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Modal Choice and the Impacts of Imperfect Information Sets for the Urban Transportation Sector

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INTRODUCTION:

Urban transportation is the cause of many externalities including wasted time, energy and money, congestion, and is responsible for environmental damage such as climate change, urban smog and acid rain. The problem faced by urban areas is to satisfy growing transportation demands within capacity, cost and environmental constraints. At present, most attention is focused on the emissions of greenhouse gases (GHG's), as policy makers consider the actions necessary to comply with emission reductions as negotiated by the Kyoto Protocol. The key to a sustainable and efficient transportation system is to better integrate economic, social and environmental considerations into decisions affecting transportation activity and implement a subsequent policy as a function of these three considerations.

The textbook explanation of why emissions are growing in the transportation sector involves externalities. In this view there are three theoretical solutions to control urban transportation. Policy makers could apply physical restraints, price restraints or encourage a revolution in the type of transport currently available through subsidies or grants. In the long term, technology may hold the most promise of providing safe, efficient, competitive and environmentally friendly transportation with the possibilities of new fuels and engine technology innovation. However the prospect of retiring millions of vehicles, retooling manufacturing plants, generating consumer acceptance and renovating current transportation systems will take time, potentially as long as 20 to 30 years in current markets, and a great deal of funding. More probable than technological

innovation is the use of physical restraints, such as reducing the supply of parking or controlling road use with bans or permits, however this would involve some sort of regulation, which again could be rather costly. The simplest and most effective method to reduce the demand for urban transportation may be the use of price restraints, making users pay for the externalities they create when they chose to drive. Price restraints could include higher fuel taxes and licensing costs or tollbooths, which would meter actual use of given roads. Ideally price restraints should be applied to recover the full congestion and other costs imposed by the user.

A departure from this view is the prospect that the motorist's apparent preference for using his car rather than public transport is not a fully reasoned choice, or one based on full information. While there is a need to focus on research that will provide the greatest payoff, such as new fuels, engine technologies, developing and improving current pedestrian access and public transit infrastructures in urban centers, all of these strategies can be quite costly and the outcomes are undetermined. This paper will investigate the potential for a simpler solution: to provide commuters with all relevant information to aid individuals in their transportation mode decision-making process. The journey to work is a special case and is of interest because it requires two trips per day, usually within peak hours.

Assuming that commuters have imperfect information sets, the willingness of urban commuters to accept a switch in their current mode of transportation once given pertinent information will be explored, using Ottawa, Ontario, Canada as a case study. Through the use of a survey (which may be viewed in the appendix), the hypothesis that urban commuters choose non-optimizing modes of transportation due to imperfect

information sets will be tested. The purpose of the survey is to determine whether or not urban commuters have gathered complete information sets regarding the costs associated with daily commutes during peak hours. There are two kinds of cost incurred in a daily commute that are mutually exclusive of each other. The private costs incurred such as time delays, fuel, insurance, parking, the costs incurred from maintaining their vehicles and so on affect the individual directly. The indirect costs of commuting, which affect not only the driver but create externalities for experienced by all, arise from congestion and environmental damage such as GHG emissions, smog and acid rain. The survey will test the individual knowledge of both costs and determine the influence full information sets have on an individual's modal choice. If it is found that individuals are more likely to consider "greener" modes after being given all the information necessary to them, policy makers may then be able to reduce dependence on the automobile by making such information readily available to the public. This potential could be optimized by making improvements to current public transportation infrastructures and facilities, as well as increased parking fees, increased fuel taxes and so on.

BACKGROUND

Canada has signed the Kyoto Protocol (although it has not yet been ratified), which would require a reduction in levels of GHG emissions by 6% relative to 1990 levels by 2008 to 2010. According to Canada's Greenhouse Gas Inventory from 1990 to 1998, road transportation was responsible for about 81% of the transportation sector's carbon dioxide emissions in 1995, with urban travel accounting for 60% of these emissions. The share of emissions caused from urban travel is weighted so heavily

because such travel produces, on average, twice the amount of GHG emissions per passenger-kilometer (i.e. due to fuel inefficiencies of idling in traffic). If current trends continue GHG emissions from transportation are expected to exceed 1990 levels by 32% in 2010 and by 53% by 2020[1]. One way in which the urban transportation sector can contribute to the achievement of this goal is to encourage shifts from the private automobile, particularly single occupant vehicles, to public transit.

To a degree Canada's vast size and harsh climate may increase transportation needs but it can be concluded that there is also a good deal of waste largely due to Canadians' marked preference for private automobiles over public transportation. There has been a growing trend in the demand for transportation as a result of an increasing population, movement towards suburban areas, and economic growth, with private automobiles being the fastest growing mode of transportation. Currently Canada holds one of the highest ratios of car ownership in the world at almost 1 vehicle for every 2 people.[2] The Auto$mart Guide, a 1999 publication from Office of Energy and Efficiency for the Government of Canada, boldly states that Canadians waste excessive amounts of energy and money by inappropriate purchase decisions (i.e. the growing number of sport utility vehicles bought each year), inefficient driving habits (speeding, rapid acceleration and so on), driving unnecessarily and poor vehicle maintenance.

While public transit is used most heavily in urban areas, three out of four Canadians drive their own vehicles to work, with the majority of these commuters driving during peak hours causing congestion. Congestion can have a profound impact on quality of life, health and the economy. According to a 1999 report on funding

[1] The interested reader is directed to the *Options Paper of the Transportation Climate Change Table*, November 1999, for detailed information on transportation and climate change.

transportation, more than 70 percent of the highway network is congested during peak periods in the Greater Toronto area, creating an unacceptably low level of service to business and residents.[3] Thus a key objective for policy makers is to increase the use of public transit, particularly during peak periods.

Perhaps the appropriate mix of policy instruments could reduce the negative impacts of transportation by internalizing the environmental externalities of passenger transport. As previously discussed, this can be done in a variety of ways. Most economists would advocate the gas-tax option since it encourages users to drive less and purchase more fuel-efficient models, whereas the other options, such as increased parking fees, are more in the nature of fixed costs, which in theory may have little or no effect. Correcting Canada's tax system for existing market distortions, having them reflect the environmental and health pressures put on by current energy and transport technologies and behaviour, could replicate the positive effects seen in other countries. For example, Europe has seen a significant decline in single occupancy vehicles due to increased fuel taxes. Worth noting is that most commuter parking in Canada is free. The 1996 Transportation Survey conducted in the Greater Toronto Area found that nearly 80% of all commuters did not pay for parking at their place of work. It has been suggested by the Transportation Table of the National Climate Change Process (NCCP) that Canada change its tax laws which currently allow employers to provide their employees with parking permits, which theoretically is supposed to be a taxable benefit (however it is difficult to enforce this) while employer provided transit passes are taxable benefits but

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[2] The Auto$mart Guide, p.1.
[3] Sustainable Transportation: The Canadian Context, p. 3

there have been no changes to date.[4] Such a tax structure not only promotes single occupancy vehicle travel but also encourages it. Many researchers such as Lichfield and Chapman believe such policies are necessary for reducing urban transportation, concluding in their 1971 paper that "for established cities beyond a certain size it is impracticable to provide for the free use of the motor car." Thus, these costs must be made well known and recovered from drivers and until they are the imbalance will continue.

DETERMINANTS OF MODAL CHOICE:

While researchers, in response to environmental concerns, are revisiting the problem of urban transportation much of the existing literature is relatively old, dating back to the oil crisis of the 1970's when transportation was last a hot topic. It is assumed that the determinants and attitudes surrounding modal choice have stayed relatively the same over the years although improvements to public transit infrastructures should be considered. Despite these innovations to public transport, which may make transit more comfortable, reliable and efficient, individuals prefer their own vehicles, perceive transit to be slower and less convenient.

Most people have a marked preference for commuting in their own vehicle as opposed to using public transit. Stubbs et al (1984) observe that expenditure on buying and running cars rises with income, while expenditure on bus trips fall as income rises. This pattern indicates that car trips are normal goods while bus trips are inferior goods. Supporting this view, Meyer et al (1965) establishes that income elasticity of car travel is

[4] The interested reader should refer to the Transportation Issue Table Tax Exempt Status for Employer Provided Transit Benefits.

positive. In contrast Guria and Gollin (1985) argue that income is overstated as a determinant of modal choice. Rather, accessibility to public transit has a much greater impact and when this factor is taken into account the observed income preference for cars over trains disappears. Nonetheless, the clear income preference for car over bus remains.

Various models exist to predict modal choice, and through the use of computers, simulations can be very sophisticated. The literature can be broken down into three categories, which was efficiently summarized by Quamby (1964) almost four decades ago. Despite the age of Quamby's paper his summary is valid today. "Firstly there is the type of study that relates city characteristics such as size and density and demographic characteristics like income and car ownership to the use of public transport. Secondly there are models of modal choice, which attempt to forecast travel behaviour, in particular, transit use and private car use for trips within a given region. Thirdly, some researchers have developed models to explain and predict individual choice of mode taking into account individual travel and household characteristics." In spite of these models and efforts to understand modal choice, little is known quantitatively about the role of perceptions, as distinct from the role of income which is well researched (see above).

Consider this simple model of full information in which individuals seek to minimize their total cost of transportation. Let TCc represent the net cost (i.e. private and external costs minus benefits) involved in a daily commute, and let TCt represent the net cost incurred from taking public transit. These benefits include the less tangible aspects such as include convenience, comfort, and congestion. Fully informed individuals are

assumed to make their modal choice be comparing TCc and TCt. Specifically if TCc – TCt > 0 then the individual chooses public transit. If TCc –TCt < 0 then the individual chooses to drive a car. Finally if TCc – TCt = 0 the individual is indifferent.

In contrast, it individuals have imperfect information, then perceptions and habit come into play. In this case, if actual TCc –TCt > 0 and the individual's chooses to drive, it is assumed that the individual believes that TCc –TCt ≤ 0. In this scenario the individual is simply unaware, basing their decisions on what they perceive the costs to be or overemphasizing the personal utility gained by driving or potentially lost by taking public transit.

In 1971, Lichfield and Chapman conducted a study on modal choice and found evidence to support the notion that individual travel behaviour is not a fully reasoned choice since individuals do not fully understand the costs incurred. Their research caused them to state that the motorist incurs heavier direct and indirect costs in the various fixed and variable costs associated with driving and maintaining a vehicle than he/she realizes and that as citizens commuters should be concerned with a transportation system which caters to the motorist since it uses more real resources than public transportation and further degrades environment. Lichfield and Chapman also suggested that other private costs are incurred including safety since the motorist is exposed to more accidents, and time since while potentially saving a margin of time by driving, there is likely a heavier consumption of time when trying to park it. About congestion Lichfield writes that in congested conditions some road users impose more costs on traffic as a whole than they themselves gain from using the road. He continues that as a result of these external costs more would be gained than lost if they did not use the road.

Broadening the idea of imperfect information sets is the possibility that individuals have incorrect perceptions of transportation options available to them and unless faced with a strong stimulus will act out of habit, never exploring their alternatives. In 1970, Mercadel found in his French study that the individual rarely takes into consideration a means of transport other than that to which he is accustomed. Influenced by this work Hensher (1975) proposed that habit and preconceptions of the individual affect his perception of the attributes of a travel mode, such as time and comfort, rather than actually incurring the costs or time loss necessary to learn the real values of alternate modes of transportation. "Modal choice can be considered as entailing a risk resolution, the operative features of which are the perceived risk, information, and pay-offs and not their actual values (Hensher, p.101)". Hensher describes a model using two periods, the "habit period" and the "decision period", where the individual only deviates from the habit period when faced with strong stimuli such as increased fuel taxes beyond a certain threshold. More specifically, when in the habit period people do not value modal attributes directly in terms of the usual and alternative modes, they simply view them in terms of deviations from the usual mode. It is hypothesized by Hensher that in the habit period conditions, the relative time and relative cost in a trade-off situation between the usual and alternative mode(s) is not necessarily the best approach since the individual will only begin to search and learn about new modes when the usual mode becomes less than satisfactory (i.e. past a certain threshold). Although no actual case study was conducted, Heshner concludes that there is a search and learning process which occurs prior to the decision to change modes or not. Other modal changes may occur if preferences change over time or due to social interactions especially in the family

unit. Heshner's final contribution is that over time reinforcement processes continuously modify perceptual limits.

Supporting the idea for increasing information sets is some results found in the Modal to Shift Transit Study (1992). This study conducted by the Canadian Urban Transit Association suggests that public transit is supported through environmental concerns. Thus the public is looking to make more environmentally friendly choices but is in need of direction, incentive and most importantly information.

It should be noted that it has been found that there is not homogeneity between transport mode choice and journey purpose. Since this paper is only concerned with urban transportation during peak hours, this is of great significance. Watson in his 1974 study found that he had to reject his hypothesis that individuals make their travel mode decision based on a time-cost tradeoff for the commuter group although his hypothesis was more significant for social/recreational travelers. This implies that commuters have different priorities perceptions, and use different relative weightings in the evaluation of the characteristics of alternative modes. These perceptions and priorities will be explored through the use of a survey, which targets the urban commuter.

SURVEY: EXPLANATION AND EVALUATION

A survey was developed to investigate the causal factors influencing travel demands for an existing situation and to examine them in relation to incomplete and full information sets. Using Ottawa, Ontario, Canada as a case study, it will be determined whether or not commuters will consider a modal shift once given complete information. The results obtained may represent a random group of urban commuters but due to time

and resource constraints the survey was conducted on a small scale and should be thought of as a pilot for future research. Therefore, the results presented should be considered preliminary.

The survey, which may be viewed in the Appendix 1, deals with the private and external costs of driving and maintaining a vehicle. The first three questions serve to target the group of interest: those who commute by a personal vehicle during peak hours. Working in sections the survey is set up to first determine the subject's current behaviour. Then it asks the subject to evaluate in detail costs of their transportation decision, followed by pertinent information about such costs incurred in driving and maintaining a vehicle. Finally, the respondent is asked whether they may change their current behaviour at some point in time. If, after learning about the costs and/or the externalities created from urban transportation, the respondent indicates a willingness to change his or her current mode, then it may be concluded that individuals do not possess the proper information needed to make an optimizing decision. They may have been acting out of habit or basing their decisions solely on their perceptions of their actions and other options available to them.

The survey deals with both the private and the external costs of a daily commute which may not be of equal importance to each individual. Thus, four different versions were created in efforts to see if people were more affected by information on private or external costs, or, if information on both was given, if the order in which it was represented affected modal choice. For the three versions that include private costs, a worksheet (which can be viewed in Appendix 2) was created to aid respondents in their

calculation to ensure that individuals considered all necessary factors and allowed for unity in the calculation procedure between respondents.

The worksheet involves the use of two tables that estimate the residual values of one's vehicle. These tables reflect a linear extrapolation of data (the data may be viewed in Appendices 3 and 4) provided in DesRosiers (2002), which show the average wholesale prices of used vehicles in Canada by age, model year, and vehicle type (passenger car or light truck). Obviously, re-sale value is expected to vary inversely with the age of a vehicle. In addition, DesRosiers argues that improved quality of vehicles over time has resulted in better retention of value with age. Thus re-sale values should be expected to vary positively with model year. A simple linear regression of re-sale value on age and model year was estimated for both passenger cars and light trucks.

The expected relationships were confirmed in the case of cars. Specifically,

$$R = 75.54 - 7.12A + 0.092M, \quad \overline{R}^2 = 0.84 \qquad (1)$$

where R denotes the re-sale value as a percentage of the original price, A denotes age, and M denotes model year. The coefficient on age was of the correct sign and statistically significant. The coefficient on model year was not statistically significant, but it did meet expectations concerning sign. Visual inspection of the data suggest that the assumption of a linear relationship is reasonable for used vehicles but not for the transition from new to used. In other words, the loss of value in the first year of a vehicle's life is governed by a relationship other than (1). Therefore, (1) is only applicable for $A \geq 1$.

In the case of light trucks, the expected relationship with model year was not confirmed; i.e. the partial regression coefficient turned out to be negative rather than

positive. Upon inspection, it became clear that there was a quadratic relationship between model year and re-sale values over the nineties – lower at the beginning of the decade, higher in the middle, and then lower again toward the end. Therefore, the assumption of a linear relationship between model year and re-sale is not valid in this case. It is possible that this quadratic relationship was due in some way to the business cycle or that there were some very popular models that hit the re-sale market in the mid-90's. However, these possibilities remain conjecture, and in the present case the model year was simply dropped. The estimated regression for light trucks is:

$$R = 81.90 - 7.62A, \quad \overline{R}^2 = 0.75. \qquad (2)$$

Equations (1) and (2) were then used to estimate the values in Tables 1 and 2.

SURVEY RESULTS:

Thirty surveys were randomly distributed, of which 14 were properly completed and returned yielding a response rate of 47%. After assessing each survey it may be concluded that individuals do not have perfect information sets. 65% of the respondents indicated in question 39 that they learned something new upon completing the survey. Of the other 35%, they had either indicated that they were unaware of the transit services to their area or their surveys showed discrepancies in their answers provided to the questions regarding private or external costs.

The results obtained in the survey coincide with those found by OC Transpo in their 1999 Attitude Survey. The predominant perception held by the public is that taking

public transportation is slower and less convenient than driving one's car. Interestingly, of the respondents from our survey 16% said they had never ridden public transit in Ottawa, yet stated that they chose to drive because it was a faster option, clearly illustrating this attitude.

Almost half (43%) of the respondents indicated an interest and/or a willingness to switch modes. It should be noted that almost half of those willing to switch indicated that they would be walking, biking, or blading during the summer months, not riding public transit, and therefore presumably back in their vehicles in worse weather. Some others indicated that they would switch to public transit if the services were improved. Of the 43% that indicated an interest in making a modal shift, only 33% (or 14% of all respondents) indicated a willingness to switch modes permanently. Here it should be explained that survey results involve some hypothetical bias and even though these individuals indicated a modal switch would take place this cannot be considered certain.

Evaluation of the results indicates that individuals may be more responsive to information on external costs than private costs. Of those that indicated a desire to change modes 50% responded entirely to questions about external costs, 37.5% indicated a change after answering questions on both external and private costs. Only 12.5% of those willing to change were swayed solely by questions pertaining to private costs.

The majority of respondents are paying more for their vehicles than they initially believed. A comparison of the answers from question 10, where the individual is asked to estimate their costs, to the answers found in question 23, where the individual is asked to calculate their private costs, shows that 67% underestimate the annual costs incurred by more than $500. Summarizing the comments made, it seems that people feel they

have been incurring the costs of maintaining and driving a vehicle and regardless of whether these costs are higher than they initially believed, will keep paying them. However, most individuals did indicate some sort of limit to what they would be willing to pay. When asked after what price per litre would gas be too expensive for them to continue commuting answers ranged from $0.60 to "I will always drive". Once again there is some hypothetical bias involved with these answers since no one could afford to drive if the price of fuel increased infinitely.

When asked if they would support an increase in fuel taxes to help fund public transit, only 17% supported the idea. As expected, those who said no were also commuters unwilling to change their current mode of transportation and surprisingly some who did indicate a willingness to switch modes. This may be because they do not plan on taking public transportation and would still be driving their car for other activities. Individuals were far more supportive of an increase in fuel taxes if the revenue went towards decreasing income taxes or the GST.

There did not seem to be any demographic correlation between those willing to switch modes. They ranged in ages and income, were an even split between males and females, had varying degrees of education and political preferences. However of the women, almost 40% stated that they would not make a modal shift under any circumstances as they were mothers who felt they needed their cars either to pick up and drop off children or in the event of an emergency no time would be lost by taking public transportation. These conclusions are not supported by regression analysis due to the small sample size.

CONCLUSION:

It is evident from the survey results that individuals are lacking complete information sets pertaining to their mode of transportation. However, when given more information the majority of those surveyed were unwilling to change their current mode of transport. While individuals do have imperfect information sets it can be concluded that the majority are making optimal modal choices since they were unwilling to switch modes after being given full information. It seems those who commute to work have perceived a need for it. Only those who indicated a willingness to switch modes can be considered to have been making non-optimizing decisions. This represents 14% of the respondents and may indicate that the hypothesis presented is somewhat correct.

Canada's National Climate Change Process currently forecasts, in the absence of any new policy changes or pricing changes, transportation GHG emissions will have to be reduced by 28% by 2010 to reach 6% below 1990 levels as specified by the Kyoto Protocol. Since road transportation is responsible for 81% of transportation GHG emissions and urban travel accounts for 60% of these, a 14% reduction in the number of commuters could have an overall reduction of 34.6%. These reductions may be slightly offset by a greater number of buses on the road or a potentially negative cyclical effect where those who would not drive previously, due to the congestion, will now find it optimal to travel in their own vehicle. Nonetheless the potential to reduce urban transportation through increasing information sets is significant. Since individuals seem to be more responsive to information about external costs, policy makers could focus on putting this information at the fingertips and in the ears of the public. This could be done

through a large-scale survey, similar to the one presented, public awareness campaigns, notices in the newspapers and reminders on the radio.

Appendices

Appendix 1

TRANSPORTATION BEHAVIOUR SURVEY

The purpose of this survey is to determine what factors influence people's choice of transportation mode. The survey was developed by Heather Mustoe as part of the research requirement for the Master of Arts degree in Economics at the University of Ottawa. Information provided will be treated as confidential. Should you have any questions regarding the survey, or the use of its information, please contact hmust087@uottawa.ca.

I. PREFERENCES REGARDING MODAL CHOICE

1. Do you own or have daily access to a vehicle? Yes No

2. Do you commute to work or school between peak hours (i.e. between 8-10am and/or between 4-6pm)? Yes No

3. Do you drive yourself to work/school? Yes No

If you have answered "Yes" to the first three questions please proceed, otherwise no further information is needed.

4. Have you ever taken public transportation in Ottawa? Yes No

5. Do you know where the closest bus stop is to your house? Yes No

6. Are you aware of the transit schedule that services your area? Yes No

8. Check all that apply. I choose to drive because
   - ❑ It costs about the same as taking public transit
   - ❑ It's faster than public transit
   - ❑ It's convenient (I only have to worry about my schedule)
   - ❑ Public transportation is unreliable
   - ❑ I need my car for work
   - ❑ The public transportation is crowded and uncomfortable
   - ❑ There is no transit service in my area
   - ❑ Other: _____

II. ASSESSMENT OF PRIVATE COSTS

9. How much does a regular transit pass cost per month for the city of Ottawa? $_____/month

10. Approximately how much do you think you spend on your car each year? $_____/year

11. On a typical day, how pressed for time are you?
    - ❑ Very
    - ❑ Somewhat
    - ❑ Not particularly

12. How long is your commute during peak hours? _____ minutes

13. If you were to drive the same route that you take to work or school at 6pm on a Sunday, how long would it take? _____minutes

14. What would you spend a lottery winning of $7 000 on? _____

15. After purchasing a new car, how much does it depreciate in its first year? _____%

16. Please refer to the appendix and complete the Capital Cost Worksheet for Owners of Automobiles and insert the total annual capital cost of your car as determined in part C.
$_____per year.

17. How much do you spend on auto insurance per month? $_____/month
Multiply by 12 to get annual insurance fee: $_____/year

18. How much do you spend on gas per month? $_____/month
Multiply by 12 to get annual expenditure for gas: $_____/year

19. Do you require a parking pass at your place of work? Yes No

20. Does your employer provide it for free or as part of your benefits package? Yes No

21. If not, how much does your parking pass cost you per month? $_____/month
Multiply by 12 to get annual expenditure on gas: $_____/year

22. How much do you spend, on average, on repairs and maintenance year? $ _____/year.

23. Based on the above estimates, you spend about $_____ per year on your vehicle.
(add the annual totals from questions 16 – 22)

III. INFORMATION ABOUT PRIVATE COSTS:

- The CAA estimated in 2001 that the average Canadian spent $6 645 per year driving and maintaining their vehicle or $546 per year – that's $18.20 per day!
- A regular transit pass for the city of Ottawa enables the pass holder to ride the bus or the O-Train and costs $59.50 per month, or $714 per year.
- Average automobile trip lengths are about 14 km, but travel times increased dramatically between the years of 1985 – 1994 from 19.5 to 26.5 minutes resulting in significantly lower speeds. This is consistent with the significant growth in congestion on major bridges and arterials throughout the day (Transport Association of Canada, 1996).
- In a survey conducted by OC Transpo last year, 80% of transit riders said that taking public transit was faster than driving themselves.

IV. PREFERENCES REGARDING MODAL CHOICE

There are various travel options available to every commuter. One can walk, bike, blade, drive, car pool or take public transportation.

25. After learning about your total costs incurred would you consider changing your mode of transportation for your daily commute? Yes No

26. If you answered no, check all that apply. I would still chose to drive because
    - ❑ It costs about the same as taking public transit
    - ❑ It's faster than public transit
    - ❑ It's convenient, I only have to worry about my schedule
    - ❑ Public transportation is unreliable
    - ❑ I need my car for work
    - ❑ Public transportation is crowded and uncomfortable
    - ❑ There is no transit service in my area
    - ❑ Other: _____

V. PRIOR AWARENESS OF EXTERNAL COSTS

(An external cost is a cost that falls on someone other than the person who generates it. For instance, playing your stereo loudly when your roommate is trying to sleep would be considered an externality)

27. Do you think that your decision to drive has any impact on others? Yes No

28. Do you consider yourself to be concerned with the environment? Yes No

29. Do you consider yourself to be knowledgeable about environmental concerns? Yes No

30. Are you aware of the issue of global warming (also referred to as climate change)? Yes No

31. If you answered yes to the previous question, then please indicate what you think will be the most likely consequences of global warming. (You may be as specific as you like.)

    _____
    _____
    _____

32. Buses create more exhaust and pollute more than cars.
    - ❑ True
    - ❑ False

    Briefly explain your answer.

    _____
    _____

Economists argue that increasing fuel taxes can help reduce pollution from automobiles by encouraging people to eliminate unnecessary trips or live closer to work.

33. Would you support an increase in fuel taxes if the revenue generated went to improving current public transport infrastructures and facilities? Yes No

34. Would you support an increase in fuel taxes if the revenue generated created an equivalent reduction in income taxes? Yes No

35. Would you support an increase in fuel taxes if the revenue generated caused an equivalent reduction in the GST? Yes No

36. After what price per litre would you find it too expensive to drive on a regular basis?
$_____/Litre

VI. INFORMATION ABOUT CLIMATE CHANGE

- Most scientists believe that human activities – primarily those that involve burning fossil fuels – are increasing the atmospheric concentration of pollutants referred to as greenhouse gases. As these gases accumulate they are causing average temperatures around the world to rise which is expected to alter climate and weather patterns.

- The predominant greenhouse gas is CO_2. With no colour or odour, it has an atmospheric lifetime of 50 to 200 years, depending on the absorption rates of the environment.

- Models developed to describe and simulate climate change processes show that, with the doubling of CO_2 concentrations likely to occur within the next century, global temperatures could increase 1.5°C to 4.5°C. (National Action Program on Climate Change, 1995)

- The Ontario/Quebec region is forecasted to experience fewer weeks of snow, a longer growing season resulting in less moisture in the soil and increased frequency of drought and forest fires. Warmer summers will increase the amount of water evaporated from land and lakes and water levels of the Great Lakes could fall by ½ meter to a full meter. The flow of water in the St. Lawerence River could fall by 20% affecting shipping, navigation and the marine environment of the river. There would also be an increase in the number of days each year when heat stress and pollution adversely affect people's health. (National Action Program on Climate Change, 1995)

- The largest contributor to greenhouse gas emissions in both absolute and growth terms is transportation. Urban travel (i.e. city driving) produces, on average, twice the amount of green house gas emissions per passenger-kilometer than highway driving.

- The average car produces about three times its weight in CO_2 every year. Cars that are poorly maintained produce even more CO_2. In contrast, one busload of passengers takes the equivalent of 40 vehicles off the road, saving 70 000 L of fuel and avoiding the emission of nine tones of pollutant per year. (Office of Energy Efficiency, Government of Canada, 2002)

- Canada is currently considering ratifying the Kyoto Protocol, which requires a reduction in greenhouse gas emissions of 6% below 1990 levels by the year 2010.

VII. PREFERENCES REGARDING MODAL CHOICE:

37. If information regarding Ottawa's transit system was sent to your dwelling would you be interested in reading it to learn more about the schedules and services for your area?
Yes No

38. After learning this information, would you potentially change your current mode of transportation at some point?

Why or why not:

_____
_____
_____
_____
_____
_____
_____

39. Did you learn anything new by completing this survey? Yes No

DEMOGRAPHICS:

40. How old are you?
    - ❑ 20 years or less
    - ❑ 21-25 years
    - ❑ 26-30 years
    - ❑ 31-40 years
    - ❑ 41-50 years
    - ❑ 51-64 years
    - ❑ 65+

41. What is your gender?
    - ❑ Male
    - ❑ Female

42. What is your marital status?
    - ❑ Single
    - ❑ Married or common law
    - ❑ Other

43. Do you have children? Yes No

44. Highest education level completed?
    - ❑ Highschool or less
    - ❑ Some college or university
    - ❑ College or university graduate
    - ❑ Masters degree
    - ❑ Doctoral degree
    - ❑ Trade school
    - ❑ Professional degree

45. If you have attended college or university, what was your field of study?
    - ❑ Physical sciences
    - ❑ Life sciences
    - ❑ Social sciences
    - ❑ Arts and humanities
    - ❑ Business
    - ❑ Engineering
    - ❑ Other
    - ❑ Not applicable

46. Have you ever taken a college or university course where climate change was the main topic of one or more lectures?
    - ❑ Yes
    - ❑ No
    - ❑ Not sure

47. What is your current status?
    - ❑ Work full time
    - ❑ Work part time
    - ❑ Non paid work
    - ❑ Retired
    - ❑ Other

48. "The annual income bracket for my family is:"
    - ❑ less than $10 000
    - ❑ $10 000 - $20 000
    - ❑ $20 000 - $30 000
    - ❑ $30 000 - $50 000
    - ❑ $50 000 - $75 000
    - ❑ greater than $100 000

49. If a provincial or federal election were held in the near future, would you be likely to vote?

Yes No

50. If you answered yes to the previous question, would you be most likely to vote for...
    - ❑ a conservative party?
    - ❑ a liberal party?
    - ❑ a social democratic party?
    - ❑ other: _____

51. Have you made donations to any environmental groups within the past two years?

Yes No

52. If you answered yes to the previous question, was the total amount of your donations to environmental groups within the last two years...
    - ❑ between $0 and $250?
    - ❑ between $250 and $500?
    - ❑ between $500 and $1000?
    - ❑ greater than $1000?

Appendix 2

Capital Cost Worksheet for Owners of Automobiles

There are two types of capital costs associated with the ownership of an automobile: interest and depreciation.

Whether you borrowed money to buy your vehicle or paid for it out of your savings, there are annual interest costs associated with ownership of the vehicle. In the first case, the interest charges are obvious and take the form of regular payments to the bank or finance company that loaned you the money. In the second case, there are no explicit interest charges to pay. Nonetheless, because part of your personal wealth is tied up in the vehicle, you can no longer earn interest on this part of your wealth. Therefore, there is an implicit interest cost – the amount of interest you must forgo in order to have the vehicle.

Depreciation refers to the loss in value of the automobile over time. You may be familiar with the fact that the re-sale value of a vehicle drops significantly as soon as you drive it off the dealer's lot. However, depreciation continues throughout the life of the vehicle, as the re-sale value continues to decline with age. This loss of value represents a real cost, since eventually you will have to replace the vehicle, which will require either taking on a new loan or using up some more of your savings.

This worksheet is designed to help you estimate the annual capital cost associated with your automobile.

A. Interest

1. What price did you pay for the vehicle? (Use the price before any trade-in value which the dealer might have given you on your previous vehicle.) _____

   To convert the cost into an annual figure, it must be multiplied by an annual interest rate. A value of 5 percent would be a reasonable estimate for the purpose of this survey. Alternatively, if you are presently making payments on a vehicle loan, you may use the interest rate you are paying on the loan.

2. The annual interest cost of my vehicle is _____. (Multiply your answer to question 1 by the interest rate. For example, if you paid $15,000 for the vehicle and the interest rate is 5 percent, then the answer to this question is $15{,}000 \times 0.05 = 750$.)

B. Depreciation

1. What is the model year of your present vehicle? _____

2. How old was your vehicle when you bought it? _____

3. What is your best guess of when you expect to replace your vehicle?
   _____ years from now

4. How old will your vehicle be when you replace it? _____ (Add answer from question 2 from your answer to question 3.)

Tables 1 and 2 on the following page provide estimates of how well vehicles hold their value over time. The next two questions require you to consult these tables.

5. What was the estimated residual value of your vehicle when you bought it? _____

   (To answer this question, find the age of your vehicle when you bought it (left-hand column) and the model year (across the top) and then note the corresponding value. If your vehicle was new, enter a value of 100. If your vehicle predates the 1992 model year, go immediately to question 8 and enter a value of zero.)

6. What will be the estimated residual value of your vehicle when you replace it?___
   (If your vehicle will be more than 10 years old, enter a value of zero.)

7. Calculate the residual retention rate for your ownership of the vehicle: _____
   (Use the formula $\frac{\text{answer to q.6}}{\text{answer to q.5}} \times 100$.)

8. Calculate the expected re-sale value of your vehicle upon replacement: _____
   $(\text{purchase price} \times \text{answer to q.7} \div 100)$

   There are a variety of techniques and assumptions that can be used to estimate the annual value of depreciation. The simplest method – and the one which will be used for this survey – involves taking the difference between what you paid for your vehicle and its expected re-sale or trade-in value (your answer to question 8), and then dividing by the number of years between the original purchase date and the expected date of replacement. For example, if you paid $15,000 for your vehicle five years ago and you expect to replace it next year, at which time its expected re-sale value will be $4,000, then its annual depreciation would be $(15{,}000 - 4{,}000)/6 = 1833$.

9. Using the method described above, calculate the annual depreciation of your automobile: _____.

C. Total Capital Cost

1. The total annual capital cost of my automobile is _____. (Add your answers to questions A2 and B9 above.)

Table 1: Estimated Residual Value of Passenger Cars
(% of Manufacturer's Suggested Retail Price)

Age	Model Year									
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	68.6	68.7	68.8	68.9	69.0	69.1	69.2	69.2	69.3	69.4
2	61.5	61.6	61.7	61.8	61.9	61.9	62.0	62.1	62.2	62.3
3	54.4	54.5	54.5	54.6	54.7	54.8	54.9	55.0	55.1	55.2
4	47.2	47.3	47.4	47.5	47.6	47.7	47.8	47.9	48.0	48.1
5	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	41.0
6	33.0	33.1	33.2	33.3	33.4	33.5	33.6	33.6	33.7	33.8
7	25.9	26.0	26.1	26.2	26.3	26.3	26.4	26.5	26.6	26.7
8	18.8	18.9	18.9	19.0	19.1	19.2	19.3	19.4	19.5	19.6
9	11.6	11.7	11.8	11.9	12.0	12.1	12.2	12.3	12.4	12.5
10	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4

Table 2: Estimated Residual Value of Light Trucks (includes SUV's)
(% of Manufacturer's Suggested Retail Price)

Age	Model Year									
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3	74.3
2	66.7	66.7	66.7	66.7	66.7	66.7	66.7	66.7	66.7	66.7
3	59.0	59.0	59.0	59.0	59.0	59.0	59.0	59.0	59.0	59.0
4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4	51.4
5	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8	43.8
6	36.2	36.2	36.2	36.2	36.2	36.2	36.2	36.2	36.2	36.2
7	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6	28.6
8	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9	20.9
9	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
10	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7

Sources: Data from DesRosiers (2002) statistical estimation by the author.

Appendix 3

Passenger Cars

Residual Value	Age	Model Year
50.5	2	1
45.6	3	1
42.3	4	1
37.5	5	1
59.0	2	2
54.6	3	2
48.9	4	2
44.1	5	2
63.3	2	3
55.6	3	3
50.7	4	3
43.1	5	3
62.8	2	4
58.1	3	4
49.5	4	4
39.4	5	4
66.3	2	5
56.8	3	5
46.6	4	5
38.3	5	5
63.1	2	6
53.1	3	6
44.0	4	6
37.3	5	6
61.0	2	7
51.9	3	7
44.5	4	7
36.4	5	7
61.3	2	8
53.2	3	8
44.4	4	8
60.5	2	9
52.7	3	9
61.3	2	10

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.9223985
R Square	0.85081899
Adjusted R Sq.	0.84119441
Standard Error	3.48456809
Observations	34

ANOVA

	df	*SS*	*MS*	*F*
Regression	2	2146.758694	1073.379347	88.40062
Residual	31	376.4086587	12.1422148	
Total	33	2523.167353		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	74.541135	2.457584328	30.33105892	1.3E-24
X Variable 1	-7.12059652	0.552280767	-12.89307351	5.39E-14
X Variable 2	0.09176471	0.239039399	0.38388946	0.703681

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*
1	60.3917067	-9.891706711
2	53.2711102	-7.671110191
3	46.1505137	-3.85051367
4	39.0299171	-1.52991715
5	60.4834714	-1.483471417
6	53.3628749	1.237125104
7	46.2422784	2.657721624
8	39.1216819	4.978318144
9	60.5752361	2.724763877
10	53.4546396	2.145360398
11	46.3340431	4.365956918
12	39.2134466	3.886553438
13	60.6670008	2.132999171
14	53.5464043	4.553595692
15	46.4258078	3.074192212
16	39.3052113	0.094788732
17	60.7587655	5.541234466
18	53.638169	3.161830986
19	46.5175725	0.082427506
20	39.396976	-1.096975973

21	60.8505302	2.24946976
22	53.7299337	-0.62993372
23	46.6093372	-2.6093372
24	39.4887407	-2.188740679
25	60.9422949	0.057705054
26	53.8216984	-1.921698426
27	46.7011019	-2.201101906
28	39.5805054	-3.180505385
29	61.0340597	0.265940348
30	53.9134631	-0.713463132
31	46.7928666	-2.392866611
32	61.1258244	-0.625824358
33	54.0052278	-1.305227838
34	61.2175891	0.082410936

Appendix 4

Light trucks

Residual Value	Age	Model Year
62.4	2	1
57.1	3	1
55.3	4	1
50.4	5	1
63.6	2	2
62.2	3	2
57.8	4	2
50.4	5	2
72.1	2	3
64.6	3	3
57.3	4	3
48.4	5	3
73.0	2	4
65.7	3	4
56.4	4	4
42.6	5	4
70.6	2	5
62.4	3	5
50.3	4	5
39.6	5	5
67.0	2	6
56.2	3	6
45.3	4	6
36.2	5	6
64.4	2	7
53.2	3	7
44.8	4	7
35.0	5	7
62.1	2	8
54.1	3	8
48.9	4	8
62.8	2	9
57.5	3	9
65.7	2	10

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.8685458
R Square	0.7543718
Adjusted R Square	0.746696
Standard Error	4.9701764
Observations	34

ANOVA

	df	*SS*	*MS*	*F*
Regression	1	2427.732746	2427.733	98.27822
Residual	32	790.4849014	24.70265	
Total	33	3218.217647		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	81.898873	2.715879872	30.15556	4.52E-25
X Variable 1	-7.6242254	0.769072153	-9.913537	2.8E-11

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*
1	66.650423	-4.250422535
2	59.026197	-1.926197183
3	51.401972	3.898028169
4	43.777746	6.622253521
5	66.650423	-3.050422535
6	59.026197	3.173802817
7	51.401972	6.398028169
8	43.777746	6.622253521
9	66.650423	5.449577465
10	59.026197	5.573802817
11	51.401972	5.898028169
12	43.777746	4.622253521
13	66.650423	6.349577465
14	59.026197	6.673802817
15	51.401972	4.998028169
16	43.777746	-1.177746479
17	66.650423	3.949577465
18	59.026197	3.373802817
19	51.401972	-1.101971831
20	43.777746	-4.177746479
21	66.650423	0.349577465

22	59.026197	-2.826197183
23	51.401972	-6.101971831
24	43.777746	-7.577746479
25	66.650423	-2.250422535
26	59.026197	-5.826197183
27	51.401972	-6.601971831
28	43.777746	-8.777746479
29	66.650423	-4.550422535
30	59.026197	-4.926197183
31	51.401972	-2.501971831
32	66.650423	-3.850422535
33	59.026197	-1.526197183
34	66.650423	-0.950422535
34	61.525717	4.174283347

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