes sense that the economic situation be present in explicative variables. In fact there is a widely accepted view that transit is more dependent on the economic cycle than the use of private cars. Among economic factors unemployment seems to be a more reliable indicator that GDP per-capita (Taylor & Fink, 2003). Generally both indicators are included and analyzed separately. Finally, as most studies aims to determine if certain policies are efficient or not they are often added as binary variables in papers.

One classic paper about the role of subsidies is Romily's one (Romilly, 2001). He estimated time series equation, using panel data from England, and then calculated the impact of subsidies taking into account bus deregulation (as a dichotomic variable). Deregulation is found to provide welfare gains as soon as subsidies are reduced so that competition can effectively work . Thus, subsidies present to alter the possible welfare loss induced by potential monopolistic markets become a dead-end in deregulated market.

Section two: contextualization

Economic situation in Canada

Fig 1: GDP and unemployment rate in Canada, 1997 to 2009



Source: CANSIM table380-0102 - Gross domestic product indexes, annual (2007=100)
CANSIM table 109-5304-Unemployment rate

The first aspect we would like to study is the economic performance of Canada from 1997 to 2009 which is the range of the ridership study. In general we find that this period has been characterized by strong growth, except in the last year, 2009. As we can appreciate in Fig 1, the unemployment rate reached a low of 6% in 2007 and the real GDP grew constantly. The 2008 financial crisis, affected the Canadian economy in 2009 during which Canada entered into a recession, the unemployment rate hiked up to 8.5%, and the GDP decreased by 2%. We find that the recession was felt differently from provinces to province. We can see in the table 1 that the unemployment rate was higher in 2009 than in 2005 in all Canadian provinces except New Brunswick and Saskatchewan. The compound annual growth of the real GDP is quite stable around 1% per year in all provinces but Manitoba, which oversaw an impressive rate of 2.5% per year, and Ontario for which GDP growth from 2005 to 2009 is almost zero. Indeed, Ontario seems to be the most affected province and we attribute this to the high number of industrial foreclosure that followed the 2008 financial crisis in the USA. In addition to small growth we can see that the rise in unemployment during the same period is among the highest in Canada.

Table 1: Unemployment and GDP growth in Canada from 2005 to 2009

	Unemployment Rate 2005	**Unemployment Rate 2009**	**Real GDP growth**	**Real GDP compound annual growth rate**
Newfoundland and Labrador	15.2	15.4	1.9%	0.5%
Nova Scotia	8.4	9.2	4.8%	1.2%

	Unemployment Rate 2005	Unemployment Rate 2009	Real GDP growth	Real GDP compound annual growth rate
New Brunswick	9.7	8.9	4.1%	1.0%
Quebec	8.3	8.5	4.3%	1.1%
Ontario	6.6	9	0.2%	0.0%
Manitoba	4.8	5.2	10.4%	2.5%
Saskatchewan	5.1	4.8	2.4%	0.6%
Alberta	3.9	6.6	4.6%	1.1%
British Columbia	5.9	7.6	4.9%	1.2%

Source: GDP growth rate were calculated with data from table 380-0102 of Cansim. Unemployment rates are extracted from the table 109-5304 of Cansim.

Data from table 2 indicates us that between 2005 and 2009 household income, not adjusted for inflation has increased in all provinces. Increase in income for households located in urban areas is the slightest. Indeed, when we adjust income for inflation, using provincial Consumer prices indexes we see that the real income decreased between 2005 and 2009 for urban households. The prairies provinces, low urbanized province, were certainly the one which suffers the least during the recession. Indicators of household income (not adjusted for inflation) show us that there are the two provinces where it increased the most (+22.5% for Saskatchewan, +30.8% for Manitoba). These two provinces are also the one which saw the strongest growth in expenditures (not adjusted for inflation). Another interesting point is that in general, expenditure growth was twice higher in rural and peri-urban areas than in urban Canada.

Table 2: evolution of income and expenditures in Canada from 2005 to 2009

	Income (non-corrected for inflation)	Real Income	Expenditures
100,000 and over	9.3%	2.3%	5.8%
Under 100,000	17.3%	11.9%	12.7%
Rural	20.8%	13.4%	11.4%
Newfoundland and Labrador	16.1%	9.0%	10.7%
Nova Scotia	9.8%	2.7%	4.0%
New Brunswick	15.8%	9.5%	12.9%
Quebec	4.2%	-1.8%	4.6%

	Income (non-corrected for inflation)	Real Income	Expenditures
Ontario	7.0%	0.6%	2.0%
Manitoba	22.5%	14.4%	16.0%
Saskatchewan	30.8%	19.4%	24.7%
Alberta	12.5%	0.1%	9.4%
British Columbia	5.6%	-0.1%	1.0%

Source: Average means of household income and expenditures from Statistics Canada's survey of household expenditures of 2005 and 2009. Real income was calculated considering the provincial inflation rate derived from Cansim table 326-0021

The previous findings are a good indication of how the crisis was lived throughout Canada. In rural areas, the surge in commodities prices due to its strong demand worldwide created a relative economic boom compared to urban Canada which depends more of the US economic conditions (or less on worldwide demand for commodities). This is an important point for our analysis, since public transport in mainly used in urban areas we have to take a particular caution in analyzing its demand using timely data due to the consequences of worsening economic conditions. We also saw in the previous section that unemployment affects negatively ridership which we interpreted mostly to the drop in daily commuter trips. Then if we do not account for economic conditions, changes in time trend can simply reflect the effect of the economic crisis rather than a policy effect change.

Table3: Yearly PTTC claims and tax expenditures resulting from it

	Number of PTTC claims	Tax expenditure (millons)
2006	916525	45
2007	1276776	110
2008	1473046	135
2009	1502507***	140***
2010	-	145***
2011	-	150***

*Source: Tax expenditures and evaluation (Canada 2012). *** indicates that the number is an estimation or a prevision*

Table4: PTTC claims per provinces in 2008

	Number of PTTC claimants	Share of Total	Average amount of claim

	Number of PTTC claimants	Share of Total	Average amount of claim
Newfoundland and Labrador	3286	0.2	267
Prince Edward Island	221	0.0	339
Nova Scotia	18773	1.3	483
New Brunswick	3902	0.3	379
Quebec	443394	30.1	674
Ontario	557378	37.8	903
Manitoba	37638	2.6	454
Saskatchewan	17014	1.2	244
Alberta	176016	11.9	461
British Columbia	213613	14.5	603
Northwest Territories	348	0.0	297
Yukon	184	0.0	223
Nunavut	38	0.0	234

Source: Tax expenditures and evaluation (Canada 2012)

The PTTC is a non-refundable tax credit which amounts to 15% of yearly expenditures for transit passes. The claim a taxfiller does can also include spending of the other member of the family. Due to the fact that it is non-refundable, we can note that the poorest families, (those with income lower than the personal tax exemption) who are more prone to use public transit systems are not eligible. It certainly concerns few families but it is worth to mention that the incentive disappears for those.

The number of claimant for the credit tax however increased substantially from 916 525 in the year of its introduction to 1473046 in 2008 but preliminary report, indicate that the growth in the number of claimant was low for 2009 (Canada, 2012). The tax expenditure resulting from the PTTC is now approximated to be 150 million dollars per year (claimants receive 15% of the amount claimed) which does not even represent 1% of total tax expenditures (Canada 2012). The highest number of claimants is found in the most populated provinces, namely Ontario, Quebec, British Columbia and Alberta. Interestingly, the average amount claimed is higher for Ontario, Quebec and British-Columbia, this may due to the fact that urban sprawling obliges a lot of people to combine transit passes from different operators which increases their total commuting cost.

Fig 2: Evolution of Ridership since 1997 in Canadian provinces

Let us now have a panorama of the state of public transport in Canada from 1997 to 2009. We find in graph 2 that its evolution is pretty different from provinces to provinces. Alberta, British Columbia and Nova Scotia oversaw a high growth in ridership whether it was steady or almost null for other provinces. The inclusion of the PTTC, which is marked by the red line on Fig 2, does not seem to be associated with a difference in the pattern of evolution for any of the provinces.

Table 5: Evolution of transport prices in Canadian provinces from 2005 to 2009

	Increase in the Consumer price index from 2005 to 2009		**Evolution of the average fare of monthly transit pass**	**General; inflation from 2005 to 2009**
	Transport	**Public Transport**		
Newfoundland and Labrador	-2.88%	13.56%	15.70%	6.51%
Nova Scotia	-1.27%	6.94%	33.33%	6.93%
New Brunswick	-4.96%	16.06%	-12.56%	5.68%
Quebec	-0.44%	14.00%	14.25%	6.08%
Ontario	1.61%	13.23%	12.37%	6.36%
Manitoba	0.90%	11.08%	5.89%	7.04%
Saskatchewan	-3.43%	13.86%	7.42%	9.54%
Alberta	1.49%	22.30%	4.23%	12.40%
British Columbia	2.81%	10.72%	6.52%	5.64%

Source: The inflation rates are derived from Cansim table 326-0021. Average fares of monthly transit pass are provided by the Canadian Urban Transport Association (CUTA).

Transport inflation from 2005 to 2009 was lower than general inflation in all provinces mostly due to the effect of gas prices (table 7). Interestingly, the average fare for monthly

transit pass (expenses which can be claimed for the tax credit) have had much more variable paths across provinces from 2005 to 2009, from -12.6% in New Brunswick to +33.3% in Nova Scotia. The average increase is also lower for prairies and western Canada compared to Eastern Canada (except New Brunswick).

Table 6: Gross and relative expenditures for public Transport in Canada,2005-2009

	Average Household expenditures for public transport in 2009	**Evolution since 2005**	**Ratio of public transport expenditures on the total of transportation expenditures of households**	**Evolution since 2005**
100,000 and over	1065.06	13.2%	24.53%	1.5%
Under 100,000	967.4803	30.5%	19.11%	-2.5%
Rural	362.4636	7.7%	8.58%	-5.8%
Newfoundland and Labrador	630.9509	1.0%	18.66%	-0.6%
Nova Scotia	608.5608	8.9%	18.57%	1.8%
New Brunswick	436.1176	19.2%	10.99%	-11.3%
Quebec	635.3035	26.0%	22.18%	5.7%
Ontario	995.4509	0.0%	22.00%	-2.7%
Manitoba	816.3663	22.3%	19.81%	-4.6%
Saskatchewan	692.1045	40.4%	13.94%	-4.7%
Alberta	1101.499	20.1%	20.48%	-1.4%
British Columbia	1154.105	11.8%	25.23%	12.1%

Source: Average means of household income and expenditures from Statistics Canada's survey of household expenditures of 2005 and 2009.

Tabe 6 gives us an overview of the evolution of expenditures for public transport in Canada, we can see that variations are wide. Alberta and Saskatchewan are the provinces spending the most in transport but Saskatchewan's inhabitants are also among the least prone to use public transport as we can see that the ratio of public transport expenditures on transport expenditures is the second lowest in Canada. Ontario has a very slow increase which can be linked to the previous findings that the recession was stronger in this province which certainly lowered the demand for transportation. On the contrary, more favourable economic conditions for Manitoba and Saskatchewan are associated with huge increases in public transport expenditures. It is to be noted that for those two provinces a low inflation rate for transport in general implied a decrease in the ratio of public transport expenditures. In Québec and British Colombia, the increase for public transport

expenditures is bigger relatively to transport expenditures' increase whether in the Maritimes both increases tend to be similar which does not affect the overall ratio. Peri-urban zones are the one were expenditures for public transport raised the most but they decreased relatively to total transport expenditures, again this may be due to a higher inflation of public transport relatively to car-transport.

Variables

The policy change implemented in 2006 will be represented by a binary variable. Preliminary findings indicate that it is hard to conclude about the evolution of the economic situation in whole Canada from 2005 to 2009 due to the structural differences of each province economy. Rural areas and prairies provinces seem to have gone softly throughout recessions, especially when compared to urban areas. The transport choices, reflected by relative expenditures of each mode, are very different from provinces to provinces and, as for the economic conditions; we cannot define a general pattern for all Canada. Since we don't want a yearly identification variable (which would reflect the policy change we want to study) to be taken as a proxy for the economic crisis we should ensure that our sample will be composed entirely by urban and fully employed workers. Provincial aspects of public transport choices lead us to conduct robustness checks to determine if a general conclusion obtained from an aggregated Canadian sample can be extrapolated for each province.

We include various controls to make sure we determine correctly the effect of the tax credit. First, we include variables aimed at capturing the economic conditions prevailing in the province or for the households. We saw previously that the 2008 global recession affected Canada but had different consequences from provinces to provinces. Mainly we use the revenue effect and the situation in the labour market to capture those differences. Secondly we control for two price effect, direct price effect by including the price consumer face for public transport and substitution effect by controlling for potential substitution with cars. A third variable commonly used in studies concerns the access to public transport, in the ridership estimation we derive it through a measure of service quality for provinces whether in the expenses estimation we use spatial location of households.

Demographic composition can also play a role in explaining urban transport demand. Studies of fares impact found that elasticity vary for different type of travelers (Balcombe et al, 2004). We can think that the presence or not of elders and students implies a more or less extended service as they are populations more prone to use public transit due to the reduced access to cars and mobility problems. We think that including those variables in our estimation then becomes necessary.

Table 7: Control variables and expected sign

Varaible's description	Proxy used in ridership analysis	Proxy used in expenses analysis	Expected sign of β
Income effect	Logarithm of the GDP per capita	Total income declared by the household deflated using provincial CPI	Positive
Situation in the labor market	Unemployment rate	Not taken into account since we use a sample of regular workers	Negative
Substitution effect with car	Consumer price index for gas	Number of vehicle Owned or leased	Negative
Price effect	Consumer price for public transport	We do not use directly a price variable but indeed deflate expenses.	Negative
Demographic control	Number of inhabitants of each province	Household composition, couple, children…	Positive since more population implies more transit
Number of students	Student population of each province	Number of youth age 18 to 24	Negative since students have a reduced access to cars
Number of elders	Population aged 65 and more	Number of seniors	Uncertain since elders live in more areas closer to services but also better deserved by public transport but they may prefer the comfort of a car
Number of young	Not taken into account	Number of children aged 0 to 4 and number of children aged 5 to17	Negative since families prefer using a car when moving with kids
Access to transport	Ratio of operation's hours of commercial vehicle to the number of commercial vehicles	Type of Dwelling the household lives in	Positive
Budget for transportation	Not taken into acount	Total expenses of a household for transport deflated using the Consumer price index for public transport	Uncertain

Section three: Empirical models

The analysis of the PTTC impact consists in assessing the sign and significance γ in the following equation:

$$y = X\beta + \gamma CreditTax + \epsilon_i$$

Where y will be the annual number of rides or the expenses for public transport. $CreditTax$ is a binary variable taking the value 1 if the year corresponds to a one for which the PTTC was in application. We will now review the estimation techniques in the two studies.

Ridership

We need to test for potential bias due to the stationarity of the time series we are analyzing. There are two cases arising in non stationarity of time series: trend and unit-root processes. If the presence of a yearly trend is quite easy to verify and correct for (OLS estimators associated to the year measure are super-convergent), unit root tests are much more complicated, especially in the context of panel data. We decided to test using two common statistics proposed respectively by Levin-Lin Chu (LLC thereafter) (Levin et al, 2002) and Im Pesaran Shin (IPS thereafter) (Im et al, 2003). The results can be found in table 2 of the annex.

We can see that results are very different for the variable of interest (number of rides) if we include or not a time trend. However we remark that the inclusion of a time trend lowers considerably the p-value associated with the statistic calculated. We can thus reasonably consider that the process does not have a unit root. Indeed this reasoning can be applied for the prices and GDP per capita series, even if as a precaution we should note that the p-values estimated by the IPS tests are quite high (33,34% and 38,69%) so we will consider two estimations one taking into account the possibility of unit-root and the other not. Considering the demographic variables we clearly see that they have a unit root as the p-value is often nearby one.

In order to correct for the presence of unit root we decided to include the variable in first differences, which is a common way to deal with the problem. We thus have to estimates the different equations

$$Rides_{it} = \beta_0 + \beta_1 lnCapGDP_{it} + \beta_2 Unemployment_{it} + \beta_3 ltCPI_{it} + \beta_4 gasCPI_{it} + \Delta(demographic_{it})\Gamma_d + \beta_5 ServQuality_{it} + \gamma CreditTax + \delta t + \epsilon_{it}$$

$$Rides_{it} = \beta_0 + \beta_1 \Delta(lnCapGDP_{it}) + \beta_2 Unemployment_{it} + \beta_3 \Delta(ltCPI_{it}) + \beta_4 gasCPI_{it} + \Delta(demographic_{it})\Gamma_d + \beta_5 ServQuality_{it} + \gamma CreditTax + \delta t + \epsilon_{it}$$

Where γ is the coefficient of interest and Δ is the operator for first differences, $lncapGDP_{it}$ is the natural logarithm of the per capita GDP, $ltCPI_{it}$ corresponds to the

local transport Consumer Price Index and$demographic_{it}$is a vector of the population level including also students and seniors' population level.

For our two estimations we have to take account of problems affecting the error term ϵ_{it}. We can classify those problems in two, first the possible heterogeneity effects, fixed effect and heteroskedasticity. Secondly we should take special precautions in order to avoid the inter-temporal and inter-individuals correlations. We have been processing the tests following this structure. The results can be found in table 3 of the annex.

Fixed effect models are used when, for each province in the sample the individual unobserved particularity is correlated with the explicative terms. For instance, in the regression estimated we could imagine that the unobserved economic structure has an incidence on the per-capita GDP and unemployment. Alternatively we could consider those individual effects to be uncorrelated with explicative variables; this is the random effect model. We proceed to a Hausman test following Greene's recommendation (Greene & Zhang, 2003), under the null hypothesis the covariance between the coefficients is zero and there is no efficiency gain from one estimation measure to another. We reject this hypothesis and conclude that we should take account of possible correlation between the error term and the explicative variables. The test for heteroskedasticity is a traditional Fisher test between the residuals and the explicative variables. We also reject the null hypothesis (no heteroskedasticity) so some correction need to be applied in the variance estimation of coefficients.

The previous tests were done in order to estimate possible miscalculation in the variance estimation due to the intrinsic characteristics of the individuals, being measured or not by the explicative variables. We now try to evaluate if our estimation procedure should take account of cross-correlation throughout individuals or throughout time. To test for bias sourcing from inter-individual correlation, that is, a bias due to the fact that contemporaneous shocks for two different provinces are correlated, we use a Breusch Pagan test (Greene & Zhang, 2003). The test for inter-temporal correlation, correlation arising when shocks propagate throughout time is done using a Wald test. For both test we obtain a p-value of zero which leads us to conclude that inter-temporal and inter-individual correlations are present and thus we should control for it in the estimation.

The results calls for a generalized least square estimation of both models presented in section 3. This can be easily done via the software Stata. The error term which we model for the estimation is then:

$$\epsilon_{i,t} = \rho_i \epsilon_{i,t-1} + \nu_{i,t}$$

Where $\nu_{i,t}$ is a white noise following a normal distribution. Also, since we assume inter-individual correlation we have $E(\epsilon_{i,t}, \epsilon_{j,t}) \neq 0$ and heteroskedasticity means

that $E(\epsilon_{i,t}|X_{i,t}) = \sigma_{i,t}\mathbf{I}$ where $X_{i,t}$ is the vector of explicative variables. Let's note that ρ_i can be assumed to be different for each province or be the same. There is no clear test for our decision and so we will report the results with both assumptions which we would denote province specific ar(1) (psar1) regressions if we consider ρ_i or ar(1) regressions if we consider only one ρ

Expenses

We try to assess the impact of tax credit on household's expenditures for public transport. Our data comes from the Canadian Survey of Household Spending of 2005 and 2009, restricting our sample to urban population so as to assess particularly the policy change consequences on the targeted population (urban population have a much better access to public transport than rural population)

Since we wish a yearly binary variable to represent uniquely the change of policy introduced by the Canadian government we try to eliminate any potential noise, the most important being the economic changes. We thus restrict our sample to fully employed individuals in 2005 and 2009. Our definition of employed is very strict since we only consider households where respondent and spouse both declared full time job for 52 weeks but it still allows for a large sample of 4428 observations. Finally another precautionary measure is to deflate the expenditures considering each particular consumer price index (CPI) category. That is, income is deflated using the provincial inflation rate calculated as the percentage change in the general CPI while transport expenditure will be deflated using provincial inflation rate of transportation CPI.

The first equation we estimate takes the form:

$$PT_i = X_i\beta + \gamma y2009_i + Z_i\theta + u_i$$

Where PT_i is the real expenditude on public transport for household i, X_i is a vector of the household real income, . Z_i is a vector of household demographic characteristics and access to cars. $y09_i$ is binary variable taking the value 1 if the household was interogated in 2009 so able to claim a tax credit for his expenses in public transit passes and 0 if not.

A second model we estimate is:

$$PT_i = X_i\beta + \gamma_1 y2009_i + \gamma_2 y09_i * Province + \gamma_3 y09 * Dwelling + Z_i\theta + u_i$$

So as to assess if the change in policy affected differently considering provinces and dwelling types which are a proxy for location in more dense areas (apartments are more prone to be situated in crowded areas where there is better access to public transit systems).

Finally we also estimate a third model:

$$\log(PT_i) = \log(X_i)\,\beta + \gamma_1 Year2009_i + Z_i\theta + u_i$$

So that the β coefficients represent the elasticity to income and the transport budget elasticity

The coefficients and variances estimation are calculated in a way that it takes into account the relative weight of each household in the original population since some type of households may be over-represented in the surveys. The weights we use are provided by Statistics Canada and corresponds to the estimated number of actual households a sampled household represents (Statistics Canada, 2007 2011).

Section 3: results

Ridership

Table 4 in annex shows us the results for the different regression runs. The first observation we can make is that the method of estimation changes greatly some coefficients and their robustness. This should lead us to some precaution in our interpretation. However, we note that the more robust coefficients, the one for which the p-value is almost constantly under 5%, are the ones for which their value do not change much in the different regression. In this section we will try to answer the different questions we developed previously. First we can find in the following tables the estimated daily increase in travelers if some variables were to be changed using two scenarios: the commuter one (245 days per year) and the everyday travel one (365 days per year). Those results have to be taken with precaution because, some of the coefficients on which are they are based are statistically non-significative. Reg 1 is the basic regression, while reg 2 is the regression using first differences for the per capita GDP and transport CPI. The data used for the calculations of effects are the coefficients estimated which can be found in table 3 of the annex.

Table 8: Estimated daily increase of travels under scenario 1 (commuters)

	reg1	**reg2**	**reg1ar1**	**reg2ar1**	**reg1psar1**	**reg2psar1**
1% increase						
GDPcapita	-75934.0	-484649.3	72976.9	15532.7	112115.1	41517.3
Unemployment	6640.4	9537.1	-3446.0	-4931.5	-6126.0	-5915.7
1 unit increase						
CPI transport	-1410.7	-818.4	-2464.0	-2448.5	-2864.6	-3108.1
CPI gas	1068.1	1209.8	-392.7	110.0	-240.3	-47.7
service quality	1843.6	1718.2	1779.5	2111.2	-91.6	2209.4
Student population	1.3	1.5	0.6	0.5	1.5	1.9
Elders population	8.6	9.0	31.6	30.7	35.0	36.3

Table 9: Estimated daily increase of travels under scenario 2 (everyday travelers)

	reg1	**reg2**	**reg1ar1**	**reg2ar1**	**reg1psar1**	**reg2psar1**
1% increase						

GDPcapita	-50969.4	-325312.6	48984.5	10426.0	75255.3	27867.8
Unemployment	4457.2	6401.6	-2313.1	-3310.2	-4112.0	-3970.8
1 unit increase						
CPI transport	-946.9	-549.3	-1653.9	-1643.5	-1922.8	-2086.3
CPI gas	716.9	812.0	-263.6	73.8	-161.3	-32.0
service quality	1237.5	1153.3	1194.5	1417.1	-61.5	1483.0
Student population	0.9	1.0	0.4	0.3	1.0	1.3
Elders population	5.7	6.0	21.2	20.6	23.5	24.3

Does the tax credit tax have an impact?

Table 10: Coefficients associated to the PTTC in the ridership equations

reg1	reg2	reg1ar1	reg2ar1	reg1psar1	reg2psar1
-4262164	-6134546	-116974	-5712275	-965963	-3169393

Legend: *** indicates that the coefficient is significant at 1%, ** indicates that the coefficient is significant at 5%, * indicates that the coefficient is significant at 10%.

We find no impact of the tax credit on the annual ridership in Canada. The coefficients are remarkably non-significative in each regression so that it is impossible to conclude that ridership on public transit has been influenced by the Canadian policy. The rise in the number of demands by taxpayers therefore seems to be due more to better awareness about the tax-credit possibility by Canadians who are already users of public transport than a change in the behaviour. This can be corroborated by the fact that the number of claims increased considerably from 2006 to 2007 but was just around 2% higher in 2009 than in 2008 .Let's remark that the sing of the coefficient is always negative. So the credit tax would have had a negative impact on ridership which is quite counter-intuitive. As we measured the policy change through a binary variable however we could think that this variable would reflect more economic disturbance than only the policy change. We will get more detail of this possibility in the next section.

Is public transit a substitute for car?

It seems that gas prices are not a strong explicative factor of public transit use in Canada. It is true that in the most basic regression which does not take account of any possible disturbances, we observe that the coefficients associated with the CPI

of gas are significative. They are positive and indicate quite a big impact as an increase of the price of gas would add around 1500 travels per day (in the 365 days scenario). However it is important to note that in those regressions we observe that the CPI of public local transport is non-significative, which is quite un-intuitive. Now, when we take account of possible disturbances in the error term we get a totally reversed panorama. First, the coefficient on the gas CPI is never robust at 5% whereas the coefficient for the public transport CPI (in a differentiated form or not) are always greatly significant. Furthermore, the impact of the price of public transport is quantitatively almost the same in each regression: around 3000 to 4000 travels per day are lost due to a public transport price increase. We think that those numbers are more representative of the gross impact of price. First, it is hard to consider public transport travel as a perfect substitute for car transport on a short term as choices in the area of transportation are greatly influenced by actual conditions of living (suburban house versus downtown apartment, owing a car or not…). Second, we cannot conclude that gas price is the unique factor which influences the decision to take the car or not, people can still prefer to have a seat for sure in their car rather than standing in a bus even if gas is expensive. Finally the scope of the impact is not impressive, if we consider that people work 245 days per year and that their use of public transport is mostly for commuting between work and home, then and decrease in the price adds around 2 500 commuters per day in buses and light rail trains which is a less important number than for unemployment for instance.

Other factors

We discussed previously various factors which could influence the use or not of public transit, we distinguished economic and non-economic factors. The sign of the coefficient associated with those indicators are generally intuitive but we should take some caution in interpreting the quantitative number as it would be quite unreasonable to suppose that 'everything holds constant'. For instance, we cannot suppose that the unemployment increases and the rate of growth of GDP holds constant.

First, economic conditions seems to be an important explicative factor for the use of public transport, the unemployment rate has a negative impact while growth of GDP has a positive impact. That is to say, growth encourages the use of public transport, it also provides more job to the economy which again encourages public transport use. However, we can note that if the coefficients attached to the measure of GDP growth are quantitatively higher than the one attached to unemployment, they range from large to low value. Furthermore, considering the possible unit-root problems, we find that it would be more informative to look at the coefficient attached to the differentiated vector. There, we find that only one coefficient is significant and we even have a negative coefficient on the first basic regression. On

the other hand, the unemployment rate coefficient, once the regressions are corrected for the error term, keeps the same sign and quite a constant value. These findings are consistent with the literature (Taylor & Fink, 2003) which insists on the commuting aspect of public transport, therefore, less employment means that less people need to go from home to a job. In our model, one point of percentage less of unemployment could add between 3500 to 6000 commuters a day per province.

Demographic and urban factors also play a role in explaining public transport. The coefficients on service quality measure and senior population are in the majority of regression significative and their sign is positive.[1] So it seems that the demographic composition of population matters, as the investment on the expansion of network. We also constantly find a positive impact of student population even if the intensity of it is mitigated by the un-stability of its value.

Results Expenses

Table 11: Coefficients of γ's in basic regression

	Basic	**Basic Regression Considering only apartment households**	**Basic regression without budget for transport**	**Interaction with provinces**	**Interaction with provinces considering only apartment household**	**Interaction with provinces without budget for transportation**
year2009	-134.68143**	-364.76456***	-135.57237**	-47.254798	196.29645	-60.051667
			Interaction of Year 2009 with provinces			
NL				-166.39107	-78.818302	-111.4774
NS				244.0084	-272.5068	244.16519
NB				-86.343267	200.49667	-56.912489
QC				80.861151	-201.6463	82.437269
ON				-181.17035	-744.46565**	-222.68355
MB				-247.5005	-543.96343*	-249.83142
SK				196.20961	-149.344	267.05989
AL				8.0181044	-164.01283	47.549623

[1] The only divergence to this observation is on regression 1 with province specific ar(1) errors where the coefficient for service quality is negative but there we should remark that it is not significative.

Legend: *** indicates that the coefficient is significant at 1%, ** indicates that the coefficient is significant at 5%, * indicates that the coefficient is significant at 10%.

Table 12: Coefficients of γ's in log regression

	Basic	**Basic Regression Considering only apartment households**	**Basic regression without budget for transport**	**Interaction with provinces**	**Interaction with provinces considering only apartment household**	**Interaction with provinces without budget for transportation**
year2009	-0.08511101	-.19842773**	-0.10091873	-0.12505505	0.20268725	-0.1561017
Interaction of Year 2009 with provinces						
NL				-0.16820961	0.93686374	-0.08459458
NS				0.12749118	-0.42591413	0.15056653
NB				-0.16303776	0.74434466	-0.08159735
QC				-0.16803205	-0.0748352	-0.18223856
ON				-0.12993551	-0.34449033	-0.20805238
MB				-0.32925349	-0.16401923	-0.3289749
SK				0.14849649	-0.06969351	0.25913006
AL				-0.12472777	0.15830274	-0.06980926

Legend: *** indicates that the coefficient is significant at 1%, ** indicates that the coefficient is significant at 5%, * indicates that the coefficient is significant at 10%.

What is the effect of the tax credit?

We do not find an evidence of impact for the tax credit in the demand for public transport in Canada. In both expenses and log regressions, the coefficients associated to the binary time variable are negative and both coefficient are non-significant when we consider a level of 99%. However we should note that in the expenses regression the coefficient is significative at a 95% confidence level. This difference however should be taken cautiously since we have seen previously that a binary time variable could also be a proxy for crisis effect. This doubt about the true nature of the binary variable is re-inforced by the fact that the coefficient is negative which would imply that if we consider the yearly variable to represent only the change in policy from the federal government then subsiding consumption of public transport leads to a decrease in real expenditures for it.

If we relax the assumption that our variable only takes into account policy change then a negative coefficient could be plausible. When describing the situation of public transport within Canada we saw that the price of public transport raised more compared to the price of general transport, changing then the relative price of public versus car transport. The real expenditures of public transport decreasing while we control for real income (therefore controlling for revenue effect) could be the reflection of the negative substitution effect. If this would be true then the tax credit simply does not provide sufficient incentives for consumer to increase their demand for public transport.

However, in other regressions (log-regressions or regressions considering interaction between variables we see that the yearly variable is insignificant (the p-value is higher than 20%) which comfort our suspicion that the tax credit does not offer a sufficient incentive for people to use more public transport than their personal car. To check the robustness of our conclusion and assess if there is not an indirect impact due to changes in behaviour of consumers we ran a structural Chow test. We ran regressions in sub-sample of 2005 and 2009 under the null hypothesis that the change in policy did not have any structural effect we have $\beta^{05} = \beta^{09}, \theta^{05} = \theta^{09}$. We compute the Chow statistics which is to be compared with the critical value of the Fisher distribution with degrees of freedom (4428, 33). The statistic of 1.51 is higher than the 5% critical value but lower than the 2.5% critical value. Again this is not a sufficiently strong evidence to conclude indoubtly that the differences between 2005 and 2009 (which include the policy change) have an impact in transport expenditures.

In addition we ran a model (basic and log-model) which excluded the budget for transport and a model limited to the households who are living in apartments. As previously, we find a negative sign for the coefficient associated to the yearly variable. This coefficient is 5% significative in the non-interacted expenditure regressions such as in the log regression considering only households living in apartments. In the regression where we interact the yearly variable with provinces we find a significative negative sign of the interacted term only for Ontario and Manitoba. Again we think that this result is due to the fact that our variable does not capture only the policy change but also some economic disturbance effects. If we accept this theory it gives sense that the significant effect is observed for the Ontario and Manitoba since they were the most variable provinces.

We can conclude arguing that the credit tax per-se did not have a real impact in public transport demand for Canadian individuals. In the regressions we ran where the impact of the tax was significant we actually found a negative impact which we interpret as the identification of a potential substitution effect since relative prices of public transport to general transportation actually increased. It is however to be

noted that those cases were found on very few estimations and that none the t-stat for the coefficients nor the Chow statistic were higher than the 2,5% critical value.

Other variables taken into consideration

Let us now concentrates on the other determinants for public transport expenditure. We will first study the monetary aspect (income and general transport budget) then study the other determinants.

Table 12: Coefficients for selected determinants of transport expenditure

	Basic	**Basic Regression Considering only apartment households**	**Basic regression without budget for transport**	**Interaction with provinces**	**Interaction with provinces considering only apartment household**	**Interaction with provinces without budget for transportation**
Real Income	.00979106***	.02125195***	.01147101***	.00959388***	.02064194***	.01124768***
Square of the real income	-7.79E-09	-4.385e-08***	-9.78E-09	-7.28E-09	-4.262e-08***	-9.23E-09
Budget for transport	.0233599***	.03409897***		.02353108***	.03556212***	
Vehicle Owned	-537.61372***	-1007.0661***	-426.4491***	-539.32821***	-1022.3096***	-426.40355***
Vehicle Leased	-716.72374***	-1217.8009***	-544.6973***	-712.85387***	-1164.5966***	-542.97022***
Semi Detached house	394.02926**		410.2506**	447.19652**		405.00149*
Terraced house	354.88833**		379.30566**	447.74702**		465.96173**
Duplex	113.98856		109.55932	178.34898		149.40288
Apartment	424.04762***		456.06892***	556.16061***		562.48834***
Hotel/Mobile home	493.08971*		501.98523*	431.63213*		428.01912*

Legend: *** indicates that the coefficient is significant at 1%, ** indicates that the coefficient is significant at 5%, * indicates that the coefficient is significant at 10%.

Table 13: Coefficients for selected determinants of transport expenditure in log regressions

	Basic	**Basic Regression Considering only apartment households**	**Basic regression without budget for transport**	**Interaction with provinces**	**Interaction with provinces considering only apartment household**	**Interaction with provinces without budget for transportation**
Real Income	.29235826**	.62462799**	.64176914***	.28165259**	.96835691**	.62276805***
Square of the real income	1.82E-07	-2.52E-07	6.09E-08	1.87E-07	-3.75E-07	6.77E-08
Budget for	.39960641***	.61868034***		.40047566***		

	Basic	Basic Regression Considering only apartment households	Basic regression without budget for transport	Interaction with provinces	Interaction with provinces considering only apartment household	Interaction with provinces without budget for transportation
transport						
Vehicle Owned	-.66731657***	-1.572676***	-.4445282***	-.66800758***	-.99861536***	-.44286414***
Vehicle Leased	-.9204531***	-1.7770178***	-.51856505***	-.9211077***	-.93326166***	-.51988929***
Semi Detached house	0.24521348		0.25637735	.41254977*		0.35111248
Terraced house	.23057235*		.29065017**	0.28250001		.30770803*
Duplex	0.11098986		0.16126578	0.1108673		0.11318008
Apartment	.40064772***		.44724496***	.39261107**		.41377793**
Hotel/Mobile home	.58390404*		.57359741*	.7843349**		.75347221**

Legend: *** indicates that the coefficient is significant at 1%, ** indicates that the coefficient is significant at 5%, * indicates that the coefficient is significant at 10%.

Both real income and real total expenditures for transport have a significant and positive impact on public transport expenditures. We do not observe a significant impact for squared income neither do we find that the elasticity of public transport expenditures is function of real income. It indicates us that the relation is quite linear for household. Being wealthier increases the demand for mobility which then implies more expenditure for public transport. We should however note that the marginal effects are quite small (mot higher than 1.5 cents in general and provincial regressions) and, the elasticity to income being lower than one, then public transport is then a necessary good rather than a luxury good (Deaton 1997, chapter 4). This is confirmed when we look at the impact of raising the budget for transportation, one more dollar for transportation just increases by 2 cents the expenditures in public transport.

It them seems that preferences in transportation are still mostly car oriented and that public transportation is seen as a "cheap" way of traveling rather than a reliable alternative in transportation modes. Indeed, we can observe that, controlling for transport expenditures, owing a car imply an average $537 decrease in public transport expenditures while leasing is associated with a $715 decrease. In average, owing a car decreases by around 60% the expenditures in public transport and leasing induces a reduction of 70%. Theses drops would imply that the share of public transportation in transport expenditures is reduced to almost nothing, confirming the predominance of car-preference in Canadian mobility scheme.

The type of dwelling is mostly a measure of spatial location of household so the coefficients on dwellings more associated with higher urban densities (and probably more access to public transport since they are very much centrally oriented) are also

the more prone to spend for public transport. Those findings are to be linked with our results in section 3 where we found that the quality of service, measure as the number of vehicle per kilometer of network, was a strong explicative factor of ridership. In annex we can find the coefficients for demographic coefficients which are expected given results in section three. Young children in the family, requiring more mobility from parents (outdoor activities, in and out school transportation...) imply a lesser share for public transport. On the other hand the presence of teenagers, young adults and seniors, population which are not able to drive due to economic or mobility constraints but sufficiently old to move by themselves, increase household share of public transport.

Conclusion

The aim of this study was to determine if the Canadian tax credit on monthly passes has been a useful explicative factor of ridership evolution and household expenditures for public transport from 2005 to 2009. We found that Canada is no different than other countries and that the main determinants of demands are: economic conditions, specially the unemployment rate; urban design such as the type of dwelling or the quality of service and the access to a car. Demographic variable plays a significant role which we attribute as the consequence of the limited mobility of certain populations.

The PTTC, did not seem to have a significative impact on both the ridership and demand equation. We think that this can be because federal government policy toward public transport is incomplete without encouraging companies to incent their employees to use shared transport option for commuting. For now the tax credit is more a tax present to transit users rather than a policy which changes the behaviour of commuters. Perhaps the federal government would get a better cost-benefit intervention if it dedicated more finance to infrastructure projects rather than try to incentive people through fiscal policy. One important thing our study did was to picture the big differences in public transport policy in each province and we believe that those differences call for a more specific rather than a unilateral approach for each province from the Canadian federal government.

We found that car is not a perfect substitute since price of private transportation play a little role in ridership explanation. However, at a micro-economic level we found that having access to a car significantly lower the expenses dedicated to public transportation. We believe that this reflects the fact that public transportation is still viewed as a non-desirable good and that Canadian still prefer car in lieu of shared transportation. Therefore it is understandable that private transportation cost would not affect demand for public transport since consumer behaves such that public transportation is not a sufficiently good substitute of private transportation.

Furthermore, if the objective of the Canadian tax exemption was to reduce car usage, we should note that public transit is still heavily centralized (downtown-suburbs) whereas more and more commuting is done in suburbs.. For instance, in Montreal, the metropolitan community observes a tendency for suburban population to commute inside their suburban region rather than to central Montreal (CMM, 2012).This is certainly a factor that has to be taken account in federal actions encouraging the use of public transport. One extension to this study could be to analyze the patterns of traffics before and after the implementation of the federal tax credit for transit passes.

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Table 1 : Data used

Variable's name	Varaible's description	Source	Used in Ridership analysis	Used in expenses analysis
lnpib_capita	Logarithm of the GDP of each province divided by number of inhabitants	CANSIM 384-0001 for provincial GDP GDP	Yes	No
ipc_essence	Consumer price index for gas	CANSIM 326-0021	Yes	No
ipc_transportlocal	public transport	CANSIM 326-0021	Yes	Yes (to deflate public transport expenses)
population	Number of inhabitants of each province	CANSIM 051-0001	Yes	No
Popetudiante	Student population of each province	CANSIM 477-0013	yes	No
Vieux	Population aged 65 and more	CANSIM 051-0001	Yes	No
Service Quality	Ratio of operation's hours of comercial vehicle to the number of comercial vehicles	CUTA-ACTU	Yes	No
realk031bis	Total expenses of a household for public tranpsport deflated using the Consumer price index for public transport	Expenses are declared in the Survey of household expenditures and the CPI come from CANSIM 326-0021	No	Yes
realincome	Total income declared by the household deflated using provincial CPI	Income is declared in the Survey of household expenditures and the CPI come from CANSIM 326-0021	No	Yes
realk001	Total expenses of a household for tranpsport deflated using the Consumer price index for public transport	Expenses are declared in the Survey of household expenditures and the CPI come from CANSIM 326-0021	No	Yes
year2009	Binary indicating if the household has been interviewed in 2009		No	Yes
nmvehonp	Number of vehicle Owned	Survey of households Expenditures	No	Yes
vehleasp	Number of vehicle Leased	Declared by household in the Survey of households Expenditures	No	Yes
typdwelp	Type of Dwelling the household lives in. 1 are single detached dwellings, 2 are semi-detached. 3 are Row dwellings. 4 are duplex. 5 are apartments. 6 are hotels or mobile home.	Survey of Household expenditures	No	Yes
hhtypep	Household Type. 1 is a household	Survey of Household	No	Yes

Variable's name	Varaible's description	Source	Used in Ridership analysis	Used in expenses analysis
	with one person. 2 is a couple. 3 is a couple with single children. 4 is a couple with relatives. 5 are lone parents. 6 and 7 are other type of households.	expenditures		
i.child0to4	Number of children aged 0 to 4	Survey of Household expenditures	No	Yes
i.child5to17	Number of children aged 5 to 17	Survey of Household expenditures	No	Yes
i.seniors65	Number of seniors	Survey of Household expenditures	No	Yes
i.youth18to24	Number of youth age 18 to 24	Survey of Household expenditures	No	Yes

Table 2 : results of Unit root tests

Unit root tests

P-value for H0: panels have a unit root

	llc	ips	test controls
tvel qtity	0	0.0773	const, trend
tvel qtity	0.881	0.9997	const
lnpib capita	0.0497	0.8226	const, trend
lnpib capita	0	0.4165	const
taux chomage	0.0071	0	const
ipc_tsport local	0.0039	0.3869	const, trend
ipc essence	0.024	0.0067	const, trend
population	0.9577	1	const, trend
popetudiante	0.5278	0.9847	const, trend
vieux	1	1	const, trend

Table 3: results of errors misspecification tests (p-values in italic)

	Regressions	
	No First Differences	*First differences*
Fixed Effect	49.28	63.92
Hausman Test	*0.00*	*0.00*
Heteroskedasticity	34.2	29.71
Fisher Test	*0.00*	*0.00*
Intra-individual	114.882	106.493

	Regressions	
	No First Differences	*First differences*
Correlation		
Breusch Pagan Test	*0.00*	*0.00*
Intertemporal correlation	340000	78694.22
Wald Test	*0.00*	*0.00*

Table 4 : Results of the regressions ran for the ridership analysis

Variable	reg1	reg2	reg1ar1	reg2ar1	reg1psar1	reg2psar1
year	3358444.8	-1302917.7	-114555.73***	-2838491.4***	-189778.72***	-4412095.7***
lnpib_capita	-37207684***		35758703***		54936381***	
ipc_tsport~l	-691241.9		-1207366.9***		-1403632.7***	
ipc_essence	523354.65***	592786.08***	-192415.11**	53879.397	-117761.91	-23394.394
taux_chomage	3253772.7*	4673167.1***	-1688531.3***	-2416443.6***	-3001737.7***	-2898712.7***
population						
D1.	-87.854687	-118.32938**	-62.266356	-6.4716697	34.323077	75.9422
popetudiante						
D1.	647.91424***	726.66414***	280.78654**	248.62148*	730.71697***	929.08373***
vieux						
D1.	4190.9216***	4416.2728***	15488.249***	15027.733***	17141.097***	17769.774***
service_qu~y	903357.34***	841939.29***	871959.08***	1034471.4***	-44876.539	1082612.8***
credit_tax07	-4262164.4	-6134546.3	-116974.12	-5712275.1	-965963.39	-3169392.7
lnpib_capita						
D1.		-27478171		7611010.7*		20343478***
ipc_tsport~l						
D1.		-401016.12		-1199759.4***		-1522966.4***
_cons	-6.256e+09	2.607e+09	0	5.679e+09***	0	8.821e+09***

legend: * p<.15; ** p<.1; *** p<.05

Table 5: result of the regression of expenses

Variable	basic	basicApartm~s	basicNok001	basicBis	basicApartm~s	basicNok001~s
realincome	.00979106***	.02125195***	.01147101***	.00959388***	.02064194***	.01124768***
realincomesq	-7.793e-09	-4.385e-08***	-9.781e-09	-7.282e-09	-4.262e-08***	-9.231e-09
realk001	.0233599***	.03409897***		.02353108***	.03556212***	
year2009	-134.68143**	-364.76456***	-135.57237**	-47.254798	126.27967	-60.051667
nmvehonp	-537.61372***	-1007.0661***	-426.4491***	-539.32821***	-1022.3096***	-426.40355***
vehleasp	-716.72374***	-1217.8009***	-544.6973***	-712.85387***	-1164.5966***	-542.97022***
typdwelp						
2	394.02926**		410.2506**	447.19652**		405.00149*
3	354.88833**		379.30566**	447.74702**		465.96173**
4	113.98856		109.55932	178.34898		149.40288
5	424.04762***		456.06892***	556.16061***		562.48834***
6	493.08971*		501.98523*	431.63213*		428.01912*
hhtypep						
2	303.05232**	240.02789	286.95589**	445.47771**	589.73802**	410.60724**
3	641.80055***	870.87475**	651.30568***	597.82338***	764.1201	607.82823***
4	1131.4419***	565.18055	1125.0039***	1110.1674***	415.58821	1128.6312***
5	387.98771**	444.88032*	376.43936**	285.14008*	19.790478	280.71409
6	830.24996***	920.4551**	842.45613***	911.88549**	1116.8256	922.21211**
7	737.60278***	888.60845***	716.51678***	856.84637**	843.64709**	844.3672**
child0to4						
1	-274.25003*	282.15647	-290.55219**	-274.30946*	262.20981	-298.75101**
2	-371.3061	3535.1501***	-311.18496	-403.75259	3324.4677***	-354.48331
child5to17						
1	-288.25827**	-480.25803*	-301.67806**	-285.64693**	-387.94032	-302.42732**
2	-119.71942	-112.36285	-98.85478	-100.13651	-56.957718	-86.025992
3	-481.87429**	1226.8822**	-447.42024*	-473.11746**	1319.8841**	-443.9856*
seniors65						
1	-54.712484	420.03826	-61.756065	-40.953033	413.60781	-54.051892
2	1832.96***	3041.2867***	1790.5258**	1769.6447***	2687.8313***	1717.9575**
youth18to24						
1	333.18433**	245.64328	341.06546**	342.38207**	281.38023	348.27885**
2	475.26786**	878.78026*	510.82918**	482.15139**	975.57823*	511.399**
provincp						
12	-35.716664	-333.10705	-45.168154	-227.06934*	-357.92096	-209.8484*
13	-135.99355	-430.26966	-147.17558	-179.91627	-599.95835	-180.1585
24	-31.508898	-177.8003	-57.001094	-150.98073	-205.45583	-150.53443
35	357.43988***	244.03732	363.90261***	362.94755**	505.34199	417.50748**
46	233.44919**	-61.012997	220.28042**	274.40301**	83.004984	289.54599**
47	203.55723*	109.39554	211.68056*	8.0844852	47.381823	1.018485
48	438.46077***	272.35231	429.92645***	355.77286**	260.90141	353.93252**
59	440.38719***	198.90413	437.93145***	364.41447**	91.567649	388.86366**
year2009# provincp						
1 10				-166.39107	-4.3401367	-111.4774
1 12				244.0084	-209.80862	244.16519
1 13				-86.343267	255.94674	-56.912489
1 24				80.861151	-140.0519	82.437269
1 35				-181.17035	-725.44581**	-222.68355
1 46				-247.5005	-505.35168*	-249.83142
1 47				196.20961	-192.23864	267.05989
1 48				8.0181044	-186.61581	47.549623
1 59				(omitted)	(omitted)	(omitted)
year2009# typdwelp						
1 1				-105.93842		-130.36069
1 2				-247.30275		-153.34251
1 3				-313.14351		-332.69717
1 4				-273.19868		-247.85975
1 5				-390.43827		-365.59133
1 6				(omitted)		(omitted)
year2009# hhtypep						
1 1				213.49855	-85.864646	229.70881
1 2				-77.594282	-956.35863*	-18.805112
1 3				318.60837	40.341832	343.05004
1 4				232.92596	1232.1692	207.04092
1 5				399.16348	587.93184	406.47175
1 6				51.213393	-519.80322	71.392281
1 7				(omitted)	(omitted)	(omitted)
_cons	83.718595	562.4915	39.17786	81.526275	480.63077	22.59797

legend: * p<.1; ** p<.05; *** p<.001

Table 6: result of the log regressions

Variable	log_reg	log_regApar~s	log_regNok001	log_regBis	log_regApar~s	log_regNok0~s
logrealinc~e	.29235826**	.62462799**	.64176914***	.28165259**	.96835691**	.62276805***
Elastreali~e	1.824e-07	-2.523e-07	6.088e-08	1.869e-07	-3.749e-07	6.765e-08
logrealk001	.39960641***	.61868034***		.40047566***		
year2009	-.08511101	-.19842773**	-.10091873	-.12505505	.20268725	-.1561017
nmvehonp	-.66731657***	-1.572676***	-.4445282***	-.66800758***	-.99861536***	-.44286414***
vehleasp	-.9204531***	-1.7770178***	-.51856505***	-.9211077***	-.93326166***	-.51988929***
typdwelp						
2	.24521348		.25637735	.41254977*		.35111248
3	.23057235*		.29065017**	.28250001		.30770803*
4	.11098986		.16126578	.1108673		.11318008
5	.40064772***		.44724496***	.39261107**		.41377793**
6	.58390404*		.57359741*	.7843349**		.75347221**
hhtypep						
2	.24871167**	.42482641**	.26949186**	.26341049*	.61510523**	.28491032**
3	.73000454***	.98835681**	.72701486***	.58928208**	.97368245*	.57198619**
4	1.0175947***	1.6791994	1.0227284***	1.013337***	1.4487507	1.017924***
5	.33796616**	.4347905	.34749663**	.1774163	.20969032	.19072912
6	.48926663**	.39024751	.57922127**	.47438305*	.68560985	.56524318**
7	.52583568***	.80147343***	.51476377**	.36935217	.61347228**	.37562989
child0to4						
1	-.42023037**	-.3683936	-.41294006**	-.43026265**	-.48702631	-.43122065**
2	.08876952	2.3442043***	.09137545	.05773191	2.9644775***	.03478994
child5to17						
1	-.30143074**	-.49744326*	-.27864692**	-.29074793**	-.60384686**	-.27180521**
2	-.18256947	-.32984977	-.09771947	-.17673945	.09019094	-.09450034
3	-.57805702**	1.0111706	-.51187116*	-.57104338**	1.0659813	-.50840411*
seniors65						
1	-.03207293	-.39033898	-.06680341	-.03090238	-.46319612	-.07404839
2	1.2443925***	.33807586	1.2463167***	1.2176308***	.53339119	1.2035356***
youth18to24						
1	.20351174**	.06657617	.24471901**	.20757841**	.07343206	.24722261**
2	.5199844***	.82486195*	.54554993***	.53207899***	.81273631**	.55298402***
provincp						
12	-.10581705	-.74391292**	-.13966723	-.25936343	-.04564067	-.2613384
13	-.20936551	-.55428467	-.2469442	-.22083977	-.61756196	-.26181721
24	-.08689474	-.38107058	-.1442012	-.08836583	.12377002	-.09553166
35	.26055863**	-.17795484	.2872897**	.23069087	.71815992	.34087265*
46	.1762003	-.20826877	.14512513	.25393381	.36898332	.26571627
47	.15285447	-.2556538	.16590162	-.05100171	.30810816	-.06854135
48	.45111017***	-.00597123	.42031948**	.4210825**	.49583852	.40452594**
59	.42842869**	.01719553	.43633988**	.34108344**	.62187986	.39337387**
year2009# provincp						
1 10				-.16820961	.93686374	-.08459458
1 12				.12749118	-.42591413	.15056653
1 13				-.16303776	.74434466	-.08159735
1 24				-.16803205	-.0748352	-.18223856
1 35				-.12993551	-.34449033	-.20805238
1 46				-.32925349	-.16401923	-.3289749
1 47				.14849649	-.06969351	.25913006
1 48				-.12472777	.15830274	-.06980926
1 59				(omitted)	(omitted)	(omitted)
year2009# typdwelp						
1 1				.36693403		.33375053
1 2				.03284348		.13610181
1 3				.26366637		.28789541
1 4				.34226329		.40480252
1 5				.35272473		.36184448
1 6				(omitted)		(omitted)
year2009# hhtypep						
1 1				-.28829446	-.28761248	-.25456969
1 2				-.32000884	-.65027078	-.28225429
1 3				-.00788095	-.20132473	.06553184
1 4				-.2734952	.89095218	-.23170359
1 5				.00239543	.15284521	.02963998
1 6				-.24738494	-.24150093	-.22061328
1 7				(omitted)	(omitted)	(omitted)
_cons	-.2938596	-3.9198369	-.92999378	-.10728324	-3.6103189	-.68218152

legend: * p<.1; ** p<.05; *** p<.001