THE IMPACT OF THE COMMUTING BURDEN ON LIFE SATISFACTION

by

Alex Fontaine

An essay submitted to the Department of Economics

in partial fulfillment of the requirements for

the degree of Master of Arts

Queen's University

Kingston, Ontario, Canada

July 2015

Acknowledgements

I would like to thank my supervisor, Dr. Christopher Cotton, for his help, suggestions, and helpful comments during the writing of this essay. I also thank Dr. Vincent Pohl and Dr. Jeffrey Penney for their very valuable contributions at the genesis of this research. Finally, I thank Bin Hu, statistical analyst at the Queen's Research Data Centre, for providing me with the relevant data in a timely and efficient manner.

Abstract

The purpose of this study is to measure the impact of the commuting burden on life satisfaction. Economic theory states that individuals choose the commuting burden they are willing to bear together with compensating factors: income and housing. In equilibrium, individuals experience the same level of utility. Using a location theory model, tested by ordinary least-squares with data from the cycle 24 of the General Social Survey (Statistics Canada, 2010), and with life satisfaction as a proxy for utility, I find that the equilibrium does not hold and that individuals with higher commuting burdens report lower levels of life satisfaction. Commuters using public transit are found to be more negatively impacted by traffic congestion than car users. I also find that the commuting burden is positively correlated with the level of stress. Across commuting time, commuting distance, and traffic congestion, I find traffic congestion to have the greatest negative effect on life satisfaction and stress. Finally, workers with flexible schedules experience higher levels of life satisfaction. These results are robust across urban and rural areas, modes of transportation, and by using three different proxies for the commuting burden: time, distance, and experienced traffic congestion.

Table of Contents

I. Introduction

Commuting is considered a necessary burden for the 15.4 million Canadians that travel to work every day. Many workers probably consider the average commuting time of about 30 minutes to be acceptable, as the feelings they experience during the commutes are mostly positive or neutral.[1] Despite that fact, it is far from being clear that travelling to work constitutes a pleasant experience. It might especially become problematic in the most populated provinces, which face higher commuting time on average (see Table 1), and in metropolitan areas facing urban sprawl.

As an increasing quantity of data becomes available on this particular topic, many studies established a link between urban sprawl and environmental, social and psychological costs such as higher pollution levels[2], social segregation[3], and diverse health problems.[4] In parallel, relative well-being has been studied more extensively in past two decades and can provide useful information about individual utility and how it relates to a variety of different factors. In conformity with the relevant literature, I use well-being, life satisfaction, and utility interchangeably throughout this paper.

In this study, I use a compensating-variation location theory model with Canadian data to test whether the location market is in equilibrium. Assuming fully efficient housing and labor markets, I define a utility function as a combination of income, housing (quality and

---

[1] Olsson, L. E., Gärling, T., Ettema, D., Friman, M. and Fujii, S. (2012), *Happiness and Satisfaction with Work Commute*, Social Indicators Research, Netherlands.
[2] Pourahmad, A., Baghvand, A., Zangenehe Shahraki, S., and Givehchi, S. (2007), *The Impact of Urban Sprawl up on Air Pollution*, International Journal of Environmental Research and Public Health, Iran.
[3] Pouyanne, G. (2006), *Étalement urbain et ségrégation socio-spatiale : une revue de la littérature*, Groupement de Recherches Économiques et Sociales, France.
[4] Hoehner, C. M., Barlow, C. E., Allen, P., and Schootman, M. (2012), *Commuting Distance, Cardiorespiratory Fitness, and Metabolic Risk*, American Journal of Preventive Medicine, U.S.

rent), and a commuting burden. Individuals seek to maximize their utility by choosing the optimal combination of these factors. In equilibrium, if agents act rationally, all negative effects from a higher commuting burden should be fully offset by a higher income or a lower rent, leaving utility unchanged. I use commuting time, commuting distance, and experienced traffic congestion as different proxies for the burden. I also seek to identify which of these proxies has the greatest effect on life satisfaction and the level of stress. To my knowledge, this is the first time such a model has been applied on this topic in a Canadian context.

The results show a negative correlation between the commuting burden and life satisfaction. Also, users of public transit report lower levels of well-being when they face traffic congestion compared to car users. Workers with a flexible schedule are found to report higher levels of life satisfaction and a greater commuting burden is positively correlated with a higher level of stress. Finally, traffic congestion is the proxy showing the greatest effect on both life satisfaction and stress. Results do not show any statistically significant difference between commuters of rural and urban areas across all specifications.

Compared with other developed countries, I would expect the result to be similar, especially in urban areas, as most population growth occurs in big cities.[5] It is interesting to compare the results obtained with studies using foreign data, as some could argue that the specific geographical situation of Canada and the long established car-culture might make Canadians more tolerant to long commutes compared to European countries. The most similar study, realized by Stutzer & Frey (2008) with German census data, provides very

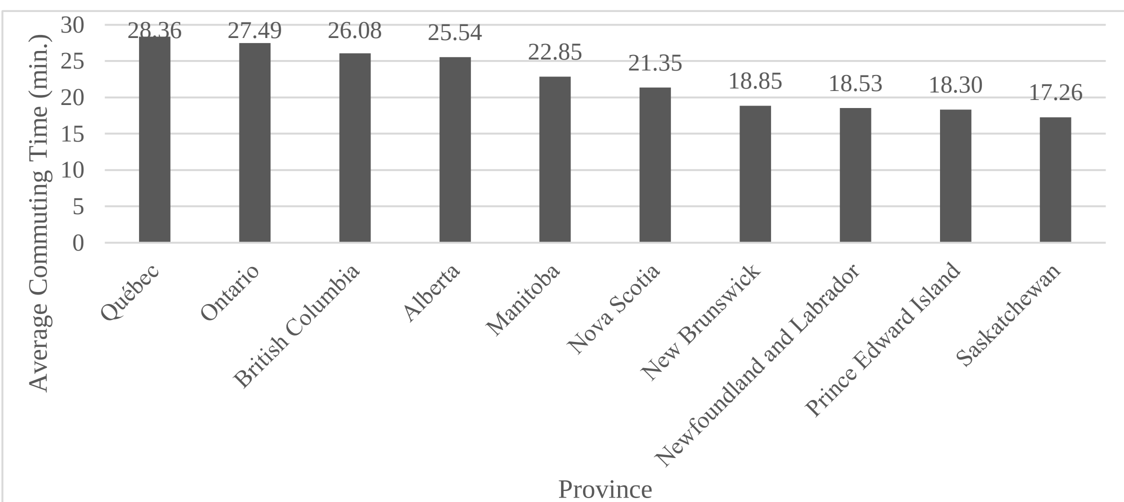
[5] Statistics Canada (2011), *Census of Population 2011*, Canada.

similar results, both in sign and magnitude, as my work using Canadian data. This tends to support similar effects despite cultural differences.

These findings might have useful implications. Having a better knowledge of commuting behaviors and their link to commuters' well-being can orient governmental legislation on residential zoning by justifying a tighter control on urban sprawl and housing density requirements. Awareness could be risen among individuals who might want to evaluate the commuting burden more accurately when taking location, housing and employment decisions. Finally, firms could use such findings to implement accommodating work policies, such as offering flexible work hours, the possibility to work at home, or even considering suburbanization.[6]

Section II contains a literature review. In Section III, I introduce the theoretical framework and the data I use. The results and their interpretation are presented in section IV, while I conclude and address some limitations and implications of the paper in Section V.

Figure 1. *Average Commuting Time by Province*



Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

[6] Suburbanization refers to firms moving in the suburbs to get closer to their working force.

II. Literature Review

i. Early Location theories

The foundation of modern location theory was developed by Johann Heinrich von Thünen in *The Isolated State*.[7] Wanting to explain how agricultural activity is geographically organized, von Thünen developed a model based on a town, located in the centre of an isolated plain, surrounded by rural areas where cultivation exploitation takes place. The further away from the city is a field located, the higher the transportation costs, but the lower the location rent, and vice-versa. The positive effect of being established close to the centre (lower transportation costs) should therefore be offset by the higher rent of the land. The key location factor being transportation, parallels can easily be made with a modern, non- agricultural context where households must decide where to establish, considering the costs of commuting. We use a similar compensating model where benefits and costs should balance in equilibrium.

Tiebout's theory on local expenditures and public good provisions is also of great interest, as I will need to make some similar assumptions when developing the theoretical framework. Tiebout assumes, among other things, perfect mobility of economic agents, a large number of communities to choose from for location purposes, and no employment restrictions.[8] In a similar fashion, I need to assume that commuters can choose to locate in a broad selection of commutes at different distances from the city centre. I also assume efficient labor markets and no moving costs. Notwithstanding their restricting nature, these

[7] Von Thünen, J. H. (1826), *The Isolated State*, Pergamon Press, London (U.K.).
[8] Tiebout, C. M. (1956), *A Pure Theory of Local Expenditures*, The University of Chicago Press, U.S.

assumptions greatly simplifies the model and help to draw simple and interesting conclusions.

ii. Recent Studies

The initial model used in this paper is inspired by the recent work of Stutzer & Frey on stress, commuting, and life satisfaction.[9] The study empirically tests the notion of equilibrium in a compensating location theory model. Similarly to von Thünen's early work, the model predicts that the benefits gained by living in a particular location will be compensated by the disadvantages, until an equilibrium is reached. The benefits of a location are defined by the rent (mainly housing price, where the further you live from the city centre, the lower is your rent) and the salary (jobs requiring a higher commuting time must pay higher wages to attract workers). The disutility of commuting is measured by the time spent by individuals on their journey to work. In equilibrium, all benefits should be offset by the costs, so any additional commuting time should have no impact on people's utility. This calculation is made possible by using life satisfaction as a proxy for utility. While previous studies primarily used commuting distance as a proxy for the commuting burden, Stutzer & Frey used commuting time (in minutes), which can capture traffic and other stressful factors. Their main finding is that the equilibrium does not hold and they find a significant, negative relationship between commuting time and self-reported well-being. In other words, when people decide where to locate, they wrongly estimate the negative impacts associated with commuting, or over-estimate the positive features of their

---

[9] Stutzer, A. and S. Frey, B. (2008), *Street that Doesn't Pay: The Commuting Paradox*, The Scandinavian Journal of Economics, Sweden.

location. People commuting more are then consistently worse off. In fact, most measures on life satisfaction and commuting time and distance found in this paper are of similar magnitude to the ones obtained by Stuzer & Frey (2008) who tested similar models with German data.

Moreover, a relevant point of analysis is made in Stuzer & Frey's paper about household utility. The authors tested to see whether a compensation was obtained at the family level, i.e. a partner sacrificing her[10] own utility for the higher well-being of her other half, leading to a potential equilibrium at the household level. No evidence is shown supporting such a thesis. The hypothesis of a negative externality was also raised (commuting creating conflicts or tensions among the family heads), a result that was statistically significant for certain models, but not consistent across specifications. The data I use only measures individual utility, without any variable on spouse commuting burden and life satisfaction, which makes impossible such an analysis.

A recent study by Hilbrecht, Smale & Mock used national data from the Canadian General Social Survey to try to establish a link between the commuting burden and life satisfaction by using a resource drain model.[11] This type of model evaluates how a particular change in a sphere of activity affects the other spheres of people's lives. The researchers measured by how much did the commuting time affect available time for other well-being augmenting activities (physical leisure activities, hours of paid work, etc.). The physically active leisure time is the one that got reduce the most by an increase in commuting time. While the resource-drain model did not provide significant results, it appeared that the perceived

[10] The feminine is used throughout this paper to simplify the reading.
[11] Hilbrecht, Smale & Mock (2014), *Highway to health? Commute time and well-being among Canadian adults*, World Leisure Journal, Spain.

seriousness of traffic congestion was a key factor influencing reported life satisfaction, as well as physically active leisure time.

In the same vein, an American study by Gordon, Richardson & Jun considered a different "commuting paradox": across years, commuters in big U.S. metropolitan areas report higher traffic congestion, while the average commuting time is decreasing.[12] This highlights the importance of the *perceived* burden of travelling to work and how subjective measures might have greater impact than actual objective variables such as time or distance. In addition, the authors tried to explain different behaviors as a result of this paradox (people moving closer to their workplace, firms moving to the suburbs, etc.).

The present research uses a similar model as Stutzer & Frey's, together with the data used by Hilbrecht, Smale & Mock, and a measure of perceived traffic congestion, considering Gordon, Richardson & Jun's findings on the importance of self-assessed variables.

iii. Utility, Measurement and Interpersonal Comparisons

The relationship between location decisions (including commuting) and utility is the most relevant for this paper: people will choose where to locate, obviously thinking they are making the best decision. But are they? Daniel Kahneman differentiates "decision utility", i.e. the prediction of utility at the time the decision is made, and "experienced utility", the actual utility felt after the decision has been taken.[13] We can easily see that while an

[12] Gordon, Richardson & Jun (2007), *The Commuting Paradox Evidence from the Top Twenty*, Journal of the American Planning Association, U.S.
[13] Hastie, R. and M. Davies, R. (2010), *Rational Choice in an Uncertain World: The Psychology of Judgement and Decision Making 2nd edition*, Sage Publication, California (U.S.).

individual chooses what she thinks is the best choice of location, the actual outcome might be completely different to what was anticipated. This contrast is of great importance for this paper and will be addressed in more details later.

Conceptually, life satisfaction and happiness are not exactly the same, as "life satisfaction measures how people evaluate their life as a whole rather than their current feelings [happiness]".[14] Life satisfaction would then be similar to an overall level of happiness, instead of being a point-in-time measure. Considering the findings of Frey & Stutzer (2012), I will use these two concepts interchangeably, as "happiness is not identical to utility, but it well reflects people's satisfaction with life. For many purposes, it can be considered a useful approximation to utility. This allows us to empirically study problems that so far could only be analysed on an abstract theoretical level."[15]

Establishing a relationship between well-being and any causal factor is a difficult task. While income plays an ambiguous role to determine one's utility[16], many papers have studied the various impacts of health, religion, social interactions, marital status, education and work on well-being.[17] Rural and urban environments could also partly explain life satisfaction. Studies have shown that city-related disturbances (air pollution, noise, crowds, etc.) might negatively affect well-being, while relationship with neighbors and social activities could positively impact utility.[18] In addition, these effects may differ between countries, as it has been demonstrated that in low-developed countries, rural inhabitants are

---

[14] OECD (2015), *Better Life Index - Edition 2015*, Paris (France).
[15] Frey, B. S., Stutzer, A. (2002), *The Economics of Happiness*, World Economics, London (U.K.).
[16] Easterlin, R.A. (1974), *Does Economic Growth Improve the Human Lot? Some Empirical Evidence*, Academic Press, New York (U.S.).
[17] Frijns, M. (2010), *Determinants of Life Satisfaction – A Cross-Regional Comparison*, Maastricht University, Netherlands.
[18] Nozhnitskiy, A. and Naples, M. (2014), *Comparative Happiness In American Living Spaces - Urban, Suburban, and Rural*, The College of New Jersey, New Jersey (U.S.).

significantly happier than urban citizens are, while in advanced countries, rural and urban inhabitants report similar levels of life satisfaction.[19] It is clear that people choosing to locate far from the city centre value more the advantages of their situation than the opposite, thus the relevant decision making judgement that is tested in this study.

Another important concern that may arise while studying well-being is the reliability of the information collected. As utility is individually experienced, like any other psychological concept, there is no perfectly objective variable that can measure it. Despite this drawback, there have now been enough studies made in this area to assert that we can "[…] be confident that individuals are able and willing to provide a meaningful answer when they are asked to value on a finite scale their satisfaction level with their own lives."[20]

The comparison between individuals can also be questioned. Of course, we have to be very careful when we interpret utility measures. When asked to rank their life satisfaction on a certain scale (say 1 to 10), a "7" for a person might not represent the same level of satisfaction as a "7" for someone else. Bond & Lang (2014) shown that when asking individuals from different groups (e.g. men and women) to rank their happiness on a certain scale (e.g. 1 to 10), it is very unlikely that we will obtain accurate results when comparing across the groups.[21] To obtain valid results, we would have to assume the cut-offs are the same for both gender (a 1/10 level of happiness is the same ordinal value for men and women, the same for a 2/10, and so on). A solution provided by the authors is to use a

[19] Veenhoven, R. (1994), *How Satisfying Is Rural Life? Fact and Value*, Society for agricultural policy research in rural society, Bonn (Germany).
[20] Ferrer-i-Carbonell, A. and Van Praag, B. M. S. (2011), *Happiness Economics: A New Road to Measuring and Comparing Happiness*, Foundations and Trends® in Microeconomics, U.S.
[21] Bond, T. N. and Lang, K. (2014), *The Sad Truth About Happiness Scales*, National Bureau of Economic Research, Working Paper, Cambridge (U.S.).

measurable outcome as a scale (mainly income) to measure happiness, but substituting happiness with money is controversial and it is far from being clear that these two measures are strongly correlated. Most probably, income and other measures of well-being are expected to be positively correlated (think of first needs, security, housing, good conditions for children, etc.), but a direct and significant correlation between money and happiness is uncertain.

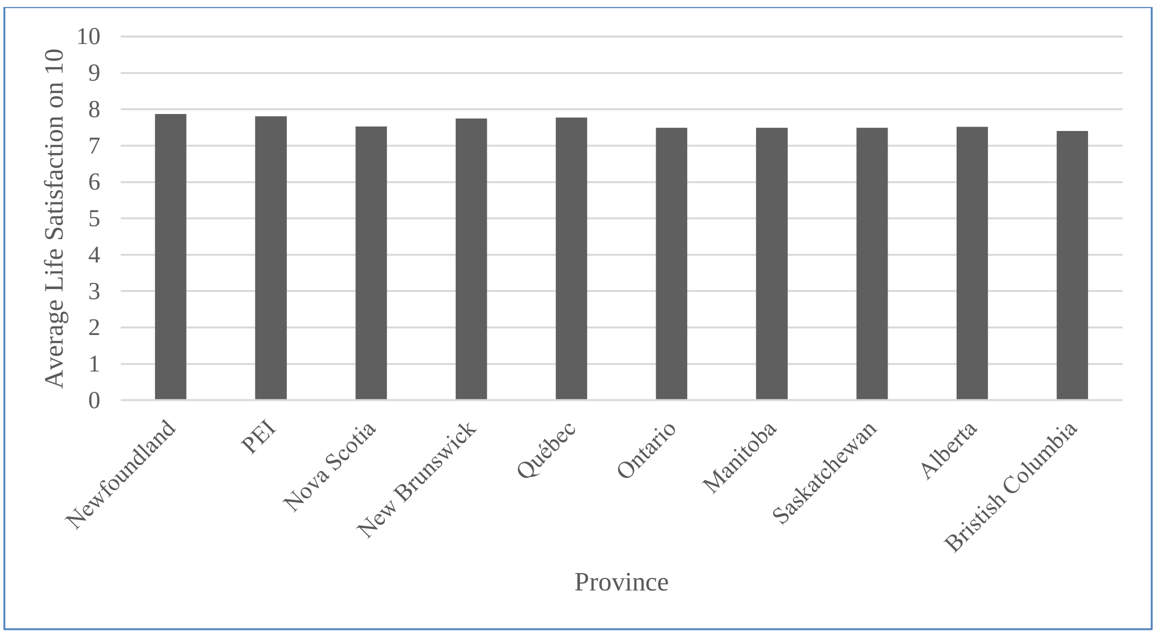
Hopefully, according to Ferrer-i-Carbonell, "the existing empirical evidence clearly supports [that] individuals do have a very similar understanding of concepts such as satisfaction and happiness."[22] Adding to these findings, while overall level of happiness might differ from a country to another, individuals seem to use the same criteria to measure their happiness level, even across different countries.[23] Also, subjective well-being seems to be correlated with objective measures, such as actions taken by people or an evaluation by an independent specialist.[24] In addition, Gundelach and Kreiner (2004) found that the marital status (more specifically being in a stable relationship) and social capital (country characteristics) are the most important factors that affect happiness.[25] In our case, life satisfaction will be analyzed only with Canadian data, and as mentioned earlier, cultural and sociological factors may play an important role in determining the level of happiness. Therefore, we can afford to compare life satisfaction between individuals in the Canadian context, as people's criteria and cultural factors are likely to be similar. We can confirm

[22] Ferrer-i-Carbonell, A. and Van Praag, B. M. S. (2011), Happiness Economics: A New Road to Measuring and Comparing Happiness, Foundations and Trends® in Microeconomics, U.S.
[23] Lee, Y. D., Park, S. H., Uhlemann, M. R., Patsula, P. (1999), *What Makes You Happy?: A Comparison of Self-Reported Criteria of Happiness Between Two Cultures*, Social Indicators Research, Netherlands.
[24] Diener, E., Sandvik, E., and Seidlitz, L, Diener, M. (1993), *The relationship between income and subjective well-being: Relative or absolute?*, Journal of Personality, U.S.
[25] Gundelach, P., Kreiner, S. (2004), *Happiness and Life Satisfaction in Advanced European Countries*, Cross-Cultural Research, Copenhagen (Denmark).

this by looking at the average life satisfaction of Canadians between provinces, which show extremely similar values (see Figure 2).

Nevertheless, this view does not make consensus and many economists still criticise inter-individual comparisons of utility, as they require “a fully comparable fundamental utility function [which] inevitably [relies on] ethical value judgements.”[26] Despite the understandable criticism, the underlying reality is that no utility measure is perfect, and interesting insights can still be drawn even by using a partially flawed variable.

Figure 2. *Average Life Satisfaction by Province on a Scale of 1 to 10*



Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

[26] Hammond, P. J. (1989), *Interpersonal Comparisons of Utility: Why and How They Are and Should Be Made*, European University Institute (Italy) and Stanford University, California (U.S.).

III. Theoretical Framework and Data

i. Model

The model used in this study was first developed by Stutzer & Frey (2008). It considers a utility function in the following form:

$$U_i = u(y_i, C_i, r_i)$$

Utility is defined as a combination of income (y_i), housing rent (r_i) and the commuting burden (C_i) for each individual i. As mentioned previously, it is a compensating model, where the combination of the benefits and the burden generate a certain level of utility.

I assume housing and labor markets are efficient: workers can choose where to work and where to live without constraints and between a wide range of different locations. Because people seek to maximize their utility, this should lead to an equilibrium where a very small change in one of these three factors should be fully offset by the two others and have no marginal impact on utility. I also assume individuals have homogeneous preferences, in order to compare and draw conclusions from a large sample of different persons. Finally, for simplicity, I make the assumption that people initially had to make a choice where to locate and that there were no moving costs. The data does not have a temporal aspect, but to judge people's situation today, I need to assume they had no restrictions on their possibilities when they previously made their location decisions. If not, a poor individual would have a restriction prohibiting her to freely decide where to locate, while a rich person would not have the same limitation, and the model would not have the same effect for both of them. I will run ordinary least square regressions on all following models.

The initial model I test is:

$$U_i = \alpha + \beta C_i + \varepsilon_i \quad (1)$$

The dependant variable on the left hand side is the individual's utility as denoted earlier. On the right hand side, C_i is the independent variable of interest, i.e. the commuting burden for individual i. Different specifications of the model will later be made using different proxies for the burden (commuting time, commuting distance and experienced traffic congestion). The first term, α, is a constant and the last is the error term, ε_i, assumed to have a zero conditional mean.

If the coefficient β is equal to 0, a change in the commuting burden has no effect on the overall subjective utility. Note that by purposely not controlling for income or housing rent, I allow all channels of compensation to vary. As both these factors are included within the utility function, if the equilibrium holds , the adjustment after a change in commuting is made on the left hand side of the equation and the utility remains the same. The alternative hypothesis, a coefficient different of 0, implies that a change in the commuting burden affects life satisfaction, hence we would not be in equilibrium and people's utility would vary depending on the commuting burden, without the anticipated compensating effects.

The second specification incorporates interaction terms to determine the marginal effects of each mode of transportation (public transportation and active transportation [walking and biking]) and the geographic area (rural or urban area). Dummies were multiplied by the burden to evaluate these terms.

$$U_i = \alpha + \beta C_i + \delta\,(C_i * L_i) + \phi\,(C_i * P_i) + \varphi\,(C_i * A_i) + \mu F_i + \varepsilon_i \quad (2)$$

When we use the geographical dummy, the coefficient β measures the impact of the commuting burden on the utility level for all individuals i that live in rural areas. The differential effect for citizens of urban areas is estimated by the coefficient δ. For transportation, the variable P_i takes the value 1 if the commuter uses public transit and ϕ corresponds to the incremental impact of using public transportation on the dependant variable. Variable A_i takes the value 1 when the individual bikes or walks to work, while the marginal impact is measured by φ. F_i is a dummy that takes the value 1 if the person has a flexible schedule, and μ is the marginal impact of such a characteristic. When all dummies take the value 0, the commuter is driving its car during its commute and does not have a flexible schedule.

The third model considers the additional effect of socio-demographic characteristics.

$$U_i = \alpha + \beta C_i + \delta\,(C_i * L_i) + \phi\,(C_i * P_i) + \varphi\,(C_i * A_i) + \mu F_i + \gamma X_i + \varepsilon_i \quad (3)$$

X_i is a vector of individual socio-demographic factors: age, age squared, gender, language of interview, years of education (for elementary and high school), highest post-secondary level of education obtained, 6 possible states of marital status, household size, and a dummy that takes a value of one if the respondent has one or more children.

The forth model uses an interaction term between commuting burden and traffic congestion to identify what has the largest impact on life satisfaction: the time by itself, or the time spent in congestion. The coefficient θ will measure that by being compared to β and we will be able to see is the allocation of the effect changes and identify the key factor influencing well-being.

$$U_i = \alpha + \beta C_i + \theta(C_i * TC) + \delta\,(C_i * L_i) + \phi\,(C_i * P_i) + \varphi\,(C_i * A_i)$$

$$+ \mu F_i + \gamma X_i + \varepsilon_i \qquad (4)$$

Finally, I use a variable measuring the experienced level of stress to test the model "in reverse". Instead of life satisfaction, I use stress as measure of *disutility* and perform the same four regressions as before, using time, distance and traffic congestion to evaluate the commuting burden. The compensating factors remain the same (income, which has a negative impact on disutility, commuting and rent, which have positive effects on disutility). The disutility function takes the form:

$$S_i = s(y_i, C_i, r_i)$$

The models become the following:

$$S_i = \alpha + \beta C_i + \varepsilon_i \qquad (5)$$

$$S_i = \alpha + \beta C_i + \delta\,(C_i * L_i) + \phi\,(C_i * P_i) + \varphi\,(C_i * A_i) + \mu F_i + \varepsilon_i \qquad (6)$$

$$S_i = \alpha + \beta C_i + \delta\,(C_i * L_i) + \phi\,(C_i * P_i) + \varphi\,(C_i * A_i) + \mu F_i + \gamma X_i + \varepsilon_i \qquad (7)$$

$$S_i = \alpha + \beta C_i + \theta(C_i * TC) + \delta\,(C_i * L_i) + \phi\,(C_i * P_i) + \varphi\,(C_i * A_i)$$

$$+ \mu F_i + \gamma X_i + \varepsilon_i \qquad (8)$$

S*i* denotes the stress level for individual *i*. The other coefficients remains the same as before. Contrary to life satisfaction, an increase in the commuting burden is expected to increase the stress level.

ii. Data and Descriptive Statistics

To evaluate the former models, I use the data available in the 2010 General Social Survey, Cycle 24, from Statistics Canada. The population sampled concerns all non-institutionalized persons, 15 years of age or older, living across the 10 provinces of Canada. While there were 15,390 respondents (response rate of 55.2%), I kept 3,930 individuals to make the regressions after dropping from the original sample those who did not have a paid job, worked at home, did not answer an essential question, or were not asked certain relevant questions.[27] The design of the data is cross-sectional, surveying individuals on 3,306 variables at one point in time.

Due to the probabilistic nature of the survey, the different observations of the sample have to be weighted to represent their relative importance in the overall population. I used personal weights, as we are interested in correlations at the individual level. A weight corresponds to the number of times a certain observation counts in a statistical procedure and is calculated by taking the inverse of the probability that each observation has been included in the dataset due to the sampling design.[28]

Multiple weighted variables are used in this study. Life satisfaction is measured by the answers to the following question: "How do you feel about your life as a whole right now?" The respondents were asked to answer using a numerical value on a scale of 1 ("Very dissatisfied") to 10 ("Very Satisfied").

[27] Most of the observations were dropped (approximately 11,159) because people were not asked about their commuting time and commuting distance. All observations used to perform the regressions correspond to the individuals who answered all the questions related to the variables used in the regressions.
[28] StataCorp (2009). *Stata 11 Base Reference Manua*l. College Station, TX: Stata Press.

Different variables are used to evaluate the commuting burden. First, the commuting time (measured in minutes), where the respondents were asked the following question: “On a usual day last week, how many minutes did it take you to go one way from home to work/school”. The maximum time allowed is 200 minutes. Second, I also use the commuting distance as a proxy for the commuting burden, the distance being measure in kilometers for a one way from home to work/school. Third, a variable reports how many times people experienced traffic congestion problems in the past week (everyday, 3-4 days, 1-2 days, or never). Traffic congestion is defined in the survey as traffic jams, start-stop problems or moving at less than 20 kilometres per hour.[29]

Furthermore, a variable details the modes of transportation used, where we can differentiate across car drivers, car passengers, public transit users, cyclists, walkers and other less used modes of transportation. Except for car (drivers), public transit, bikers, and walkers, the number of respondent for all other modes of transportations are too low to perform proper regressions. The minimum sample size was determine by applying Green’s (1991) rule of thumb, suggesting to only use samples of at least 50 individuals, plus 8 people per independent variables in order to get reliable correlations.[30] [31]

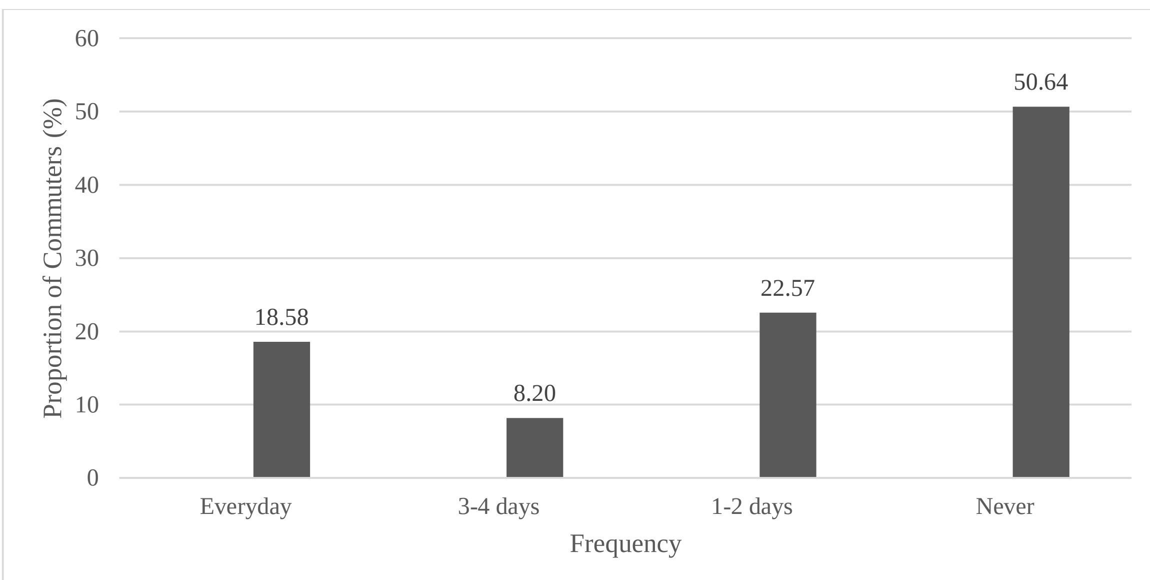
Finally, the variable *S* (stress) is built by asking respondents: “Thinking about the amount of stress in your life, would you say that most days are”, with answers ranging from “not at all stressful” (value of 1) to “extremely stressful” (value of 5).

---

[29] Statistics Canada (2010), *General Social Survey Cycle 24*, Canada.
[30] Wilson VanVoorhis, C. R., Morgan, Betsy L. (2007), *Understanding Power and Rules of Thumb for Determining Sample Sizes*, Psi Chi Journal of Undergraduate Research, Tennessee (U.S.).
[31] Green, S. B. (1991), *How Many Subjects Does It Take To Do A Regression Analysis*, Multivariate Behavioral Research, U.S.

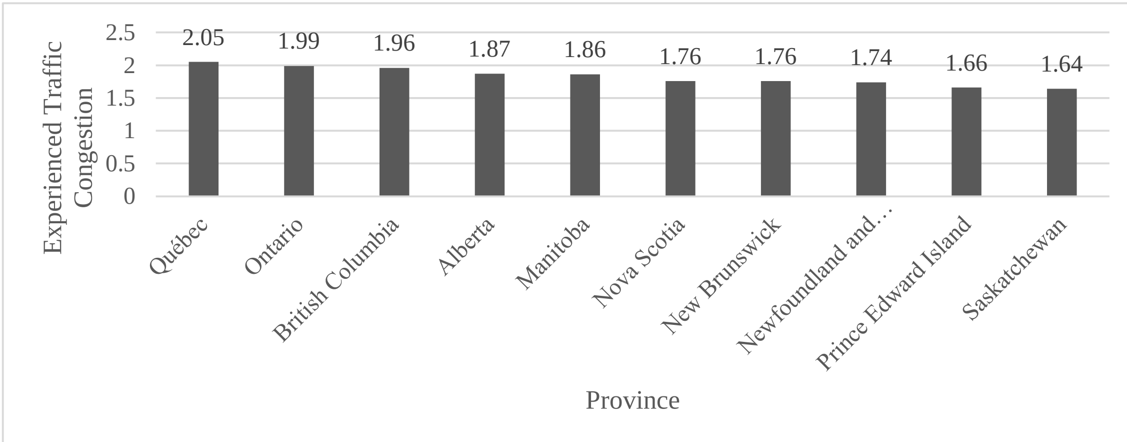
By looking at the sample, we see that half the commuters never experience traffic congestion, but almost 20% of them face it every day (Figure 3). Not surprisingly, the provinces with the biggest metropolitan areas have higher traffic congestion problems (Figure 4). We can also note that the great majority of commuters drive their own car to go to work, while only about 9% of them use some form of public transit, less than 5% walk, and 2.11% bike (Figure 5). The data does not provide any information on the use of different modes of transportation by a same individual on a single way to work.

Figure 3. *Frequency of Traffic Congestion amongst Respondents*



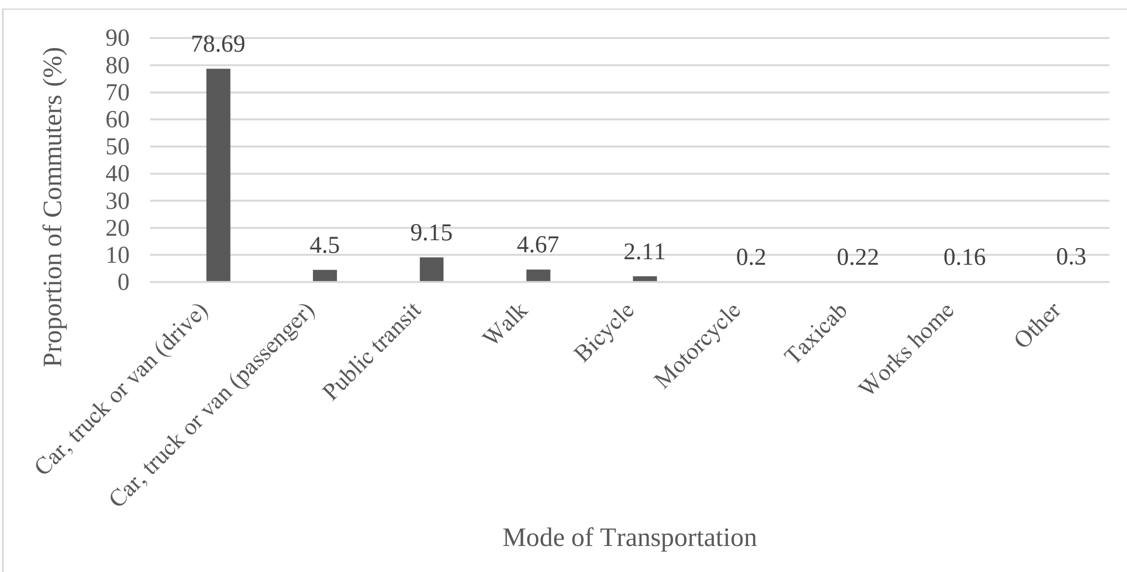
Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

Figure 4. *Experienced Traffic Congestion by Province in Days per Week* [32]



Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

Figure 5. *Modes of Transportation*



Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

[32] Initially, the variable took the values 1 for every day, 2 for 3-4 days, 3 for 1-2 days, or 4 for never. I reversed the order to have a higher numerical value for more frequent experienced traffic congestion. The numbers correspond to the number of traffics days experienced in the previous week.

A first look at our data (Table 1) shows an average reported life satisfaction of 7.56 on 10, with the great majority of answers lying between 6 and 9. Commuters spent 26.33 minutes on average for a one-way trip to work (52.66 minutes for a round trip) and the average distance traveled for the same journey is 20.93 kilometers (41.86 km for a round trip). Both of these measures have a great variability. The typical respondent is 41 years old female, married, has a diploma or an undergraduate degree and expresses herself in English.

Table 1: *Descriptive Statistics*

	Mean	Std. dev.		Percentage (%)
Life satisfaction	7.56	1.60	Female	58.06
Commuting Time (min.)	26.33	21.88	Male	41.94
Commuting distance (km)	20.93	21.10	English	78.53
Age	40.73	11.95	French	21.47
Children in household	0.90	1.05		
Child (1 if one or more child)	0.50	0.50	*Highest level of education*	
			Doctorate	2.04
			Medicine	7.90
			Masters	0.97
		Percentage (%)	Undergraduate	28.32
Traffic congestion			Diploma, community college	23.80
Everyday		18.58	Diploma, other	18.42
3-4 days		8.20	Some university	7.49
1-2 days		22.57	College/Cégep	6.75
Never		50.64	Technical school	2.96
			Other	1.34
Mode of transportation				
Car, truck or van (drive)		78.69	*Marital status*	
Car, truck or van (passenger)		4.50	Married	56.43
Public transit		9.15	Common-law	14.6
Walk		4.67	Widowed	0.76
Bicycle		2.11	Separated	2.11
Motorcycle		0.20	Divorced	4.17
Taxicab		0.22	Single, never married	21.93
Works home		0.16		
Other		0.30		

Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

Table 2 gives a more detailed summary of average stress and life satisfaction amongst respondents depending on some particular socio-demographic variables. With the exception of motorcycle, no mode of transportation clearly stands apart concerning average life satisfaction, although it is possible to observe below average levels of stress for walkers and bikers. Those experiencing more than 2 days of traffic per week report much higher levels of stress and much lower life satisfaction on average than those facing traffic 2 days or less per week. People practicing active transportation (bike of walk) report lower levels of stress than the average, while people using car of public transportation show above average stress levels. The level of income does not give evidence for the magnitude of life satisfaction, while it appears that people with higher income report higher levels of stress than those with low income. Public transit users have the higher average commuting time, while motorcyclists have the lowest, followed by walkers. Lastly, high-income earners commute for longer times than low-income earners.

Table 2: *Life Satisfaction, Stress and Commuting Time by Socio-Demographics*

	Average Life Satisfaction	Std. dev.	Level of Stress	Std. dev.	Average Commuting Time (min.)	Std. dev.
Average	7.56	1.60	3.00	0.88	26.33	21.88
Mode of Transportation						
Car (driver)	7.56	1.62	3.02	0.88	25.55	21.68
Car (passenger)	7.63	1.63	2.74	0.92	24.09	17.88
Public Transit	7.41	1.62	3.05	0.83	37.88	22.63
Walk	7.68	1.23	2.93	0.87	17.03	12.18
Bicycle	7.59	1.38	2.82	0.97	26.21	21.86
Motorcycle	8.52	1.00	3.64	0.79	7.17	4.40
Taxi	7.93	1.37	3.10	1.01	-	-
Works at home	7.12	1.57	3.09	0.87	-	-
Other	8.23	1.37	2.76	0.99	-	-
Traffic Congestion						
Never	7.70	1.54	2.89	0.88	-	-
1-2 days	7.54	1.58	2.93	0.86	-	-
3-4 days	7.30	1.58	3.17	0.83	-	-
Everyday	7.32	1.74	3.30	0.87	-	-
Income ($)						
No Income	6.78	1.07	2.35	1.09	22.76	15.97
Less than 5000	7.68	1.41	2.41	1.07	21.33	13.34
5000 < 10000	7.57	1.35	2.63	0.69	16.51	11.58
10000 < 15000	7.33	1.75	2.94	0.92	23.22	19.16
15000 < 20000	7.51	1.61	2.80	0.78	28.10	25.76
20000 < 30000	7.29	1.94	2.97	0.91	22.27	20.51
30000 < 40000	7.37	1.69	3.03	0.91	24.49	20.87
40000 < 50000	7.48	1.75	2.92	0.88	24.05	19.73
50000 < 60000	7.60	1.51	2.94	0.85	27.61	22.56
60000 < 80000	7.70	1.38	3.07	0.83	27.31	22.37
80000 < 100000	7.65	1.51	3.08	0.92	29.93	20.48
More than 100000	7.83	1.48	3.22	0.83	30.24	25.13

Income is the previous year's earnings in Canadian dollars. Mode of transportation and traffic congestion correspond to what the respondents experienced the week before the survey. Life satisfaction is measured on a scale of 1 to 10, 10 being the highest, stress on a scale of 1 to 5, 5 being the highest, and time in minutes for a one-way trip to work.
Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

IV. Results

i. Commuting Time

The first four models presented in Table 3 use the commuting time as a proxy for the commuting burden. As described earlier, in Model 1, no interaction term is used. In Model 2, the impact of commuting time together with the location (urban or rural area) is measured, as well as the marginal impacts of the different modes of transportation (public and active). Models 2 and 3 include the incremental impact of having a flexible schedule on life satisfaction, and model 3 adds socio-demographic effects. Finally, Model 4 incorporates an interaction term between commuting time and traffic congestion.

Our results show that an additional minute of commuting is correlated with a 0.005 decrease in the average life satisfaction in Models 1 and 3. Model 2 shows a decrease of 0.004. All else equal, an extra hour of commuting per day would be correlated with a 0.3 lower reported life satisfaction on a scale of 10 (0.24 for Model 2). This result is both statistically and economically significant, as the variability of the life satisfaction variable is relatively small, a 0.3 lower well-being has an important impact.

Model 4 provides some very interesting insights. By incorporating an interaction between traffic congestion and commuting time, we are able to separate time spent in traffic and time spent commuting without traffic. The results change completely, as the commuting time becomes positively correlated with life satisfaction (with a low significance level), while time spent in congestion is significantly and negatively affecting well-being. As soon as there is traffic (so when the traffic congestion variable takes a value higher than 1), the effect of time spent in traffic offsets completely the positive result of commuting time and decreases significantly life satisfaction. Also in Model 4, we see that users of public transportation report lower levels of life satisfaction, i.e. are more sensitive to time spent commuting in a traffic exempt environment. This result only shows in Model 4, because it was previously hidden through the commuting time variable that incorporated traffic in models 1 to 3. In practice, we can explain these findings by the fact that the time spent stuck in traffic is damageable because it creates stress, frustration, delays, etc. At the same time, we see that time spent commuting without traffic is neutral, if not slightly affecting well-being. Driving without traffic could in fact be a pleasant experience for some people, providing a break from work or household duties, or even enjoying the drive of a powerful engine.

None of the other interaction terms shows statistically significant effects in models 1 to 3, except for workers with a flexible schedule who report a significantly higher life satisfaction of 0.135 to 0.173 on 10. This last result could be expected, as a worker with a flexible schedule could manage to avoid rush hour and go to work at off-peak hours.

Some socio-demographic factors show statistically significant effects. Age is negatively correlated with life satisfaction, while being married or francophone are positively correlated with higher levels of well-being. People living in a common law union show higher levels of life satisfaction. In addition, Models 3 and 4 display a lower level of life satisfaction for educated individuals (undergraduate degree of higher) and a higher level of well-being for numerous families.

Table 3. *Commuting Time and Life Satisfaction (Dependant variable: life satisfaction)*

Independent Variables	Model 1 Coefficient	Model 1 SE	Model 2 Coefficient	Model 2 SE	Model 3 Coefficient	Model 3 SE	Model 4 Coefficient	Model 4 SE
Commuting time (min.)	-0.005***	0.002	-0.004**	0.002	-0.005**	0.002	0.005*	0.003
CT[33] x Location			0.000	0.0007	0.000	0.007	0.000	0.0007
CT x Public transport			-0.004	0.003	-0.003	0.003	-0.006**	0.003
CT x Active transport			0.002	0.003	0.001	0.003	-0.002	0.003
Flexible schedule			0.173***	0.063	0.135**	0.06	0.142**	0.063
CT x TC[34]							-0.003***	0.0008
Constant	7.681***	0.050	7.606***	0.058	9.124***	0.549	9.102***	0.548
Demographics								
Age					-0.097***	0.020	-0.098***	0.020
Age squared					0.001***	0.0002	0.001***	0.0002
Sex (female = 1)					-0.098	0.064	-0.093	0.063
Years of secondary education					0.001	0.004	0.001	0.004
Undergraduate degree					-0.356**	0.178	-0.349**	0.177
Masters					-0.584***	0.205	-0.577***	0.205
Doctorate					-0.561**	0.263	-0.544**	0.265
Married					0.591*	0.307	0.634**	0.309
Common-law Union					0.552***	0.210	0.433	0.318
Language of interview (French = 1)					0.395***	0.077	0.387***	0.077
Household size					0.079**	0.038	0.075*	0.038
Children (1 or more kids = 1)					-0.084	0.104	-0.078	0.104

The significance levels are: * p<0.10, ** p<0.05, *** p<0.01. The dependant variable is life satisfaction and the independent variable of interest is the commuting time (CT), in minutes. Location refers to urban (1) or rural (0) areas. Public transport and Active transport are dummy variables that take the value 1 if the commuter uses the particular mode of transportation. Flexible schedule takes the value 1 if the worker has such a timetable.
Data source: Statistics Canada, General Social Survey, Cycle 24

The main findings that can be taken away from this table are that individuals experiencing longer commutes report, on average, lower levels of life satisfaction. Moreover, we can

[33] CT = Commuting time in minutes.
[34] TC = Traffic congestion in days per week.

identify time spent in traffic as the major factor decreasing life satisfaction. These results are robust across rural and urban areas, as well as between modes of transportation, with the exception of public transit users who report lower levels of well-being as traffic time increases. The logic behind this last result might be that a person commuting by public transport expects to avoid traffic, hence is increasingly negatively affected if traffic occurs.

Therefore, we can reject the initial hypothesis of an equilibrium in our location model. If higher commuting times decrease travellers' utility, the compensation through better or cheaper housing and higher salaries does not seem to be enough to offset the negative effects of commuting. In other words, people misevaluate the benefits and costs of commuting. Using Kahneman's terminology, the decision utility ends up being higher than the experienced utility. As previously addressed, we cannot reject the fact the whole household might be in equilibrium, hence the individual disutility shown in Table 3 might in fact be offset by an increase in utility for the spouse.

ii. Commuting Distance

The four following models use the distance in kilometers as a proxy for the commuting burden (see Table 4). The other specifications are the same as in Table 3.

In this case, the coefficients measuring the impact of the commuting distance on life satisfaction are not significantly different from zero, no matter the geographical area or if using active transportation. Models 3 and 4 show a different effect for users of public transit: people commuting by using public transportation report lower life satisfaction as the commuting distance increases. We might think this is the case because of the discomfort associated with long distance commutes, namely the bus starting and breaking repetitively, uncomfortable seating, time spent standing up, etc. The socio-demographic factors are of similar magnitude and significance to what has been previously seen. Once again, workers with a flexible schedule show higher levels of well-being (from 0.132 to 0.167 more than workers with a fixed schedule).

Model 4 incorporates an interaction term between the commuting burden (distance) and traffic congestion. The results are statistically significant: the distance someone commutes in a traffic-congested environment negatively affects life satisfaction. The commuting distance variable remains insignificant, hence, we can once again identify traffic congestion as being the real threat to well-being.

All of these specifications would fail to reject the null hypothesis. This could be explained by the fact that the commuting distance alone does not include some stressful factors that commuting time can catch, such as traffic congestion. When deciding where to locate, we can expect individuals to estimate the distance they will commute more accurately than they estimate the expected time of travelling, which is subject to some random factors (traffic, road construction, weather, etc.). To address this concern, we will later perform three other regressions using a traffic congestion variable as the regressor of interest. We can also note that while distance itself cannot reject the initial hypothesis, the interaction term between distance and traffic is sufficient to reject the null.

Table 4. *Commuting Distance and Life Satisfaction (Dependant variable: life satisfaction)*

	Model 1		Model 2		Model 3		Model 4	
Independent Variables	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Commuting distance (km)	-0.001	0.002	0.000	0.002	-0.001	0.002	0.002	0.002
CD[35] x Location			-0.001	0.001	-0.001	0.0006	0.001	0.0006
CD x Public transport			-0.006	0.004	-0.005**	0.003	-0.004*	0.003
CD x Active transport			0.003	0.004	-0.001	0.003	0.000	0.003
Flexible schedule			0.167***	0.064	0.132**	0.063	0.141**	0.063
CD x TC							-0.003***	0.001
Constant	7.593***	0.044	7.528***	0.054	9.089***	0.548	9.097***	0.548
Demographics								
Age					-0.099***	0.020	-0.097***	0.020
Age squared					0.001***	0.0002	0.001***	0.0002
Sex (female = 1)					-0.091	0.064	-0.093	0.063
Years of secondary education					0.001	0.004	0.001	0.004
Undergraduate degree					-0.348*	0.180	-0.341*	0.177
Masters					-0.574***	0.207	-0.571***	0.205
Doctorate					-0.546**	0.264	-0.537**	0.264
Married					0.596*	0.307	0.615**	0.310
Common-law Union					0.411	0.315	0.412	0.318
Language of interview (French = 1)					0.385***	0.077	0.397***	0.077
Household size					0.080**	0.038	0.075*	0.038
Children (1 or more kids = 1)					-0.080	0.104	-0.080	0.104

The significance levels are: * p<0.10, ** p<0.05, *** p<0.01. The dependant variable is life satisfaction and the independent variable of interest is the commuting distance (CD), in kilometers. Location refers to urban (1) or rural (0) areas. Public transport and Active transport are dummy variables that take the value 1 if the commuter uses the particular mode of transportation. Flexible schedule takes the value 1 if the worker has such a timetable.

Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

[35] CD = Commuting distance in km.

iii. Traffic Congestion

The four regressions presented in Table 5 are made by using an indicator of traffic congestion as a proxy for the commuting burden. The variable takes different values for no experienced traffic (1), 1 or 2 days of traffic per week (2), 3 or 4 days (3), and every day traffic (4). Again, an interaction term for the burden and geographical location is added in Model 3, as well as for the mode of transportation and the flexible schedule. Model 4 incorporated interaction terms between traffic congestion, commuting time, and commuting distance.

Across all specifications, we can observe a statistically significant negative correlation between self-reported experienced traffic congestion and life satisfaction, from -0.100 to -0.141. The particular construction of the traffic variable makes the interpretation of these coefficients arduous at the margin. Nevertheless, we can conclude that, on average, someone experiencing traffic congestion every workday of the week would report a 0.564 lower life satisfaction than a commuter not experiencing any traffic according to Model 3, and similar results for Models 1 and 2. This result is economically significant and of higher magnitude than the one obtained with commuting time. While time and traffic cannot be compared on the same scale, we can still see traffic congestion as having a huge impact on one's life satisfaction, perhaps even more than time. In fact, a long but traffic-free commute could be seen as less damageable to well-being than a short commute with traffic, as it does not necessarily involve the stressful factors that traffic congestion addresses.

Even though there is still no significant effect of living in an urban or rural region, Models 2 and 3 show that, when paired with traffic congestion, the mode of transportation matters. For these models, our interpretation of the coefficient associated with the traffic congestion variable changes and now represents the change in life satisfaction for a car driver. Consequently, people driving their car would report on average a lower life satisfaction by 0.400 to 0.564 if there are stuck in traffic every day, in comparison to a person never experiencing traffic. For a public transit user, there is an additional effect between -0.005 (Model 4) and -0.130 (Model 3) per level of traffic seriousness. Therefore, when compared to a person never facing traffic problems, a commuter using public transportation would report a lower life satisfaction of 0.020 to 0.520 on 10 if stuck in traffic every day. As seen before, these results can be explained by the fact that if people renounce to the comfort of being in their own car, they expect avoiding the disagreement of being stuck in traffic, and therefore are less tolerant to traffic jams (i.e. more negatively affected if traffic occurs).

We also note that, as for all the previous models, workers with flexible schedules report a higher average well-being by 0.146 per traffic level increment. Workers with flexible schedules that are very sensitive to traffic have the freedom to rearrange their schedule in order to avoid traffic, hence leading to higher life satisfaction.

Finally, the two interaction terms show interesting results. When traffic congestion is paired with commuting time, an additional (but small) effect is shown, which is coherent with the results seen in Table 3. When traffic is interacted with commuting distance, no additional effect appears which is also coherent to what has been seen in Table 4. Therefore, we can see that traffic congestion is clearly the most important factor explaining the negative impact of the commuting burden on life satisfaction

Table 5. *Experienced Traffic Congestion and Life Satisfaction (Dependant variable: life satisfaction)*

	Model 1		Model 2		Model 3		Model 4	
Independent Variables	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Traffic Congestion	-0.136***	0.029	-0.126***	0.033	-0.141***	0.029	-0.100**	0.050
TC[36] x Location			-0.007	0.014	0.000	0.0006	0.000	0.0007
TC x Public transport			-0.130**	0.058	-0.006**	0.003	-0.005*	0.003
TC x Active transport			0.004	0.052	-0.002	0.003	-0.001	0.003
Flexible schedule			0.188***	0.034	0.146**	0.063	0.146**	0.063
TC x CT							-0.002*	0.001
TC x CD							0.000	0.0003
Constant	7.828***	0.061	7.766***	0.065	9.338***	0.553	9.248***	0.552
Demographics								
Age					-0.099***	0.020	-0.098***	0.020
Age squared					0.001***	0.0002	0.001***	0.0002
Sex (female = 1)					-0.089	0.063	-0.088	0.063
Years of secondary education					0.001	0.004	0.001	0.004
Undergraduate degree					-0.322*	0.177	-0.317*	0.178
Masters					-0.549***	0.203	-0.541***	0.206
Doctorate					-0.501*	0.267	-0.505*	0.268
Married					0.619**	0.307	0.612**	0.309
Common-law Union					0.426	0.316	0.423	0.317
Language of interview (French = 1)					0.365***	0.077	0.375***	0.078
Household size					0.078**	0.038	0.077**	0.038
Children (1 or more kids = 1)					-0.082	0.104	-0.083	0.103

The significance levels are: * p<0.10, ** p<0.05, *** p<0.01. The dependant variable is life satisfaction and the independent variable of interest is the traffic congestion (TC). Location refers to urban (1) or rural (0) areas. Public transport and Active transport are dummy variables that take the value 1 if the commuter uses the particular mode of transportation. Flexible schedule takes the value 1 if the worker has such a timetable.
Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

All the regressions in Tables 3, 4, and 5 were also tested by controlling for income and housing type (as a proxy for the housing rent). I do not include the tables, as the results are not drawn from the same theoretical models and are even more negative and significant. This can be explained by the compensating-variation nature of the model. If we control for

[36] TC = Traffic congestion.

income and housing, we take away two channels of compensation for the commuting burden by isolating their impact. Consequently, when the burden increases, life satisfaction is even more affected, as the negative effect cannot be offset by other positive ones (higher income and better housing).

iv. Stress

I now perform the same regressions as in section III, parts i, ii and iii, and apply a reversed logic. A stress variable is used as the new dependant variable, a proxy for disutility. The results we can get out of these modified models are relevant since "time pressure and time stress reduce emotional well-being."[37] If we compare with our initial compensation variation model, the new regressand (disutility) should increase when the commuting burden increases, decrease when income increases (higher income is expected to increase utility, therefore to decrease disutility), and decrease with a lower rent (or with a greater housing quality). The use of stress as an indicator of unhappiness is supported by the literature, including the recent work of Schiffrin and Nelson who demonstrated the existence of a significant negative relationship between perceived stress and happiness.[38]

In Table 6, I find that the perceived level of stress is positively correlated with commuting time. In Model 5, we observe that an extra minute of commuting is correlated with a 0.005 increase in stress, on a scale of 1 to 5. Model 6 incorporates interaction terms for the geographical area and for modes of transportation, while Models 6 and 7 have a dummy

---

[37] Gärling, T., Krause, K., Gamble, A., and Hartig, T. (2014), *Emotional well-being and time pressure*, Wiley Publishing Asia, China.

[38] Schiffrin, H. H., Nelson, S. K. (2010), *Stressed and Happy? Investigating the Relationship Between Happiness and Perceived Stress,* Springer Science+Business Media B.V., USA.

variable for the flexible schedule, and socio-demographic variables. Finally, Model 8 uses an interaction term between commuting time and traffic congestion. None of these interaction terms has statistically significant coefficients, expect the one between commuting time and traffic. Across specifications 5 to 7, we see that an extra hour of commuting is positively correlated with a higher stress level of 0.30 on 5 for all models. In other words, commuting for a longer time is linked to higher reported feelings of stress. On a scale of 1 to 5, these results show high economic significance, as an extra hour of commuting could represent up to 6% of the stress scale. Model 8, by adding the interaction of time and traffic, transfers all the explanatory power from commuting time to traffic congestion. The time itself loses its significance, while time spent in traffic increases the level of stress by 0.003/10 per minute. We can observe here that commuting time without traffic congestion is not correlated with stress, while time spent in traffic significantly affects the level of stress.

People working flexible hours do not show different levels of stress when compared to those working regular hours. The socio-demographic variables show similar patterns across models. Age and being female are positively correlated with higher stress, by 0.069 and 0.204 on 5 respectively, while education does not interferes with stress. Finally, French-speaking individuals show greater stress levels by an extent of 0.222 to 0.228 on 5, on average.

Table 6. *Commuting Time and Stress (Dependant variable: stress)*

Independent Variables	Model 5 Coefficient	Model 5 SE	Model 6 Coefficient	Model 6 SE	Model 7 Coefficient	Model 7 SE	Model 8 Coefficient	Model 8 SE
Commuting time (min.)	0.005***	0.001	0.005***	0.001	0.005***	0.001	-0.002	0.001
CT x Location			0.000	0.0004	0.000	0.00004	0.000	0.00004
CT x Public transport			0.000	0.001	-0.001	0.001	0.001	0.001
CT x Active transport			-0.002	0.002	-0.002	0.002	0.001	0.002
Flexible schedule			0.002	0.038	-0.009	0.037	-0.014	0.037
CT x TC							0.003***	0.0004
Constant	2.867***	0.028	2.866***	0.030	0.887***	0.322	0.905***	0.323
Demographics								
Age					0.069***	0.012	0.070***	0.012
Age squared					-0.001***	0.0001	-0.001***	0.0001
Sex (female = 1)					0.208***	0.036	0.204***	0.035
Years of secondary education					-0.002	0.003	-0.002	0.003
Undergraduate degree					-0.13	0.121	-0.135	0.125
Masters					0.055	0.132	0.049	0.136
Doctorate					0.051	0.150	0.038	0.154
Married					0.158	0.157	0.124	0.160
Common-law Union					0.226	0.164	0.199	0.167
Language of interview (French = 1)					0.222***	0.049	0.228***	0.049
Household size					0.010	0.022	0.014	0.022
Children (1 or more kids = 1)					0.036	0.058	0.032	0.059

The significance levels are: * p<0.10, ** p<0.05, *** p<0.01. The dependant variable is stress and the independent variable of interest is the commuting time (CT), in minutes. Location refers to urban (1) or rural (0) areas. Public transport and Active transport are dummy variables that take the value 1 if the commuter uses the particular mode of transportation. Flexible schedule takes the value 1 if the worker has such a timetable.

Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

In Table 7, using commuting distance to approximate the commuting burden, we see that for models 5, 6, and 7 (identically specified as models in Table 6, except for the regressor of interest), an additional kilometer of commuting is positively and significantly correlated with an increase in stress 0.003. Commuting the average of 41.86 km per day would therefore be associated with higher average levels of stress of 0.126 on a scale of 1 to 5.

Having a flexible working schedule is not significantly correlated with stress in this case. This can be explained by the fact that choosing her schedule does not allow the commuter to travel of shorter distance.

Table 7. *Commuting Distance and Stress (Dependant variable: stress)*

	Model 5		Model 6		Model 7		Model 8	
Independent Variables	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Commuting distance (km)	0.003***	0.001	0.003***	0.0009	0.003***	0.0008	-0.004***	0.001
CD x Location			0.000	0.0005	0.001	0.0004	0.000	0.0004
CD x Public transport			0.003	0.002	0.001	0.001	0.002*	0.001
CD x Active transport			0.000	0.002	0.000	0.002	0.001	0.002
Flexible schedule			0.008	0.038	-0.007	0.038	-0.012	0.037
CD x TC							0.003***	0.0004
Constant	2.938***	0.026	2.934***	0.028	0.901***	0.320	0.873***	0.322
Demographics								
Age					0.071***	0.012	0.071***	0.012
Age squared					-0.001***	0.0001	-0.001***	0.0001
Sex (female = 1)					0.205***	0.036	0.206***	0.035
Years of secondary education					-0.002	0.003	-0.002	0.003
Undergraduate degree					-0.127	0.116	-0.119	0.126
Masters					0.055	0.128	0.072	0.136
Doctorate					0.051	0.147	0.040	0.155
Married					0.146	0.156	0.118	0.158
Common-law Union					0.207	0.164	0.188	0.165
Language of interview (French = 1)					0.235***	0.049	0.249***	0.049
Household size					0.009	0.022	0.014	0.022
Children (1 or more kid = 1)					0.033	0.059	0.028	0.059

The significance levels are: * p<0.10, ** p<0.05, *** p<0.01. The dependant variable is stress and the independent variable of interest is the commuting distance (CD), in kilometers. Location refers to urban (1) or rural (0) areas. Public transport and Active transport are dummy variables that take the value 1 if the commuter uses the particular mode of transportation. Flexible schedule takes the value 1 if the worker has such a timetable.

Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

Interestingly, Model 8 shows that distance spent in traffic congestion affects positively and significantly the level of stress, while at the same time the distance drove by a person is negatively correlated with stress. We might think that driving can be a pleasant and relaxing experience when experiencing no traffic at all.

Lastly, Table 8 displays the results obtained by using experienced traffic congestion to measure the commuting burden, and stress as the regressand.

Table 8. *Experienced Traffic Congestion and Stress (Dependant variable: stress)*

	Model 5		Model 6		Model 7		Model 8	
Independent Variables	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
Traffic Congestion	0.133***	0.016	0.138***	0.018	0.137***	0.016	0.105***	0.027
TC x Location			-0.004	0.008	0.000	0.0004	0.000	0.0004
TC x Public transport			0.010	0.029	0.002*	0.001	0.001	0.001
TC x Active transport			-0.063	0.044	0.002	0.002	0.001	0.002
Flexible schedule			-0.003	0.037	-0.019	0.037	-0.020	0.037
TC x CT							0.001	0.0005
TC x CD							0.000	0.0005
Constant	2.744***	0.035	2.750***	0.038	0.690**	0.325	0.719**	0.327
Demographics								
Age					0.072***	0.012	0.071***	0.012
Age squared					-0.001***	0.0001	-0.001***	0.0001
Sex (female = 1)					0.197***	0.035	0.204***	0.035
Years of secondary education					-0.002	0.003	-0.002	0.003
Undergraduate degree					-0.165	0.124	-0.147	0.127
Masters					0.017	0.134	0.035	0.137
Doctorate					-0.012	0.156	0.015	0.158
Married					0.130	0.158	0.124	0.158
Common-law Union					0.200	0.165	0.195	0.165
Language of interview (French = 1)					0.252***	0.049	0.249***	0.049
Household size					0.011	0.022	0.012	0.022
Children (1 or more kid = 1)					0.033	0.059	0.034	0.058

The significance levels are: * $p<0.10$, ** $p<0.05$, *** $p<0.01$. The dependant variable is stress and the independent variable of interest is the traffic congestion (TC). Location refers to urban (1) or rural (0) areas. Public transport and Active transportation are dummy variables that take the value 1 if the commuter uses the particular mode of transportation. Flexible schedule takes the value 1 if the worker has such a timetable.

Data source: Statistics Canada, General Social Survey, Cycle 24 (2010)

In accordance to the literature on commuting and health issues, I find experienced traffic congestion to be correlated with greater levels of stress. Someone being stuck in traffic every day is expected to report, on average, a 0.392 to 0.548 higher degree of stress than someone who never experiences that problem. Again, this result is understandable: commuters cannot control traffic, therefore the longer the congestion lasts, the higher the stress they should be subject to. The last three models do not show any impact of having a flexible schedule on the level of stress. All other socio-demographic variables have similar effects as in tables 6 and 7. Finally, none the interaction term between traffic congestion, commuting time and commuting distance show any statistically significant correlation. This is another fact showing that traffic is the main source of stress.

Section III, part iv showed that across model specifications, a greater commuting burden is positively correlated with higher reported levels of stress, hence higher disutility (lower life satisfaction). These results are consistent with the previous ones in subsections i, ii, and iii, where a bigger commuting burden is shown to be negatively correlated with lower levels of life satisfaction. In addition, it appears to be the traffic congestion that truly and most importantly affects life satisfaction and the level of stress, before time of distance and time alone.

V. Conclusion

While everybody might not react the same way to commuting, it is safe to say that it generally constitutes an unpleasant burden. In a context of urban sprawl and personal car use, it is important to raise the question of how the commuting burden might affect well-being.

In this paper, I use a compensating-variation location theory model to test the notion of equilibrium in urban economics. The model predicts that rational individuals will choose where to locate by taking into consideration their expected life satisfaction, which depends on the disagreement of commuting, as well as the costs and quality of housing, and the income earned. Assuming efficient housing and labor markets, individuals who commute more should not experience lower subjective well-being, as they should be compensated through the two other channels that are incorporated in their utility function.

Using Canadian data from the General Social Survey, Cycle 24 (2010), I find that the equilibrium does not hold when the commuting burden is measured by commuting time and experienced traffic congestion. In fact, an extra hour of commuting leads, on average, to a lower life satisfaction of 0.30 on a scale of 1 to 10. Moreover, commuting time and distance paired with traffic congestion are both correlated with lower levels of well-being. Someone who is stuck in traffic every day is expected to report, on average, a lower life satisfaction when compared to an individual who never experiences traffic jams. Users of public transit are even more negatively affected by traffic than car users with an additional effect of up to -0.520 on their average life satisfaction evaluation, if facing traffic daily.

When commuting distance is used as a proxy for the travelling burden, the results are not statistically significant and the null hypothesis cannot be rejected.

I also find that the commuting burden is positively correlated with stress. Knowing that feelings of stress negatively affect life satisfaction, a higher resented level of stress can be seen as the equivalent of a lower utility. The results show that a greater commuting burden is associated with a higher dissatisfaction with life across all model specifications. Once again, traffic congestion explains most of the correlation and constitutes the main source of stress related to commuting.

Moreover, workers who have a flexible schedule generally show higher levels of life satisfaction, while no significant effect is shown on the level of stress. This holds under all previous model specifications.

The major contribution of this paper is to identify traffic congestion as having a greater impact of both life satisfaction and stress than commuting time or commuting distance. It seems that traffic is the most relevant proxy for the commuting burden, as it represents what affects the most people's well-being. The use of interactions between traffic congestion, commuting time and commuting distance in the regressions allowed us to see that, when they are present, these interaction terms capture the majority of the effects of commuting on stress and life satisfaction and greatly reduces the sole effects of the other proxies. The key takeaway is that traffic congestion, more than other measures of commuting, is what actually matters when determining one's utility, and it significantly negatively correlated with life satisfaction, while positively correlated with stress.

This study has a number of limitations. First, the homogeneous preferences assumption between individuals allows us to compare utility, assuming they are similarly affected by the different factors under consideration. This might not be exact. For example, some people might dislike longer commutes much more than others. I try to address this concern by using different specifications and compare people with similar characteristics (rural/urban settings and transportation modes), and I find similar responses in most cases, except for public transit, although further and more narrow specifications would be interesting to look at. As mentioned earlier, while life satisfaction measures provide some interesting insights on human behavior, their use is often criticized, as it is hardly comparable between different individuals. Many studies confirmed that most people have similar evaluation of their well-being (see section I, part iii), but one must remain careful while interpreting the results, as is it still possible that a certain level of subjective well-being might not be exactly the same for person A and person B.

Second, housing and labor markets might not be fully efficient. Therefore, some people could not fully choose where to locate. For example, a person that cannot afford quitting her job or that is constraint to live in a certain area could not compensate a higher commuting burden through these channels.

Third, the observations might suffer from a reporting bias. For many variables, people were asked questions about situations than happened in the past. The respondents might not remember perfectly what they experienced and approximate their answer. Some memories can also be distorted because of the mood the individual had at the moment of the event.[39]

[39] Hastie, R. and M. Davies, R. (2010), *Rational Choice in an Uncertain World: The Psychology of Judgement and Decision Making 2nd edition*, Sage Publication, California, (U.S.).

For example, traffic can cause stress, therefore one might remember this particular event as particularly unpleasant and alter her memory. Nonetheless, the questions were neutral (the open-end nature of the questions did not try to influence the respondent's answers), and usually referred to an event that happened in the previous week. For these reasons, I consider the risk of a reporting bias to be acceptable.

Forth, due to the cross-sectional design of the survey, we cannot observe the behaviors of individuals over time and draw causal relationships.[40] We are not in a controlled environment, and without a time component, the data used in this paper can only provide us with measures of correlation. Although we can still draw some relevant conclusions, it would be interesting to observe if and how people react to their situation over time, for example by moving or negotiating higher wages, in order to compensate for their current disutility associated with commuting.

Finally, we have to keep in mind that this is an individual equilibrium analysis. The results found in this paper might not be the same if we were looking at households' utility. Therefore, when rejecting the initial hypothesis on an individual basis, we cannot do the same at the household level. One's disutility could help increasing even more someone else's utility, therefore leading to an increase in overall utility. It would be interesting in further studies to perform a similar analysis at the family level.

These results can have interesting implications in various areas. Governments and policy planners should consider the importance of commuting when allowing cities to expand their geographical limits. In addition, the importance of an efficient and traffic-less public

[40] Angrist, J.D., and Pischke, J.S. (2008). *Mostly harmless econometrics: An empiricist's companion*, Princeton university press, U.S.

transportation system is confirmed and could encourage the development of better public transit. Moreover, individuals might want to carefully evaluate the actual burden they will face by commuting and should be aware that they might very well underestimate the cost of their journey to work. Lastly, firms should keep in mind the impact of commuting on the well-being of their employees, and may consider offering flexible hour schedules, telework opportunities, or even locate out of city centres, closer to residential areas. This could be beneficial in many ways, as employees reporting higher levels of well-being are typically more productive, have lower absenteeism episodes and tend to be more loyal to their employer.[41]

---

[41] Warr, P., Kahneman, D., Diener, E., and Schwarz, N. (1999), *Well-being: The foundations of hedonic psychology*, Russell Sage Foundation, New York (U.S.).

VI. Bibliography

Alonso, W. (1964), *Location and Land Use: Toward a General Theory of Land Rent*, Harvard University Press, Cambridge, Massachusetts (U.S.).

Angrist, J. D., and Pischke, J. S. (2008). *Mostly harmless econometrics: An empiricist's companion*, Princeton university press, U.S.

Bond, T. N. and Lang, K. (2014), *The Sad Truth About Happiness Scales*, National Bureau of Economic Research, Working Paper, Cambridge (U.K.).

Diener, E., Sandvik, E., Seidlitz, L, and Diener, M. (1993), *The relationship between income and subjective well-being: Relative or absolute?*, Journal of Personality, U.S.

Easterlin, R. A. (1974), *Does Economic Growth Improve the Human Lot? Some Empirical Evidence*, Academic Press, New York (U.S.).

Ferrer-i-Carbonell, A. and Van Praag, B. M. S. (2011), *Happiness Economics: A New Road to Measuring and Comparing Happiness*, Foundations and Trends® in Microeconomics, U.S.

Frijns, M. (2010), *Determinants of Life Satisfaction – A Cross-Regional Comparison*, Maastricht University, Netherlands.

Gärling, T., Krause, K., Gamble, A., and Hartig, T. (2014), *Emotional well-being and time pressure*, Wiley Publishing Asia, China.

Gordon, Richardson & Jun (2007), *The Commuting Paradox Evidence from the Top Twenty*, Journal of the American Planning Association, U.S.

Gundelach, P., Kreiner, S. (2004), *Happiness and Life Satisfaction in Advanced European Countries*, Cross-Cultural Research, Copenhagen (Denmark).

Green, S. B. (1991), *How Many Subjects Does It Take To Do A Regression Analysis*, Multivariate Behavioral Research, U.S.

Hastie, R. and M. Davies, R. (2010), *Rational Choice in an Uncertain World: The Psychology of Judgement and Decision Making 2nd edition*, Sage Publication, California, (U.S.).

Hammond, P. J. (1989), *Interpersonal Comparisons of Utility: Why and How They Are and Should Be Made*, European University Institute (Italy) and Stanford University, California (U.S.).

Hilbrecht, Smale & Mock (2014), *Highway to health? Commute time and well-being among Canadian adults*, World Leisure Journal (Spain).

Hoehner, C. M., Barlow, C. E., Allen, P., and Schootman, M. (2012), *Commuting Distance, Cardiorespiratory Fitness, and Metabolic Risk*, American Journal of Preventive Medicine, U.S.

Lee, Y. D., Park, S. H., Uhlemann, M. R., Patsula, P. (1999), *What Makes You Happy?: A Comparison of Self-Reported Criteria of Happiness Between Two Cultures*, Social Indicators Research, Netherlands.

Nozhnitskiy, A. and Naples, M. (2014), *Comparative Happiness In American Living Spaces - Urban, Suburban, and Rural*, The College of New Jersey, New Jersey (U.S.).

OECD (2015), *Better Life Index - Edition 2015*, Paris (France).

Olsson, L. E., Gärling, T., Ettema, D., Friman, M. and Fujii, S. (2012), *Happiness and Satisfaction with Work Commute*, Social Indicators Research, Netherlands.

Pourahmad, A., Baghvand, A., Zangenehe Shahraki, S., and Givehchi, S. (2007), *The Impact of Urban Sprawl up on Air Pollution*, International Journal of Environmental Research and Public Health, Iran.

Pouyanne, G. (2006), *Étalement urbain et ségrégation socio-spatiale : une revue de la littérature*, Groupement de Recherches Economiques et Sociales, France.

Schiffrin, H. H., Nelson, S. K. (2010), *Stressed and Happy? Investigating the Relationship Between Happiness and Perceived Stress*, Springer Science+Business Media B.V., USA.

StataCorp. (2009). *Stata 11 Base Reference Manual*. College Station, TX: Stata Press, U.S.

Statistics Canada (2011), *Census of Population 2011*, Canada.

Stutzer, A. and S. Frey, B. (2008), *Street that Doesn't Pay: The Commuting Paradox*, The Scandinavian Journal of Economics, Sweden.

Tiebout, C. M. (1956), *A Pure Theory of Local Expenditures*, The University of Chicago Press, Michigan (U.S.).

Veenhoven, R. (1994), *How Satisfying Is Rural Life? Fact and Value*, Society for agricultural policy research in rural society, Bonn (Germany).

Von Thünen, J. H. (1826), *The Isolated State*, Pergamon Press, London (U.K.).

Warr, P., Kahneman, D., Diener, E., and Schwarz, N. (1999), *Well-being: The foundations of hedonic psychology*, Russell Sage Foundation, New York (U.S.).

Wilson VanVoorhis, C. R., Morgan, Betsy L. (2007), *Understanding Power and Rules of Thumb for Determining Sample Sizes*, Psi Chi Journal of Undergraduate Research, Tennessee (U.S.).