THE JOURNAL OF TRANSPORT AND LAND USE http://jtlu.org
VOL. 8 NO. 2 [2015] pp. 107–123

JTLU

Using an accelerated vehicle retirement program (AVRP) to support a mode shift: Car purchase and modal intentions following program participation

Ugo Lachapelle
Université du Québec à Montréal
lachapelle.ugo@uqam.ca

Abstract: To stimulate the economy and reduce greenhouse gas emissions from older vehicles, most accelerated vehicle retirement programs (AVRPs) provide participants with incentives to purchase a new, less-polluting vehicle. The province of Québec also designed its AVRP as a mode-shift tool by providing alternative travel incentives to participants. Alternatives include public transit passes, rebates on bicycles and car-sharing memberships. In the absence of post-program assessment, the theory of planned behavior is used to assess participants' modal intentions and intentions to purchase a new or used vehicle following participation. A subset (22 percent) of program participants (2009-2011; n=9070) filled out an optional survey about vehicle purchases and travel intentions. Age, gender, income, distance traveled in the previous year and perceived access to public transit were used as independent variables in logit and multinomial logit regressions. Car purchase intentions and traveling by car were associated with greater distance traveled. Higher-income participants were more likely to purchase new vehicles, and lower-income people and students were more likely to purchase used vehicles or refrain from any purchase. Alternative travel intentions were each associated with different socio-demographic characteristics. Québec's program offers a promising incentive-based opportunity to influence mode shift if favorable circumstances are in place to enhance access to alternative travel modes.

Article history:
Received: November 30, 2013
Received in revised form: February 5, 2015
Accepted: February 16, 2015
Available online: May 29, 2015

1 Introduction

Getting North Americans out of their vehicles and stimulating the use of alternative travel modes has proven to be a considerable challenge. One way to reduce vehicle emissions without restricting vehicle use is to develop accelerated vehicle retirement programs (AVRPs). In such schemes, older vehicles are scrapped in exchange for a rebate on a new vehicle. The efficiency of these programs with respect to reducing greenhouse gas (GHG) emissions has been limited, context sensitive, and highly dependent on program characteristics (International Transit Forum [ITM] 2011). While vehicle scrappage programs are typically designed (or promoted) to reduce GHG emissions, they support the purchase of a new vehi-

http://dx.doi.org/10.5198/jtlu.2015.659
ISSN: 1938-7849 | Licensed under the Creative Commons Attribution – Noncommercial License 3.0

The Journal of Transport and Land Use is the official journal of the World Society for Transport and Land Use (WSTLUR) and is published and sponsored by the University of Minnesota Center for Transportation Studies. This paper is also published with sponsorship from WSTLUR and the Institutes of Transportation Studies at the University of California, Davis, and the University of California, Berkeley.

cle through manufacturer rebates and/or government incentives, which reduces their GHG mitigation effectiveness. Many travel demand management (TDM) tools also implicitly attempt to reduce the negative impacts of travel on GHG emissions. Promoting a mode shift to less-polluting forms of travel is a core objective of TDM and one of the most prominent means of achieving emission reductions. Through its AVRP, the Association Québécoise de Lutte Contre la Pollution Atmosphérique (AQLPA) developed a series of partnerships to offer alternative travel incentives as an additional objective of the program. AQLPA's objective is to use the program to promote a mode shift that would increase the GHG reduction potential of the program while making program participation more attractive for potential program participants. Whether this innovative characteristic of the program influences travel intentions and car replacement, resulting in an actual mode shift, has not been studied in depth.

Using a travel behavior framework and the theory of planned behavior, this paper assesses reported travel intentions as well as vehicle-purchase intentions at the time of participation in the vehicle retirement program. This approach is used because of the lack of actual travel behavior data post-program participation. The analysis is preceded by a presentation of the program's characteristics, the analytical framework, and a description of available participant data. Results point to the challenges involved in breaking travel habits, especially in the context of limited travel alternatives (e.g. transit access or car-sharing clubs nearby) for participants.

1.1 The "Adieu Bazou!" accelerated vehicle retirement program as TDM

"Adieu Bazou!" (literally Goodbye Clunker), the Quebec component of the Canadian national AVRP (Retire Your Ride) was funded by Environment Canada and managed by the Clean Air Foundation (CAF). It allowed for owners of vehicles made during or before 1995 (a year when more stringent emissions restrictions were imposed on vehicles) to scrap their vehicles or light trucks in exchange for various incentives (Environment Canada 2009). Some incentives favored a shift to alternative travel modes in an attempt to use the vehicle retirement program as a TDM tool.

Participants of "Adieu Bazou!" could receive a $300 incentive, rebates of up to $3000 on a new vehicle (Ford, GM, Chevrolet, and Hyundai joined the program), transit passes, or a selection of alternative travel options that included registration to a car-sharing cooperative (Communauto), rebates on bicycles and electric scooters, and an interurban transit pass (AQLPA 2011). The objective of such alternative transportation incentive programs was to ensure a temporary mode shift from automobile to other alternative modes. By incentivizing drivers to experiment with the use of other modes, it is expected that some could decide to permanently reduce their driving in favor of alternative modes (Léger Marketing 2010). For participating public transit agencies, such longer-term transit take-up would justify the cost of subsidizing free transit-pass incentives. A year into the program, transit agencies agreed to expand the transit offer from a six-month to a 15-month free, unlimited basic transit pass.

By influencing owners of older vehicles to reduce the amount of driving they do through a shift to other modes of transportation, the objective is to reduce vehicle emissions by a greater factor than what could be achieved through vehicle replacement (AQLPA 2011, Léger Marketing 2010). There are reasons for trying to incentivize participants to adopt other travel modes as part of AVRPs instead of promoting the purchase of a new car. As participants purchase a newer vehicle, they tend to increase the amount of driving they do thereby reducing the benefits achieved through the purchase of a less-polluting vehicle (ITF 2011, Dill 2004, Van Wee et al. 2000). Improvements in fuel efficiency and reduced travel costs associated with the new vehicle could be at the core of this change in behavior (Zolnik 2012). Another issue with programs that do not restrict auto purchases to certain vehicle classes is the risk that participants will upgrade their vehicles to larger and relatively more-polluting vehicles. This can also decrease expected benefits and was identified as a program drawback in Germany's AVRP (ITF 2011). The report recommends restricting vehicle type or adjusting incentives to cover certain types of vehicles based on emissions.

Only a few other AVRPs were designed with similar alternative travel-incentive programs and mode-shift objectives. Scotland (a one-day program in Glasgow) and Hungary were the only ones referred to in the literature that offered public transit incentives (Dill 2001). British Columbia's SCRAP-IT program is the only one for which reasonable documentation is available (Antweiler and Gulati 2011). An assessment of these programs' success with respect to mode shifts was not found in the available literature.

Participating agencies that are providing incentives are interested in knowing if this is a useful strategy to seduce new riders or promote the use of public transit. This paper serves to explore how intentions of participants may be shaped by factors external to the program. These range from perceived access to public transit as a barrier, participants' income, attitudes toward travel, and environmental concerns. Reducing vehicle use may be facilitated by interrupting habitual driving (through vehicle retirement), especially in cases where longer travel distances can influence the moral motivation to reduce driving (Eriksson et al. 2008). Environmental concerns are one such potential moral motivation.

1.2 Objectives

The paper is structured around two main objectives.

1. Identify the determinants of the intention to purchase a new or used vehicle
2. Identify the determinants of modal intention once a vehicle is recycled

The next section provides three complementary frameworks and theories that can help structure the current analysis. Through the analyses, I show that these bodies of knowledge and available data can contribute to analyzing this question, but that ultimately, follow-up data is required to assess actual mode shift outcomes of the program during and after the incentive period is over.

1.3 Theoretical Framework

1.3.1 Travel Demand Management (TDM)

Different bodies of literature can help us understand vehicle purchase and travel intentions in the context of this study. TDM evolved out of the need to mitigate the impact of the rapid motorization of developed countries. It refers to policies and urban-planning strategies to reduce the number of single-occupancy vehicles on the roads. This can be done by adapting infrastructure and investing in alternative forms of transportation and by changing the pricing of different transportation alternatives through the use of incentives and disincentives. Meyer (1999) suggests that carrots are more efficient than sticks as demand management tools. This is because they promote certain travel behaviors while not limiting the use of others. Disincentives can also often be perceived as creating an unpopular additional tax burden and may reduce the mobility of the low-income population (Lachapelle and Pelletier Audette 2013). The AVRP being studied included alternative travel incentives that can reduce the cost of travel.

1.3.2 Travel behavior and choice models

Understanding the effect of policies on travel requires that we assess how these policies contribute to shaping the behavior of individuals with respect to travel. The discrete choice model used in many transportation applications can provide insights into this question (Dommencich, McFadden 1975; Ben-Akiva and Learman 1985). Choice sets made up of different travel modes can be assessed at the level of individual trips or through measures of habitual travel patterns (e.g., most frequent commute mode). The discrete choice framework proposes that the utility of a travel option in specific circumstances can be compared against the utility of other modes. This utility can be a function of travel time, distance, convenience, cost of trip, and overall cost of transportation options and may be influenced by socioeconomics. Service quality, perceived access, and satisfaction (Lai and Chen 2011) are some of the indicators of service convenience used to assess public transit use. Other land-use measures representing the ease of use of various travel modes, such as population density, can also be integrated into the choice framework

(Cervero 2002). This behavioral model can also be used to understand other choice processes related to personal travel. Vehicle ownership has been analyzed using the discrete choice model. Potoglou and Kanaroglou (2008) found that household life-cycle stage, socioeconomic factors, density, and land-use diversity influenced a household's decision to own a given number of vehicles. Choice models of vehicle ownership have also been developed using class and type of vehicle as well as cost and size (Nayum et al. 2013).

1.3.3 Insights from psychology: intentions in the theory of planned behavior

Gärling and colleagues (2002) developed a framework based on travel psychology and economics to identify the determinants of successful TDM policy adoption. In order to shift travel behavior, individuals are thought to go through a process of travel goal setting. These goals may involve, for example, reducing travel distance, shifting modes, or reducing ecological impacts. They then explore "how travel is influenced by the impact various TDM measures have on time, cost, and convenience of travel options" (Gärling et al. 2002, p.59). Life changes are considered to be important opportunities for mode shift (Gärling and Schuitema 2007) because they can force people to break travel habits (Eriksson et al. 2008).

The theory of planned behavior (TPB) explicitly refers to the concept of intentions as a predictor of behavior (Ajzen 1991). According to this theory, in order to adopt a behavior, individuals need to have the intention to do so. Intentions capture the motivational factors that influence a behavior: How hard are people willing to try and how determined are they to perform the behavior? A strong intention should result in a strong adoption of the desired behavior. In the case of travel, this intention will be formed by attitudes toward travel, subjective norm, and perceived behavioral control. Attitudes toward travel by a certain mode can be defined as how favorable or unfavorable the evaluation of this behavior is. Behavioral beliefs, "what will actually occur," and outcome evaluation, "is this a good or a bad thing," are the two components of attitudes and were not available in this study. Subjective norm refers to the personal and social pressures to comply with a behavior. Travel-related subjective norms include the social image associated with driving and the perception that certain travel behaviors are more environmentally responsible than others. Normative beliefs, "what my mother/other important person wants," provide a social pressure to perform a certain behavior.

Behavioral control refers to the ability to actually complete a certain behavior. The resource and opportunities available to a person will help determine intention formation and behavior adoption. The perception of the ease or difficulty of completing a behavior will be of varying accuracy, depending on knowledge of the behavior. With only limited information about the behavior, perceptions may be flawed. Actual or objective behavioral control can hence provide additional information, especially when perceptions are flawed by lack of knowledge. Perceptions may come from second-hand information, such as the experience of friends, and may be misleading. Actual information, although theoretically clearer, may sometimes be difficult to access. In order to adopt a certain behavior, individuals must have volitional control over this behavior; they must actually be able to complete the behavior. Perceived behavioral control is more important when volitional control declines. Transit is one such situation in which individuals have varying levels of volitional control, since service is not systematically and widely available to individuals. For example, Pushkarev and Zupan (1977) and Rogalsky (2010) found considerable discrepancies in access to public transit across metropolitan areas of various sizes. Availability of requisite opportunities and resources such as time, money, and skills (Ajzen 1991) can also influence perceived control over the ability to travel. Hence household income can, in the case of travel choices, confer a certain volitional control.

Finally, the TPB is open to the inclusion of additional variables, provided that they capture a portion of the variance in intention. An important role is attributed to past behavior in setting up future behavior. "Repeated performance of a behavior results in the establishment of a habit" (Ajzen 1991 p. 203). Past behavior is considered the residual effect not accounted for in the theoretical model because of missing information or incomplete theory (Ajzen 1991). While it is used to test the theory's sufficiency, it can provide additional explanatory power in shaping intentions and behaviors.

The TPB has been used to directly elicit mode choice through past behavior, habit, and reasoned action (Bamberg et al. 2003). Dill and colleagues (2010) used the theory of planned behavior to test the effect of individual marketing programs on TDM. While intention is notoriously different from behavior, it is nonetheless considered a useful marker of behavior (Gärling and Schuitema 2007, Jakobsson 2004). Weather, illness, and unspecified unexpected events may all cause discrepancies between intentions and actual use of different modes (Jakobsson 2004). Varying degrees of ability to complete a behavior (perceived behavioral control) can also cause a discrepancy between intentions and behavior (Ajzen 1991).

Travel intentions have particularly been studied in tourism, as it is not difficult to survey respondents at the time of a specific vacation trip. As a result, intentions are often used to estimate demand for tourism travel (Weaver and Lawton 2007). The TPB and additional measures of past behavior have been used in assessing intentions to choose a travel destination (Lam and Hsu 2006). Numerous other examples exist in the urban travel literature (e.g., Chen and Chao 2011, Jakobsson 2004, Bamberg et al. 2003).

1.3.4 Analyzing "Adieu Bazou!"

Many of these theoretical frameworks share common features. They refer to enablers, which make a travel behavior more likely, and disablers, which prevent or inhibit certain behaviors. Using these frameworks, models of vehicle purchase intentions and travel mode intentions of participants in a scrappage program that includes alternative travel incentives can be developed (Figure 1). As in Potoglou and Kanaroglou's (2008) analysis of vehicle ownership, choice models are used to assess purchase intentions. Other examples of studies using the TPB to assess travel choices also exist (Bamberg et al. 2003, Klöckner and Blöbaum 2010). The models are specified using the available and relevant information described below.

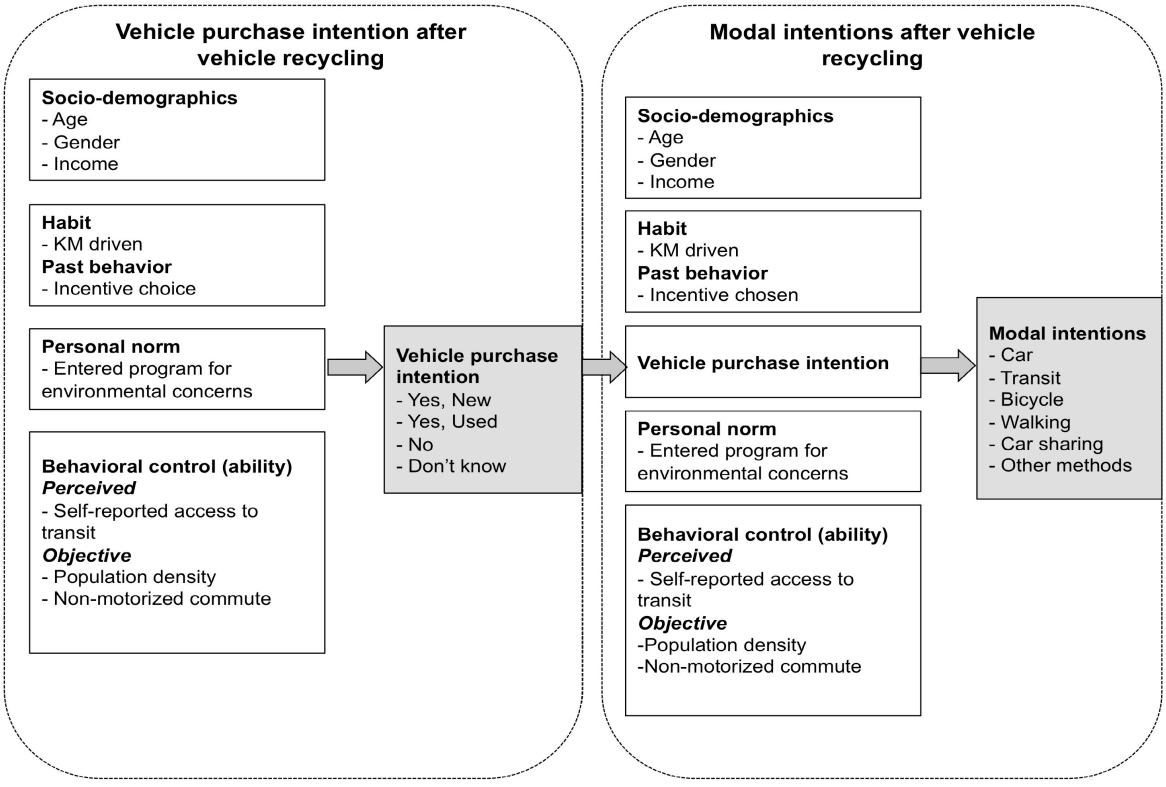

Figure 1: Analytical framework

Socio-demographic characteristics were expected to have an influence on intentions by shaping tastes, preferences, financial ability, and physical ability. Gender, age, and income were identified in other studies as influencing travel mode choice and intentions (Scheiner and Holz-Rau 2012, Rogalsky 2010, Jakobsson 2004, Cervero 2002, Boarnet and Crane 2001). Personal norm was assessed using an item on the perception of environmental concern as important in entering the program. For example, Flamm (2009) found lower vehicle ownership and use in households with pro-environmental behavior. Eriksson and Forward (2011) also found associations between pro-environmental travel behavior and travel intentions.

As users develop strong travel choice habits, changing their behavior becomes more difficult (Gardner 2009). In a study of intention to switch to transit use, habitual behavior of drivers strongly hindered intentions (Chen and Chao 2011). In the current study, habit was expressed through a self-reported measure of kilometers driven in the previous year. Another form of previous travel behavior, the incentive chosen when registering for the program, is also expected to be associated with travel intentions.

Indicators of behavioral control (ability) relevant to this analysis are the perceived quality of transit service as well as characteristics of the built environment associated with alternative travel (Transportation Research Board [TRB] 2001, TRB and Institute of Medicine [IOM] of the National Academies 2005). Measures of ability to travel by alternative modes were found to be salient factors in influencing travel intentions (Eriksson and Forward 2011).

The same framework is applied to the intention of choosing individual travel modes with the exception that the intention to purchase a vehicle is also included. Vehicle purchase intention is considered an enabler of automobile travel and a deterrent to alternative travel. While the questions asked in the optional survey of participants do not completely reflect the TPB and other psychological concepts presented, they are used here to explore the individual roles of environmental concerns, travel habits, past behavior, and measures of ability to switch travel mode in shaping travel intentions. Such analysis can clarify under what circumstances mode-shift incentives obtained through participation in an AVRP can influence travel behavior.

2 Method

All data used in this analysis was retrieved from three sources of data: participant records for the AVRP, an optional survey of participants, and Canadian Census data from 2006.

2.1 Program administrative data and survey of participants

Between February 2009 and April 2011, over 40,000 vehicle owners participated in the program and recycled their vehicle. Participant registration to the "Adieu Bazou!" program required information on home location, sex, and age in addition to the incentive selected. A subset of 9070 (22.4 percent) participants voluntarily filled out an optional survey that included questions on intentions:

1. "Will you purchase another vehicle?" (yes, no, don't know/not sure), and if yes, "Will it be new or used" (new, used, don't know/not sure). These two variables were used to develop four categories of vehicle purchase intentions (new, used, no intention, don't know/not sure).
2. "What mode of transportation will you use now that you have retired your vehicle?" Participants could check more than one of the following: car, bicycle, public transit, walking, carpooling, and vehicle sharing.

The survey also included questions on attitudes (through habit and previous behavior), norms, and perceived behavioral control:

3. Habit: self-reported average km traveled in a year (six distance categories)
4. Previous behavior: incentive chosen
5. Subjective norm: entered program for environmental concerns (yes, no)

6. Perceived behavioral control (ability to travel by alternative modes): "The transit system is accessible to me" (five-point scale from totally agree to do not agree at all).

Five categories of combined household income ("What is the combined revenue of your household?") were also included in the optional survey, and a sixth category states, "None, I am a student." (This category also includes students with part-time jobs).

2.2 Census data

Using participants' home locations, additional information was collected on the characteristics favoring alternative travel mode use where participants live. The province of Quebec includes 13,409 dissemination areas (DA). Each participant was assigned to his or her home location's DA to calculate population density near each respondent's home using aggregated data from the 2006 Census. It was expected that lower density would be associated with higher intention of personal vehicle use, and that higher densities would be associated with higher intention of alternative travel options use, and lower intentions to purchase a vehicle. The area's proportion of the population commuting by public transit and the proportion of the population commuting by non-motorized transportation were tested as proxies for an area where alternative transportation options are more feasible. These variables were expected to have a positive association with the intention to use alternative transportation and a negative association with the intention to purchase a car. Previous work on incentive choice using the same data reported that the probability of transit incentive choice was higher in areas with higher densities and where a higher share of the census population commuted to work by public transit (Lachapelle 2013). An Indicator variable for living in one of the six census metropolitan areas of the province of Quebec (CMAs vs. not) was computed to account for the presence of more important transit service in such areas.

2.3 Statistical analyses

2.3.1 Intention to purchase a new vehicle

After registration to a vehicle retirement program, what are participants' intentions with respect to the purchase of a new vehicle? The four possible answers to this question (new, used, no, don't know/not sure) were modeled as choices using a multinomial logit model (MNL). Socio-demographic variables, the chosen incentive, previous distance traveled, environmental concern as a reason for recycling a vehicle, population density, the proportion of non-motorized commuters, and a self-reported measure of transit accessibility are included in the final model. MNL was used because answers are exclusive. Having no intention to buy a replacement vehicle was used as a reference category.

2.3.2 Modal intention

Modal intention was studied using a series of six binary logistic regressions because more than one response was accepted (answers were non-exclusive). Modal intention was estimated using the same variables as used in modeling vehicle purchase intentions. Additionally, intention to purchase a vehicle was added to this model, because owning a vehicle would be expected to influence modal intention. Vehicle ownership and availability are strong predictors of vehicle travel. All analyses were carried out using Stata 11.

3 Results

A description of variables for the study sample is presented in Table 1. The first column includes variable description for all variables included in the analyses. The second column presents the values that were available for the entire participating population to compare them to the values of the subsample used in this analysis. With respect to age and gender, the subsample is similar to the population of program par-

ticipants (Chi square test between subsample and rest of population was non-significant). With respect to program incentive choice, more participants chose other modes than the car in the analytical sample (Chi square test between subsample and rest of population was significant). Transit passes were also chosen more frequently in the overall population. Because the paper assesses associations between intentions and individual characteristics, slight differences in sample and population likely do not distort results.

Table 1: Sample description (proportions and means) and comparison to universe of program participants

	Analytical sample	Program participants
	Proportion or mean	**Proportion or mean**
Observations	**9070**	**40321**
Women	0.34	0.36
Participant age		
16-24	0.13	0.13
25-34	0.16	0.16
35-44	0.16	0.17
45-54	0.25	0.25
55-64	0.18	0.18
65+	0.11	0.11
Incentive chosen		
Cash ($300)	0.92	0.82
Car rebate	0.03	0.06
Transit pass	0.04	0.09
Bicycle, vehicle sharing, carpool	0.01	0.03
Area characteristics		
Lives in CMA	0.65	0.60
Population density (mean of ln)	6.75	6.60
Non-motorized commute (mean of area proportion)	0.08	0.08
Environmental concerns were important reason for program participation	0.11	0.21
Car purchase intention		
New	0.21	
Used	0.41	
No	0.25	
Not sure	0.13	
Modal intention		
Car	0.82	
Public transit	0.27	
Bicycling	0.26	
Walking	0.19	
Car-share program	0.04	
Other methods	0.03	
Household income		
Less than $25,000	0.21	
$25,001–$35,000	0.16	

	Analytical sample	Program participants
	Proportion or mean	**Proportion or mean**
$35,001–$50,000	0.21	
$50,001–$75,000	0.19	
More than $75,000	0.15	
None, I am a student	0.08	
Distance traveled in previous years		
Less than 10,000 km	0.32	
10,000–15,000 km	0.30	
15,000–20,000 km	0.20	
20,000–25,000 km	0.10	
Over 25,000 km	0.05	
Don't know	0.03	
Transit system is accessible to me		
Totally agree	0.30	
Somewhat agree	0.13	
No opinion	0.13	
Somewhat disagree	0.12	
Totally disagree	0.31	

3.1 Intention to purchase a new vehicle

Vehicle purchase intentions can be used to assess the program's potential in fulfilling its mode-shift objective. A multinomial logit regression of intention to purchase a new or used vehicle is presented in Table 2. Gender and age were not significantly associated with the intention to purchase a new or used vehicle. One explanation is that the data only reflects the previous owner of the vehicle and not that of the other potential household members involved in the decision to purchase a new vehicle. As income increased, the propensity to purchase a new vehicle increased and the propensity to purchase a used vehicle decreased. Students were more likely to have the intention to purchase a vehicle than the lowest-income group (reference category). The lower-income groups were more frequently undecided about vehicle purchase. In comparison with those having traveled less than 10,000 km in the previous year, those who drove between 10,000 km and 25,000 km were more likely to have the intention of purchasing a new vehicle, and to a lesser extent, a used one. Traveled distance was not associated with uncertainty about vehicle purchase. Participants having chosen a car rebate were in the process of purchasing their cars at the time of filling out the survey. This likely explains this variable's negative relationship with the intention to buy another new vehicle. There was a negative relationship between environmental concerns and the purchase of a new vehicle. As perceived access to public transit increased, participants were less likely to have the intention to purchase a new vehicle. Even those who somewhat disagreed with the statement were less likely to purchase a new vehicle than those who totally disagreed, reflecting the influence of increasing perceived quality on purchase intentions. The relationship of perceived access to public transit with the purchase of a used vehicle was weaker and only influenced purchase intention when access was high. There were no significant associations with any of the area characteristics. Associations were likely suppressed by the strength of the perceived access to transit variable.

Table 2: Multinomial logit model of car purchase intentions

Base: No intention to purchase car	New	Used	Don't know
	Coef.	Coef.	Coef.
Women	0.039	0.002	-0.018
Participant age			
16–24 [ref.]			
25–34	0.062	-0.111	-0.136
35–44	-0.107	-0.038	-0.089
45–54	-0.117	-0.103	-0.145
55–64	-0.12	-0.08	-0.079
65+	-0.195	0.019	-0.171
Household income			
Less than $25,000 $[ref.]			
$25,001–$35,000	0.721***	0.012	-0.084
$35,001–$50,000	0.756***	-0.224**	-0.071
$50,001–$75,000	0.697***	-0.470***	-0.432***
More than $75,000	0.876***	-0.560***	-0.542***
None, I am a student	-0.131	0.321**	0.216
Incentive choice			
Cash ($300) [ref.]			
Car rebate	-0.469*	-0.18	-0.228
Transit pass	0.037	0.028	-0.114
Bicycle, vehicle sharing, carpool	0.253	-0.535	-0.048
Distance traveled in previous years			
Less than 10,000 km [ref.]			
10,000–15,000 km	0.523***	0.294***	0.056
15,000–20,000 km	0.634***	0.237**	0.092
20,000–25,000 km	0.560***	0.267**	-0.135
Over 25,000 km	0.066	0.092	-0.085
Don't know	-0.377	-0.15	0.208
Environmental concerns were important reason for program participation	-0.204*	-0.028	-0.143
The transit system is accessible to me			
Totally agree	-0.857***	-0.458***	0.118
Somewhat agree	-0.466***	-0.184*	0.218
No opinion	-0.389***	-0.046	0.017
Somewhat disagree	-0.319**	0.094	0.179
Totally disagree [ref.]			
Area characteristics			
Lives in CMA	0.031	-0.045	0.012
Population density (ln)	0.031	0.019	0.001
Non-motorized commute (proportion)	-0.359	-0.471	-0.168
Constant	-0.806***	0.711***	-0.483**
Observations	9070		
ll (base)	-11816		
ll (model)	-11418.5		
Chi-square	795.1		

Base: No intention to purchase car	New	Used	Don't know
	Coef.	Coef.	Coef.
Significance	0.000		

Note: ll = Log likelihood of base and full model
Coef.=Coefficient; ref.=reference category
**p<0.05, **p<0.01, ***p<0.001*

3.2 Modal intention

The second group of models assesses modal intentions once a vehicle is recycled using a series of binary logistic regression (Table 3). The same independent variables used in the vehicle purchase model are included with the addition of a vehicle purchase intention variable. Significant associations were found for key socio-demographic variables.

Being a woman had no relationship with travel intention for any mode. Age also was poorly associated with travel intentions, except for three instances: participants between the ages of 35 and 44 were more likely to have the intention of using public transportation than participants aged 16 to 24; most age groups that were older than the reference category were more likely to have the intention to travel using vehicle-sharing systems; and participants over 65 were less likely than the youngest ones to choose carpooling or other means (unspecified). Household income was associated with all travel intention outcomes. As income increased, intention to travel by vehicle increased. This relationship was inversed for other incentives. Participants earning between $25,000 and $35,000 were less likely to have the intention to use transit than those earning Less than $25,000. All groups were less likely than the lowest-income group to walk and car share, and two of the wealthier groups were less likely to choose carpooling or other travel modes. Students were more likely to have the intention to use public transit and bicycling and less likely to have the intention to carpool or use other modes. The incentive chosen by participants was not associated with any travel intention.

Participants' travel habits were strongly associated with travel intentions. As reported distance traveled in the previous year increased, participants were more likely to have the intention to travel by vehicle. They were also significantly less likely to travel by public transit and walking. The intention to purchase a vehicle was, as expected, strongly and positively associated with the intention to travel by vehicle and negatively associated with the intention to use public transit, bicycling, vehicle sharing, carpooling, and other modes. Being undecided about the purchase of a vehicle was negatively associated with the intention to travel by vehicle and positively associated with the intention to travel by public transit, bicycling, walking, and vehicle sharing. Having entered the program because of environmental concerns was not associated with any of the travel intentions. It can only be assumed that environmental concerns do not trump the need for automobile mobility for most participants or stimulate the use of other modes.

The strongest and most consistent relationship found in travel intention models was perceived access to transit. As perceived access to the transit system increased, participants were less likely to have the intention to travel by car, and were more likely to have the intention to travel by public transit, bicycling, and walking. Only those who totally or somewhat agreed with the statement were more likely to have the intention to car share. Objective characteristics of the area showed limited relationships. Living in a CMA increased the probability of vehicle sharing (likely because car sharing is only available in large metropolitan areas), and population density surprisingly increased the probability of using a personal vehicle, possibly an effect linked to the strength of the perceived access to transit measure or to the negative, albeit non-significant relationship with living in a CMA. Surprisingly, the percentage of non-motorized commuters in a population's DA was negatively associated with the intention to travel by public transit and by bicycle. For bicycling, the negative effect was potentially tied to higher usage of bicycles for leisure activities outside of denser, bicycle-friendly areas. Perhaps because the subjective measure of access to transit was strongly associated with most alternative travel, objective measures had somewhat

counter-intuitive results, potentially explained by the fact that all participants were drivers to begin with. Those already driving in high-density areas with large shares of non-motorized commutes were already exposed to favorable alternative travel options that they chose not to use. Without information about the presence of other cars in the household, these results remain surprising.

Table 3: Individual logit models of travel intentions

	Car	Public transit	Bicycle	Walking	Car share	Carpool and others
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Women	0.072	0.043	0	0.061	0.06	0.121
Participant age						
16–24 [ref.]						
25–34	0.034	0.031	0.08	-0.042	0.560**	-0.225
35–44	0.052	0.166	0.142	0.037	0.267	-0.166
45–54	-0.059	0.168	0.064	-0.008	0.634**	-0.021
55–64	0.112	0.072	-0.082	-0.125	0.497*	-0.235
65+	-0.059	0.158	-0.047	-0.149	0.662**	-0.784**
Household income						
Less than $25,000 [ref.]						
$25,001–$35,000	0.377***	-0.156	0.025	-0.214*	-0.347*	-0.041
$35,001–$50,000	0.650***	-0.099	0.021	-0.285***	-0.469**	-0.476*
$50,001–$75,000	0.580***	0	0.112	-0.337***	-0.548**	-0.510*
More than $75,000	0.647***	0.260**	0.163	-0.221*	-0.31	-0.36
None, I am a student	-0.064	0.812***	0.349***	0.083	-0.333	-0.867**
Incentive chosen						
Cash ($300) [ref.]						
Car rebate	0.037	0.088	0.126	0.145	-0.333	-0.488
Transit pass	0.28	-0.015	-0.033	-0.162	-0.641	-0.396
Bicycle, car sharing, carpool	-0.046	0.544	0.106	0.214	0.804	0.607
Distance travelled						
Less than 10,000 km [ref.]						
10,000–15,000 km	0.302***	-0.005	0.135*	-0.006	-0.038	-0.108
15,000–20,000 km	0.463***	-0.214**	0.002	-0.239**	-0.169	0.009
20,000–25,000 km	0.493***	-0.300**	-0.016	-0.335**	-0.451*	-0.227
Over 25,000 km	0.847***	-0.544***	0.018	-0.289*	0.12	-0.129
Don't know	-0.019	0.106	-0.266	-0.114	0.281	0.342
Car purchase intention						
New	1.504***	-0.878***	-0.576***	0.542***	-0.959***	-0.526**
Used	1.539***	-0.468***	0.026	0.025	-0.643***	-0.737***
No intention [ref.]						
Not sure	-0.162*	0.395***	0.226**	0.279**	0.329*	0.137
Environmental concerns were important reason for program participation	-0.149	0.145	0.055	0.135	-0.006	-0.078

	Car	Public transit	Bicycle	Walking	Car share	Carpool and others
The transit system is accessible to me						
Totally agree	-1.384***	2.984***	0.710***	1.011***	0.467***	0.069
Somewhat agree	-1.093***	2.577***	0.614***	0.722***	0.360*	-0.095
No opinion	-0.539***	1.901***	0.373***	0.620***	0.16	-0.126
Somewhat disagree	-0.115	1.294***	0.565***	0.582***	0.284	-0.142
Totally disagree [ref.]						
Area characteristics						
Lives in CMA	-0.152	0	-0.073	-0.001	0.282*	-0.048
Population density (ln)	0.035*	-0.007	0.001	0	-0.04	-0.007
Non-motorized commute (proportion)	-0.54	-0.678*	-0.751*	-0.356	-0.17	0.377
Constant	0.793***	-2.715***	-1.501***	-1.686***	-3.034***	-2.599***
Observations	9070	9070	9070	9070	9070	9070
ll (base)	-4301.81	-5325.7	-5160.45	-4461.35	-1614.86	-1200.84
ll (model)	-3560.46	-4175.26	-5000.03	-4254.33	-1536.02	-1163.35
Chi-square	1482.7	2300.9	320.8	414	157.7	75
Significance	0.000	0.000	0.000	0.000	0.000	0.000

Note: ll = Log likelihood of base and full model

Coef. = Coefficient

** p<0.05, ** p<0.01, *** p<0.001*

4 Discussion

Beyond upgrading vehicles, the studied AVRP program seeks to influence a mode shift. The paper shows that having the intention to shift travel mode to alternative forms of transportation seems to be inhibited by limited alternative travel services and infrastructures that would ease this transition. Household income (a marker of the potential for a household to own multiple cars), habit (in terms of kilometers driven in the past year), and perceived access to transit presented the strongest and most consistent relationships across analyses. Intentions to drive and purchase a vehicle stood in stark contrast with all other modes. The lowest-income group was more likely to have the intention to purchase a used car while the wealthier ones showed interest in new vehicles. Cash incentives can easily convert to the purchase of a used vehicle and may yield small to non-existent environmental benefits yet may enable participation of lower-income groups. Students participating in the program either had the intention to buy a used vehicle or had the intention of switching to public transit. Higher income was also associated with less uncertainty about the purchase of a car.

Previous travel behavior, in the form of average yearly distance traveled in the previous year was associated with intentions to purchase and use a vehicle. Traveling longer distances may make public transit and cycling incentives much less feasible than continuing to drive. Unless life situations have changed, past behavior can have a strong influence on intentions. People who travel longer distances, because they enjoy it or because they live far from their place of work or leisure may be harder to incentivize to shift to alternative modes of transportation.

Perhaps because of the strong influence of the self-reported transit accessibility variable, relationships with objective environmental variables were weak, non-existent, or even counter-intuitive. Perceived accessibility may be more important at the time of setting goals and intentions than actual access, especially for a regular vehicle driver with limited knowledge of the transit system. In any case, perceived access to transit service, a measure of behavioral control, had a strong negative influence on vehicle purchase and

travel intentions. These results are consistent with Eriksson and Forward's (2011) analysis of modal intention. Low driving habit and high transit access may be crucial factors in shaping mode-shift intention. Eriksson and colleagues (2008) suggest that interruptions in car use such as the one caused by this program may also facilitate a reduction in car use. To have the intention to shift travel modes, a synergy between these factors is likely required.

Not surprisingly, wanting to purchase a vehicle was also strongly associated with the intention to drive and not with the intention to use other modes. While the strength of this variable may suppress the effect of other variables, it seems unjustified to remove it from the model, especially given some people have already bought a new vehicle with their car rebates, and others already owned another vehicle that they did not recycle. Previous research suggests that when a new vehicle is purchased, distance traveled is likely to increase due to novelty and fuel economy (Zolnik 2012). It is, on the other hand, somewhat surprising that the incentive chosen was not associated with any travel or purchase intentions. One would expect that to the contrary the chosen incentive would largely drive future intention. The only possible explanation is that the choice of a $300 incentive (the most popular) has no influence on travel choice, and alternative travel incentives are often chosen for a purpose other than travel (purchasing a bicycle for leisure), or were given to other members of the family (this may be the case for public transit passes or rebates on bicycles). Other environmental and social variables were tested without success. With a few exceptions, results are plausible and follow expected and existing evidence. These notable exceptions are the influence of area characteristics on driving, walking, and bicycling.

4.1 Limitations

Limitations to this study include the cross-sectional and optional nature of the survey and the use of intentions instead of actual self-reported behavior. Intentions can be shifted as a result of unforeseen circumstances and may not always accurately represent actual behavior. Existing data limit our ability to understand actual mode shift associated with the program. A survey of travel behavior after vehicles are recycled would help confirm the modal transfer caused or supported by the program. The studied voluntary sample was dependent on participants' willingness to participate, and therefore may not accurately represent the entire participating population or future program participants. However, given the data comparing all program participants to the studied sample, this subgroup of the population seems to represent program participants reasonably well in terms of age, gender, and location. However, there were differences in terms of the incentive chosen: 92 percent of the subsample chose the $300 incentive, while 82 percent of all participants did, with associated decreases in the choice of other incentives. Since the paper analyses the associations between characteristics and intentions, distinctions between the sample and the population is of lesser importance than if the objective were to estimate prevalence across a population. The more recent version of the program systematically asked the questions used in this analysis to all participants and should be recommended to any program manager interested in assessing the effectiveness of the program.

In light of the results of this analysis, information on additional vehicles available in households would be crucial in explaining intended travel behavior. Not knowing whether a participant gave up his or her only vehicle, or a second one, would likely clarify discrepancies between expected and obtained results. Because objective public transit, car sharing and bike path data were not available province wide, these were not included in the analyses but could improve future analyses. Finally, the TPB, the mode choice framework, and TDM concepts were used, yet available data were not designed with this specific purpose. Questions could be more accurately tied to this useful theory.

5 Conclusion

This paper reported on the travel and vehicle purchase intentions of participants to an AVRP. Economic and psychological theories were applied to this transportation problem. Low selection of alternative travel incentives inhibits the mode-shift capabilities of this tool, but the program still contributed to some mode shift. Furthermore, there are many factors external to the program that reduced the ability of participants to change habit and shift modes. For both purchase and travel intentions, travel habits (distance traveled in the previous year), income, and perceived access to transit had inverse associations with intentions to use alternative travel modes (especially transit and bicycling) and with vehicle travel and purchase intentions. Where a positive relationship was found for alternative travel, a negative association was found for automobile travel and purchase intentions. Program managers and participating agencies must be cognizant of the difficulties associated with breaking habits, dealing with households' pecuniary constraints, and with limited real or perceived access to alternative travel as barriers to behavioral intention. Intentions to travel using an alternative mode were strongly associated with how feasible this mode of travel effectively was perceived. Favorable alternative travel circumstances should enhance this program's ability to influence mode shift. With changing social norms, incentive-based TDM programs, such as this one, can generate greater benefits (Gärling and Schuitema 2007) by attracting more convinced mode shifters. Changing social norms is an integral part of the program itself and so is breaking habits. Targeting markets of users that typically travel short distances will ensure greater take-up of alternative travel incentive and could have a stronger impact on permanent mode shift. Broader sustainable travel objectives include the objective of reducing overall travel distances to reduce emissions from the vehicle fleet. If successful, this objective could potentially have the indirect effect of making alternative travel adoption more popular with program participants. Without a clear pre-post design to assess post-program behavior, the modal shift attained with this program cannot, however, be confidently asserted.

6 Acknowledgments

The author thanks AQLPA for sharing its program data and providing insights on its use throughout the project. The *Service aux collectivités* of the Université du Québec à Montréal as well as the *Villes, régions monde* network are also thanked for funding the project and supporting this University-Community Partnership. Finally, Alexis Pelletier Audette is acknowledged for help with data gathering and literature review.

References

Ajzen, I. 1991. The theory of planned behavior. *Organizational Behavior and Human Decision Processes* 50(2): 179–211.

Antweiler, W. and S. Gulati. 2011. *An analysis of British Columbia's SCRAP-IT Program: Emissions Savings, Participation, and Transportation Choice*. Vancouver: Sauder School of business, University of British Columbia.

Association québécoise de lutte contre la pollution atmosphérique (AQLPA) 2011. Faites de l'air: Le programme québecois de recyclage de véhicules. Présentation aux membres de l'ATUQ. May 17, 2011, Montréal.

Bamberg, S., I. Ajzen, and P. Schmidt. 2003. Choice of travel mode in the theory of planned behavior: The roles of past behavior, habit, and reasoned action. *Basic and Applied Social Psychology* 25(3): 175–187.

Ben-Akiva, M. E. and S. R. Lerman.1985. Discrete choice analysis: Theory and application to travel demand. *MIT Press Series in Transportation Studies* 9: 390.

Boarnet, M. and R. Crane. 2001. *Travel by Design: The Influence of Urban Form on Travel.* New York: Oxford University Press.

Cervero, R. 2002. Built environment and mode choice: Toward a normative framework. *Transportation Research Part D* 7: 265–284.

Chen, C. F. and W. H. Chao. 2011. Habitual or reasoned? Using the theory of planned behavior, technology acceptance model, and habit to examine switching intentions toward public transit. *Transportation Research Part F: Traffic Psychology and Behavior* 14(2): 128–137.

Dill, J. 2001. Design and administration of accelerated vehicle retirement programs in North America and abroad. *Transportation Research Record* 1750*:* 32–39.

Dill, J. 2004. Estimating emissions reductions from accelerated vehicle retirement programs. *Transportation Research Part D: Transport and Environment* 9(2): 87–106.

Dill, J., C. Mohr, and A. Nohad. 2010. *Long-Term Evaluation of Individualized Marketing Programs for Travel Demand Management*. Portland, OR: Oregon Transportation Research and Education Consortium.

Domencich, T. A., D. McFadden, and Charles River Associates. 1975. *Urban travel demand: a behavioral analysis: A Charles River Associates research study.* Amsterdam; New York, North-Holland Pub. Co.; American Elsevier.

Environment Canada. 2009. Government of Canada Launches Vehicle Scrappage Program. (press release, 11-5-2009). URL: http://www.ec.gc.ca/default.asp?lang=En&n=714D9AAE-1&news=5F2CADD5-0E59-4BFD-9075-54D4288CEC54.

Eriksson, L. and S. E. Forward (2011). Is the intention to travel in a pro-environmental manner and the intention to use the car determined by different factors? *Transportation Research Part D: Transport and Environment* 16(5): 372–376.

Eriksson, L., J. R. Garvill, A. M. Nordlund. 2008. Interrupting habitual car use: The importance of car habit strength and moral motivation for personal car use reduction. *Transportation Research Part F: Traffic Psychology and Behavior* 11(1): 10–23.

Flamm, B. 2009. The impacts of environmental knowledge and attitudes on vehicle ownership and use. *Transportation Research Part D: Transport and Environment* 14(4): 272–279.

Gardner, B. 2009. Modeling motivation and habit in stable travel mode contexts. *Transportation Research Part F: Traffic Psychology and Behavior* 12(1): 68–76.

Garling, T., D. Eek, P. Loukopoulos, S. Fujii, O. Johansson-Stenman, R. Kitamura, R. Pendyala, and B. Vilhelmson. 2002. A conceptual analysis of the impact of travel demand management on private car use. *Transport Policy 9*(1): 59.

Garling, T. and G. Schuitema 2007. Travel demand management targeting reduced private car use: Effectiveness, public acceptability, and political feasibility. *Journal of Social Issues* 63(1): 139–153.

International Transport Forum (ITF). 2011. *Car Fleet Renewal Schemes: Environmental and Safety Impacts — France, Germany and the United States*. Paris: OECD.

Jakobsson, C. 2004. Accuracy of household planning of car use: Comparing prospective to actual car logs. *Transportation Research Part F: Traffic Psychology and Behavior* 7(1): 31–42.

Klöckner, C. A. and A. Blöbaum. 2010. A comprehensive action determination model: Toward a broader understanding of ecological behavior using the example of travel mode choice. *Journal of Environmental Psychology* 30(4): 574–586.

Lachapelle, U. and A. Pelletier Audette (2013). Programmes de mise au rancart volontaire de vieux véhicules et justice environnementale et distributionnelle: Perspectives sur le volet québécois du programme fédéral Retire your Ride/Adieu Bazou. *Cahiers de Géographie du Québec* 57(161): 257–276.

Lachapelle, U. 2013. Participation and incentive choice of participants in an early vehicle retirement program in Québec, Canada. *Transportation Research Record* 2375(1): 8–17.

Lai, W. T. and C. F. Chen. 2011. Behavioral intentions of public transit passengers: The roles of service quality, perceived value, satisfaction and involvement. *Transport Policy* 18(2): 318–325.

Lam, T. and C. H. C. Hsu (2006). Predicting behavioral intention of choosing a travel destination. *Tourism Management* 27(4): 589–599.

Léger Marketing. 2010. *Habitudes de déplacements des participants au programme "Faites de l'air/Adieu Bazou" ayant chois les titres de transport en commun comme incitatif.* Montréal: AQLPA.

Meyer, M. D. 1999. Demand management as an element of transportation policy: Using carrots and sticks to influence travel behavior. *Transportation Research Part A: Policy and Practice* 33(7–8): 575–599.

Potoglou, D. and P. S. Kanaroglou. 2008. Modeling car ownership in urban areas: A case study of Hamilton, Canada. *Journal of Transport Geography* 16(1): 42–54.

Pushkarev, B., and J. M. Zupan. 1977. *Public Transportation and Land Use Policy*. Bloomington, IN: Indiana University Press.

Rogalsky, J. 2010. The working poor and what GIS reveals about the possibilities of public transit. *Journal of Transport Geography* 18(2): 226–237.

Scheiner, J. and C. Holz-Rau. 2012. Gendered travel mode choice: A focus on car deficient households. *Journal of Transport Geography* 24(0): 250–261.

Transportation Research Board (TRB). 2001. *Making Transit Work: Insights from Western Europe, Canada, and the United States.* Washington, DC: TRB.

Transportation Research Board and Institute of Medicine of the National Academies (TRB-IOM) 2005. *Does the Built Environment Influence Physical Activity? Examining the Evidence*. Washington, DC: TRB.

van Wee, B., H. C. Moll, and J. Dirks. 2000. Environmental impact of scrapping old cars. *Transportation Research Part D: Transport and Environment* 5(2): 137–143.

Weaver, D. B. and L. J. Lawton (2007). Twenty years on: The state of contemporary ecotourism research. *Tourism Management* 28(5): 1168–1179.

Zolnik, E. J. 2012. Estimates of statewide and nationwide carbon dioxide emission reductions and their costs from Cash for Clunkers. *Journal of Transport Geography* 24: 271–281.