DO CANADIANS ENJOY CONGESTED TRAVEL? MEASURING COMMUTE SATISFACTION AND THE EFFECTS OF CONGESTION IN CANADIAN CITIES

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Introduction

Transportation planners and policymakers continue to justify large transportation programs on the basis of travel time savings and the implicit quality of life welfare gains from a shorter or more satisfactory commute. But while travel time savings remain perhaps the most important benefit analyzed in conventional benefit-cost analyses of infrastructure investments, it remains unclear whether travel time savings actually materialize after an increase in capacity (not the focus of this paper) and what type of transportation systems and travel conditions are most conducive to social welfare improvements – the topic of this research. In the current era of policymaking, the broad focus remains on 1) saving commuting times, and 2) alleviating traffic congestion, but priorities have recently shifted from encouraging large-scale road building programs towards 3) switching modes from vehicular travel to public transit, cycling, and walking. In the Greater Toronto and Hamilton Area [GTHA] for example, $16 billion has been committed to fund nine priority transit projects as of 2013, while ten further projects totaling an additional $34 billion are in various stages of planning and design as part of the Big Move regional transportation plan. This total reflects merely the capital budget for new infrastructure, as millions more are being spent on a variety of initiatives such as managing transportation demand, promoting active transportation, planning intensification around transit, and implementing a regional farecard (Metrolinx, 2013).

One of the central justifications behind the Big Move regional transportation plan is the modeling of forecasted travel times in the

year 2031 for the 'do-nothing' and full implementation scenarios while taking into account the expected growth of population in the GTHA. Compared to the present average of 82 minutes, the model has forecasted average two-way commutes of 109 and 77 minutes for the do-nothing and full implementation scenarios respectively (Metrolinx, 2008). In an effort to bolster public knowledge of the Big Move, a local advocacy group has attracted significant media attention in highlighting the 32-minute difference in commute times attributed to realizing the plan's goals. Some confusion arises from this analysis, as it may appear as though full implementation of the Big Move will potentially shave 16 minutes off of an individual's present 82-minute average one-way commute trip – certainly an appealing prospect for many. However, it actually considers the difference between the do-nothing and full implementation scenarios in 2031. Thus, if the Big Move's projects are built out, these investments will have resulted in a net average travel time savings of only 2.5 minutes in each direction.

Of course, if long run travel time budgets are indeed stable in the aggregate as popularly argued by Metz (2008), the assumption of average one-way commutes of nearly 55 minutes in the do-nothing scenario are not likely to be achieved. Such criticisms of the Big Move's modeling assumptions suggest important implications for the justifications offered in support of such a large investment in transportation infrastructure in the Toronto region, and we return to this later. However, let us first cast these criticisms aside for the time being to continue our analysis within the framework of the existing policy context in the GTHA.

Better guidance is needed in identifying the types of transportation systems, policy and planning tools, infrastructure investments, and travel behavior outcomes that are most promising in improving social welfare. Although most transportation policies and programs are framed on the basis of impacting average commute times, the largest welfare benefits may actually accrue from improving only a small subset of commuting conditions which are most detrimental to the welfare of residents in an urban area.

Still, we do not know the nature of the relationship between commuting, congestion, and travel times. Benefit-cost analyses generally take the product of the total expected project-induced travel

time savings (regardless of mode or reference travel times) and the estimated value of time to arrive at an estimate of total project benefits. But by focusing on average commuting and travel times and the value of time savings, the potentially more transformative impacts of encouraging those travel conditions which are most social welfare-improving are ignored. Saving two minutes on an 18-minute commute is not likely to represent the same social benefits as saving two minutes on a 52-minute commute for example. Furthermore, in addition to wear and tear on an individual's automobile, congestion also imposes significant physical and mental costs on drivers (Stutzer & Frey, 2008). But how does the stress of congestion affect commuting satisfaction? Do all individuals respond to travel times and congestion in the same manner? Or is there some heterogeneity in the link between commute satisfaction, travel time, congestion, and location?

That these questions remain unanswered suggests that understanding the variation in how travel behavior and different incremental changes in commute lengths and congestion influence commute satisfaction is of paramount importance. This paper sets out to address this gap in our understanding of the nature of commuting. Working primarily from the perspective of drivers, we seek to measure the effects of travel time and congestion on an individual's satisfaction with their commute and reflect on the implications of these findings for policy.

Background

Unlike the American Community Survey in the United States, no information related to commuting travel times has been collected on such a large scale through the Canadian Census of Population prior to the addition of a travel time variable in the 2011 National Household Survey. Nevertheless, round-trip travel times for the trip to work have been collected as part of four time-use waves of the Canadian General Social Survey between 1992 and 2010 (Table 1). In contrast to Metz (2008), who documented that travel times have been relatively stable across the United Kingdom over several decades despite billions spent on road infrastructure, Table 1 shows that time budgets are not stable across time in Canada and within Canadian cities. Average duration of commute to and from work increased for

automobile and transit users between 1992 and 2005 across Canada, though they have fallen since. Vancouver is an exception, as commute times appear to have steadily declined since 1992. In Toronto, commute times have seen a sharp decline from their high of 79 minutes in 2005 to 66 minutes in 2011, though they continue to be the highest in Canada. We may never know if Toronto would have achieved worst-case projections of average travel times of 109 minutes, but with the region presently below the Big Move's target of a 77-minute commute, even as many of the plan's projects remain in planning or under construction, such trends warrant further investigation.

Table 1 Average Commute Times in Canadian Cities, 1992-2011

	1992[a]	1998[a]	2005[a]	2010[a]	2011[b]
Canada Total	54	59	63	52	51
Toronto	68	76	79	66	66
Montréal	62	65	76	62	60
Vancouver	70	68	67	60	57
Ottawa-Gatineau	57	62	65	54	52
Calgary	52	64	66	52	54
Edmonton	50	58	62	46	51

Sources: a) General Social Survey; b) 2011 National Household Survey

Much of this variability in average commute times remains unexplained in the Canadian context. Like their counterparts in the United States, travel times have declined since 2005, part of which may be explained by the recession that began in 2008. Some variability can also likely be explained by differences in sample size, which has grown from less than 10,000 in 1992 to 20,000 in 1998 and 2005 and to 25,000 in 2010. In contrast, more than 2.5 million households completed the 2011 National Household Survey. We have developed several other hypotheses, but due to length restrictions they are omitted for the present paper.

Whatever the explanation, researchers need to realize a better understanding of the nature of commuting satisfaction as it relates to commute duration and the impacts of congestion. Based on the construct of travel as a derived demand, one would expect different commuting times, the use of different modes, and exposure to traffic congestion to be associated with different levels of commuting

satisfaction which systematically reflect patterns in the underlying population's travel preferences. This study tests this expectation in the Canadian context.

Data and Methods

The primary data source for this analysis is the 2010 edition of the Canadian General Social Survey [GSS]. Our sub-population selected within the 2010 GSS for this analysis consists of a weighted sample of 3,319 individuals who are at least 16 years of age, live in any of Canada's 33 Census Metropolitan Areas as of the 2006 census, are employed full-time or part-time, and commute to work by car, and only by car for the entire trip

Model Variables: Commute to Work

Commute Dissatisfaction (COMDISSAT): The dependent variable for this research is an individual's stated dissatisfaction with their commute. Respondents to the GSS were asked "Overall, how satisfied are you with the amount of time it took you to get to work/school last week?" with answers recorded on a scale of 1-4 ranging from 'very satisfied' to 'very dissatisfied'.

Travel Time (TRVMIN): The travel time variable captures an individual's stated one-way travel time on their commute to work. The distribution of travel times organized according to commute dissatisfaction is presented in Figure 1. In general, the distribution is skewed towards shorter commute times that are more satisfying, though it can be seen that dissatisfaction grows as travel times increase. The distribution of travel times was truncated to remove a very small number of commutes less than 5 minutes and over 90 minutes in duration, as it was felt that such trips were not representative of commuting in general. The gap in travel times between 50-59 minutes in the distribution can likely be attributed to the stated nature of the travel time question where an estimate of roughly 60 minutes is more convenient than offering a more precise estimation of travel time less than this major trip duration increment.

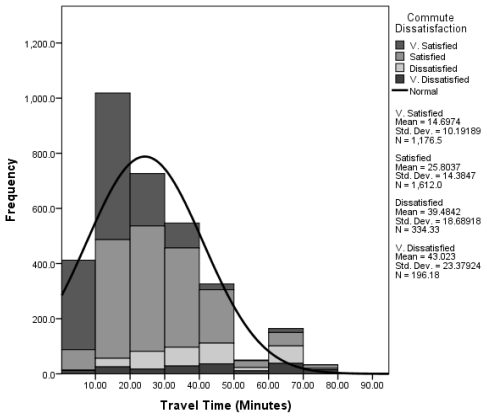

Figure 1 Distribution of One-Way Travel Times and Commute Satisfaction

Frequency of Congestion (CONFREQ): Respondents were asked "Last week, how often did you experience traffic congestion during your commute to work/school?" with answers coded on a scale of 1-4 ranging from 'never' to 'every day'.

Severity of Congestion (CONSEVER): In addition to the frequency of congestion, respondents were asked "Overall, how serious a problem is traffic congestion for you?" Answers were recorded on a scale of 1-4 ranging from 'not at all serious' to 'very serious'.

Table 2 Sample Descriptive Statistics

Vector	Variable	Mean (Prop.)	Std. Deviation
Dependent Variable			
Commute Dissatisfaction (1-4)	COMDISSAT	1.86	0.82
1) Very satisfied	*(Reference)*	(35.4)	
2) Satisfied		(48.6)	
3) Dissatisfied		(10.1)	
4) Very dissatisfied		(5.9)	
Independent Variables			
Commuting			
One-Way Travel Time (Minutes)	TRVMIN	24.26	16.80
Frequency of Congestion (1-4)	CONFREQ	2.14	1.19
1) Never	*(Reference)*	(41.8)	
2) 1-2 days per week		(24.9)	
3) 3-4 days per week		(10.5)	
4) Every day		(22.8)	
Severity of Congestion (1-4)	CONSEVER	2.03	0.95
1) Not at all serious	*(Reference)*	(34.4)	
2) Not very serious		(37.7)	
3) Serious		(18.3)	
4) Very serious		(9.5)	
Congestion Factor (Numeric)	CONFACT	0.03	1.03
Socio-Economic and Demographic			
Age Category (1-7)	AGE10	3.24	1.23
Male (0-1)	MALE	(0.58)	0.49
Visible Minority (0-1)	VISMIN	(0.17)	0.37
Bachelors Degree or Above (0-1)	BAPLUS	(0.66)	0.82
Location			
Greater Toronto and Hamilton Area (0-1)	GTHADUM	(0.24)	0.43
Montréal (0-1)	MTLDUM	(0.13)	0.34
Vancouver (0-1)	VANCDUM	(0.08)	0.27
n			3,319

Model Specification

We employ a multinomial logit regression model to measure the effects of commuting duration and congestion on an individual's satisfaction with their commute to work. Due to collinearity between commute duration and commute distance, only commute duration is considered. Strong correlations between incidences of congestion

and an individual's account of the severity of congestion also means that for this research we investigated congestion according to three different specifications. The first considers incidences of congestion only, the second the severity of congestion only, and the third constructs a congestion factor that combines both the incidences and severity measures. While it sacrifices some resolution in accounting for the total effects of congestion, model output for the first specification is displayed below as it provides the most accurate and easily interpretable account of the effects of congestion on commute satisfaction.

Results

Table 3 displays the results of the multinomial logit model. The dependent variable category 'Very Satisfied' acts as the reference group for the analysis. The reference category for the frequency of congestion variable is the response group corresponding to those that never experienced congestion on their commute to work.

Focusing primarily on column 4, pecific model results indicate that a one-minute increase in travel time (TRVMIN) causes in a statistically significant increase in the probability of being dissatisfied or very dissatisfied the amount of time spent commuting compared to those that described themselves as very satisfied, all else being equal. Differences in the frequency of congestion experienced during the previous week are generally the strongest and most significant predictors of commute dissatisfaction. Relative to those who never experienced congestion, individuals who experienced congestion between 1-2 days, 3-4 days, and every day of the week were much more likely to be very dissatisfied with their commute (column 4). Similar trends are seen for column 3. Congestion also had a negative effect on satisfaction in general, with congestion occurring 3-4 times per week or more increasing the probability of reducing reported satisfaction from 'Very Satisfied' to 'Satisfied' (column 2). However, compared to those that never see congestion, congestion a few times a week increases commute satisfaction.

Table 3 Commute Dissatisfaction - Model Results

Commute Dissatisfaction	2. Satisfied		3. Dissatisfied		4. Very Dissatisfied	
(Ref. = Very Satisfied)	Estimate	P-Value	Estimate	P-Value	Estimate	P-Value
Commuting						
TRVMIN	0.078	0.000	0.111	0.000	0.122	0.000
CONFREQ						
1) Never			*(Reference)*			
2) 1-2 days	-0.697	0.005	-0.066	0.815	1.230	0.002
3) 3-4 days	0.594	0.000	2.834	0.000	2.735	0.000
4) Every day	1.624	0.000	4.193	0.000	2.860	0.000
Socioeconomic and Demographic						
AGE10	-0.043	0.235	-0.161	0.011	-0.141	0.059
MALE	-0.220	0.016	0.061	0.700	-0.345	0.060
VISMIN	0.496	0.000	0.490	0.018	0.182	0.471
BAPLUS	-0.286	0.003	-0.141	0.407	-0.327	0.000
Location						
GTHADUM	-0.204	0.094	-0.100	0.602	0.102	0.655
MTLDUM	-0.426	0.004	-0.331	0.149	-0.234	0.385
VANCDUM	0.441	0.024	-0.103	0.756	1.037	0.002
Intercept	0.212	0.323	-1.331	0.000	-2.115	0.000
Log-likelihood at convergence						4238.292
Pseudo R2 (McFadden)						0.254
Pseudo R2 (Nagelkerke)						0.485

Of the location dummy variables, results suggest first that location does not appear to play a large role in commute satisfaction given the large amount of CMA control variables that were not significant and not included in the model. Instead, the largest dissatisfaction effects are found in the travel time and congestion frequency variables, meaning no commuting satisfaction effects beyond these variables can be statistically determined. Nevertheless, as with its average travel time trend, Vancouver presents an exception, with drivers there more sensitive to other local commuting factors in addition to travel times and congestion. Other variables generally perform as expected, but due to space considerations their discussion is omitted.

The Relationship between Travel Time, Congestion, and Commute Satisfaction

One powerful attribute of multinomial logit models is the ability to calculate predicted probabilities for each case within the sample. A predicted probability consists of the model's estimated probability that the individual in question falls within any given category of the dependent variable given the characteristics of the explanatory variables. For this research, predicted probabilities are first calculated from the third specification of the model that incorporates a combined factor accounting for both the frequency of congestion and an individual's account of the severity of that congestion to their commute. This model formulation has the benefit of offering the most comprehensive account of the effects of congestion on commute satisfaction. The predicted probabilities are then stratified into four groups according to the respondent's frequency of experienced congestion and plotted according to their stated one-way travel time to work. Next, a polynomial trend line is fit to the plotted points. Together, these steps detail the relationship between travel time, levels of congestion, and commute satisfaction (Figure 2). For clarity, plotted probabilities are omitted with just the polynomial trend line shown. Instead, each line's fit to its plotted probabilities is denoted by the corresponding R^2 value.

From Figure 2 it can be seen that congestion and travel times have a profound effect on commute satisfaction. Panel A plots probabilities for individuals that never experienced congestion.

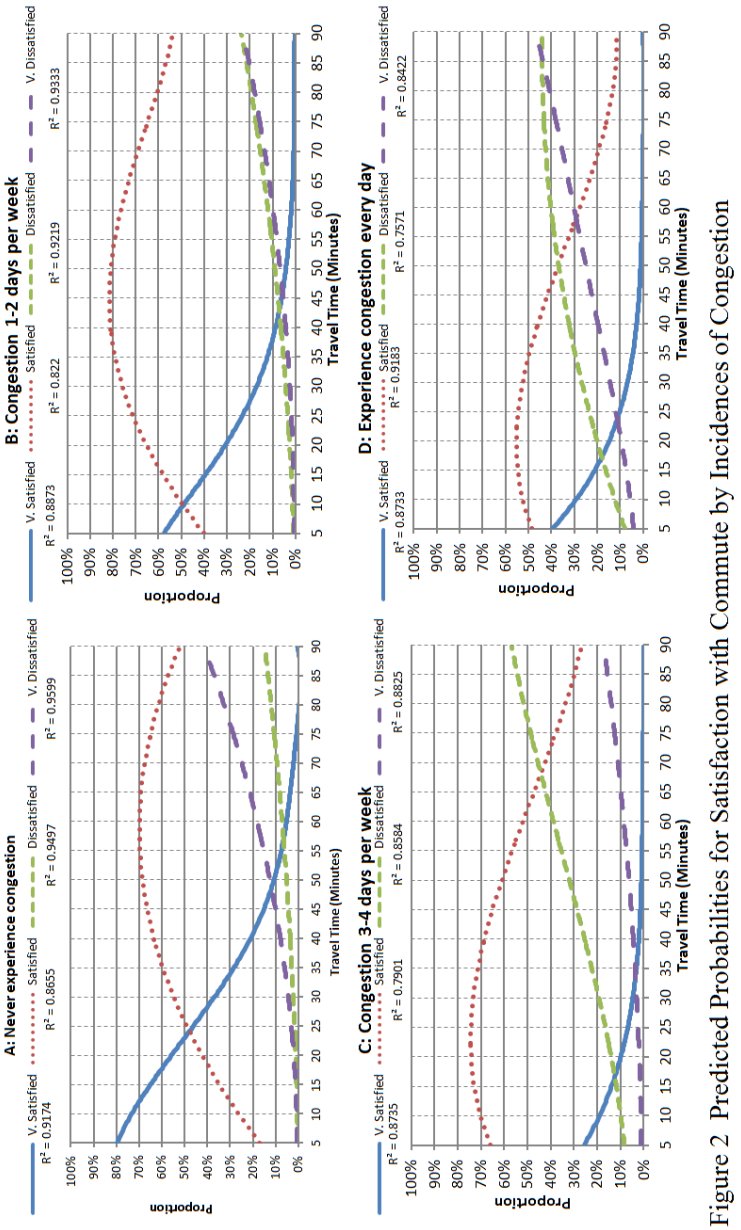

Figure 2 Predicted Probabilities for Satisfaction with Commute by Incidences of Congestion

Polynomial trend lines show that with a 5-minute commute, approximately 80% of individuals will be very satisfied with their commute. It is not until around 25 minutes that more individuals switch from being 'very satisfied' to 'satisfied'. Levels of dissatisfaction slowly rise with travel time, though with no congestion, only 5% and 10% of individuals are predicted to be 'very dissatisfied' or 'dissatisfied' with one-way commutes of 45 minutes respectively.

Generally, slight incidences of weekly congestion (Panel B) do not appear to have a large effect on commute dissatisfaction, and even appear to increase the probability of being satisfied compared to those that never experience congestion. It is not until individuals experience congestion 3-4 times per week or more that congestion starts to have a noticeable effect on commute satisfaction. Panel C shows that the probability of being 'very satisfied' is much lower across all travel times and that the probability of dissatisfaction rises faster with travel times than in Panels A and B, though the probability of being 'very dissatisfied' continues to rise at a slower pace. Likewise, in Panel D, levels of satisfaction in general are much lower than Panels A-C, and the probability of being 'dissatisfied' or 'very dissatisfied' shows a much greater increase as travel times grow. However, it is interesting to note that even among those experiencing congestion every day on their commute to work, it is not until a one-way commute reaches 90 minutes in duration that approximately 50% of individuals become very dissatisfied with their commute.

Figure 3 expands on this finding in greater detail. Here we combine the 'dissatisfied' and 'very dissatisfied' categories and plot the cumulative probability of dissatisfaction according to travel time and levels of congestion. Again it can be seen that for those never experiencing congestion, it is not until one-way commutes reach a duration of 85 minutes that more than 50% of drivers are predicted to be dissatisfied with their commute – a staggering amount of travel time. Similarly, only 1-2 days of congestion per week appear to have little effect on altering this relationship, suggesting that slight congestion imposes no discernable effects on commute satisfaction compared to no congestion. Taken together, this research appears to support the idea that in general, people appear to take satisfaction in what the literature would consider a very long commute to work. In

contrast, congestion 3-4 times per week has a large impact on commute satisfaction, lowering the point at which a majority of individuals report dissatisfaction to approximately 65 minutes. Congestion every day lowers this further to approximately 40 minutes. Note that in all cases this model offers predictions of dissatisfaction that occur at levels of congestion and travel times that are much greater than what may have been expected.

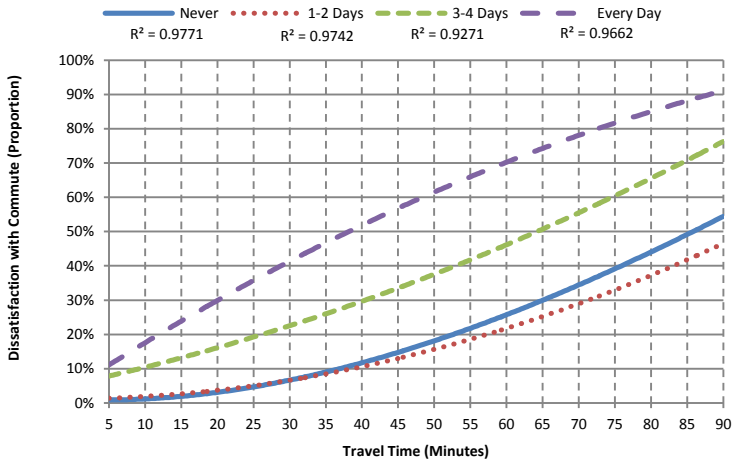

Figure 2 Dissatisfaction with Commute by Travel Time and Level of Congestion

Conclusions: The Policy Implications of Congestion, Travel Times, and Commute Satisfaction

The results of this research on the relationship between congestion, travel times, and commute satisfaction offers several implications for research and policy. First, traditional benefit-cost approaches feature travel time savings as the core benefit of transportation projects and interventions. Basic research evidence supports this view that travel times matter and that there are conditions under which transportation policy interventions can be justified to shift travel times.

But the newer literature on travel and subjective well-being has highlighted that travelers have an affinity for travel, that it can confer

a positive utility independent of its derived demand (Mokhtarian et al., 2001; Mokhtarian & Salomon, 2001). The outcomes of the present analysis appears to support this argument that travel may in fact be associated with some degree of positive utility. In general, the vast majority of those that experience no or little congestion do not appear to be dissatisfied with their commutes, even as one-way travel times approach levels that would be considered far above average. It seems as though Canadians in uncongested areas *like* commuting, in so far as they report satisfaction with their commute. But as Table 1 has shown, average travel times have not grown to excessively high average two-way commutes times. It may be instead that while the act of commuting for these individuals is satisfying in and of itself, there are other cost elements such as time or fuel that influence the duration of one-way commutes in the absence of congestion, and such variables are not captured by this research.

Second, if travel times in and of themselves do not appear to be greatly associated with commute dissatisfaction, congestion certainly is. Those that experience congestion at least 3-4 days per week show drastically different tolerances for commute satisfaction across all travel times. It is not until congestion is taken into account that we begin to see combinations of travel time and dissatisfaction that approach what would correlate with national and CMA-level averages. In this sense, it is not travel times that influence satisfaction, but travel reliability. Incidences of congestion that shift what was planned to be a 30-minute commute to a 40-minute commute no doubt entail a significant reduction in commute satisfaction. Such findings also indirectly reinforce the finding that congestion burdens commuters with considerable physical and mental stress costs (Stutzer & Frey, 2008).

Third, and somewhat contradictory to the previous point, the present research finds substantial heterogeneity in sensitivity to congestion among Canadian drivers. As Figure 2 has shown, even when experiencing congestion every day of the week, very large numbers of drivers remain satisfied with their commutes, albeit only at low travel times. Nevertheless, even with a one-way travel time of 60 minutes in daily congestion, approximately 30% of drivers will still remain perfectly satisfied with their commute.

To return to the policy implications of these findings for transportation plans such as the Big Move, there are several points that can be considered. The first and most obvious take away is that travel times alone do not appear to have much of an impact on commute satisfaction. It is the combination of time spent in congested travel that should be reduced. Second, focusing on the Big Move specifically, there is no question that a 55-minute one-way commute in the plan's worst case scenarios would entail a significant reduction in commute satisfaction. In congested travel, nearly 70% of individuals would be dissatisfied. However, it remains unclear whether such commute lengths are attainable given the recent trend in average commute times both in Toronto and other Canadian cities, and the complex urban system, which would be likely to re-equilibrate around shorter commute times given the dissatisfaction associated with the duration of such a congested commute.

It is more interesting to consider the implications of the Big Move's purported reductions in travel times from 41 to 38 minutes after the full implementation of the transportation plan's projects. In congested travel, such a small reduction of travel time would be likely to only produce a very small decrease in the proportion of individuals that are dissatisfied with their commute. Furthermore, even at a 41-minute one-way commute in daily congestion, approximately 47% of drivers would still be satisfied with their commute to work. But if the Big Move can reduce incidences of congestion, it stands to have a much larger impact on driver welfare as measured though commute satisfaction.

Beyond travel time savings, the Big Move's plan of shifting commuters from the automobile to public transit operates in a complex environment. Congestion acts as an incentive for mode switching. But if research from authors such as Lee et al. (2009) is correct, switching to transit may actually increase average travel times. Nevertheless, the individual must then make a tradeoff between a shorter commute that is dissatisfying due to congestion, or a longer commute that is potentially more satisfying due to a lack of congestion. Future research will extend this analysis beyond drivers to examine the dissatisfaction curves of additional modes to give a more complete picture of the satisfaction structure of transportation options in Canadian cities.

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