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Potential Impacts of Telecommuting on Transportation Behaviours, Health and Hours Worked in Québec

GEORGES A. **TANGUAY**

UGO **LACHAPELLE**

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CIRANO
Allier savoir et décision

Centre interuniversitaire de recherche en analyse des organisations

Potential Impacts of Telecommuting on Transportation Behaviours, Health and Hours Worked in Québec[1]

Georges A. Tanguay,[2] Ugo Lachapelle[3]

Summary

Drawing on data from the Statistics Canada General Social Survey 2010 (GSS), this research presents a statistical characterization of telecommuters in Québec, and estimates some of the potential impacts of telecommuting on transportation behaviours, health and hours worked. First, we describe the context that fuelled the growth of telecommuting, and estimate the size of the worker populations concerned by the different types of telecommuting by industry, based on the main socioeconomic and spatial statistics. These results are then compared with experiences outside Québec linked to incentive measures to favour telecommuting.

Second, we make estimates to explain telecommuting activity. We show that the number of telecommuters in Québec is situated at about the national average, but, all things being equal, the probability of observing telecommuting in Québec is greater than elsewhere in Canada. Compared with employees working uniquely at the regular workplace, telecommuters are on average more affluent and educated, more urban, live closer to or farther from the workplace and are less unionized.

Third, we econometrically estimate the relationships between telecommuting and: i) total travel time); ii) travel schedules; iii) levels of reported health and stress, and the feeling of being pressed for time; and iv) hours worked. These estimates consider behaviours according to types of organization of work, socioeconomic characteristics and time use. The models estimated specifically pertain to Québec and show that there are generally few significant differences between respondents in Québec and in the rest of Canada.

Concerning transportation behaviours, telecommuting is generally associated with a reduction in travel during peak periods. In contrast, compared with work uniquely at the regular workplace (*e.g.* office), telecommuting may have different effects on total travel time during the workday. Employees working only at home travel on average 19 minutes less, whereas those who divide their work between home and the regular workplace travel for the same amount of time as other employees. Employees working at several sites, including third places (*e.g.* cafes), travel for about 17 minutes longer per day on average.

Further, depending on its form, telecommuting is associated with increases or decreases in hours worked on the survey day. Compared with employees who work only at the regular workplace, people who work only at home work about 2 hours and 15 minutes less. Respondents who combine work at home and/or at the regular workplace with other places work about 43 minutes less. In contrast, employees who work at home and at the regular workplace reported nearly 49 more minutes of work. Lastly,

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[1] Study conducted in cooperation with Maryse Boivin, Juste Rajaonson and Marc-Olivier Pepin.

[2] CIRANO *Fellow* and Professor, Department of Urban and Tourism Studies, Université du Québec à Montréal.

[3] CIRANO *Fellow* and Professor, Department of Urban and Tourism Studies, Université du Québec à Montréal.

telecommuting is associated with increased feelings of stress and being pressed for time, but has no links to reported health.

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1. Introduction

An analysis of data from the Statistics Canada General Social Survey (GSS) from 2000 to 2008 found that 11.2% of Canadians employed in the private and public sectors telecommuted in 2008 (Turcotte, 2010). Data from the same survey also clarified the scope of the phenomenon for Québec: the Greater Montréal and Québec City Areas accounted for 11% and 16% of telecommuters respectively (Turcotte, 2010). These percentages rise to nearly 20% if self-employed workers are included. In fact, the trend has been growing moderately since 2000. Further, with the growth of the digital economy and the proliferation of self-employed workers, the number of people working at home and in "third places" is likely to rise in the future, particularly concerning co-work, which involves working in shared spaces. This growth can be explained by the many positive impacts demonstrated in numerous international studies. For example, telecommuting contributes to increasing productivity and reducing rush hour congestion (Bailey & Kurland, 2002; Lister & Harnish, 2011; Bussière & Lewis, 2002; Lari, 2012). However, although a large body of scientific literature on telecommuting exists at the global level, this field remains fairly embryonic in Canada and Québec, where researchers have mainly examined the general characteristics of telecommuters (e.g. age, place of residence, job category), and case studies have been limited by the small number of businesses and workers studied (Tremblay, 2001; Turcotte, 2010; Schweitzer & Duxbury, 2006; Moos *et al*., 2006).

In this context, it is important to evaluate the potential impacts of telecommuting in Québec, notably on work time. The shrinking workforce in Québec has negative implications for economic growth. One way to accelerate this growth would be to increase hours worked by changing the organization of work. This could translate into the introduction of measures favouring telecommuting, which, as numerous scientific studies demonstrate, has potentially positive effects not only on productivity, but also in terms of health and of reducing negative externalities of transportation. Therefore, the present research aims to evaluate the possible impacts of telecommuting on: i) travel; ii) work schedules and workplaces; iii) levels of reported health and stress; and iv) hours worked. The analyses are put into context by a literature review of the study themes.

To achieve the research objectives, we make econometric estimates using the data from the Statistics Canada GSS 2010. The results can shed light on the impacts of telecommuting and can facilitate the formulation of strategies to favour telecommuting: regulation of telecommuting in the public service, etc.

1.1 The mandate

The present study aims to enrich knowledge and inform the public debate by characterizing telecommuters in Québec and by estimating some of the potential impacts of telecommuting on transportation behaviours, health and hours worked.

Specifically, the report answers the following questions. What characteristics do telecommuters in Québec exhibit? How does telecommuting modify individuals' travel behaviours? Do telecommuters travel more or less given all their trips (e.g. for work and personal reasons)? At what times of day do they travel? Do they manage to avoid rush hour travel? How are levels of reported health and stress related to telecommuting? What are the differences in terms of hours worked between people who telecommuting

and those who work at the organizations' premises? How do these behaviours vary according to different types of telecommuting, job types and socioeconomic characteristics? How do the Québec results compare with those of Canada and other provinces? What incentive measures exist outside Québec and how can they inspire the formulation of provincial measures?

1.2 Methodology

We answer these questions using the GSS 2010 data for six Canadian provinces. This survey links the demographic and socioeconomic characteristics of 15,390 respondents to about 283,000 episodes of time use, including time spent at work, travelling or with family. Hours worked, workplaces, transportation modes used, travel time and schedules of these activities during one day can all be compiled based on the activity diaries used in the survey. Given that a probabilistic sample of the population was formed, the responses represent 28 million Canadians. For Québec, the database contains 2,277 respondents representing 6.56 million Quebecers ages 15 and over. Raising factors allow us to project the estimates to this population and to weight the analysis results. The samples used for our analyses are smaller because the GSS included people who were retired or unemployed, whereas our study does not.

Estimates are based on the characteristics of the data available. The data on time use pertaining to travel often include distributions with censored dependent variables, and require Tobit estimates, whereas estimates on the choice of travel time (e.g. peak periods) are made with a multinomial logistic model. Estimates concerning health are made with ordinal logistic models, whereas those related to hours worked are based on ordinary least square regressions.

The dependent variables represent different types of telecommuters (e.g. full time, working at home), their socioeconomic characteristics, industry classifications (SCIAN) and time use. Our database lets us consider most of the potential explanatory variables described in the literature. To take specific provincial factors into account, particularly those of Québec, we estimate three models for each of the subjects: two for Canada, with and without provincial effects, and one for the Québec subsample.

Further, our bibliographical research enabled us to compile a vast number of cases of organizations around the world that introduced telecommuting programs. Ample information is available regarding the success of these programs. This formal and informal information comes from surveys and specific cases. However, as Westfall (1998) and Bailey and Kurland (2002) point out, this information must be considered prudently given that it is based on anecdotal evidence coming strictly from employee and/or employer reports. Given these limitations and the spatial and time constraints, the analyses of the effects of telecommuting in the specific chapters on the effects on transportation, health and hours worked (chapters 5 to 7), are based solely on the scientific literature (*e.g.* articles, research reports)[4] and on our statistical estimates. To establish the general context, the introductory chapters (2 and 3) contain survey information related to specific cases.

Regarding the limitations of our analyses, although the GSS allows us to explore aspects related to telecommuting, the usable variables are limited by the questions put to

[4] In fact, many of the case studies compiled are cited in scientific papers and research reports.

respondents and by the sample sizes. For example, concerning hours worked, it is impossible for us to precisely consider the factors affecting the labour market such as those associated with wage disparity, taxation and regulation. In addition, industry codes cannot be used directly given the small sample sizes.

Further, the GSS is a cross-sectional study, which makes it difficult to establish causal links between forms of work and variables concerning different subjects. Therefore, phenomena of simultaneity or inverse causality seem possible between the decision to telecommuting and travel, hours worked and health.

For travel and hours worked, the observations concern only one particular day and are not necessarily correlated with individuals' habitual behaviours. For the survey day, decisions concerning travel and worktime may have ensued from a prior decision about the form of work chosen, and not the opposite. However, it is also theoretically possible that these decisions were made simultaneously.

For health and feelings of stress and of being pressed for time, the variables used are linked to general perceptions and are not valid exclusively for the study day. This therefore clearly raises the possibility that the decision to telecommuting is linked to the perceived and reported state. For example, individuals who generally view their health as poor, or who feel rushed, may be more inclined to telecommuting. Our analysis makes the inverse hypothesis on the potential effect of telecommuting on health variables.

The use of an instrumental variable for telecommuting was thus considered, but no variable from the GSS could reasonably play this role.

Given the circumstances described above, the analysis is therefore interpreted in terms of association rather than causality.

In addition, the Québec sample is limited because we observe only the workforce, and telecommuting concerns limited groups within the population. Lastly, the data date back six years ago.

1.3 The report

This study, conducted in 2016-2017, was directed by Georges A. Tanguay, CIRANO Fellow and Professor in the Department of Urban and Tourism Studies of Université du Québec à Montréal, and Ugo Lachapelle, Professor in the Department of Urban and Tourism Studies of Université du Québec à Montréal. The work was done in cooperation with Maryse Boivin, Juste Rajaonson and Marc-Olivier Pepin, student researchers and research professionals at CIRANO.

The remainder of the document is organized as follows.

In chapter 2, because telecommuting can be construed in several ways regarding place, workers' status, etc., we first specify the definitions that will be used in the present research according to the three themes studied. We also explain how information and communication technologies (ICT) required for telecommuting may influence activities and travel. We then briefly present the technological context that spurred the growth

of telecommuting. We conclude the chapter by reviewing the general impacts of telecommuting documented in the literature.

Chapter 3 provides an overview of the scope of telecommuting around the world by focusing on Canada and Québec, together with the United States and France, where several measures were introduced to develop and regulate telecommuting. In addition, we discuss measures that can encourage the adoption of telecommuting programs.

In chapter 4, we present the general methodological approach in greater detail regarding the three specific subjects examined. For Québec and Canada, we estimated the proportions and size of the populations of workers concerned by different types of telecommuting based on the main socioeconomic, demographic and spatial statistics associated with the workers concerned. We end the chapter by presenting the logistic regression models explaining telecommuting activities. Our estimates show that the number of telecommuters in Québec is situated at about the national average, but, all things being equal, the probability of observing telecommuting in Québec is greater than elsewhere in Canada. We show that, compared with employees working solely at the regular workplace, telecommuters are on average more affluent and educated, more urban, live closer to or farther from the workplace and are less unionized.

In chapters 5 to 7, we analyze some of the links between telecommuting and transportation behaviours (chapter 5), health (chapter 6) and hours worked (chapter 7). Each chapter begins with a review of the literature of the potential effects of telecommuting, followed by econometric estimates of models with dependent variables associated with three main elements: i) travel time and times of day; ii) reported health and stress levels; and iii) hours worked. The explanatory variables of interest concern data on reported workplaces, and correspond to four main work arrangements: work at the workplace only, work at home only, work at the workplace and at home during the day, and a combination of work outside the home, at the workplace and/or at home. The control variables selected are associated with different factors established in previous research, and notably pertain to respondents' socioeconomic characteristics (e.g. income, age, sex, presence of children in the home) and characteristics linked to the respondents' work. The models estimated specifically consider Québec, and show that there are generally no significant differences between respondents in Québec and in the rest of Canada. The direction and scope of the results obtained are thus consistent across the different provinces and regions of Canada.

In terms of transportation behaviours, our results show that compared with work done solely at the regular workplace (*e.g.* office), telecommuting may have different effects on total travel time during the workday, depending on the forms it takes. For example, employees working exclusively from home travel 19 minutes less on average, whereas those who divide work between home and the regular workplace have equivalent travel time to non-telecommuters. Employees working in several places, including third places, travel for about 17 minutes longer per day on average. Further, telecommuting is generally linked to a reduction in rush hour travel. In addition, telecommuting is associated with increased feelings of stress and being pressed for time, but is not linked to reported health.

Lastly, we show that depending on the forms it takes, telecommuting can decrease or increase hours worked in a given day. Compared with employees who work solely as the regular workplace, people who work only at home work about 2 hours and 15 minutes less. Respondents who combine work at home and/or at the regular workplace

with other places work about 43 minutes less. In contrast, employees who work at home and at the regular workplace work nearly 49 minutes more.

To conclude the report, a summary of the results is presented in chapter 8, where we review the potential implications for policy formulation in Québec.

2. Telecommuting: definition, effects and context

The concept of telecommuting was introduced in the United States in the 1970s by Jack Nilles, who was seeking a solution to automobile traffic congestion (Bailey & Kurland, 2002; Mokhatarian *et al.*, 2005; Telecommuting Research Network, 2011a). Allowing employees to work at home could reduce the number of vehicles on the road, particularly at peak periods. Although the concept was originally linked to research on transportation, several fields of study have tried to understand the mechanisms of telecommuting and its broader effects on society and the labour market.

Since 1990 access to technology and the Internet has increased dramatically in homes and workplaces. At the turn of the millennium, the multiplication of communication platforms has greatly advanced exchanges between individuals and organizations. Electronic messaging, telephones, online chat, videoconferences and cloud computing have become commonplace. The era of virtual reality has arrived: telecommuting is gradually reshaping the working world. To better understand this reality, it is important to clearly define the notion of telecommuting.

2.1 Definition

It is widely recognized that the concept of telecommuting is difficult to define, mainly owing to its multitudinous forms (Mokhtarian *et al.*, 2005; Pratt, 2000. 2002). The definition may vary depending on where telecommuting is practised, the equipment used, the frequency of the activity and the employees' status. Nonetheless, "*the broader the definition, the larger the number of telecommuters that will be counted in a given region or country*" (Tremblay, 2001). To avoid confusion, Pratt (2000) recommends the use of measurable variables such as workplace or time spent working in each location. Even when an objective definition has been established, diverse measure instruments, sampling and research interests may also affect the quality of the data (Mokhtarian *et al.*, 2005). It is therefore crucial to clarify the concept of telecommuting as it will be used in this report. This definition necessitates specification of place, the ICT required, the intensity of the practice and the employment status. Table 2 summarizes the elements retained.

Table 2.1 Elements retained to define telecommuting

Characteristics	Elements retained
Place	Away from the regular fixed workplace, recognized as the employer's premises
Equipment required	Use of a computer to do the work and existence of an IT link to the employer
Intensity of the practice	Regularly, full or part-time (days per week or per month, evenings and weekends).
Status	Salaried employees and self-employed workers, depending on the subject studied

Inspired by Mokhtarian *et al*. (2005)

2.1.1 Question of place

The primary idea inherent in telecommuting is that of work carried out away from the regular fixed workplace, recognized as the premises of the organization that hired the individual. Illustrative of the multitude of places where it may be carried out and the

inherent confusion about the phenomenon, the terms *telecommuting, telecommuting, at-home work, hoteling, home-based business, road warriors* and *mobile workers* have all been used to refer to telecommuting in different forms (Pratt, 2000; Vilhelmson & Thulin, 2001). In fact, this type of work can be done in various places: home, hotel, satellite office, coffee shops, etc. (WorldatWork, 2011a). Although some studies chose a definition that restricts the practice of telecommuting to the home, as does Statistics Canada (Turcotte, 2010), the expression "home work" does not necessarily cover all forms of telecommuting. For example, according to the Home Work Convention put forth by the International Labour Organisation (ILO, 1996), "*the term **home work** means work carried out by a person, to be referred to as a homeworker in his or her home **or in other premises of his or her choice**, other than the workplace of the employer, for remuneration, which results in a product or service as specified by the employer, irrespective of who provides the equipment, materials or other inputs used*." It is therefore important to consider the diversity of places where telecommuting is practised.

2.1.2 Information technology required

The sole fact of working outside the company premises is not a sufficient condition to determine whether work is telecommuting or not. For instance, the term teleworking is also used in general to refer to work outside the workplace but not necessarily involving ICT. Therefore, given the nature of the present research, we use the term telecommuting. The elimination of the need to travel by the use of technology is instrumental to the interactions that may be linked to telecommuting (Andreev *et al.*, 2010; Salomon, 1998). In this case, telecommuting implies the use of information technologies by employees as part of their duties.[5] As the second indispensable element in the concept of telecommuting, we therefore assume the existence of an IT link with the employer to carry out some work-related tasks.

2.1.3 Intensity of the practice

Telecommuting also implies the notions of frequency and regularity. For example, people may work at home or elsewhere full time, one or two days a week, regularly during evenings and weekends, or ad hoc. Relative frequency appears to be an important moderator of telecommuting within businesses (Bailey & Kurland, 2002). It is notably linked to gender, occupation, distance from work and income (Hjorthol, 2006). In terms of attitude, women, married people, employees with young children, those with large homes, and those who live far from work are likely to telecommuting (Iscan & Naktiyok, 2005).

Beyond the intensity of work done outside the regular workplace, the recurrence of the practice seems to have the power to institutionalize it, although few Canadian organizations have formalized telecommuting agreements (Schweitzer & Duxbury, 2006), even in cases where such agreements in work contracts may eliminate confusion and optimize the process (Government of Canada, 1999; Ministère de la Fonction publique, 2016). In Québec in 2001, nearly three out of four telecommuters reported that they did not have a formal agreement on telecommuting with their employer (Tremblay, 2001). Because formal agreements still do not characterize most telecommuting situations, this report considers both formal and informal telecommuting.

[5] Nonetheless, telecommuting does not always substitute for travel. As we will see below, effects of remote technologies on travel include complementarity, modification or neutrality (Andreev *et al.*, 2010).

2.1.4 Status of salaried employees and self-employed workers

The status of worker is also salient to the definition of telecommuting. Salaried employees and self-employed workers must be differentiated from the outset when measuring and analyzing the telecommuting phenomenon (Pratt, 2000). All self-employed workers can be said to do remote work, so their weight is particularly heavy when they are included in the telecommuting figures. For example, a report by the United States Census Office shows that nearly half of home workers are self-employed workers (United States Census Office, 2012). Some reports assert that limiting research on telecommuting to salaried employees can clarify the potential benefits of this practice related to commuting (Telecommuting Research Network, 2011a). To better understand the dynamics of telecommuting on transportation behaviours, we therefore consider salaried employees exclusively. For questions related to health and hours worked, we consider both salaried employees and self-employed workers.

2.1.5 Definition retained

Given the findings above, the basic definition of telecommuting retained for this report refers to situations where **"***salaried employees of an organization replace or modify the commute by working at home or at a location closer to home than the regular workplace, generally using ICT to support productivity and communication with supervisors, co-workers clients and other colleagues*" (Andreev *et al.*, 2010). As mentioned above, we supplement this definition by excluding self-employed workers in the analysis of transportation behaviours, but include them in the analyses of health and hours worked (Pratt, 2000).

The characterization of telecommuting to date has underlined the preponderant role of ICT, particularly concerning the Internet. In the next section we briefly describe the evolution of Internet connectivity in Québec and Canada that contributed to the growth of telecommuting.

2.2 Internet and telecommuting

Growth in the use of personal computers and Internet access has certainly powered the development of telecommuting (Pratt, 2002). The link between access to technology and the practice of telecommuting has been affirmed in several studies (Neirotti *et al.*, 2013; Pérez *et al.*, 2005; Vilhelmson & Thulin, 2001).

Table 2 illustrates the rapid, continuous, and recent growth of Internet access in households in Québec and Canada according to Canadian data on Internet use compiled by Statistics Canada (2010, 2013). In Canada, the residential Internet access rate rose from 60.9% in 2005 to 83% in 2012, compared with an increase of 52.5% to 78% in Québec for the same period.[6] Further, the connection rate in Québec households was 90% in 2016 (CEFRIO, 2016). Therefore, almost all employees in Québec have the technical capacity to work away from their regular workplace. This trend will likely amplify because the Canadian government and the CRTC recently announced substantial financial contributions to telecommunications companies to bring Internet

[6] The *Institut de la statistique du Québec* reported a rate of Internet access in Québec households of 81.6% in 2012 (ISQ, 2013b). For standardization purposes, we will use the Statistics Canada estimates exclusively.

access in "remote" regions up to current standards.[7] In addition, Internet connections are now available at many public places.

Table 2.2 Evolution of Internet access at home

Region, Year	Percentage
Canada	
2005	60.9
2007	68.6
2009	77.1
2012	83.0
Québec	
2005	52.5
2007	63.1
2009	72.9
2012	78.0

Sources: Statistics Canada, 2010, 2013.

Concerning workplaces, 84.2% of Québec private sector firms had an Internet connection in 2012. This proportion increases with firm size, as table 2.3 shows, with 78.1% for very small firms and 10% for the largest firms (ISQ, 2013a). Note that almost all businesses with 10 employees or more are connected. Regarding mobile Internet, more than half of businesses are connected (54.4%), but the gap is even more pronounced according to business size. Lastly, high-speed penetrated one-third of large businesses in Québec in 2012, compared with the overall percentage of 14.4%. Largely connected to the Internet, several organizations can thus offer their employees new telecommuting options. In Canada in 2012, this is particularly true for large businesses, which are twice as likely to offer their employees this option than are smaller firms (47% *vs* 22%; BMO, 2013).

[7] http://plus.lapresse.ca/screens/c424098e-156f-4f8c-912d-88baaf01269b%7C_0.html.

Table 2.3 Internet access within Québec businesses, 2012

Type of access	Percentage
At workplaces	84.2
1 to 4 employees	78.1
5 to 9 employees	84.7
10 to 49 employees	94.8
50 to 249 employees	99.2
250+ employees	100
Mobile Internet	54.4
1 to 4 employees	49.0
5 to 9 employees	50.7
10 to 49 employees	60.1
50 to 249 employees	80.0
250+ employees	92.5
High speed	14.4
1 to 4 employees	12.9
5 to 9 employees	14.4
10 to 49 employees	15.9
50 to 249 employees	18.6
250+ employees	31.8

Source: ISQ, 2013a

However, despite the rising use of ICT, the initially anticipated growth of telecommuting does not seem to have occurred (Turcotte, 2010). The early predictions about the evolution of telecommuting were overestimated mainly due to the emphasis on technological factors to the detriment of social considerations (Bailey & Kurland, 2002; Salomon, 1998). Certainly, access to a computer and a connection represent determining factors of telecommuting, but the progress of this practice is much slower than the penetration rate of ICT (Vilhelmson & Thulin, 2001).[8] Nonetheless, as we will see in greater detail below, the practice of telecommuting is fairly widespread in Canada, and its development potential seems important.

According to an analysis based on the GSS for the years 2000 to 2008, 11.2% of Canadians employed in the private and public sectors telecommuted in 2008 (Turcotte, 2010). Data from the same survey show the scope of the phenomenon in Québec: the Greater Montréal and Québec City Areas account for 11% and 16% of telecommuters respectively (Turcotte, 2010). These percentages would increase by nearly 20% if self-employed workers were included. These data illustrate a trend that has been growing moderately since 2000. With the development of the digital economy, the number of people working at home and in "third places" (e.g. coffee shops, shared spaces) is likely to rise in the future, transforming the links between organizations and their employees, together with their clients, other organizations, etc. (Tremblay, 2001).

The next section paints a general portrait of the impacts of telecommuting.

2.3 Review of the impacts of telecommuting

Given the central role of ICT in the telecommuting phenomenon, we begin the review of the impacts of telecommuting by explaining how telecommuting can fundamentally

[8] This phenomenon is largely due to regulatory and tax issues (Alizadeh et Sipe, 2013), which we will discuss in Chapter 3.

influence the organization of time, activities and travel, and thus change how, where and when work is done. We then discuss the many effects found in the literature that can be traced specifically to telecommuting by specifying the impact on employees, employers and society in general.[9]

2.3.1 ICT, telecommuting, activities and commuting

By reducing constraints on time and means, ICT influence types of activities and reasons for commuting, as the literature confirms. Three types of personal activities are associated with ICT (Andreev *et al*., 2010; Mokhtarian 2006): a) mandatory (e.g. work); b) maintenance (e.g. hygiene and health); and c) discretionary or leisure. As Mokhtarian (2006) notes, the limits between these types of activities are often blurry given their multiple attributes (e.g. eating = mandatory and leisure), simultaneity (e.g. eating while working), and their temporal and spatial fragmentation (e.g. tasks interrupted by breaks and/or done in different places). In addition, ICT contribute to blurring these limits because they offer more flexibility and can thus have several impacts related to work organization. For instance, we can consider the effects of ICT on the fragmentation of activities and on the type and number of activities and trips.

Fragmentation of an activity is defined as a process where an activity is done in several parts at different times and/or places (Lenz & Nobis, 2007). Fragmentation is not a new concept, in that the performance of activities in fragments existed before the development of ICT, but ICT has nonetheless modified activity management in time and space by increasing the possibilities for carrying out activities. Lenz and Nobis (2007) and Couclelis (2000) assert that the process of fragmentation facilitated by ICT can take three forms. First, spatial fragmentation consists in performing an activity in different places. For example, the work done traditionally at the workplace may now be done in different places with different technological, communication and transportation means. Second, temporal fragmentation occurs when an activity is done at different times. This type of fragmentation is notably facilitated by cell phones and the Internet, which allow communication and work to take place at any time, for example when eating at a restaurant. Lastly, fragmentation may consist in doing an activity by various means, such as when a text is read partly on a paper copy and online, on IT support.

In terms of impacts of ICT on the types and numbers of activities and commutes, four types of effects are possible (Andreev *et al*., 2010; Mokhtarian *et al*., 2005; Salomon, 1998). First, ICT can serve as substitutes for some activities and trips, thus decreasing their number. For instance, the use of the computer could allow telecommuting and thus eliminate commuting to the main workplace. Second, ICT could be complementary and generate certain activities and trips. One example would be when an increase in communication via ICT leads to a larger number of business meetings. Third, ICT can fundamentally change the way activities and travel take place without changing the types and numbers of trips. Public transit (PT) applications may cause such effects.

[9] Note that some impacts compiled may be considered both advantages and disadvantages (*e.g.* increase in hours worked). For example, employees' attitude toward telecommuting would modify their perception of the advantages and disadvantages for themselves and their employer (Iscan & Naktiyok, 2005). We are not debating these possibilities. Instead, we list the main potential aspects of telecommuting identified that are directly or indirectly linked to the aspects covered in this report. Specific literature reviews of the effects of telecommuting on transportation behaviours, health and hours worked are presented in the chapters on these subjects.

Lastly, ICT may be neutral and have no effect on activities and travel, including their types and frequency.

To summarize, the use of ICT in telecommuting may have several types of effects on the frequency and duration of activities and travel, schedules, location (e.g. urban sprawl), etc. For example, in terms of transportation and mobility, telecommuting notably: i) reduces demand at peak periods (Mitomo & Jitsuzumi, 1999; Andrey *et al*., 2004); ii) favours the use of public transport (Mokhtarian & Verdier, 1998; Kitou & Horvath, 2006); and iii) reduces commuting (Choo *et al*., 2005; Andreev *et al*., 2010). Telecommuting can thus be integrated in measures businesses deploy to guide their employees' choices toward sustainable travel, by promoting public transport, carpooling or active transport such as cycling (Vanoutrive *et al.*, 2010). However, negative impacts of telecommuting on transportation behaviours are also possible. For instance, telecommuting can reduce the frequency of travel for multiple purposes (Lenz & Nobis 2007; Hilbrecht *et al*., 2013) and lead households to settle farther from the centre of urban economic activities (Rhee, 2009; Zhu, 2013). Indeed, there is a positive correlation between telecommuting and distance between the home and workplace (Tremblay & Najem, 2010). In his seminal works, Nilles (1975) hypothesized about possible *telesprawl,* whereby telecommuting would cause urban sprawl.

Changes in activities and travel are closely linked to the possibility of more flexible schedules resulting from telecommuting, which we discuss below.

2.3.2 Schedules, work-life balance

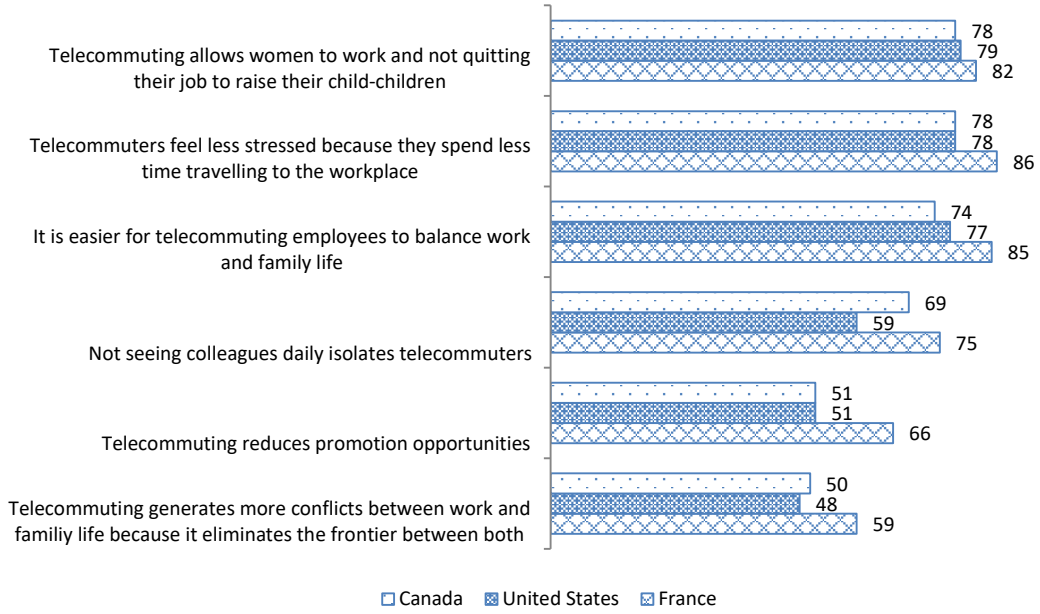
Having a flexible work schedule is among the main advantages of telecommuting cited by employees (Scaillerez & Tremblay, 2016).

More flexible time use can enable telecommuters to improve the balance between their work obligations and personal life. Work-life balance may be an important factor in employee fatigue and stress (Bailey & Kurland, 2002; Maruyama & Tietze, 2012). For women in particular, telecommuting facilitates the balance between work and fulfilment of their maternal responsibilities (Maruyama & Tietze, 2012; Tremblay, 2016).

Work at home is not immune from conflicts. The boundaries between personal and work life may be adversely affected, which induces dissatisfaction for some telecommuters. It may also gradually hinder workers' productivity (Dumas & Ruiller, 2014). This problem may be due to the perverse effects of schedule flexibility that lead employees to work excessively, which can impair their quality of life and health (Dumas & Ruiller, 2014; Brun & Durieu, 2012).

Figure 2.1 illustrates the viewpoint of employees in Canada, the United States and France concerning various statements related to telecommuting, particularly concerning work-life balance and isolation. It shows that telecommuting is mainly viewed positively (Ipsos, 2011).

Figure 2.1 Percentage of respondents who agree with the following statements concerning telecommuting



Source: Ipsos, 2011

For the employer, the possibility of modulating telecommuters' schedules may be an important asset in their quest to adjust to customers' and suppliers' needs (Scaillerez & Tremblay, 2016). For example, by having workers work at home in the evening or early morning, some companies may gain a workforce for a longer period of the day to better serve their customers, which may be particularly advantageous for activities on the international scale.

However, telecommuting and schedule flexibility pose risks for employers that lack trust in their telecommuting employees and fear losing control over their activities (Neirotti *et al.*, 2013; Topi, 2004; Bailey & Kurland, 2002). This fear is reflected in low telecommuter participation in activities planned by the organization and by a loss of versatility linked to strict compartmentalization of employees in their tasks; some telecommuters may also refuse other assignments (Tremblay, 2001). These management-related risks are among the reasons that deter some businesses from adopting telecommuting (Bailey & Kurland, 2002). Indeed, the literature underlines the importance of training managers to optimize and take full advantage of telecommuting practices (Cavanaugh *et al.*, 2014).

As we will see in the next subsection, increased employee satisfaction and motivation are among the main reasons that organizations opt for telecommuting.

2.3.3 Motivation-satisfaction

WorldatWork (2011b) affirms that employees generally perceive the telecommuting option as a sign of recognition that boosts their satisfaction and motivation at work, which increases productivity (Gallup, 2015; Schweitzer & Duxbury, 2006). Data from a 2000 survey shows that most telecommuters in Québec would refuse to return to a traditional office if they were offered this opportunity, and some would even consider stopping work if they could not telecommuting (Tremblay, 2001). In Canada, a 2011 survey found that half of telecommuters would be willing to telecommuting full-time if given the opportunity (Ipsos, 2011).

Regarding employers, a 2013 survey found that two-thirds of Canadian companies thought telecommuting had a positive impact on employee motivation, and contributed to maintaining a staff sensitive to schedule flexibility (BMO, 2013). This finding was confirmed by many sources that emphasized that businesses that offer telecommuting options are more likely to attract and retain competent employees (Gallup, 2015; Schweitzer & Duxbury, 2006). One study found that 78% of employees surveyed saw telecommuting as a means of attracting and retaining female talent, for example following the birth of a child. In addition, work-life balance is a major concern for nearly 70% of organizations and workers in Québec (CRHA, 2016).

Although most of the documents consulted confirm that telecommuting boosts satisfaction and motivation, some studies mentioned the possibility of loss of motivation caused by the level of discipline that telecommuting demands (Gallup, 2015; Tremblay, 2001). Many Canadian companies hesitate to offer their employees the telecommuting option because of fear of demotivation (61%) and of loss of productivity (53%) (BMO, 2013).

2.3.4 Interruptions at work and isolation

Several studies suggest that telecommuting can decrease interruptions at work, notably linked to interactions with office colleagues (Bailey & Kurkland, 2002). Telecommuting thus contributes to improving time use, which would enhance productivity and the quality of work (BMO, 2013). The rise in productivity due to the reduction in interruptions is perceived positively by employees (Bailey & Kurland, 2002; de Graaff & Rietveld, 2007). However, in some cases such as households with children, telecommuting may increase work interruption time and thus reduce productivity (Dumas & Ruiller, 2014).

If we assume that telecommuting would allow time savings, businesses could improve their performance by reducing the risks of lost output due to breaks, sick leave, delays caused by bad weather and traffic congestion. Telecommuting can also facilitate management of leave for family reasons (McKinnon, 2013; Bloom *et al*., 2015).

Work-life balance is one of the main reasons justifying telecommuting, yet it may also have negative impacts linked to distance from the regular workplace. For example, by limiting work-related interruptions, resulting from interactions with colleagues, telecommuting may create professional and social isolation, and thus hinder employees' long-term productivity (Ipsos, 2011; Tremblay, 2001; Bailey & Kurland, 2002). Colleagues' perception of telecommuting could thus greatly influence the attitudes of employees who are considering telecommuting (Scott *et al*., 2012; Iscan & Naktiyok, 2005). In Canada in 2011, 70% of employees said that not seeing their colleagues daily creates a feeling of isolation (Ipsos, 2011). Further, by being relatively less engaged in organizational activities, telecommuters may also decrease their chances of promotion (Armstrong-Stassen, 1998; Ipsos, 2011).

As we will see below, telecommuting also implies effects in terms of costs associated with the job, for both workers and organizations.

2.3.5 Costs for employees and employers

Telecommuting allows employees to spend less on food, clothing and transportation. For the year 2011 in Canada, the savings were estimated at between $600 and $3,500 annually for an individual doing telecommuting two days per week (Telecommuting Research Network, 2011a).

Telecommuting also lets employers reduce some production costs, notably in terms of office space (Bailey & Kurland, 2002). In addition, some telecommuters use their own equipment to work, which implies fewer expenses for the business (Telecommuting Research Network, 2011a). McKinnon (2013) maintains that newly recruited employees are more willing to accept a lower salary than that normally commensurate with their qualifications because they would be saving money by working at home. A 2011 report found that an employer can save up to $10,000 annually per employee who telecommute one or two days per week (Telecommuting Research Network, 2011a) owing to gains linked to reduction of absenteeism, increased productivity, higher employee loyalty and lower general expenses (Bailey & Kurland, 2002). This reduction in costs may be particularly significant if the employer can deploy shared workspaces at its premises. For small businesses, telecommuting reduces the cost of hiring candidates and enlarges the potential talent pool (McKinnon, 2013).

Despite these advantages, telecommuting may increase some expenses in that the performance of tasks remotely may necessitate the purchase of equipment to facilitate communication and information sharing, along with additional investments to set up the home to allow work-family balance.

Aside from the advantages and disadvantages described above, telecommuting has various impacts on society in general, which we review below.

2.3.6 General impacts on society

Telecommuting affects quality of life, notably regarding issues related to the environment and congestion, health, public services and employment inclusion.

Travel, environment and congestion

In addition to reducing the ecological footprint by shrinking office space (McKinnon, 2013; Bailey & Kurland, 2002), by lowering the number and duration of trips telecommuting can attenuate congestion and pollution, and hence create benefits in terms of time available, health and stress (Kitou & Horvath, 2008; Tremblay, 2001; Pratt, 2002; Vanoutrive *et al.*, 2010). In terms of congestion in Montréal and Québec City, flexible work arrangements would reduce commuting in the morning rush hour by 6% (Bussière & Lewis, 2002). Concerning the environment, telecommuting could reduce polluting emissions, including GHG (Pratt, 2002; Vanoutrive *et al.*, 2010; Kitou & Horvath, 2003, 2006; Moos *et al.*, 2006). According to Canadian estimates for 2011, if everyone whose job was compatible with telecommuting worked at home twice a week, Canada would reduce its annual consumption by about 390 million litres of gasoline and 5.2 million barrels of oil (Telecommuting Research Network, 2011a). In addition, the decrease in road commutes could increase the possibilities of urban revitalization and extend the life of infrastructures (Graizbord, 2015; Telecommuting Research Network, 2011a). As we will now see, lesser commuting could yield health benefits.

Health of workers and families

Health is an important domain associated with various benefits linked to telecommuting. Because telecommuting decreases the number of trips by car at peak periods, it may have a positive impact on health and quality of life by reducing GHG emissions that cause respiratory problems, and by easing pressure on related public health services (Kitou & Horvath, 2003, 2006; Moos *et al*., 2006; Telecommuting Research Network, 2011a). Further, by promoting work-life balance, telecommuting

reduces needs for physical and mental health care among workers in Canada who experience fatigue and stress notably arising from difficulties achieving work-life balance (Telecommuting Research Network, 2011a). This may be due to greater schedule flexibility that facilitates consumers' ability to access services (Scaillerez & Tremblay, 2016) and that would reduce stress linked to commuting. In 2011, nearly 4 out of 5 Canadians thought that telecommuters felt less stress because they spent less time in transit (Ipsos, 2011).

Telecommuting may also favour access to the labour market for some individuals, particularly those with health problems.

Employment inclusion

Telecommuting facilitates the hiring of some individuals who may be disadvantaged on the job market, such as people with reduced mobility or people constrained by their family situation (Tremblay, 2001). For employees who experience accidents or illnesses that reduce physical mobility, work at home may eliminate some barriers to their return to work or recruitment by a company (Bricout, 2004). Telecommuting may also contribute to territorial redistribution of work toward economically disadvantaged regions (Tremblay, 2001; Telecommuting Research Network, 2011a). A longitudinal study confirms that virtual mobility represents a viable alternative to physical mobility, by reducing individual or territorial exclusion (Kenyon, 2010; Kenyon *et al*., 2002).

In addition to clearly defining the concept of telecommuting that will be considered in this report, this chapter provided an overview of the impacts of telecommuting on employees, employers, and society in general. We also reviewed the potential evolution of telecommuting by linking it to its main determinant in terms of ICT, the Internet. In the next chapter we continue analyzing this evolution by describing the scope of telecommuting in the world, with particular attention paid to Québec and Canada, along with the United States and France.

3. Profiles of telecommuting in Canada, Québec and elsewhere

To clearly grasp the scope of telecommuting and its growth potential, this chapter begins by painting a general portrait of the scope of telecommuting in the world. We then describe the situations prevailing in Canada and Québec. They are put into perspective relative to the case in the United States given its proximity and economic integration with Canada and Québec. In addition, telecommuting is much more widespread in the US. We also present the situation in France, where the legal status of telecommuting is integrated in the Labour Code in order to promote its generalization with the goal of improving firm performance and facilitating work-life balance (Partenaires sociaux, 2013). For each case, we present data on the scope of the telecommuting practice and review the measures put in place to favour and regulate it. We also give examples of incentive measures that may be applicable to Québec. The uncertainty linked to estimates of the number of telecommuters in general is noteworthy, a difficulty explained by the multiples facets of telecommuting, which spawn diverse definitions and varied measurement tools (Mokhatarian *et al.*, 2005). Nonetheless, the estimates presented here allow us to compare and validate those obtained from the data, which we will use in later chapters.

3.1 Worldwide

Telecommuting is a widespread global phenomenon. However, a 2005 study by the firm Gartner called "*Telecommuting, the quiet revolution*" shows that some OECD countries are more advanced in this area, such as Finland (32.4%), the United States (27.6%), Sweden (26.8%), Japan (24.0%) and the United Kingdom (22.3%) (Gartner Research, 2005). These figures rest on a synthesis of the data published by national statistics institutes, consolidated and supplemented by market knowledge (Centre d'analyse stratégique, 2009). The data in Table 3.1 show that both Canada (12.3%) and France (8.4%) are among the OECD countries where telecommuting is least developed, together with Spain (6.2%) and Italy (5.0%).

Table 3.1 Percentages of telecommuters in selected OECD countries, 2005

Country	Share of telecommuting (%)
Finland	32.4
Belgium	30.0
United States	**27.6**
Sweden	26.8
Japan	24.0
United Kingdom	22.3
Germany	18.8
Denmark	17.4
Canada	**12.3**
France	**8.4**
Spain	6.2
Italy	5.0

Source: Gartner Research, 2005

A more recent Ipsos study done in 2011 (Table 3.2) found that worldwide, 17% of workers telecommuting on a regular basis; this proportion rises to 35% when those who

telecommuting from time to time are considered (Ipsos, 2011).[10] This doubling of the percentages of telecommuters underlines the need to carefully consider definitions of telecommuting in order to better determine the scope of the phenomenon. For instance, Sweden more than quadruples its percentage when the definition of telecommuters includes casual workers. For Canada, the percentage of telecommuters grows from 8% to 17% when the concept of telecommuter is expanded. Nonetheless, regardless of the definition retained, the classification of countries is generally stable, and international trends persist. Thus, telecommuting is particularly popular in countries such as India, Indonesia, Mexico, South Africa and Turkey, where more than 50% of workers telecommuting on a regular or casual basis. By the same definition, at the other end of the spectrum we find countries such as Japan, Canada and France, with percentages below 20%. By comparison, note that the Canadian results are consistently lower than those of the United States and the United Kingdom, but higher than those of France, Italy and Germany.

Table 3.2 Share of telecommuting in various countries in 2011

Country	Always or regularly	Always or regularly + from time to time
Total	**17%**	**35%**
India	57%	82%
Indonesia	34%	71%
Mexico	30%	58%
South Africa	28%	56%
Turkey	27%	56%
Saudi Arabia	26%	48%
Argentina	29%	45%
Russia	21%	42%
China	13%	41%
Australia	15%	33%
Poland	14%	31%
Brazil	16%	28%
United Kingdom	13%	28%
Sweden	6%	26%
United States	**11%**	**26%**
Belgium	15%	24%
Spain	12%	24%
Japan	9%	18%
Canada	**8%**	**17%**
South Korea	9%	17%
Italy	8%	14%
France	**6%**	**12%**
Germany	5%	12%
Hungary	3%	8%

Source: Ipsos, 2011

[10] The Ipsos survey uses the term "'Telecommuting' to describe what an employee does when they use a stationary or portable computer to do their office work from a location outside of their office–either from their home or another location–either regularly or from time to time. These employees, called 'telecommuters,' often have the flexibility of using telecommunications (such as email, phone, Online chat) to communicate with colleagues in real time or do their work."

3.2 Canada and Québec

At the turn of the millennium, telecommuting progressed in Canada, albeit modestly (Table 3.3).[11] An analysis of GSS data finds that 10.2% of salaried employees in Canada worked at home in the year 2000, whereas this proportion rose to 11.2% in 2008 (Turcotte, 2010). The Gartner report estimated the number of telecommuters in Canada at 12.3% in 2007, which illustrates the variation in estimates despite similar definitions (Gartner Research, 2005). Both Statistics Canada and Gartner incorporate home workers in their definition, yet Gartner specifies "work from home at least one day per month," whereas Statistics Canada excludes additional hours worked at home, be they paid or not. By comparison, the 2011 Ipsos study found that 17% of Canadian salaried employees did telecommuting permanently, regularly or from time to time (Ipsos, 2011). Presumably, gaps in the estimates are due to different considerations related to the inclusion or exclusion of types of work from the calculations: overtime, self-employed workers, etc. Consequently, the figures should be interpreted prudently given the variance between the proportions of telecommuters and the underlying definitions (Akyeampong & Nadwodny, 2001).

Some sectors, roles or tasks are more conducive to telecommuting (Boell *et al.*, 2016). In Canada, 44% of jobs are compatible with this practice (Telecommuting Research Network, 2011a). Ill-suited to the primary and secondary sectors, telecommuting occurs mainly in the tertiary sector (Turcotte, 2010). Jobs requiring face-to-face contact (e.g. sales sector) or more manual jobs (e.g. manufacturing sector) are less concerned, whereas for functions of an intellectual nature, e.g. managerial or professional, technology has become indispensable (Pratt, 2000). Overall, employees who telecommuting in Canada in 2008 are highly educated (university degree: 54% *vs* 26% in Canada in 2011) (Statistics Canada, 2011; Turcotte, 2010). The tasks most commonly carried out remotely are writing, accounting, computer graphics, software and website design, and management or administration (Bailey & Kurland, 2002; Tremblay, 2001). In Canadian firms, the business and finance sector stands out: 28% of businesses offer employees the telecommuting option (BMO, 2013). In Canada, one-quarter of telecommuters (24.6%) worked in the public sector in 2001(Tremblay, 2001).

Table 3.3 Evolution of telecommuting by salaried employees in Canada

Year	Percentage
Statistics Canada (1 day/month)	
2000	10.2
2008	11.2
Gartner (1 day/month)	
2007	12.3
Ipsos (once/week and +)	
2011	17.0

Sources: Gartner Research, 2005; Ipsos, 2011; Turcotte, 2010.

Regarding Québec, specific data on telecommuting are difficult to access and not very recent. In 2001, a CEFRIO study put the proportion of telecommuters in Québec at 4%, 58.8% of whom were self-employed workers, 35% nonunionized salaried workers and 6% unionized workers (Tremblay, 2001). This report defined telecommuting as paid work at home for one day or the equivalent of one day per week, mainly done on a

[11] Although the studies presented in Table 3.3 analyze diverse types of data from different sources (e.g. GSS and other surveys), we can still present orders of magnitude in a context where limited information is available.

computer, generally transmitted to a client or employer via the Internet or on a diskette (Tremblay, 2001). By excluding self-employed workers from this proportion, it seems that fewer than 2% of employees in Québec telecommuted in 2000, which is much lower than the Canadian proportion of 10.2%. Evidently, this rate may have subsequently increased, although the evolution presented by Turcotte (2010) suggests stability in the number of salaried telecommuters and growth in self-employed workers. At this stage, we do not have published data to this effect, but the analysis of our database will let us make an estimate in the next chapter.

Some characteristics deserve particular attention to better understand the telecommuting landscape in Canada. First, Table 3.4 illustrates that more telecommuters are found in urban areas than rural areas (Turcotte, 2010). The Greater Québec City and Ottawa-Gatineau Areas stand out from other agglomerations with a telecommuting rate of 16%, compared with Vancouver (14%), Toronto (13%) and Montréal (11%). A study conducted in these cities demonstrates that the growth of home work does not accentuate urban sprawl, but rather increases the flexibility of location in the existing urban form (Moos & Skaburskis, 2007). Apparently, men (13%) telecommute more often than women (10%), and the presence of children in the home engenders a higher than average rate of telecommuting (13%) (Turcotte, 2010). Telecommuting is particularly prevalent for university graduates (22%) and among managers, professionals and employees who work more than 50 hours per week (23%).

Table 3.4 Percentages of people who telecommuting in Canada according to certain characteristics in 2008

Characteristics	**Percentage**
Mean for Canada	**11.2**
Greater Area	12
Québec	16
Ottawa	16
Vancouver	14
Toronto	13
Montréal	11
Outside urban areas	9
Sex	
Male	13
Female	10
Children	
Presence of children at home	13
Typical profile	
University degree	22
Managers and professionals	23
Employees working 50+ hrs/week	23

Source: Turcotte, 2010

Another study estimated the proportion of businesses that offer telecommuting options in Canada at 23% in 2013 (BMO, 2013). Among the Canadian provinces (Table 3.5), Alberta hosts the largest proportion of businesses that offer employees telecommuting options (34%), whereas businesses situated in the Atlantic provinces are the least likely (16%). British Columbia ranks second (26%), followed by Québec, at a similar level to the Prairies (23%), and Ontario (20%) (BMO, 2013).

Table 3.5 Percentages of businesses in Canada that offer employees the telecommuting option, 2013

Canada	23%
Alberta	34%
British Columbia	26%
Québec	23%
Prairies	23%
Ontario	20%
Atlantic	16%

Source: BMO, 2013.

Actions, measures and policies

In terms of actions implemented to favour telecommuting in Canada, the legal framework appears incomplete (Scaillerez & Tremblay, 2016). International labour law can nonetheless serve as a regulation tool for businesses and employees. Note that the International Labour Organization (ILO) adopted an agreement, together with a recommendation on home work, as early as 1996 (ILO, 1996). This legal basis obliges employers to treat home workers the same as the other workers, in terms of both legislation and labour Law. Nonetheless, only 10 countries ratified the agreement; neither Canada nor the United States is among them. Federal and provincial governments in Canada have been reluctant to legally regulate telecommuting. The Canadian National Centre for Occupational Health and Safety (CCOHS) produced an information and question and answer sheet concerning telecommuting to equip employers and employees during the formulation of telecommuting agreements (CCOHS, 2001). This guide serves as a reference to optimize the practice of telecommuting with respect for both parties.

Telecommuting has been part the Canadian public sector for some time: the government launched a pilot program in 1992 and produced a telecommuting guide for its agencies in 1995 (Government of Canada, 1995). There is also a telecommuting policy for the public service in Canada, introduced in 1999 by the Treasury Council (Government of Canada, 1999). This policy aims to "allow employees to work at alternative locations, thereby achieving a better balance between their work and personal lives, while continuing to contribute to the attainment of organizational goals." Recognizing the opportunities that a flexible working arrangement like telecommuting can present, the government encourages departments to implement telecommuting practices where it is economically and operationally feasible to do so, and in a fair, equitable and transparent manner (Government of Canada, 1999). Requirements and responsibilities of both parties are then required to successfully deploy telecommuting. In 2008, 8% of employees in the public administration performed telecommuting (Turcotte, 2010). In Québec, the 2012-2017 human resources strategy of the Québec public service frequently mentioned the concept of technology, but telecommuting is clearly not among the measures put forth (Sous-secrétariat au personnel de la fonction publique, 2012).

3.3 United States

Telecommuting is more common in the United States than Canada, as Table 3.6 illustrates. According to the Census Office, the percentage of workers who worked at home at least one day a week rose from 7% in 1997 to 9.5% in 2010 (United States Census Office, 2012). Further, the number of salaried employees who work at home at

least once a month ballooned by 61% between 2005 and 2010 to reach 16 million individuals, corresponding to 17% of employees (Telecommuting Research Network, 2011b). Lastly, a recent survey of full-time and part-time employees found that 37% of employees claim they have already done telecommuting (versus 9% in 1995), either during regular hours (46%) or outside of these hours (45%) (Gallup, 2015). Average time dedicated to telecommuting per month by people who identify as telecommuters was 6.4 hours in 2015. Telecommuting is considered as "*working from home using a computer to communicate for your job*."

Table 3.6 Evolution of telecommuting in the United States, selected years

Years	Percentage
Census Office, 2012 (1 day/week)	
1997	7.0
2010	9.5
Gartner Research (1 day/month)	
2007	27.6
Telecommuting Research Network, 2011b (once/ month)	
2005	15.4
2009	17.0
Ipsos, 2011b (once/week and +)	
2011	26.0
Gallup, 2015 (already did telecommuting)	
1995	9.0
2015	37.0

Sources: Gallup News Service, 2015; Gartner Research, 2005; Ipsos, 2011; Telecommuting Research Network, 2011b; United States Census Office, 2012.

A special report published in 2011 nonetheless paints a contrasting picture of the rise of telecommuting in the United States (WorldatWork, 2011b). Considering employee telecommuters as "*A regular employee (full or part time) who works remotely at least one day per month during normal business hours*," the results show that the telecommuting curve was ascending until 2008, and then declined in 2010 (WorldatWork, 2011b). If the number of telecommuters increased markedly between 2005 and 2010. it is nonetheless clear that the growth was temporarily halted by the economic situation in the United States, a period where the employment rate also declined (WorldatWork, 2011b). In addition, although fewer Americans telecommuted regularly in 2010 compared with 2008, the frequency of the practice increased: 84% of Americans telecommuted at least once a week, compared with 72% in 2008 (WorldatWork, 2011b). We can also assume that the increase in the number of self-employed workers in the United States lowered the observed rate of telecommuting.

Actions, measures and policies

Legislation governing telecommuting is rudimentary in the United States. Nonetheless, since 2010, legislation on improvement of telecommuting, called the "*Telecommuting Enhancement Act,"* ensures promotion of telecommuting and facilitates its implementation in the federal public service (Scaillerez & Tremblay, 2016). This telecommuting implementation program within the government was documented in a report that sets out its initial policy and recounts the first findings following its

implementation in different bodies (Report to Congress, 2013). The *Telecommuting Enhancement Act* thus proposes the formulation of a policy under which eligible employees would be allowed to telecommuting, designation of a telecommuting managing officer, determination and notification of employee eligibility, a written agreement between managers and employees authorized to telecommuting, provision of a training program for employees concerned and their managers, and that telecommuting be integrated in the Continuity of Operations plan of the Agency concerned. Over the years, the critical components instrumental to the successful deployment of telecommuting have proven to be the establishment of clear and well-defined objectives, evaluation of the results obtained and improvement of follow-up methods (Report to Congress, 2016).

In 2012, one year after the implementation of the policy, the number of jobs considered eligible for telecommuting increased by 49%, whereas formal agreements on telecommuting soared by 84% (Report to Congress, 2013). In 2015, 44% of the 2,157,608 employees in the US federal public service were eligible for telecommuting, and 46% of them used it. This represents 20% of all employees, compared with 14% in 2012 (Report to the Congress, 2016). Although these results appear encouraging for the practice of telecommuting in the American public service, no legal mechanisms exist for businesses. Further, some national pilot projects deserve mention, notably *eCommute,* introduced by the EPA (1999 to 2004), intended to promote the implementation of telecommuting in businesses situated in five large cities in the United States: Denver, Houston, Los Angeles, Philadelphia and Washington (Scaillerez & Tremblay, 2016). States such as California and Oregon have also adopted laws to promote and implement telecommuting.

3.4 France

Telecommuting figures in France point to a gradual penetration of telecommuting in business (Table 3.7). Nonetheless, the progress appears timid despite a more developed legal context than in Canada or the United States. A report by the *Centre d'analyse stratégique en France* illustrates the weak growth of telecommuting on the territory compared with other OECD countries (Centre d'analyse stratégique, 2009). Whereas there were 6.3% telecommuters in 2002, 12% of the workforce telecommuted at least once a week in 2011 (Ipsos, 2011; SIBIS Consortium, 2003). By comparison, on the European scale this proportion reached 19.5% (Ipsos, 2011). More recently, the proportion climbed to 14.2% of the French population in 2013, which illustrates a growing interest in the practice (de Mazenod, 2012; LBMG Worklabs, 2013). The *Agence nationale pour l'amélioration des conditions de travail* (ANACT) nonetheless mentioned the challenge of counting the number of telecommuters in France (ANACT, 2013).

Table 3.7 Evolution of telecommuting in France according to various surveys

Year	Percentage
SIBIS (part of home work)	
2002	6.3
Gartner (1 day/month)	
2007	8.4
Ipsos (once/week and +)	
2011	12.0
LBMG Worklabs	
2013	14.2

Sources: Centre d'analyse stratégique, 2009; Ipsos, 2011; LBMG Worklabs, 2013.

Although only certain functions are eligible for telecommuting, the potential for development of telecommuting in France appears high: 40% to 50% of jobs may be affected by this work mode over a 10-year horizon (Centre d'analyse stratégique, 2009).

Actions, measures and policies

Although not a leader in terms of proportion of telecommuters, France was nonetheless a frontrunner in the European Union, together with Belgium and Italy, by adopting a law on telecommuting (Legifrance, 1994; Scaillerez & Tremblay, 2016). Regarding Europe, an interprofessional framework agreement on telecommuting was concluded on May 23, 2002 and signed in Brussels on July 16, 2002 (CES *et al.*, 2002). This European agreement was integrated in French law in 2005 (UNICE *et al.*, 2005). Initiated in 2008, the French digital plan aimed to galvanize the labour market and motivate businesses to use telecommuting (ANACT, 2013; Besson, 2008). The objectives notably concerned support for social partners and the development of telecommuting in the public sector, with the goal of publicizing the advantages of this form of work, the need to increase the visibility of job offers concerned, and deployment of national action on the subject (Besson, 2008).

The legal status of telecommuting was enshrined in the Labour Code only in 2012 (Legifrance, 2012a, 2012b). Subsequently, an agreement on the quality of life at work and professional equality was signed in 2013, promoting the generalization of telecommuting to improve firms' performance and to ensure better work-life balance and gender equality in workplaces (Partenaires sociaux, 2013). The social chamber of the *Court of Cassation* specifies that an employee is not obliged to agree to work at home or to set up a workspace in the home (Cour de cassation, 2013). In the case where the employee requests telecommuting, the employer is not obliged to agree. This dual voluntary nature appears indispensable to the effectiveness of the telecommuting practice (Centre d'analyse stratégique, 2009). Further, the organization of telecommuting must be specified in the work contract or in a rider of an established contract (Scaillerez & Tremblay, 2016).

In the early 2000s, telecommuting was formally put in place at some large businesses in France like EDF, IBM France and France Télécom (Forum des droits sur l'Internet, 2004). Nearly absent in the public sector in 2004, telecommuting is now part of the employment policies for salaried French public servants. Among the recommendations concerning telecommuting issued by the Forum on Internet rights, struck in 2004 by the Ministry of Social affairs, Work and Solidarity, the creation of a climate of trust between the employee and employer is the cornerstone of the deployment of telecommuting (Forum des droits sur l'Internet, 2004).

A 2011 report on the growth outlooks of telecommuting in the public service proposed a new situational analysis of ongoing experiments in the public and para-public sectors, local authorities, and private businesses in France (Lartail *et al.*, 2011). Over 20 formal experiments were cited as examples, notably the ministries of Finance and Justice, the Mayor's office of Paris and the *Caisse nationale des allocations familiale*s. Although the experiences documented in this report were largely positive, telecommuting was apparently not yet widely used in 2011 (Lartail *et al.*, 2011). Recommendations are based on the credibility of employers' objectives, establishment of a secure environment, determination of the eligibility of positions, the launching of a project-based approach with a generalization outlook, coordination of reflection and research, and incentives to practise telecommuting (Lartail *et al.*, 2011).

More recently, the French public service adopted the *Guide of telecommuting,* which should promote the spread of the practice within different ministries (Ministère de la Fonction publique, 2016). Based on Decree 2016-151 of February 11, 2016 regarding the conditions and modes of the implementation of telecommuting in the public service and the judiciary, each employer must define the conditions for implementing telecommuting in their organization (Legifrance, 2016). Questions noted include the eligibility conditions for telecommuting, places of practice, work time, assumption of costs, information systems, risk prevention, and support for telecommuting (Ministère de la Fonction publique, 2016). By structuring telecommuting, France thus aspires to achieve effective deployment of this form of work.

3.5 Québec context and experience outside the province

Much work remains to be done in Québec to develop and regulate telecommuting. In fact, the Québec government is currently promoting technological innovation and methods intended to stimulate economic growth, notably by developing the digital economy, a subject that was recently addressed in a provincial action plan (Gouvernement du Québec, 2016). Given the close links between ICT and telecommuting, it may be opportune to synchronize actions within these domains.

The growth of telecommuting activities may be favoured by the adoption of measures inspired by experience outside Québec, such as in the United States, France and other countries where the penetration rate of telecommuting activities is much higher than in Canada and Québec. In the next subsection, we propose a brief review of these measures, which we group into three categories: i) incentives based on dissemination of information (e.g. awareness campaign); ii) incentives based on the working environment (e.g. supply of IT equipment); and iii) incentives based on compensation of employees and employers (e.g. employee benefits, tax deductions). Because the adoption of telecommuting can yield net potential gains for employees and employers, the most widespread incentives are mainly related to information dissemination measures, to ensure that the parties are fully informed of the mutual advantages of telecommuting.

3.5.1. Incentives based on information dissemination

Incentives based on information dissemination mainly entail providing information to employers and employees about how telecommuting functions (e.g. advantages, management). Such measures thus promote the adoption of telecommuting programs. Regulation and internal dissemination, adoption of a certification system for organizations, production of guides for telecommuters, and participation in awareness campaigns are among the most frequently used measures.

Internal regulation and dissemination

As in the United States, Québec may turn to the *Telecommuting Enhancement Act* of 2010 for guidance on how to regulate telecommuting in the public service. This Act states that the critical elements of successful deployment of telecommuting are well-defined objectives and the implementation of evaluation and results follow-up processes (Report to Congress, 2016). The annual report on the status of telecommuting within the US Federal Government lists the most widespread initiatives within its agencies, transferable to organizations of different sizes and diverse sectors (*United States Office of Personnel Management*, 2016). These incentives mainly concern information dissemination measures such as:

- Conducting an awareness campaign. Organizations may multiply opportunities to highlight the advantages of telecommuting by forming a dedicated work committee in charge of implementing an awareness campaign. Posters and promotional pamphlets online and at the main workplace may be among the tools adopted.

- Promoting telecommuting at meetings and events within the organization. For example, the organization may set up teleconference rooms and allow employees to attend meetings remotely using a telepresence system. It can also launch webinars and self-paced online workshops that offer flexibility of both place and time, especially for organizations with several branches and employees with varied work schedules.

- Demonstrating that telecommuting can be aligned with strategic objectives and the mission of the organization. One case would be that of an organization that strives to offer reasonable accommodations to employees with disabilities or health or family constraints.

- Helping put in place objectives and indicators to manage telecommuting effectively. For example, an organization can create a dashboard that provides follow-up statistics on telecommuting such as the number of eligible employees, frequency of telecommuting requests, productivity measures (e.g. number of calls processed), and factors facilitating/hindering the practice of telecommuting.

Adoption of a certification system for organizations

Creation of a certification system similar to *Best Workplaces for Commuters*, national certification of excellence issued by the US Department of Transport to employers that favour sustainable mobility, may be a means of encouraging organizations to adopt telecommuting. To attain this status and thus increase their power to attract employees, organizations must meet a series of criteria that include adoption of telecommuting. Home–work travel must represent less than 6% of employees' monthly vehicle trips (*United States Environmental Protection Agency*, 2006).

Formulation of a telecommuting guide for management and employees

As in France, the formulation of a telecommuting guide defining the conditions of telecommuting can help determine employee eligibility for telecommuting and its management conditions such as the nature and frequency of contact with the employer, eligible locations and their layout, equipment to acquire, and operating expenses. In addition, telecommuting activities should be integrated in the usual activities of organizations to increase their efficiency. This integration could include ensuring complementarity of tasks permitted and prioritized at home and at the office. A situational analysis of telecommuting incentives produced by the Ministry of the Economy, Industry and Employment in 2011 underlined that telecommuting agreements in force in French public organizations conveyed five principles: double voluntary action (employee and employers); equality of treatment in career development; reversibility between telecommuting and conventional work; provision of IT equipment, and signing of a personalized agreement with each employee (Ministère de l'économie, de l'industrie et de l'emploi, 2011).

Participation in awareness campaigns

Lastly, various examples of telecommuting awareness campaigns adopted elsewhere in Canada and in other countries may be transferable to Québec. For example, partnerships may be established with organizations like the *Smart Commute Association* and

Resource Conservation Manitoba, which promote telecommuting among employers (Transport Canada, 2010). In Japan, alongside the preparation for the 2020 Tokyo Olympic Games, a "Telecommuting Day" campaign was initiated on July 24, 2017. It will be held annually on that day until the start of the Games, and aims to encourage employees of participating organizations to work at home to ease traffic congestion and crowding on public transit. In fact, telecommuting is among the official measures adopted by the Japanese government to manage traffic congestion in the Tokyo Metropolitan Area (Bloomberg, 2017). In another example, the Australian government provided national information support in the form of a website where users can calculate the benefits of telecommuting, and includes parameters such as the return on investment along with an analysis of impacts on employees and employers (Australian Public Service Commission, 2014).

3.5.2. Incentives based on the work environment

Incentives based on the work environment refer to measures that offer employees an environment conducive to the adoption of telecommuting. Upon the initiative of public administrations or employers, these incentives may be translated by planning development measures that include the territory (e.g. creation of third places), the main premises of the organization (e.g. implementation of telepresence systems) and telecommuters' workspace (e.g. purchase of mobile equipment).

Development of territories hosting telecommuting activities

In France, the generic term "third place" is used to describe "a space dedicated to new forms and organizations of remote and collaborative work" (CGET, 2015, p.11). Originally, development of these spaces was intended to ease the isolation of independent workers by offering them a workspace and environment that favours dialogue and collaboration. Today there are about 200 third places in the large French cities. Their target clientele has expanded to telecommuters, to whom they offer an alternative to working at home. This option may encourage organizations to adopt telecommuting because it offers mutual benefits for the employee, employer and the host territory. It can contribute to: i) reducing the time and distances associated with employees' commute between work and home; ii) increasing firms' productivity by facilitating telecommuter management and by creating opportunities for telecommuters to dialogue and collaborate; and iii) making host territories attractive (CGET, 2015). To this end, municipal authorities can change zoning regulations as a telecommuting incentive because telecommuting represents alternative use of a dwelling normally situated in a "residential" zone.

Redesigning organizational premises

Organizations may achieve savings by favouring telecommuting and by redesigning their regular premises to make room for unassigned offices, fewer workstations, open-air spaces, removable furniture and technological equipment oriented toward remote communication. Within Canadian federal departments and agencies, such measures are fairly recent and are part of the adoption of workplace 2.0 (Public Services and Procurement Canada, 2017).

Designing the workspace around the telecommuter

To encourage employees to telecommuting, organizations may also help improve telecommuters' working environment, for example by providing mobile equipment such as laptop computers and cell phones, and by assuming expenses linked to telecommunications and essential tools for employees' work activities. Nortel, a

Canadian telecommuting pioneer, offered telecommuters secure and direct access to all corporate services (e.g. intranet, directories, and applications). Thus, employees may be fully operational, and the employer benefits from potentially substantial reductions in expenses related to the cost of leasing office space, buying work equipment, and logistics (e.g. maintenance). For instance, Nortel saved $9,000 per employee per year on average by allowing telecommuting (Transport Canada, 2010).

3.5.3. Incentives linked to financial compensation

Telecommuting incentives may also consist of financial compensation related to: i) pay or competitive working conditions for telecommuters; ii) reimbursement of expenses associated with telecommuting; and iii) tax measures. Below we provide some examples of these measures.

Working conditions that favour telecommuting

One way to encourage telecommuting in an organization is to offer, during recruitment, working conditions that favour telecommuting. These conditions may take the form of flexible schedules, insurance programs covering the employee during hours worked at home, and reimbursement of expenses linked to time and travel to the central workplace.

Reimbursement of telecommuting-related expenses for workers

Reimbursement of some expenses linked to telecommuters' duties may encourage telecommuting. For example, federal agencies such as the *United States Patent and Trademark Office* adopted measures to reimburse the Internet connection fees of their employees who telecommuting, which range from 50% to 100% of their monthly bill according to the frequency of Internet use during designated work hours. Some employers offer telecommuters financial compensation for their time and travel expenses to the regular workplace. In Belgium, telecommuters may obtain a tax-refund for expenses related to IT equipment (BeCompta, 2014). The success of such initiatives nonetheless rests on the prior implementation of a performance and employee productivity evaluation and follow-up system that includes quantifiable indicators.

Tax measures

Tax measures may also encourage organizations to offer telecommuting. In Virginia, for example, businesses that put in place a telecommuting program could receive a tax deduction in 2018 ranging up to $50,000 for expenses related to telecommuting, to a maximum of $1,200 per employee. However, the program must comply with the telecommuting policy of the Department of Rail and Public Transportation (Virginia State, 2017). The state of Georgia grants tax deductions to businesses whose employees telecommuting, owing to the putative benefits of telecommuting such as employee productivity gains and reduction of air pollution and traffic congestion. Such businesses may also receive an income tax credit for expenses linked to equipment and setting up of a workspace at home (Georgia State, 2017).

Currently, self-employed workers in Canada may receive tax deductions for maintaining a home office, as can salaried employees who telecommuting, subject to certain conditions. The home office must be the place where employees carry out most of their work, and must be used exclusively to earn employment income. Eligible expenses concern maintenance of the portion of the home that the office occupies, and

may include insurance premiums and real-estate taxes. The portion of the space allotted for personal use must be deducted during the calculation of eligible expenses (Institut Québécois de la Planification Financière, 2016).

Although actions concerning the development of telecommuting in Québec may be inspired by cases implemented elsewhere, it is important to establish the determinants of potential effects of telecommuting in the Québec and Canadian contexts to understand how, and especially why, to favour them. Therefore, in the next chapters we analyze the characterization of telecommuting and its possible effects on transportation behaviours, health, stress and hours worked.

4. Data and general research methodology

In this chapter we present the methodology used for the data and analyses of the effects of telecommuting on behaviours linked to transportation, health and hours worked. This basic information will be supplemented by information specific to each of the analyses in subsequent chapters. We can thus grasp the problems related to the subjects and determine the variables to include in our estimates. As mentioned above, dozens of cases of organizations that have introduced telecommuting programs exist. However, as Westfall (1998) and Bailey and Kurland (2002) point out, these cases are based on anecdotal evidence coming strictly from statements by employees and/or employers. Given these limitations, we focus on literature reviews of studies published in the form of scientific articles and research reports.[12]

4.1 Data

The analyses done within this report are based on the Statistics Canada General Social Survey - Time Use (GSS), 2010 (Cycle 24). The GSS attempts to understand how Canadians use their time in order to formulate public and social policies to improve the living conditions of Canadians. The study also includes traditional questions on socioeconomic and demographic characteristics of individuals, their households and their jobs. The study is done annually, but cycle 24 of the year 2010 includes a module on time use that will be used in this project. Modules on time use are deployed in rotation in the survey approximately every five years.

The module on time use attempts to follow changes in Canadians' living conditions and to understand how they use and manage their time in order to grasp the factors that contribute to their well-being and stress level (Béchard, 2011). Consequently, questions on perceptions are also part of the survey questionnaire.

A more recent cycle of the survey exists (Cycle 29, 2015 - 2016), but the data were available only starting from fall 2017. The sample size also decreased, which makes estimating an activity with a low level of participation, such as telecommuting, more difficult, particularly in the context of a provincial analysis. Few results are available for this survey (http://www23.statcan.gc.ca/imdb/p2SV_f.pl?Function=getSurvey&SDDS=4503).

4.2 Sampling

As part of this cross-sectional study, sampling is random and probabilistic, and includes everyone age 15 and over who does not live in an institution. To be sampled, respondents must reside in one of the 10 Canadian provinces and have a home telephone line. Respondents were reached and interviewed by telephone using Computer Assisted Telephoning Interviewing (CATI) software, which allows branching of specific questions based on the previous answers, and performs consistency checks of the answers. The sampling process deliberately selected one person per household.

Answers from 15,390 respondents were compiled between January 4 and December 31, 2010. A sample with 27 strata was deployed to represent the 15 largest Census Metropolitan Areas (CMAs), to group the other CMAs in Québec and Ontario, and to produce representative samples of the respondents outside CMAs in the 10 provinces. Statistics Canada cautions that because they are more likely proportionately not to have a telephone line, people living in low-income households are slightly underrepresented

[12] Some of the cases of telecommuting are mentioned in the scientific papers and research reports cited. In addition, the main survey-based studies reviewed are /discussed in chapters 2 and 3.

in the sample. However, the estimates, after being weighted with raising factors provided by Statistics Canada, are representative of the residents of each of the provinces, and may be projected to the general population to estimate the real size of the targeted groups. In total, 2 277 respondents were sampled in Québec (Béchard, 2011).

Because we are focusing on workers, the sample used in the analyses below excludes people who are unemployed, students or retired. To perform multivariate analyses, Statistics Canada recommends rescaling the raising factors to ensure that the sum of the standardized weights is equal to the sample size (Béchard, 2011). The questions contained in the respondent file will be used to establish workers' characteristics and their answers to questions about their lifestyle and perceptions.

4.3 Time use diary

In addition to the respondent file, a second file of episodes records the sequence of respondents' activities on the day preceding the study. In total, the respondents participated in 283,287 activities during the day preceding their interview. A logical validation process ensured that the sum of episodes of one respondent is equal to 24 hours (1,440 minutes). The interviewer began recording the activities at 4 a.m. on the morning preceding the survey and stopped entering activities at 3:59 a.m. the following morning. For each activity the participant recorded the start time, end time, duration, a code defining the activity, and a code defining the location of the activity (Béchard & Marchand 2006). We can thus identify a paid work activity done at home, at the regular workplace or in a third place such as a coffee shop or library. Because the location codes of the activity include transportation modes, we can use the same method to determine whether a trip took place by car, on foot, or via public transport, along with its duration, start time and the reason for the trip.[13] The start time of commutes also lets us analyze rush hour travel. The data produced by coding the time use file can then be re-associated with the individual who recorded them via a unique and anonymous personal identifier. In the analysis of rush hour travel (section 5.3.2), it is mainly individuals' characteristics that are linked to individual episodes of travel. The unit of analysis is thus the trip, not the individual.

4.4 Classification of telecommuters

Telecommuters can be defined according to two strategies: a survey question and an episode file. Each strategy has its advantages and disadvantages, and is used in different analyses. The survey question can define the general practice of home work: "*Some people do all or some of their paid work at home. Excluding overtime, do you usually work any of your scheduled hours at home?(MAR_Q190).*" This question is used to create a binary indicator of occasional telecommuting practice, and is asked of all respondents who claim that they work. It excludes forms of telecommuting done outside the home.

The episode file lets researchers refine their classification of work episodes during the reference day according to their occurrence and location. Given that the study covers a single day, the number of respondents who claimed to work is small. This is partly due to the fact that the time use journal is designed to gather records for each day of the

[13] As we will see below, 23 reasons for commuting were recoded into eight general reasons.

week, including Saturdays and Sundays. Employees who work on shifts may also not have worked during the reference day.

Table 4.1 presents all the places where work episodes were recorded during the survey day, along with the number of work episodes recorded by the respondents. When these episodes are compressed at the individual level, varied trajectories of activities emerge. An individual will thus be classified as a telecommuter based on work episodes that took place outside the regular workplace. To establish these locations, the classification of telecommuters follows the criteria presented in Table 4.2 and in Figure 4.1, and uses the activity code "Work for Pay at Main Job" (ACTCODE = 110) and the place codes mentioned in Table 4.1. No restrictions on work time are set.

Four categories were thus created: workers who work only at their regular workplace, workers who work only at home, workers who combine episodes of work at home and at the regular workplace, and workers who work in several places aside from these two places, which may or may not include an episode of work at home and/or at the workplace. The last category of telecommuters encompasses several work behaviours that are atypical or at least rare in the survey. Seven categories were initially developed (as a Venn diagram with three main groups would suggest, Figure 4.1), and marginal portions of the workforce working during the survey day made up several subgroups. We therefore grouped all the observations in the shaded circle (blue) to avoid producing overly small categories of telecommuters.

Table 4.1 Work episode location: numbers and weighted and non-weighted percentages

Place of work episode	Employee			Self-employed worker			Total		
	Obs.	Pop.	% weighted	Obs.	Pop.	% weighted	Obs.	Pop.	% weighted
Home	845	1,474,599	7.08	987	1,732,113	41.54	1,832	3,206,713	12.83
Workplace	9,461	18,854,124	90.50	1,147	2,214,078	53.10	10,608	21,068,203	84.27
Other private dwelling	67	141,218	0.68	34	55,560	1,33	101	196,778	0.79
Restaurant or bar	16	31,528	0.15	5	10,463	0.25	21	41,991	0.17
Place of worship	2	8,175	0.04	0	0	0	2	8,175	0.03
Supermarket	1	60	0.00	0	0	0	1	60	0
Other store, shopping centre	23	38,924	0.19	9	8,436	0.20	32	47,360	0.19
School	13	36,273	0.17	0	0	0.00	13	36,273	0.15
Outdoors (far from home)	34	46,558	0.22	17	35,537	0.85	51	82,095	0.33
Other place	126	200,733	0.96	64	11,1296	2.67	190	312,029	1.25
Not reported	0	0	0.00	1	2,248	0.05	1	2,248	0.01
Total	**10,588**	**20,832,191**	**100**	**2,264**	**4,169,732**	**100**	**12,852**	**25,001,923**	**100**

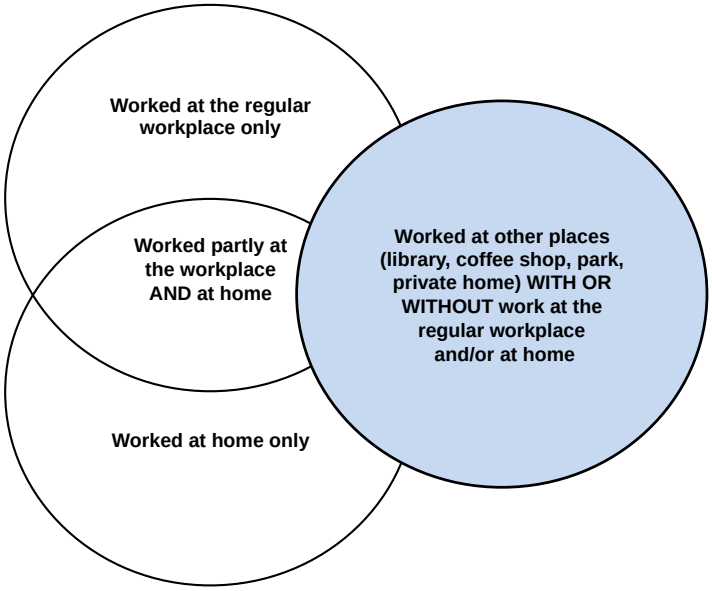
Individual work episodes may last less than 5 minutes, but represent on average 208 minutes, or nearly 3 hours and 30 minutes (standard deviation = 152 minutes). In terms of productivity and hours worked, such short work periods may accumulate over one week and represent a fairly large number of hours. It is also possible that a short period of work can increase the overall productivity of a business because it takes place at a key time of day (*timeliness*). This interpretation results from the literature on fragmentation of activities discussed in chapter 2. Further, even during a work day at

the office, a worker will often report two or four work episodes (interspersed with breaks and lunch hour, for example). The rest of the analyses will cover the sum of the individual episodes.

Table 4.2 Classification of workers on the survey day

Workplace	During the reference day
Regular workplace	Worked at the regular workplace only
Home	Worked at home only
Workplace and home	Worked partly at the workplace and at home
Other places and/or/without workplace, home	Worked at other places (library, coffee shop, park, private home) with or without work at the regular workplace and/or at home

Figure 4.1 Classification of workers for the survey day



Two measures of telecommuting will be used in the analysis, a general and a more specific question. The general question about occasional work at home will be associated with questions on perceived health, stress and the feeling of being pressed for time, given that these questions deal with general perceptions and the medium term. We also use this general variable to estimate the relationships between socioeconomic and demographic factors and the practice of telecommuting at home.

The estimates related to activities that took place during the reference day (total travel time, rush hour travel, and hours worked) will be based on the classification of telecommuters during the reference day. This approach lets us observe hours worked during a telecommuting day rather than hours worked during a survey day for a worker who does telecommuting from time to time. The same logic applies to travel.

Lastly, because the literature defines telecommuters in the strict sense as workers who have a fixed workplace (researchers differentiate *telecommuters* from *telecommuters*), we distinguish self-employed workers without a fixed workplace from those who avoid commuting by working somewhere other than their regular workplace (*telecommuters*). The survey question: "Were you mainly: ...? (MAR_Q172)". A paid worker; Self-employed) let us make this distinction. It will be used to exclude self-employed workers from certain analyses (e.g. regarding travel) or to compare self-employed workers without fixed workplaces with other telecommuters (in analyses of the practice of telecommuting, health and hours worked). The survey question: "Did you have a job or were you self–employed at any time last week? (MAR_Q133)" let us select the workers for the study.

4.5 Dependent variables

The analytical approach behind this project is to understand the relations between telecommuting in all its forms and a series of potential consequences on the organization of daily life, perceptions, and work. We posit, as in the literature, that telecommuting may influence the dependent variables linked to transportation, health and hours worked. These variables correspond to the themes covered in the three analytical chapters of this report (5 to 7). As mentioned above, the sample will vary according to the analyses that use either data on all workers surveyed (choice of working at home from time to time, relationships with perceived health, stress level and time stress), or data on workers who reported work hours during the survey day (total travel time, rush hour travel, hours worked). Descriptions of the dependent and independent variables selected for each analysis will be presented in detail in the appropriate chapters, along with the estimation strategies specific to each analysis.

4.6 Independent variables

The independent variables used to describe the characteristics of telecommuters are broken down into three large groups of variables: demographic variables and household characteristics, socioeconomic variables characterizing the worker, and geographical and household location variables.

The demographic variables pertinent to one or all of the analyses include age (4 categories), sex (binary) and the presence of children ages 0 to 14 in the household (binary).

The socioeconomic variables characterizing the worker include personal income (*vs* family income, which will not be used here) (four categories), highest level of education reached by the respondent (three categories), type of job following the categorization of the National Occupational Classification (2006) of the respondent (NOCS2006_LWK_C10 from which the jobs best suited to telecommuting were established, binary), the status of unionization or coverage by a collective agreement (binary), full-time worker (binary), self-employed worker (binary), and permanent employee (binary). Based on the job type, we also created a binary variable of jobs conducive to telecommuting. From the list of the National Occupational Classification (Table 4.3), we determined categories that have higher potential for telecommuting. Other jobs generally require the worker to be at the main workplace (*e.g.* stores, factories) or on the road. Note that we also tried to use the North American Industry Classification System 2007 (NAICS) to identify relationships between industries, telecommuting and hours worked. The large number of categories was problematic because it greatly increased the degrees of freedom of the estimates, so we tested some

categories individually. The category of jobs in public administration and government service appeared particularly noteworthy. Analyses using these variables nonetheless did not allow us to identify relationships with the telecommuting variables and hours worked when the other variables of the model are considered, and were consequently not included in the estimates presented.

Table 4.3 Categories of work that favour telecommuting ("Occupations with telecommuting potential" variable)

	Potential	No potential
Management occupations	x	
Business, finance and administrative occupations	x	
Natural and applied sciences and related occupations	x	
Health occupations	x	
Occupations in social science, education, government service and religion	x	
Arts, culture, sports and leisure	x	
Sales and services		x
Trades, transportation and machinery		x
Occupations unique to primary industry		x
Occupations unique to processing, manufacturing and utilities		x

To ensure confidentiality, the public data released by Statistics Canada include little information on the geography of the respondents. As part of this analysis, a variable for large geographic regions let us identify respondents from Québec, Ontario, the Atlantic provinces, the Prairies and British Columbia. The study also includes a binary variable that determines if the respondent lives in a Census Metropolitan Area (CMA) or Census Agglomeration (CA), or outside of these urban centres. Note that Québec comprises six CMAs (Montréal, Québec, Gatineau, Sherbrooke, Saguenay, Trois-Rivières) and 25 ARs (including Granby, Rimouski and Alma).

4.7 Analyses

After the literature reviews on each of these subjects, we begin the specific analyses by presenting the basic data and the selection of the sample based on the answers to the questions. A short methodological section precedes each analysis in the chapters of the report, intended to supplement the basic information presented here. These sections cover the sample selection, the variables retained, and the statistical estimation method. This information is followed by the presentation and interpretation of the data and the analyses. The next section describes some basic characteristics of the survey.

For each dependent variable studied, we formulate one model for the Québec subsample, one model for the complete Canada sample, and one model for the complete Canada sample that includes a categorical variable that uses Québec as a reference category. This model can identify whether the other provinces or regions diverge from Québec and the relationship with the dependent variable studied. To supplement this

information we also perform a test of equality of the coefficients of our telecommuting variables and, when pertinent, a test of the simultaneous equality of all the coefficients of the model. In most cases the differences between coefficients and models are not significant.

Lastly, for most of the models, the coefficients or odds ratios estimated are shown in the appendix in order to highlight the marginal effect evaluated at the mean value of each variable. In contrast, for the three ordinal logistic models associated with health, the main results are presented as odds ratios, but we supply the marginal effects in the appendix for readers more familiar with this representation of data.

4.8 General characterization of the survey

Because not all the respondents will be analyzed, we first present some of the broad characteristics of the survey along with the samples of workers and telecommuters in the data.

As table 4.4 illustrates, depending on the broad geographical region of Canada, between 17.22% and 26.24% of workers report that they sometimes work at home. These differences are statistically significant according to a Chi-square test. At 21.94%, Québec is situated at the national average of 21.85%. The Cramer's V test for categorical data, similar to a Pearson correlation for continuous data, nonetheless suggests a weak relationship between telecommuting and the provinces and regions.[14]

Concerning telecommuters on the survey day, Québec has a smaller percentage of workers who worked neither at home nor at the regular workplace. Although the differences between the broad regions are statistically significant, they rarely exceed 2% or 3%. Québec and the Atlantic provinces have the highest rates of workers who worked only at the regular workplace (81.22% and 81.64% respectively). Workers in British Columbia report working in several different places most frequently (the last two categories, 13.26%), whereas those from Québec and Atlantic provinces have the lowest combined rate of work at home and in other places (less than 8% for Québec).

[14] Statistical tests were done on the non-weighted sample, but the percentages presented are weighted.

Table 4.4 Number of observations, weighted percentage of workers by region

	Atlantic	Québec	Ontario	Prairies	BC	Total	Chi square and Cramer's V
Total observations in the survey	3,242	2,277	4,340	3,318	2,213	15,390	
General question on telecommuting							
Observations, all workers	2,056	1,472	2,799	2,317	1,368	10,012	
Observations, work at home	354	323	613	539	359	2,188	
Work at home (%)	17.22	21.94	21.9	23.26	26.24	21.85	0.00
	,	,	,	,	,	,	0.07
Data on survey day							
Observations, workers that day	1,137	867	1,607	1,344	782	5,737	
Categories of telecommuters (%)							0.00
Only at the workplace [ref.]	81.64	81.22	79.88	78.27	75.03	79.37	0.05
Only at home	8.64	10.86	9.82	10.96	11.71	10.45	
At the workplace and at home	5.53	5.21	6.86	6.01	5.83	6.09	
Other places beside the workplace and/or home	4.19	2.71	3.44	4.77	7.43	4.09	
Total	100	100	100	100	100	100	

Table 4.5 presents, for information purposes, the data projected on the population using raising factors. In Québec, estimates indicate that nearly 1 million workers sometimes work at home from among 4.5 million workers estimated by the data. During the reference day, 867 Quebecers worked, which represents about 2.6 million workers. Almost 500,000 workers in Québec worked at home or another place (19%), a value proportionately similar to the rest of Canada (21%) albeit slightly lower.

Table 4.5 Number of observations, number projected on the population (weighted estimation) of workers, Québec *vs* rest of Canada

	Rest of Canada	Québec	Total
Total observations in the survey	13,113	2,277	15,390
General question on telecommuting			
Observations, all workers (estimated)	15,455,913	4,562,284	20,018,197
Work at home (estimated)	3,108,751	973,643	4,082,395
Data on survey day			
Observations, workers that day	4,870	867	5,737
Categories of telecommuters			
Only at the workplace	6,837,457	2,161,495	8,998,952
Only at home	895,762	288,916	1,184,677
At the workplace and at home	551,855	138,629	690,484
Other places and the workplace and/or home	391,890	72,134	464,024
Total	8,676,963	2,661,174	11,338,138

4.9 Socioeconomic and demographic characteristics, home work

To understand the relationship between socioeconomic and demographic characteristics and telecommuting, in this section we describe the characteristics of the sample of categories of telecommuting on the survey day (Table 4.6) and analyze the factors associated with work at home by a binary logistic regression (Table 4.7). These results let us better select and interpret the variables to consider in the models in the other analytical chapters. The dependent and independent variables used will be described in detail in the appropriate chapters. Several variables presented here have been used by Turcotte (2010) in his bivariate analyses of work at home using prior data. We formalize this model in a multivariate context by adding socioeconomic variables related to the worker, such as unionization.

First, note that Table 4.6 indicates that, aside from being female, having children and the type of dwelling, the other demographic and socioeconomic variables all present significant differences depending on the categories of telecommuters. These differences are generally very minor (Cramer's V below 0.15) with the exception of self-employed workers (Cramer's V of 0.36) and permanent employees (Cramer's V of 0.31), which display modest effects. Additional checks are done when these variables are used in the models.

Table 4.6 Description of characteristics of the sample of the four categories of telecommuting on the survey day (weighted percentages)

	Only at the workplace	Only at home	At the workplace and at home	Other places and at the workplace and/or at home	Total	Chi square (p)	Cramer's V
	%	%	%	%	%		
Age (years)						0.00	0.10
15-29	24.7	12.7	8.8	13.3	22.0		
30-44	33.8	36.6	43.9	35.4	34.7		
45-59	35.0	33.8	35.7	36.6	35.0		
60+	6.5	16.9	11.5	14.7	8.3		
Level of education						0.00	0.10
Secondary or less	22.9	17.3	10.1	27.6	21.7		
College or vocational	48.3	41.5	37.6	35.7	46.4		
University	28.8	41.1	52.3	36.8	31.9		
Personal income ($)						0.00	0.07
0 - 19,999	17.9	15.8	6.6	23.2	17.2		
20,000 - 39,999	26.9	24.6	15.5	16.8	25.6		
40,000 - 59,999	23.3	20.7	24.5	20.9	23.0		
60,000 or more	32.0	38.9	53.4	39.1	34.2		
Commuting time (min)						0.00	0.06
0 – 14	28.4	36.1	29.0	36.8	29.2		
15 – 29	34.1	24.7	30.0	29.3	33.2		
30 – 44	20.3	14.0	20.7	16.5	19.9		
45 – 59	8.0	7.2	6.9	5.5	7.8		
60 – 89	6.9	9.2	9.2	7.3	7.2		
90 et plus	2.2	8.8	4.3	4.6	2.8		
Female	45.6	43.8	40.4	40.9	44.9	0.08	0.03
Children at home	33.8	34.8	43.6	34.1	34.5	0.06	0.04
Weekend	9.7	25.2	9.2	18.1	11.6	0.00	0.17
Type of dwelling						0.12	0.03
Single-family home	70.7	74.2	73.0	77.4	71.5		
Apartment/condo	13.2	11.1	9.4	8.4	12.5		
Other	16.1	14.7	17.6	14.2	16.0		
Information on the employee							
Self-employed worker	10.2	51.5	29.8	31.6	16.6	0.00	0.36
Occupation with telecommuting potential	53.6	67.7	68.6	54.4	56.0	0.00	0.09
Work, full time	84.5	75.1	90.8	70.7	83.3	0.00	0.14
Permanent employee	76.7	36.2	63.5	52.6	70.7	0.00	0.31
Unionized employee	26.2	12.2	28.6	16.6	24.5	0.00	0.13
Urban area (CMA/CA)	82.7	76.9	83.4	76.2	81.9	0.03	0.04

The logistic model (Table 4.7) of work at home indicates that workers ages 30 to 44 are most likely to work at home, all things being equal. Similarly, the probability of doing telecommuting increases with income. The marginal effects calculated at the mean of all the variables may be interpreted for each binary indicator as a change in probability associated with moving from the reference category to that category, with all other variables being considered at the mean. For example, in the Québec model, falling into the income category "$60,000 or more" increases the probability of working at home by 16.8% (compared with the lowest income category).

Relative to the reference category, farther distances from the workplace are associated with a greater probability of telecommuting, particularly when this distance exceeds 100 km. Employees living close to the workplace are also more likely to work at home. Being a self-employed worker or a unionized employee is also positively linked to work at home. Those who work in an occupation with telecommuting potential are most likely to work at home.[15] This analysis validates the use of this categorization in subsequent estimates.

Further, telecommuting is less common in Québec than in the rest of Canada, with the exception of British Columbia. McFadden's pseudo R^2 is, according to the models, about 0.21, a value considered reasonable in this type of model (Mokhtarian, 2016). Also note that in this model, as in several others mentioned in this report, the model concerning the subsample of workers in Québec performs better in terms of pseudo R^2 but gives significant results for only a few variables. The effects always go in the same direction, but the coefficients may appear quite different. However, when we test the difference between the coefficients of the Québec and Canadian models (without the region variable) without adjustments, only two of the distance variables are significantly different (10 to 49.99 km; $p = 0.034$, and more than 100 km; $p = 0.030$). The joint test of all the variables is not statistically significant either ($p = 0.274$). After adding the Bonferroni correction for multiple comparisons, none of the coefficients exhibit significant differences between the models.

The results of the models expressed in the form of odds ratios are presented in the appendix in Table A1.

In the next chapter we analyze the impact of telecommuting on transportation behaviours.

[15] We also estimated models with a binary variable considering whether individuals work in the public or private sectors. We did not find a statistically significant effect of this variable in the models estimated.

Table 4.7 Logistic model of work at home, all workers

	Québec		Canada		Canada / Regions	
	Marginal effects	**Standard deviation**	**Marginal effects**	**Standard deviation**	**Marginal effects**	**Standard deviation**
Age						
15-29 [ref.]						
30-44	0.022	(0.039)	0.047**	(0.016)	0.044**	(0.016)
45-59	-0.017	(0.040)	0.031*	(0.016)	0.028	(0.016)
60+	-0.029	(0.061)	0.023	(0.019)	0.023	(0.019)
Personal income ($)						
0 - 19,999 [ref.]						
20,000 - 39,999	0.058	(0.044)	0.049**	(0.017)	0.046**	(0.017)
40,000 - 59,999	0.081	(0.045)	0.069***	(0.018)	0.072***	(0.018)
60,000 or more	0.168***	(0.045)	0.123***	(0.017)	0.127***	(0.017)
Distance from work (km)						
Less than 1	0.099	(0.052)	0.169***	(0.016)	0.172***	(0.016)
1 to 9,99 [ref.]						
10 to 49,99	-0.017	(0.026)	-0.002	(0.010)	-0.002	(0.010)
50 to 99,99	0.032	(0.051)	0.032	(0.018)	0.036*	(0.018)
More than 100	0.135*	(0.058)	0.081***	(0.023)	0.082***	(0.023)
Female	-0.046	(0.025)	-0.009	(0.010)	-0.007	(0.010)
Children at home	0.001	(0.025)	-0.001	(0.010)	-0.000	(0.010)
Information on the worker						
Self-employed worker	0.128**	(0.047)	0.158***	(0.017)	0.157***	(0.017)
Occupation with telecommuting potential	0.114***	(0.028)	0.093***	(0.011)	0.091***	(0.010)
Full-time worker	0.025	(0.031)	-0.001	(0.012)	-0.001	(0.012)
Permanent employee	-0.060	(0.032)	-0.012	(0.015)	-0.010	(0.014)
Unionized employee	-0.120***	(0.026)	-0.072***	(0.011)	-0.077***	(0.011)
Urban area (CMA-AR)	0.031	(0.031)	0.013	(0.011)	0.014	(0.011)
Region/province						
Atlantic Region					-0.038*	(0.015)
Québec [ref.]						
Ontario					-0.054***	(0.013)
Prairies Region					-0.050***	(0.014)
British Columbia					-0.028	(0.015)
Constant						
Observations	1086		7419			7419
Wald chi2(20)	138,1		678,6			672,9
Prob > chi2	0.000		0.000			0.000
Pseudo R^2 (McFadden)	0.218		0.203			0.208
AIC	1428,1		5753,5			5721,2

Sig. = Level of significance; * p < 0.05, ** p < 0.01, *** p < 0.001; AIC: Akaike information criterion. Notes: marginal effects: positive values signify a positive change in the probability of working at home relative to the reference category and the inverse is true for negative values: E.g. people ages 30 to 44 are 4.4% more likely to work at home than those ages 15 to 29.

5. Telecommuting and transportation behaviours

Telecommuting is considered a travel management measure, similar to carpooling and programs that provide incentives to use public transport (Litman, 2011). It is also recognized as a possible strategic element to reduce demand and influence individuals' and households' behaviour related to transportation and mobility (Mokhtarian *et al*., 1995). Therefore, this chapter discusses relationships between telecommuting and individuals' transportation behaviours in terms of total time and commuting schedules.

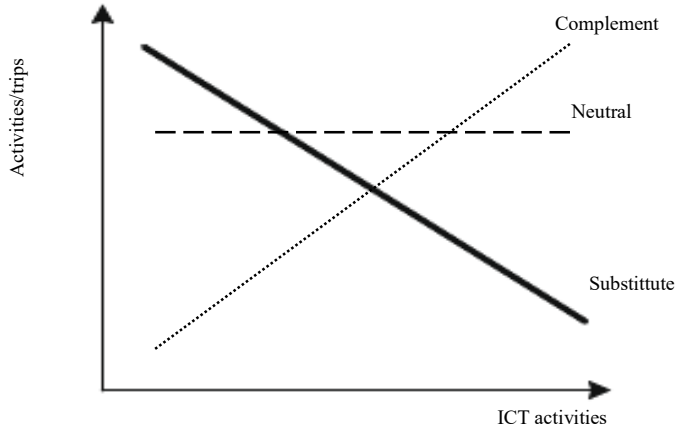
First, we review the literature on the potential effects of telecommuting on individuals' transportation and mobility including: i) travel schedules; ii) transportation modes; iii) number of trips and distances travelled; and iv) choice of location of households and organizations. This review of the research shows that although telecommuting can improve some aspects of transportation (*e.g.* less commuting at peak periods), one should be vigilant for potentially perverse effects, notably related to the substitution of travel induced by telecommuting. To determine the control variable of our estimates, we discuss the other individual and organizational factors that influence workers' transportation choices. After presenting the data used and the methodology specific to this chapter, we estimate, for Québec and Canada, different models of transportation behaviours according to workplaces, corresponding to different work arrangements: work at the workplace only, work at home only, combination of work at the workplace and at home, work outside the home (e.g. coffee shop), etc. We show that: i) telecommuting at home is correlated with a decrease in total travel time during a telecommuting day; ii) work at several places is associated with longer travel time; and iii) telecommuting, particularly if done jointly at the workplace and at home, and that done from other places, is associated with a reduction in rush hour travel, particularly in the morning. Further, Québec does not differ much from the other provinces according to the analyses, potentially due to the size of the sample available after the necessary exclusion of some observations. Our results have implications regarding the potential contribution of telecommuting to reducing travel by motorized vehicle and decreasing congestion during peak periods. This is especially important because the longest estimated commuting times occur in metropolitan regions that face the most pressing congestion problems.

5.1 Literature review: telecommuting and transport

As mentioned in chapter 2, the use of ICT in telecommuting eases time and resource constraints. It thus affects the types of activities and reasons for travel. Three types of personal activities can be influenced by ICT: a) mandatory (*e.g.* work); b) maintenance (*e.g.* hygiene); and c) discretionary or leisure (Andreev *et al*., 2010; Mokhtarian 2006).

Concerning travel, Figure 5.1 illustrates that the use of ICT in telecommuting may have four types of effects on transportation demand (Andreev *et al*., 2010; Mokhtarian *et al*., 2005; Salomon 1998): a) a substitution effect, where the use of ICT could decrease time dedicated to transportation; b) a complementary effect, where ICT are aligned with travel and therefore increase commuting time (*e.g.* more Internet interactions = more commuting); c) a change, where ICT fundamentally modify commuting routines (*e.g.* public transport applications); and d) neutrality, in the case where ICT have no effect on commuting.

Figure 5.1 Potential theoretical effects of ICT on travel



Source: Andreev *et al*., 2010 citing Senbil and Kitamura, 2003

As we will see in the following subsections, these effects induce potential variations in schedules and transportation modes, along with the number of trips and their distances.

5.1.1 Telecommuting and travel schedule

Improving time management is one factor that motivates telecommuting policies (Kitou & Horvath, 2008; Pratt, 2002; Vanoutrive *et al.*, 2010). For example, telecommuting may facilitate work-family balance by allowing more flexibility in commuting (Tremblay, 2010; Maruyama & Tietze, 2012). This broader set of choices implies changes not only to travel schedules, but also to transportation modes, and numbers of trips and distances travelled.

Most studies show that telecommuting can reduce traffic congestion (Bussière & Lewis, 2002; Kitou & Horvath, 2008; Mitomo & Jitsuzumi, 1999; Pratt, 2002; Vanoutrive *et al.*, 2010) by decreasing the number of vehicles travelling at peak periods and by limiting the associated commuting time. These studies that paint an optimistic picture of the impacts of telecommuting on transportation demand generally assume that telecommuters commute less, especially during rush hour (Kitamura *et al*., 1990).[16] This reduction has motivated several pioneering studies that envisioned telecommuting as a potential measure for managing travel demand in urban areas. For example, in 1983, the *California Energy Commission* stated that promoting telecommuting to California businesses could reduce distances travelled at peak periods by eliminating some commutes (*JALA Associates*, 1983). In the United Kingdom, Dodgson *et al.* (1997) proposed to integrate telecommuting more in the practices of public and private organizations to mitigate the increase in congestion in the major metropolitan areas. In Canada, a study of the city of Waterloo also demonstrated the potential for telecommuting to reduce congestion without affecting general household activities (Andrey *et al*., 2004).

[16] Although the potential effects of substitution of commuting by other travel at peak periods have been demonstrated (Kim, 2016), they are fairly limited (Zhu, 2012).

Nonetheless, telecommuting may generate other travel whose duration may be longer than that under non-telecommuting conditions. This is why the impact of telecommuting should be interpreted with prudence (Litman, 2011). Thus, telecommuting may have little or no effect on the number of hours of travel in a given period. This may happen when the time freed by not commuting to work is simply used for other travel by the telecommuter (Lila & Anjaneyulu, 2013) or replaced by travel by another member of the household in the same period (Kim *et al*., 2015). Telecommuting can also contribute to creating new traffic volume peaks during the day (van Lier *et al*., 2014). This may occur in the case of part-time telecommuting, which increases the number of commutes outside of morning and evening rush hour (Zhu, 2012; Asgari *et al*., 2015; Kim, 2016).

5.1.2 Telecommuting, types and numbers of trips, distances travelled

By reducing travel to a fixed workplace, telecommuting can theoretically have three types of indirect or induced effects.

First, telecommuting favours the emergence of other types of demand. One induced effect is linked to the rise in latent demand, which corresponds to travel prompted by smoother traffic flow. The elimination of home-work commuting can improve traffic flow at peak periods, which may increase travel demand (Hopkins *et al.*, 1994). Second, aside from the potential emergence of latent demand, the literature also suggests different substitution effects of commuting with other types of travel. Two typical scenarios may occur when one household member is in a telecommuting situation. First, commutes "saved" by telecommuting allow the worker to do non-commuting travel such that the final travel total may be less than, equal to or greater than that of a worker with a fixed workplace. This substitution of "saved" commutes is, as Andreev *et al*. (2010) contend, the most probable impact of telecommuting, according to their compilation of other types of impacts based on a review of 100 international conceptual and empirical studies. Further, commutes saved by the telecommuter can allow other household members to use the vehicle. Due to this substitution, telecommuting contributes to reducing home-work commutes while potentially favouring other travel demand within the household (Mokhtarian, 1998; Choo *et al*., 2005). One way to explore this effect is to analyze the relationship between one day of telecommuting and total travel time, as we do in this report.

Second, telecommuting may prompt changes to total distance travelled by the telecommuter and by households that include at least one telecommuter. Two hypotheses result from these observations and fuel debates about the effects of telecommuting on distances travelled. First, authors such as Saxena and Mokhtarian (1997), Alizadeh (2012) and Graizbord (2015) assert that telecommuting is associated with shorter distances travelled by car than in the usual work situation. Their studies demonstrate that by concentrating their travel more around the home, telecommuters travel shorter total distances than do traditional commuters, who generally travel longer distances, with activities concentrated around the regular workplace. Typical workers are also associated with a trajectory that is more linear and more concentrated in time compared with telecommuters, whose routes are more diffused in space and time, and whose activities are more concentrated around the home (Elldér, 2015). Authors such as Andreev *et al.* (2010) and Wang and Law (2007) defend the opposite viewpoint whereby telecommuting is associated with longer distances travelled by car than in a typical work situation.

Distances saved or reduced for work reasons are thus replaced by additional distances travelled for other reasons (Andreev *et al*., 2010). Overtime and flexibility created by telecommuting allow car travel that would not be possible otherwise (Wang & Law, 2007). In addition, when travel by other household members is considered, the existence of telecommuters increases the total travel distance of the household (Helminen & Ristimäki, 2007).[17]

Third, the hypothesis that telecommuting reduces multiple-stop opportunities and would thus likely to lead to an increase in total trip frequency in a household remains anchored in the literature (Lenz & Nobis, 2007; Wang & Law, 2007; Hilbrecht *et al*., 2013). Work-home commuting by car typically offers commuters the opportunity to make multiple stops without significantly increasing their distance or travel time, if these stops are located along or near the route to work. This can optimize the total travel distance and time compared with single-stop trajectories, which require one outing for each individual stop instead of making several stops on the same trip.

5.1.3 Telecommuting and transportation modes

Other potential telecommuting impacts discussed in the literature concern changes in behaviour related to the use of different transportation modes. Impacts related to the use of public transport and active transport are examined in this subsection.[18]

First, telecommuting may increase or decrease the modal share of public transport. On the one hand, the impacts of telecommuting may be positive if we assume that telecommuters who would have used this mode to go to work replace their commutes with other types of travel using the same mode (Kitou & Horvath, 2006). In this scenario, telecommuting could increase the overall use of public transport because telecommuters could use the commuting time saved to travel to other destinations such as coffee shops and libraries, where they could work. On the other hand, the impacts of telecommuting may also be negative because telecommuters who no longer take the train, bus or carpooling to go to work would contribute to the decline in the use of these modes (Mokhtarian, 1998). This decline may erode the need for public transport networks that are used moderately in a schedule highly dependent on rush hour commuting (Mokhtarian, 1998).

Second, telecommuting may positively or negatively influence the modal share of active transport. The positive influence of telecommuting stems from the fact that telecommuters are likely to visit stops closer to their home, particularly for food consumption (Hynes, 2013). This may occur in a context where the telecommuter lives in a fairly dense urban environment, or based on the principles of mixing of urban functions. In contrast, in other contexts such as that of telecommuters who live on the outskirts of large urban areas, telecommuting may negatively influence the modal share of active transport in that walking is a necessary mode of transportation for workers whose fixed workplace is not their home (Boell *et al*., 2013).

5.1.4 Telecommuting and household location

Another subject raised in the literature is the choice of location of households in which at least one member telecommutes. In a traditional work context that requires the worker's full-time presence at a fixed workplace, the length of the route may be a factor in the choice of location. By reducing or eliminating work-related travel,

[17] Given the nature of the data (one individual per household), we cannot consider this possibility.
[18] Active transport is also discussed in chapter 6, which looks at the effects on health and stress.

telecommuting lets workers live farther from the employer's premises. They can then choose their place of residence based on factors other than distance from the job site, such as preference and quality of life. Studies support the idea that living farther from the workplace may be a potential effect of telecommuting (the term *telesprawl* was coined to describe this phenomenon). Nonetheless, Rhee (2009 argues that telecommuting influences distance from the workplace only when both members of a household telecommuting. This suggests that the lack of the telecommuting option for one household member may be the factor that prevents the household from relocating.

Lastly, concerning the telecommuting-distance from workplace relationship, a Finnish study shows that the probability of doing telecommuting increases with the distance between the home and principal workplace (Helminen & Ristimäki, 2007). These results have been validated by Turcotte (2010) for Canada.

5.1.5 Transportation and travel: other determining factors

Aside from elements linked to telecommuting, other factors have been shown to play a role in individuals' commuting behaviours. They notably include the following groups of variables: i) individuals' socioeconomic characteristics including level of education, income, age and marital status (Choo & Mokhtarian, 2007; Graizbord, 2015); ii) the number and category of telecommuters in a household (Saxena & Mokhtarian, 1997; Zhu, 2013; Graizbord, 2015); and iii) the telecommuter's main transportation mode (Matthews & Williams, 2005).

Regarding the number and category of telecommuters in a household, Kitou and Horvath (2006) emphasize that the study of the variation in the frequency of multiple stops made by part-time telecommuters is not generalizable to full-time telecommuters. Similarly, Graizbord (2015) argues that it is important to discriminate among categories of telecommuters, in that some do more work-related travel than others.

Lastly, the automobile is not necessarily the preferred transportation mode of all people who telecommuting. Other qualitative variables such as commuters' preferences, personality, and lifestyle also influence their choice of modes (Choo & Mokhtarian, 2007).

5.1.6 Hypotheses on the relationship between telecommuting and transportation behaviours

In terms of transportation behaviours, research shows that telecommuting may increase or decrease total travel time. For our analysis we test the hypothesis that telecommuting is associated with a decrease in total travel time. Regarding rush hour commuting, it has generally been demonstrated that telecommuting reduces the number of such trips. We therefore test this hypothesis. However, given the information at our disposal, we cannot directly analyze the links between telecommuting and distances travelled.[19]

5.2 Data and method

Our database lets us consider most of the variables described in the literature that can explain transportation behaviours. Specifically, we study total travel time and travel at peak periods. To take specific provincial factors into account, particularly those of

[19] However, we showed in chapter 4 that the probability of telecommuting is higher for employees living very close to the regular workplace (1 km or less) or very far from it (over 100 km).

Québec, we estimate three models for the first dependent variable: two for Canada with and without provincial effects and one for the sample limited to respondents in Québec.

We use the information contained in the time use diary to code trips and telecommuters. We can thus assess relationships between telecommuters' total travel time during a day where different forms of telecommuting occur or not. For all analyses of travel, self-employed workers are excluded given that their use of "telecommuting" does not theoretically contribute to reducing commuting to a fixed workplace. Note that this is typically how these workers are treated in the telecommuting literature (Choo & Mokhtarian, 2007; Mokhtarian, 1996).

The first analysis examines total travel time. Based on the time use diary, we added together all the episodes of travel activity (the diary contains 23 activity codes for travel for different reasons). Because some respondents did not report minutes of travel during the day, we chose to use a Tobit model to estimate the factors associated with this variable. In addition, because some travel time observations seem improbable due to their length or because they probably represent long-distance intercity travel (e.g. by plane), we excluded from the analysis individuals who reported that they travelled for more than 6 hours (360 minutes, 17 cases excluded from the analysis). We also excluded employees who reported that their home was their main workplace (n = 63) because their inclusion would bias the results. The central variable in our analysis is the categorization of the type of worker on the survey day. The model also includes other variables mentioned in the literature review that may affect total travel time. We also added a binary variable to denote workers who used public transport during the survey day. The rationale is that these workers report longer travel time because public transport is generally a slower mode. Three models are presented. The first estimates the total travel time for workers in Québec, the second for all Canadian workers, and the third for Canadian workers that includes binary variables representing the provinces.

The second analysis concerns travel during periods of congestion, which implies a different data structure. In these analyses, the unit of analysis is no longer the individual but rather each individual trip. The survey data can be coded to categorize each trip by start time, to analyze the effect of telecommuting on rush hour travel. We thus categorize start times into five categories: night-morning (between 11 p.m. and 6:59 a.m.), morning rush (between 7 a.m. and 8:59 a.m.), day (between 9 a.m. and 3:59 p.m.), afternoon rush (between 4 p.m. and 5:59 p.m.) and evening (between 6 p.m. and 10:59 p.m.).

In this model, a multinomial logistic regression is estimated using the episode file, to which variables characterizing individuals and their telecommuting status are added. Each trip that telecommuters take during the day is therefore modelled individually, but a grouping variable is used (individual's unique identifier) to take into account the fact that the observations are not entirely independent. Estimates of variance-covariance are therefore grouped at the individual level. As in the first analysis, we exclude self-employed workers. We also exclude observations of non-motorized travel because they are much less subject to congestion problems and much fewer in the database. For this analysis of rush hour travel, only two estimates are presented based on the preliminary results obtained. One model yields the results for the entire population of Canada and includes a binary variable for observations of Québec participants; a second model is restricted to Québec participants.

The cross-sectional nature of the data used makes it more difficult to establish causal relations between the forms of work and the travel variables. Therefore, phenomena of simultaneity or reverse causality may be possible between the decision to telecommuting and total travel time during rush hour. In addition, data on individuals are limited by the questions asked, and do not let us consider some variables that would also influence transportation behaviours, such as whether the individual owns a vehicle, or the supply of public transport according to respondents' exact location.

For total travel time, because the data used pertain to only one particular day, travel time is observed only for that day, and is not necessarily correlated with general travel habits. For the survey day, it is possible that travel time observed is explained partly by the prior decision about the form of work chosen, but we cannot confirm causal relations because of other potential determinants that were not considered.

Regarding travel during peak periods, decisions on the form of work and travel times may be made sequentially or simultaneously. Once again, other possible explanatory factors not considered may also play a role.

Nonetheless, the possibility of using an instrumental variable for telecommuting was considered, but no suitable variables were found among the available data. Therefore, the analysis will be interpreted in terms of correlations rather than causality.

For both travel time and rush hour travel, we present the marginal effects estimated for different combination of variables, which constitute the telecommuting categories.

5.3 Estimates and analysis

5.3.1 Travel time during the survey day

The results of the first series of Tobit models (Table 5.1) present the marginal effects unconditional on censoring (extensive margin). Given the very low number of censored observations (9 in Québec, 55 in Canada), it would be imprudent to partition the effects by calculating the extensive and intensive margins and by reporting the probability of censorship. In addition, it is important to consider the total relationship (uncensored) of telecommuting to travel time for the whole sample of workers, not only those who travelled. The low rate of censorship minimizes the variations between extensive and intensive marginal effects (which generally corresponds to less than one minute). Table A2 in the appendix presents the coefficients of the model.

The results of our analysis suggest that working only at home is associated with an average decrease in travel time of 19 minutes compared with workers who travel to a workplace (based on the estimates of the third model, Canada/regions, the most powerful in terms of Pseudo R^2 and the Akaike information criterion). Dividing time between the regular workplace and home in the same day is not associated with a decrease in travel time, and people who travel to several destinations have average higher travel time than those who commute to a workplace (by about 17 minutes). These results appear reasonable because they suggest that work partly at home and at the workplace has no influence on travel time, but the combination of workplaces implies a larger number of trips, and therefore potentially longer travel time. The results partly corroborate the information taken from the literature review above. In addition, we shed light on other variables with significant effects.

Age and income are not linked to total travel time. However, there is a positive correlation between distance from the workplace and total travel time, which reinforces the plausibility of the model.

The following variables are associated with increases in travel time: having children, living in a metropolitan area and using public transport during the reference day. In the first case, the presence of children in the household often necessitates additional travel (*e.g.* driving them to school or activities). In the second case, travel time increases in metropolitan areas because although these areas host a larger variety of services, individuals may need to travel longer distances and for longer periods to procure specialized services depending on their preferences and needs. These areas are also the most subject to road congestion, which may increase travel time. In the third case, travel by public transit, for the same distance, tends to have a longer duration, as mentioned above.

Workers in Québec (reference category of the third model) do not stand out significantly from Canadians in other provinces regarding total travel time. However, residents of the Atlantic provinces have slightly shorter travel time. Presumably, the residents of these provinces take shorter trips around small municipalities and urban areas.

McFadden's pseudo R^2 cannot be interpreted as the traditional measure of R^2 (percentage of variance of the dependent variable explained by the independent variables). It refers to the reduction in uncertainty associated with the information contained in the model. We must acknowledge that although the values of the models are similar to those of several scientific studies that use similar individual data (Zhu, 2012, 2013; Kim *et al*., 2012), these values remain relatively low. We can thus assume that unobserved variables are missing from the model or that random variations between individuals are large. Given the small categories of interest regarding telecommuting, not all the relationships are established significantly for the model restricted to workers in Québec.

Table 5.1 Tobit model of total travel time for the reference day (minutes)

	Québec		Canada		Canada / Regions	
	Marginal effects	**Stand. Dev.**	**Marginal effects**	**Stand. Dev.**	**Marginal effects**	**Stand. Dev.**
Categories of telecommuters						
Only at the workplace [ref.]						
Only at home	-20.5*	(9.39)	-18.91***	(3.77)	-19.27***	(3.77)
At the workplace and at home	10.2	(11.57)	3.48	(3.71)	3.55	(3.71)
Other places and the workplace and/or home	-4.94	(15.13)	17.4***	(4.88)	16.96***	(4.89)
Personal income ($)						
0 - 19,999 [ref.]						
20,000 - 39,999	5.56	(7.072)	-0.62	(2.72)	-0.66	(2.72)
40,000 - 59,999	10.55	(7.86)	4.8	(2.78)	4.84	(2.78)
60,000 or more	19.43*	(7.85)	6.64*	(2.74)	6.75*	(2.74)
Age						
15-29 [ref.]						
30-44	-4.37	(6.44)	-3.02	(2.41)	-3.17	(2.4)
45-59	-9.54	(6.36)	-0.4	(2.33)	-0.51	(2.33)
60+	-16.57	(12.46)	-5.33	(3.96)	-5.4	(3.96)
Other information						
Children at home	5.15	(5.04)	7.6***	(1.87)	7.72***	(1.87)
Urban area (CMA - CA)	4.84	(5.74)	12.63***	(2.15)	11.63***	(2.18)
Commuting by public transport	23.59**	(7.23)	29.37***	(2.76)	29***	(2.76)
Distance from work (km)						
Less than 1	6.77	(13.25)	-4.52	(4.82)	-4.13	(4.82)
1 to 9.99 [ref.]						
10 to 49.99	26.91***	(4.59)	23.68***	(1.77)	23.57***	(1.77)
50 to 99.99	44.04***	(9.23)	56.02***	(3.29)	55.86***	(3.3)
More than 100	79.96***	(20.95)	89.75***	(6.06)	90.06***	(6.06)
Region/province						
Atlantic Region					-7.17*	(3.45)
Québec [ref.]						
Ontario					-0.39	(2.1)
Prairies Region					-3.92	(2.52)
British Columbia					2.17	(2.78)
Constant	47.13***	(7.61)	42.31***	(2.97)	44.36***	(3.32)
Observation = 0	9		55		55	
Observation ≤ 1	532		3.534		3.534	
Number of observations	541		3.589		3.589	
Significance	0.000		0.000		0.000	
Pseudo R^2 (McFadden)	0.015		0.019		0.019	
AIC	9,807.1		41,516.7		41,515.5	

Note: Marginal effects: Unconditional expected value (minutes); positive values signify an increase in travel time, and negative values a decrease; Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; AIC = Akaike information criterion

Further, we tested the insertion of binary variables representing full-time workers (*vs* part-time), being in a couple (*vs* living alone or with a roommate), being a tenant, being

female, and having completed the time use diary for a weekend day. These variables did not present significant effects so we disregarded them to design more parsimonious models.

Lastly, Wald tests on the equality of coefficients between the Québec and Canadian models (without regional binary variables) were performed. These tests revealed no significant difference ($p < 0.05$) for all the variables considered jointly, nor for those specifically related to telecommuting, by making a Bonferroni correction for multiple comparisons.

The table presenting the results of the models in the form of coefficients are presented in the appendix (Table A2).

To facilitate the interpretation of the relationships between categories of telecommuting and travel time, we generated marginal means for types of workers within rural and urban areas (metropolitan areas and agglomerations). Table 5.2 uses the estimates produced by the Canadian model, including the urban *vs* rural variable. It shows that people in rural regions who work only at home spend the least time travelling, whereas workers in urban areas who work at several different places travel for an average of 1 hour and 40 minutes per day.

Table 5.2 Estimation of marginal means of travel time (minutes) according to telecommuting status and area of residence

	Rural areas			Urban areas		
Categories of telecommuters	**Mean**	**CI 95% Low**	**CI 95% High**	**Mean**	**CI 95% Low**	**CI 95% High**
Only at the workplace [ref.]	67.93	66.32	69.54	80.93	80.11	81.74
Only at home	56.44	50.15	62.73	64.11	60.71	67.50
At the workplace and at home	69.18	62.66	75.70	86.36	82.92	89.80
Other places and the workplace and/or home	83.56	73.59	93.54	98.04	93.04	103.04

5.3.2 Rush hour travel

The second series of analyses aims to estimate relationships between forms of telecommuting and rush hour travel. The percentages of individual trips done by different categories of telecommuters are compiled in Figure 5.2 for all the study participants included in the models that follow (17,410 trips done by 4,613 participants). Figure 5.3 repeats this exercise for 2,309 commutes made by 702 respondents in Québec. The reference period day (9 a.m. - 3:59 p.m.) is shown in white. Note that for both Canada and Québec, workers who went to the regular workplace during the survey day have higher percentages of travel during the morning and evening rush hour. For Canada, individuals who work at several workplaces, thus elsewhere from the home and the regular workplace, report the lowest percentages of rush hour travel. For Québec, workers who work at the regular workplace and at home report the lowest percentages of rush hour travel. In both cases, all forms of telecommuting are linked to lower percentages of rush hour travel.

Figure 5.2 Periods of travel by workplace, Canada

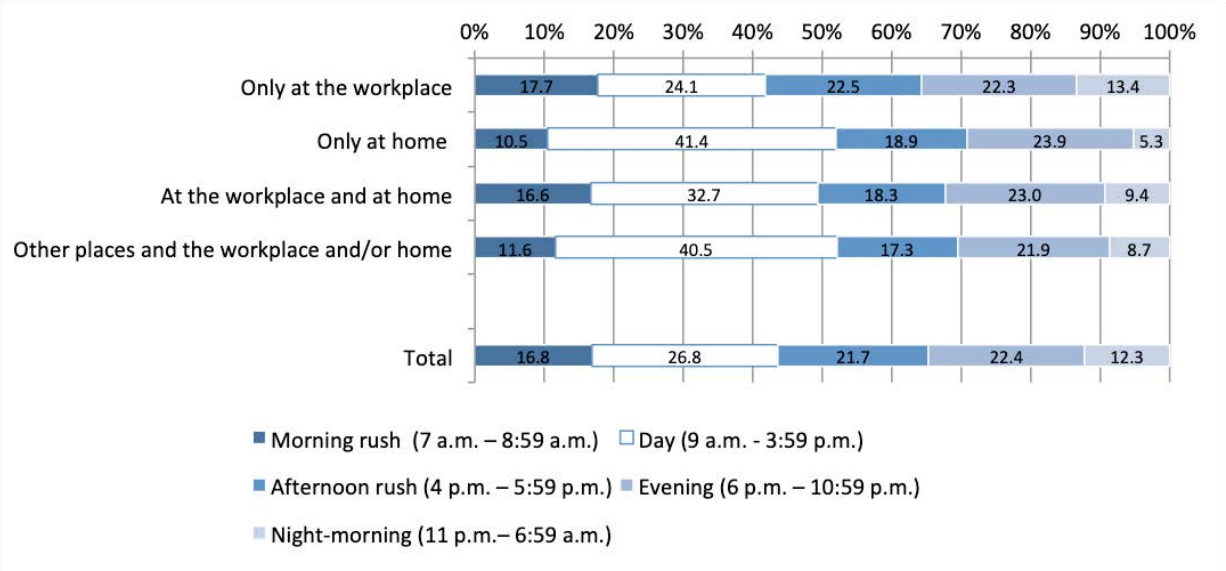
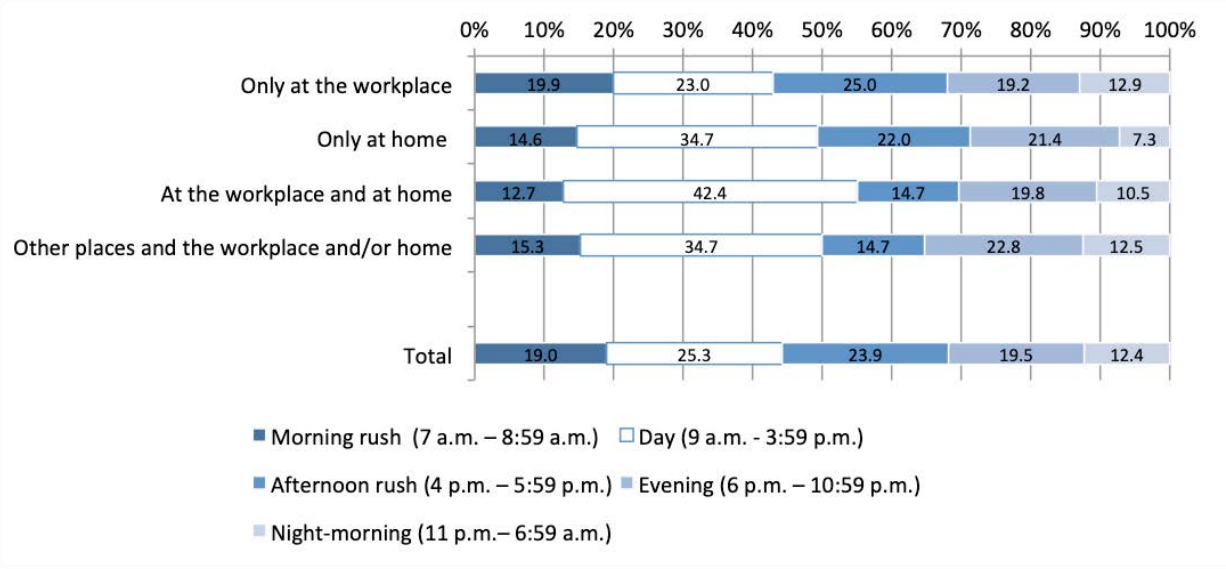


Figure 5.3 Periods of travel by workplace, Québec



To verify these results in a multivariate context, multinomial logit models of rush hour travel were estimated for all respondents in Canada (Table 5.3) and Québec (Table 5.4). These tables compile the marginal effects of each variable when other variables are kept at the mean; tables A3 and A4 in the appendix present the coefficients of the models. To simplify the tables, we did not report standard deviations. Note first that several other variables are largely associated with the time period during which the trip took place. Table 5.3 of the model for Canada is used as an example. The model suggests that higher income is always associated with more travel, regardless of the time period. The model also shows that older people and families with children travel less often during the evening than during the day (reference category), and travel on weekends is always less frequent regardless of the time of day. Travel for shopping and services, restaurant dining and visiting friends is also more frequent in the evening than during the day and at night. These results are generally similar to those in the model restricted to observations for Québec, but some relationships are not statistically significant. In the Canadian model, all the groups of telecommuters show an increase in the probability of travelling during the day (13% for home workers; 10% for workers who combine

work at home and the workplace, and 14% for those who also work in other places). Falling into these groups reduces the probability of evening rush hour travel by 4%, 6% and 5% respectively.

Table 5.3 Multinomial logit model of rush hour travel, Canada

	Morning rush (7 a.m. - 8:59 a.m.)	Day (9 a.m. - 3:59 p.m.)	Afternoon rush (4 p.m. - 5:59 p.m.)	Evening (6 p.m. - 10:59 p.m.)	Night-morning (11 p.m.– 6: 59 a.m.)
	Marginal effects	**Marginal effects**	**Marginal effects**	**Marginal effects**	**Marginal effects**
Categories of telecommuters					
Only at work [ref.]					
Only at home	-0.01	0.13***	-0.04*	-0.04*	-0.04**
At the workplace and at home	-0.02	0.10***	-0.06***	0.01	-0.03**
Other places and the workplace and/or home	-0.05***	0.14***	-0.05***	0	-0.04***
Full-time work	0.03*	-0.12***	0.03*	0.03	0.03**
Personal income ($)					
0 - 19,999 [ref.]					
20,000 - 39,999	0.01	0	-0.02	-0.01	0.01
40,000 - 59,999	0.02	-0.04	0.01	0	0.01
60,000 or more	0.01	-0.06**	0.02	0.02	0.02
Age					
15-29 [ref.]					
30-44	0.03**	0.01	0.02	-0.04*	-0.02*
45-59	0.03**	0.05**	0	-0.06***	-0.02*
60+	0.02	0.10***	0.02	-0.10***	-0.04***
Female	0.03***	-0.02	0.03***	-0.01	-0.04***
Children at home	0.02*	0.02	0	-0.04**	-0.01
Weekend	-0.02	0.12***	-0.07***	-0.04*	0.01
Type of travel					
Work [ref.]					
Household chores	-0.22***	0.03	-0.01	0.24***	-0.04
Driving children or adults	0.01	-0.04*	0.04*	0.11***	-0.12***
Goods and services	-0.18***	0.08***	0.05***	0.18***	-0.13***
Restaurant dining	-0.16***	0.09***	-0.06***	0.23***	-0.10***
Courses/studies	0.05	0.03	-0.05	0.09	-0.12***
Other	-0.18***	-0.05***	-0.06***	0.34***	-0.05***
Visits with friends/family	-0.22***	-0.12***	0.01	0.39***	-0.06***
Urban area (CMA - CA)	0.01	0.01	-0.01	-0.01	0
Québec [ref.]					
Ontario	-0.01	0.01	-0.04***	0.03*	0.01
Rest of Canada	-0.01	0.01	-0.02	0.01	0.01

Observations – Travel	17 410	Individuals	4613
Log-likelihood (base)	-29859.9		
Log-likelihood (model)	-27647.8		
Chi squared	1705.2		
P value	0.000		
Pseudo R^2 (McFadden)	0.074		
Pseudo R^2 (Nagelkerke)	0.232		
AIC	55487.5		

Note: Sig. = p value of marginal effects: * p < 0.05, ** p < 0.01, *** p < 0.001; AIC: Akaike information criterion

Table 5.4 Multinomial logit model of rush hour travel, Québec

	Morning rush (7 a.m. - 8:59 a.m.)	Day (9 a.m. - 3:59 p.m.)	Afternoon rush (4 p.m. - 5:59 p.m.)	Evening (6 p.m. - 10:59 p.m.)	Night-morning (11 p.m.– 6: 59 a.m.)
	Marginal effects	**Marginal effects**	**Marginal effects**	**Marginal effects**	**Marginal effects**
Categories of telecommuters					
Only at work [ref.]					
Only at home	0	0.1	-0.05	-0.02	-0.02
At the workplace and at home	-0.07**	0.19***	-0.13**	0.03	-0.02
Other places and the workplace and/or home	-0.02	0.06	-0.09*	0.07	-0.02
	0.07*	-0.17***	0.04	0.05	0.02
Personal income ($)					
0 - 19,999 [ref.]					
20,000 - 39,999	0	0.03	0.02	-0.04	-0.01
40,000 - 59,999	-0.02	0.01	0	-0.01	0.03
60,000 or more	0	0.01	0	0.01	-0.01
Age					
15-29 [ref.]					
30-44	0.03	0.02	0.06*	-0.08*	-0.03
45-59	0	0.07*	0.04	-0.11**	0
60+	0.01	0.1	0.09	-0.14**	-0.06*
	0.03*	-0.04	0.06**	-0.01	-0.04**
Female	0.02	0	0.02	-0.05	0.01
Children at home	-0.01	0.17***	-0.16**	-0.04	0.03
Type of travel					
Work [ref.]					
Household chores	-0.25***	0.14	-0.03	-0.04	0.18
Driving children or adults	0.02	-0.02	0.06	0.05	-0.12***
Goods and services	-0.19***	0.09*	0.05	0.18***	-0.12***
Restaurant dining	-0.20***	0.06	0.01	0.25***	-0.12***
Courses/studies	-0.06	-0.08	0.21***	0.04	-0.11**
Other	-0.20***	-0.12***	-0.04	0.36***	0
Visits with friends/family	-0.25***	-0.13**	0.05	0.34***	-0.02
Urban area (CMA - CA)	0.01	0.08**	-0.02	-0.06*	-0.01

Observations - Travel	2309	Individuals	702
Log-likelihood (base)	-6,417.311		
Log-likelihood (model)	-5,876.707		
Chi squared	2,258.2		
P value	0.000		
Pseudo R2 (McFadden)	0.084		
Pseudo R2 (Nagelkerke)	0.375		
AIC	11,929.4		

Note: Sig. = p value of marginal effects: * p < 0.05, ** p < 0.01, *** p < 0.001; AIC: Akaike information criterion

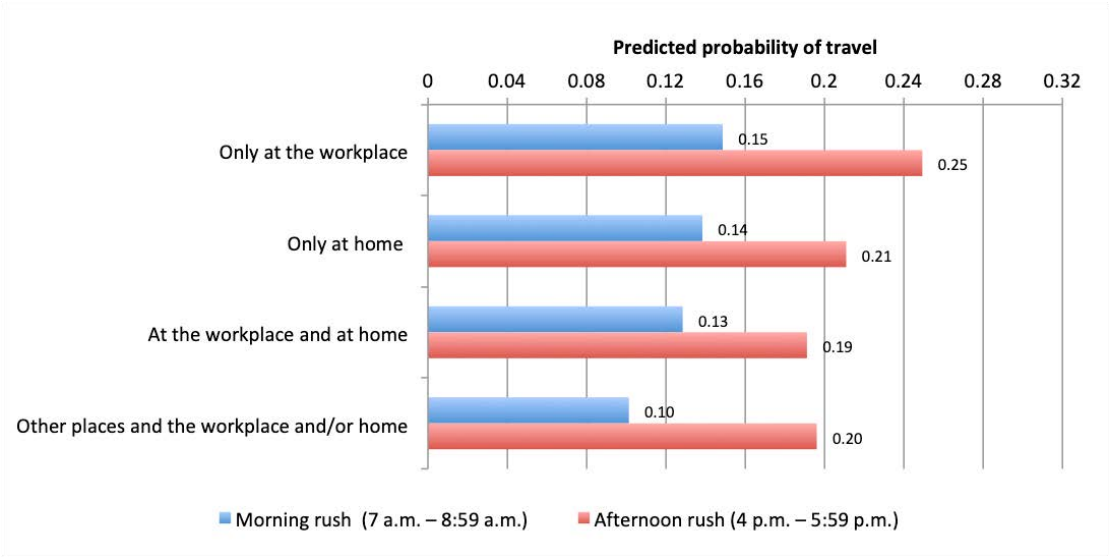
Given that these models include reference categories for both the dependent and independent variables, the results are difficult to interpret in the tables of coefficients provided in the appendix (A3 and A4). To simplify their interpretation, we also estimated the probability predicted by the models of travel during peak periods for four groups of workers (telecommuting variable) while keeping the other variables at their mean value. These results are presented in figures 5.4 and 5.5 for Canada and Québec.

Figure 5.4 shows that the afternoon rush hour is always associated with a greater mean probability of travel than the morning rush hour. This may be explained by the fact that travel for other activities may also occur during this period, such as end of day shopping or picking up a child at school.

In addition, on average, workers who go to the regular workplace only are associated with a greater probability of rush hour travel than are all telecommuters.

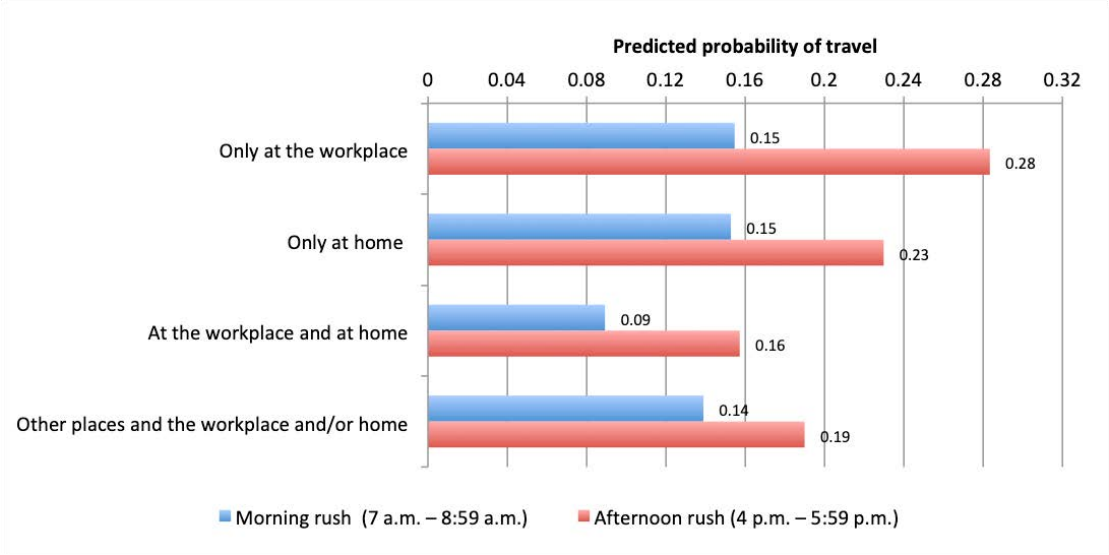
The lowest mean probabilities of travel during morning and afternoon rush hour are respectively associated with workers who go to another workplace in addition to having potentially worked at home and at the regular workplace, and those who worked at the regular workplace and at home.

Figure 5.4 Predicted probability of morning and evening rush hour travel, Canada



For Québec only, Figure 5.5 presents generally similar results despite a few differences. On average, the lowest probabilities of travel during morning and afternoon rush hour are linked to workers who combine work at home and at the regular workplace. In contrast, employees working in several different places have, on average, a slightly higher probability of commuting during morning rush hour than do those in the rest of Canada.

Figure 5.5 Predicted probability of morning and evening rush hour travel, Québec



Lastly, Wald tests of the equality of coefficients between the Québec and Canadian models (without regional variables) revealed some differences regarding telecommuting. Without making a Bonferroni correction for multiple comparisons of coefficients, we can observe significant differences in coefficients for morning rush hour for home workers ($p = 0.022$) and people who work in multiple places ($p = 0.038$). At afternoon rush hour, only the "work at home" variable has a significantly different coefficient ($p=0.038$). The joint test of all variables also presents significant differences ($p = 0.001$). After adding the Bonferroni correction for multiple comparisons, none of the coefficients of interest pertaining to the form of telecommuting and the workplace exhibit significant differences between the models. Similarly, the coefficients of the telecommuting variables for Québec and Canada do not indicate significant differences for travel at other times of day.

6. Telecommuting, health, stress and feeling of being pressed for time

This chapter examines the potential effects of telecommuting on health, along with feelings of stress and being pressed for time. First, a literature review shows the telecommuting may have physiological and psychological effects on employees and the population in general. These effects, linked to time management and travel behaviours, seem mainly positive concerning physical health, but somewhat negative concerning mental health and stress. To determine the control variables to consider in our estimates, we also discuss other individual and organizational factors that influence workers' health. After presenting the data and the specific methodology used in this chapter, we estimate, for Québec and Canada, different models linking reported health and stress levels according to answers to the general question on occasional work at home.[20]

Telecommuting is not related to self-reported health, but is associated with stronger feelings of stress and of being pressed for time. These results may justify prudence regarding the context in which telecommuting measures are implemented, at least for some employees (*e.g.* those with children at home).

6.1 Literature review

6.1.1 Effects of telecommuting on health and stress

As mentioned above, improving time and activity management is an important goal of telecommuting policies (Kitou & Horvath, 2008; Pratt, 2002; Vanoutrive *et al.*, 2010).[21] The advantages of flexible time use partly explain why telecommuters generally feel more satisfied with their jobs than do employees who work at the main workplace exclusively (Schweitzer & Duxbury, 2006; Tremblay, 2001). Telecommuting is notably translated by lesser use of sick days and reduced absenteeism (Bailey & Kurland, 2002; Bloom *et al.*, 2014; McKinnon, 2013). However, a study of the intensity of telecommuting shows that the beneficial effects on health follow an inverted U curve, which signifies that the moderate practice of telecommuting offers maximum benefits for health, compared with very low or very high intensity of telecommuting (Henke *et al.*, 2016).

The greater flexibility of time use is largely explained by the influence of telecommuting on travel. Time saved by avoiding commuting to work may be reallocated to leisure activities, leading to an improvement in physical fitness and mental health. Therefore, employees who telecommuting have more time to exercise and to eat better (Moos *et al.*, 2006). Potentially positive effects of telecommuting in terms of reducing alcohol abuse, consumption of tobacco products, physical inactivity and obesity have also been demonstrated in a recent study (Henke *et al.*, 2016). These studies may partly explain why employees' blood pressure is significantly higher during a workday at the office (compared with a day of telecommuting) given the differences in the nature of tasks. However, telecommuters have higher adrenaline rates at the end of the day because they tend to work later hours (Lundberg & Lindfors, 2002).

[20] We use this variable instead of the telecommuting variable for the study day because it would be illogical to associate a general answer about health and stress with activity on a specific survey day.
[21] As discussed in chapter 5, time freed by avoiding commuting can be used for other travel or for work, but we focus here on the possible use of this time for personal purposes associated with stress and health.

Further, schedule rearrangement and travel may have both positive and negative effects on stress and mental health. The positive effects result mainly from the decrease in travel by car during periods of road congestion, which are recognized as stressful and are known to heighten individuals' aggression (Mello, 2007; Wener & Evans, 2007). Research shows that a reduction in travel time by car reduces stress-related illnesses (Kitou & Horvath, 2008; Mitomo & Jitsuzumi, 1999; Pratt, 2002; Vanoutrive *et al.*, 2010). Telecommuters are also less likely to experience episodes of depression than are traditional workers (Henke *et al.*, 2016). In addition, telecommuting may positively contribute to work-life balance by allowing parents of young children to spend more time with their family (Tremblay, 2010), and by facilitating the assumption of maternal responsibilities (Maruyama & Tietze, 2012).

Several potential risks that telecommuting poses to mental health and stress should be noted. The possible negative effects are often linked to the difficulty in setting boundaries between work and personal life (Hilbrecht *et al.*, 2013). Golden (2012) shows that time management and constraints associated with telecommuting may create two-way conflicts between work and family. Such interference is notably associated with emotional burnout and is exacerbated by extended work schedules. In addition, people who experience major conflicts in this area are in worse physical and mental condition and tend to use the Canadian health system more often (Telecommuting Research Network, 2011).

Other risks result from isolation, organization of the workstation and hours worked (Montreuil & Lippel, 2003), and have emotional impacts associated with solitude, irritability, worry and guilt (Mann & Holdsworth, 2003). In the course of their duties, telecommuters thus feel symptoms linked to mental stress more frequently than do office employees, along with symptoms linked to physical health (Mann & Holdsworth, 2003). These symptoms are apparently more pronounced in women, who, wanting to excel in all spheres of their life, may feel more stress by combining telecommuting and personal tasks (Gurstein, 2001). Guides on telecommuting implementation emphasize the psychosocial risks that employers should consider, such as the difficulty achieving work-life balance, stress linked to objectives or to the nature of the task, demotivation, poorly adapted materials, rejection from colleagues, and impaired socialization due to distance (CCHST, 2001; Ministère de la Fonction publique, 2016).

6.1.2 Other potential effects of telecommuting on transportation and health

Because of their influence on transportation, other potentially positive effects of telecommuting on health and stress deserve mention.

As seen in chapter 5, there is a consensus on the ability of telecommuting to reduce automobile congestion, which translates into a decline in the number of cars at peak periods and shorter travel time. When the use of technology fully or partly replaces car travel, telecommuting could reduce polluting emissions that are harmful to health (Kitou & Horvath, 2008; Mitomo & Jitsuzumi, 1999; Moos *et al.*, 2006; Pratt, 2002; Vanoutrive *et al.*, 2010). This reduction in pollution could be linked to reorganization of activities according to workplaces (Pérez *et al.*, 2004). Thus, reducing the frequency of trips to the regular workplace would stimulate the choice of soft mobility linked to schedule flexibility, and shorter distances. Further, the use of public and alternative transport has a positive impact on health in that it favours an active lifestyle (Lachapelle & Frank, 2009; Saelens *et al.*, 2014; Lachapelle & Pinto, 2016). In addition, if

telecommuting reduces rush hour travel (Bussière & Lewis, 2002; Mello, 2007), lesser road congestion can contribute to: i) fewer vehicle accidents (Duduta *et al.*, 2013; Litman, 2011; Shepherd, 2008; Sivak & Schoettle, 2010; Wang *et al.*, 2013); ii) faster response time by emergency services (Telecommuting Research Network, 2011); and iii) more accessible health care (Litman, 2016b).

In addition, by easing travel and schedules, telecommuting facilitates integration in the labour market for people with reduced mobility or who face family constraints (Bricout, 2004; Tremblay, 2001). Virtual mobility thus represents a viable alternative to physical mobility that can mitigate labour market exclusion (Bricout, 2004; Kenyon, 2010; Kenyon *et al.*, 2002).

Lastly, alternative mobility choices resulting from telecommuting may improve social cohesion and the feeling of well-being in the population (Newhook *et al.*, 2011). For example, an increase in walking could boost positive interactions between individuals (Litman, 2016a; Thomas, 2007), while countering depression and mental illness (Berke *et al.*, 2007; Larson *et al.*, 2006).

6.1.3 Workers' health: other determining factors

Beyond the elements associated with telecommuting, several other determinants linked to the individual or the employer have major effects on health. Some of these determinants are impossible to consider in our estimates. First, studies find that leadership style plays an important role in general health, the use of sick leave or the well-being of junior employees (Kuoppala *et al.*, 2008; Wegge *et al.*, 2014). For example, support from colleagues and the immediate supervisor influences health, and decreases the use of medical services. Conversely, overly high commitment to the company may harm health, leading instead to more frequent consulting of a general practitioner (Steenbeek, 2012). In addition, poor autonomy in tasks, a fast work pace and an emotionally demanding job hinder performance and intensify the use of sick days (van den Heuvel *et al.*, 2010). Lastly, the quality of the work environment plays a determining role in workers' health, on a par with socioeconomic status (Datta Gupta & Kristensen, 2008).

Below, we therefore limit the analysis of factors influencing health and stress to those that can be considered in our estimates. First, we discuss individual variables related to age, sex, socioeconomic situation and family situation. Second, we address organizational variables linked to occupation and intensity of work.

Individual variables

Among the individual variables that affect health in general, age is apparently an important indicator. Some researchers find a major negative gradient between advancing age and deterioration of health (Datta Gupta & Kristensen, 2008). The older one gets, the poorer the latent state of health. Indeed, chronic illnesses are much more prevalent among older people (Devaux *et al.*, 2008).

Research also shows that gender influences health status. Generally, women are in a poorer state of health than men and report chronic diseases more often, along with psychological problems (Devaux *et al.*, 2008) and physical limitations (Datta Gupta & Kristensen, 2008). At the workplace, women experience more health concerns and use medical services more often than men do (Steenbeek, 2012). Lastly, women are

significantly more likely to be hospitalized for depression than men are (Savoie *et al.*, 2004).

Individuals' financial situation may also influence their health. For example, regular income and higher education have positive effects on health (Datta Gupta & Kristensen, 2008). Regarding mental health, low income and low education are among the factors that increase the likelihood of depression (Savoie *et al.*, 2004). Further, people with a precarious economic status are more inclined to think that holding a job plays a determining role in health (Robert et Booske, 2011).

The type of household is another variable that can explain health status. For example, the health status of members of single-parent families is generally poorer than that of members of other types of families (Devaux *et al.*, 2008). In addition, people who are separated or divorced are more likely to be hospitalized for depression than are people who are widowed, married or living in a couple or single (Savoie *et al.*, 2004).

Organizational variables

Differing job responsibilities also affect health status. For example, a high degree of decision latitude is linked to fewer health concerns in males (Steenbeek, 2012). Individuals who hold top management positions are in better health than those who hold blue-collar positions, who more commonly report deteriorating health (Datta Gupta & Kristensen, 2008). In contrast, other studies show that employees who do physically demanding work report less of a decrease in performance linked to health than do people who hold intellectual jobs, although they use more sick days (van den Heuvel *et al.*, 2010). That said, depending on the type of position held and the possibilities of adapting daily tasks, employees may manage their workplace health problems differently. Consideration of activities and latitude for individuals seems to promote physical and mental health (Sarnin *et al.*, 2011). Work characteristics influence the tendency to consult general practitioners, particularly for males (Steenbeek, 2012). Further, industry has only a minimal effect on workers' health (Datta Gupta & Kristensen, 2008).

Lastly, there is a negative relationship between the number of hours worked and individuals' health (Datta Gupta & Kristensen, 2008). For example, full-time workers consult doctors more often than part-time workers do (Steenbeek, 2012).

6.1.4 Hypotheses considered: relationships between telecommuting, health and feelings of being stressed and pressed for time

In terms of physical health, the research generally shows that telecommuting has positive effects associated with travel and schedule flexibility. We therefore test the hypothesis that telecommuters report better states of health than traditional workers do.

In terms of feelings of stress and of being pressed for time, the research emphasizes many negative effects. Although we believe that some associated risks may be attenuated by telecommuter management (e.g. contact, supervision, equipment), we test the hypothesis that telecommuting is associated with increased feelings of stress and of being pressed for time.

6.2 Data and method

We explore three perception variables that affect people's daily lives: Perceived health (self-reported), stress level reported by workers, and the extent that they feel pressed

for time (often called the Time Crunch). From the survey, we identified the following dependent variables that can be influenced by the organization of work:

- *"In general, would you describe your health as: (SRH_Q110)" The ordinal variable includes 5 categories of answers (recoded into 4 categories from Poor or Fair to Excellent).*
- *"Thinking about the amount of stress in your life, would you say that most days are? (MSS_Q110)." The ordinal variable includes 4 categories of answers (from Not at all stressful to Extremely stressful).*
- *"How often do you feel rushed? (GTU_Q110)" The ordinal variable comprises five categories of responses (from Every day to Never).*

These ordinal categorical variables will be analyzed using a series of ordinal logistic regressions. The analyses relate these more general variables of perception to the survey question on work at home. For these estimates, we use the sample of all workers and the self-reported variable of work at home drawn from the Statistics Canada survey. It seems unreasonable to associate these more general variables of perception with the activities of a single survey day. We opt to use this general question in the analyses because the activities reported in the survey day do not necessarily reflect the typical conditions and organization of an individual's daily life. Also note that unlike travel activities, self-employed workers' perceived health can be positively or negatively affected by telecommuting. We therefore consider self-employed workers in the analyses and add a binary variable to capture the individual effect of this variable on their perceived health, after occasional at work home is considered.

In addition, the variables related to health seem to present potential problems of endogeneity with the explanatory variables. A worker with health complaints may be motivated to telecommuting to avoid having to travel, the associated fatigue, etc. Similarly, workers may decide to telecommuting because they are stressed. Given these possibilities, we express the results in terms of association rather than causality.[22]

Nonetheless, endogeneity may be excluded at least partly, because the decision to telecommuting rests ultimately not on the employee but on the employer that allows this organization of work. To summarize, deciding to telecommuting for health reasons seems fairly exceptional and conditional on the possibility of telecommuting.

6.3 Estimates and analysis

From the outset, it is important to describe the dependent variables in this analysis. The three dependent variables retained are described in Table 6.1 according to the telecommuter's status, for Québec in the left-hand columns and for all of Canada in the right-hand columns. Note that for Québec, none of the questions (health, stress, feeling pressed for time) presents significant differences depending on whether the individual works at home or not. For Canada, only the question on being pressed for time does not present significant differences between workers who say they sometimes work at home and those who never telecommuting.

Quebecers are more likely to report being healthy, but also feel a higher stress level. For Canada, where the values are significant, respondents who claim to work at home

[22] As mentioned above, we could not identify an instrumental variable for telecommuting.

generally report being in slightly better health. They also are more likely to report often feeling stressed.

Nonetheless, these findings must be revised in light of multivariate models given that several socioeconomic characteristics may have a greater effect than telecommuting on health, stress and the feeling of being rushed.

The ordinal logistic models below present information in the form of odds ratios. To observe the marginal effect of the variables of each model, tables A5, A6 and A7 in the appendix present the estimates of changes in the probability of reaching the highest levels for two of the variables studied (*Excellent health and Every day)* and the second to highest level *(Fairly stressful days)* for the stress variable, which makes up only about 3% of the observations in the highest category according to the sample used. We therefore preferred to estimate a category more frequently reported. For each of these models, the probability of attaining the highest value of the dependent variable (perceived health) is low and even non-significant.

Note that the ordinal logistic models include a series of constants representing the upper thresholds of each level of the dependent variable modelled. These auxiliary parameters are derived from the latent variable used to formulate the model, when the parameters of the dependent variables were estimated at the y-intercept (x = 0 for all the variables).

Table 6.1 Distribution of categories of answers to questions on health, stress and time stress

	Québec				**Canada**			
	Works at home	Never	Total	**Chi squared Test**	Works at home	Never	Total	**Chi squared Test**
Observations	323	1,149	1,472		2,188	7,824	10,012	
Health				0.06				0.00
Poor or fair	10.77	13.27	12.74		11.98	12.24	12.19	
Good	28.56	32.98	32.04		30.03	33.76	33.00	
Very good	38.55	33.56	34.62		38.69	36.35	36.83	
Excellent	22.12	20.19	20.60		19.30	17.65	17.98	
Stress				0.38				0.02
Not at all stressful	6.45	8.54	8.10		7.85	9.52	9.18	
Not very stressful	17.64	19.79	19.33		19.88	22.62	22.06	
A bit stressful	39.99	41.78	41.4		45.87	44.52	44.80	
Quite a bit stressful	30.87	27.19	27.97		22.6	20.73	21.11	
Extremely stressful	5.04	2.70	3.20		3.8	2.61	2.85	
Feeling rushed				0.35				0.12
Never	1.59	4.48	3.87		2.59	3.23	3.10	
Less than once a month	3.23	3.98	3.82		3.65	3.59	3.60	
About once a month	4.16	7.00	6.40		4.54	6.64	6.21	
About once a par week	12.02	13.73	13.37		12.80	15.06	14.60	
A few times a week	37.20	34.67	35.21		35.03	35.33	35.27	
Every day	41.79	36.13	37.34		41.40	36.15	37.22	

6.3.1 Effects of telecommuting on health

The first model examines the relationships between telecommuting and perceived health (Table 6.2) expressed in the form of odds ratios. Odds ratios higher than one suggest better perceived health. The health model does not indicate a relationship with telecommuting. In contrast, people with higher incomes have better perceived health. Age is negatively correlated with health, but this relationship is fairly constant across age groups. Note that in a model including only the work at home variable, telecommuting is positively correlated with health. This variable may capture the effect actually attributed to other variables, or there may be too many variables in the model, which prevent us from capturing the effect of work at home. In the last model on the right, the other provinces display nonsignificant relationships with the reference category of Québec. The health model gives a very poor result in terms of Pseudo R^2,

which suggests that perceived health varies very little according to the variables selected.

Table 6.2 Ordinal logistic regressions of perceived health

	Québec Odds ratios	Canada Odds ratios	Canada/Regions Odds ratios
Occasional work at home	1.19	1.07	1.06
Age (years)			
15-29 [ref.]			
30-44	0.69*	0.74***	0.74***
45-59	0.69*	0.72***	0.71***
60+	0.80	0.74**	0.74**
Personal income ($)			
0 - 19,999 [ref.]			
20,000 - 39,999	0.82	0.99	0.99
40,000 - 59,999	1.42	1.33**	1.34**
60,000 or more	1.86**	1.62***	1.63***
Female	1.01	1.07	1.07
Children at home	1.16	1.08	1.08
Full-time worker	1.00	0.93	0.94
Self-employed worker	0.85	1.094	1.095
Urban area (CMA - CA)	0.90	0.99	0.98
Region/province			
Atlantic			0.91
Québec [ref.]			
Ontario			0.91
Prairies			0.88
British Columbia			1.08
Constants			
Poor or fair	0.13***	0.14***	0.13***
Good	0.73	0.82*	0.77*
Very good	3.77***	4.70***	4.42***
Excellent [ref.]			
Number of observations	1,334	8,977	8,977
Chi squared	41	81	90.2
Significance	0.00	0.00	0.00
Pseudo R^2 (McFadden)	0.01	0.01	0.01
AIC	5,943.6	25,502.4	25,496.4

Notes: Odds ratios > 1 indicate a greater probability of reporting being healthy, and the opposite is true for ratios < 1. Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; AIC = Akaike information criterion

All the Chow tests show that there are no statistically significant differences ($p < 0.05$) between the coefficients of the Québec and Canadian models (tests by pairs and joint tests with or without Bonferroni correction for multiple comparisons).

6.3.2 Telecommuting and feeling of stress

In the model of perceived stress (Table 6.3), a positive odds ratio signifies a higher stress level, similar to a positive marginal effect. The occasional work at home variable is positively linked to stress in the Canadian models, and would therefore be associated with more stress. However, it is difficult to distinguish here if people under more stress ask their employer for permission to work at home to reduce their stress level, or if telecommuting itself causes stress. The literature review suggests that the first possibility is more plausible. Yet without longitudinal data on the perception of stress before and after development of a telecommuting program, it is difficult to distinguish the cause and effect relationship in this case.

As the literature review showed, other variables have a notable effect on stress. Regarding age, people ages 30 to 44 feel more stress, whereas the stress level decreased after age 60. Level of income (in its highest bracket), being female, working full-time, and living in Québec all have positive associations with stress, that is they increase the level of perceived stress. Increased stress is also observed in residents of urban areas, but only in the Canadian model without dummy variables for the provinces. The models of stress perform slightly better than those of health in terms of Pseudo R^2, but the values remain low. The Canadian model that includes variables for the regions of Canada seems to be superior in terms of the Akaike information criterion and the Pseudo R^2.

The test of equality of the coefficients of the Québec and Canadian models without Bonferroni adjustments for multiple tests does not point to significant differences between the coefficients of the telecommuting variables ($p = 0.291$); neither does the joint test of all the variables ($p = 0.162$). Following the Bonferroni correction for multiple comparisons, none of the coefficients display significant differences between the models.

Table A6 (in the appendix), which presents the marginal effects of the feeling of stress, shows that occasional telecommuting increases the feeling of stress by 3% compared with not reporting telecommuting. All of the significant variations never exceed 8% in absolute value.

Table 6.3 Ordinal logistic regressions of stress

	Québec Odds ratios	Canada Odds ratios	Canada/Regions Odds ratios
Occasional work at home	1.06	1.21**	1.19**
Age (years)			
15-29 [ref.]			
30-44	1.80***	1.47***	1.45***
45-59	1.02	1.11	1.10
60+	0.67	0.60***	0.60***
Personal income ($)			
0 - 19,999 [ref.]			
20,000 - 39,999	1.03	1.06	1.04
40,000 - 59,999	0.81	1.00	1.01
60,000 or more	1.78**	1.45***	1.48***
Female	1.48***	1.65***	1.66***
Children at home	1.10	1.11	1.12
Full-time worker	1.84***	1.68***	1.68***
Self-employed worker	1.17	1.01	1.03
Urban area (CMA - CA)	1.08	1.14*	1.10
Region/province			
Atlantic			0.60***
Québec [ref.]			
Ontario			0.73***
Prairies			0.65***
British Columbia			0.65***
Constants			
Not at all stressful	0.20***	0.24***	0.18***
Not very stressful	0.95	1.20*	0.87
A bit stressful	6.49***	9.31***	6.84***
Quite a bit stressful	98.51***	106.40***	79.10***
Extremely stressful [ref.]			
Number of observations	1 330	8 956	8 956
Chi squared	127.6	448.6	505.6
Significance	0.00	0.00	0.00
Pseudo R^2 (McFadden)	0.04	0.03	0.03
AIC	5 903	25 702.9	25 628.3

Notes: Odds ratios > 1 indicate a greater probability of reporting feeling stressed, and the opposite is true for ratios < 1. Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; AIC = Akaike information criterion

6.3.3 Telecommuting and feeling pressed for time

The third dependent variable analyzed in this section on health effects is the reported feeling of time stress. As in the other analyses of health, this ordinal variable is modelled using an ordinal logistic regression (Table 6.4). All the workers surveyed are included (including self-employed workers), and we link the general feeling of being pressed for time with reporting occasional work at home. Odds ratios higher than 1 are linked to a greater probability of feeling stressed.

The perception variable of feeling pressed for time exhibits similar relationships to that of stress. Telecommuters report feeling pressed for time more often in the two Canadian models but not in the Québec subsample. Once again, sample size is probably the cause. A similar effect on stress can be noted regarding age. People feel less time stress at the start of their career, and feel more rushed between ages 30 to 44. The perception of time stress decreases after age 60. Being female and having children at home increase the feeling of being pressed for time, as does being a full-time or self-employed worker. These relationships are observed in all the models.

As for the previous models, the models of time stress perform slightly better than those of health and stress in terms of Pseudo R^2, but the values are considered low. The Canadian model that includes variables for the regions also seems to yield the best result in terms of the Akaike criterion and the Pseudo R^2. Lastly, causality is also difficult to establish. Does the feeling of being pressed for time lead people to consider working at home? Or does working at home increase the feeling of being pressed for time? As for the other models, given that the decision to telecommuting is partly made by the employer, at least for salaried employees, it seems reasonable to employ telecommuting as an independent variable in the model of feeling of being rushed.

As in the previous models, the test of difference of the coefficients of the Québec and Canadian models without adjustments for multiple tests does not present significant differences between the coefficients of the telecommuting variables ($p= 0.713$); neither does the joint test of all the variables ($p = 0.265$). Following the Bonferroni correction for multiple comparisons, none of the coefficients display significant differences between the models.

Table A7 (in the appendix) that presents the marginal effects of the feeling of being pressed for time illustrates how occasional telecommuting increases the feeling of being rushed by 3.7% compared with not reporting telecommuting. Significant variations between the dependent variable and the independent variables may reach 19% in absolute terms.

Table 6.4 Ordinal logistic regressions, feeling pressed for time

	Québec	Canada	Canada/Regions
	Odds ratios	**Odds ratios**	**Odds ratios**
Occasional work at home	1.12	1.17*	1.18*
Age (years)			
15-29 [ref.]			
30-44	1.99***	1.52***	1.52***
45-59	1.22	1.15	1.15
60+	0.44**	0.49***	0.49**
Personal income ($)			
0 - 19,999 [ref.]			
20,000 - 39,999	0.77	0.94	0.94
40,000 - 59,999	0.91	1.01	1.01
60,000 or more	1.29	1.31**	1.31**
Female	1.45**	1.68***	1.68***
Children at home	1.68***	1.55***	1.55***
Full-time worker	1.427*	1.71***	1.71***
Self-employed worker	1.51*	1.21*	1.21*
Urban area (CMA - CA)	1.11	1.08	1.04
Region/province			
Atlantic			0.90
Québec [ref.]			
Ontario			1.10
Prairies			0.87
British Columbia			0.93
Constants			
Never	0.08***	0.07***	0.07***
Less than once a month	0.17***	0.17***	0.16***
About once a month	0.35***	0.38***	0.36***
About once a par week	0.88	1.04	0.99
A few times a week	4.60***	5.23***	5.03***
Every day [ref.]			
Number of observations	1 330	8,965	8,965
Chi squared	153.80	643.3	666.3
Significance	0.00	0.00	0.00
Pseudo R^2 (McFadden)	0.05	0.04	0.04
AIC	6,195.4	26,839	26,822.8

Notes: Odds ratios > 1 indicate a greater probability of reporting feeling pressed for time, and the opposite is true for ratios < 1. Significance: * p < 0.05; ** p < 0.01; *** p < 0.001; AIC = Akaike information criterion

7. Impacts of telecommuting on hours worked

The present chapter examines the impacts of telecommuting on hours worked. First we examine how telecommuting influences workers' production and productivity.[23] We then analyze how telecommuting can change the allocation of work and leisure time in a theoretical model of time allocation, and show how telecommuting can increase the number of hours worked. Next, we present empirical studies on the subject. To determine the control variables to consider in our estimates, we specify other socioeconomic and market factors that can explain the variations in hours worked. Lastly, we estimate, for Québec and Canada, different models linking the number of hours to reported workplaces, corresponding to four possible work arrangements: work at the regular workplace only, work at home only, combination of work at the workplace and at home, work outside the home and the workplace and/or at home. We demonstrate that for a given day of telecommuting, working only at home is associated with fewer hours worked than a workday at the regular workplace. In contrast, a combination of telecommuting and work at the workplace is correlated with an increase in hours worked. We explain this result by the additional work that can get done if the individuals avoid traffic congestion, and by additional hours worked in the evening or at other times of day. This result has implications for the form of telecommuting that employers should favour, and for arrangements to deploy with employees.

7.1 Telecommuting, time allocation, productivity and production

Westfall (2004) contends that telecommuting has four possible effects on organizational productivity. First, it influences the quantity of work by allowing workers to save time by eliminating commuting. The time thus saved would be fully or partially dedicated to increasing the number of hours worked.[24] Second, telecommuting acts on the intensity of work by decreasing interruptions. Third, the use of ICT in telecommuting can modify the effectiveness of work. Lastly, telecommuting may enhance productivity if it prompts the employer to reorganize the workplace (e.g. office space, software).

Collectively, these four effects produce the total impact of telecommuting on productivity. Several possibilities emerge given that these effects may be cumulative, positive or negative.

For example, employees may increase their production per hour and use this productivity gain to reduce the number of hours worked. A study of the effects of telecommuting on production should ideally consider that marginal and mean production decreases beyond a certain number of hours worked. On this topic, a recent study by Pencavel (2015) shows that marginal productivity is constant for up to 49 hours of work per week, and then becomes decreasing for subsequent hours of work.[25] It is therefore possible that employees increase their production by working more hours, but with lower productivity per hour. Further, workers may associate a rise in productivity with a simple increase in production linked to a larger number of hours

[23] Although they are not the main subject of this chapter, the potential effects on productivity are also discussed given their connection to the subject. However, no statistical estimates were done for these effects due to the limits of the data available.

[24] The average commuting time to work in 2011 was estimated at 29.7 minutes for the Montréal CMA, and 23.9% of commutes lasted 45 minutes or more. For the Québec City CMA, the average time was estimated at 22 minutes, and 9.6% of commutes lasted 45 minutes or more (hhttps://www12.statcan.gc.ca/nhs-enm/2011/as-sa/99-012-x/2011003/tbl/tbl02-eng.cfm).

[25] Pencavel's works have sparked debate on the need to decrease hours worked to increase productivity (http://www.economist.com/blogs/freeexchange/2014/12/working-hours).

worked (Baruch & Nicholson, 1997; Bailey & Kurland, 2002). In addition, the study of the global effects of telecommuting on productivity would be complicated because the time freed by not commuting to and from the workplace may be used for several purposes: more personal travel, hours worked, etc. Lastly, as mentioned above, the limits between leisure activities and other types of activities are often vague given their multiple attributes, temporal and spatial fragmentation, and simultaneity (Chen & Mokhtarian, 2006).

The many possibilities and the lack of detailed data on telecommuters' behaviours limit the feasibility of certain econometric estimates in this chapter. Thus, we estimate the effects of telecommuting on hours worked, but we cannot estimate the total effect of telecommuting on productivity.

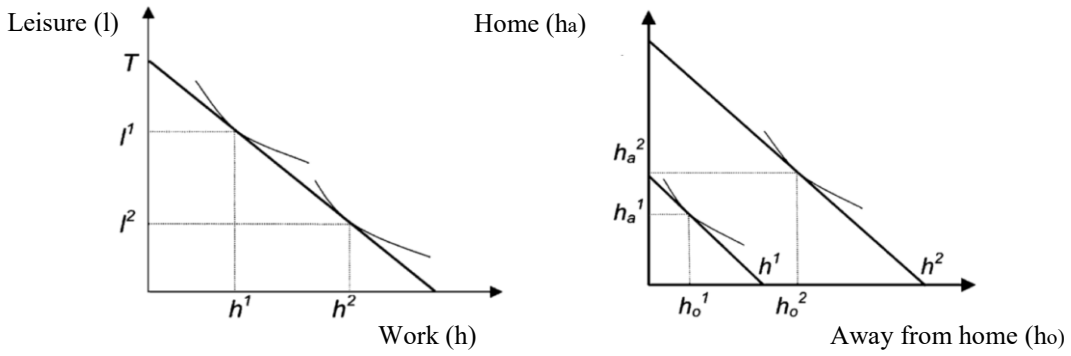
First we can theoretically establish the effect of telecommuting on hours worked. To do so, we assume that, as Chen and Mokhtarian (2006) demonstrate, the choice of leisure and associated travel is modified by individuals' preferences and constraints, and by the attributes of activities. The use of ICT in telecommuting can thus affect households' time allocation as well as work: hours worked, schedules, etc.

To illustrate different time use options, we draw on the study by De Graaff and Rietveld (2007), who modelled the supply of individual work as the sum of the hours worked at home and outside the home. For a given week work, the time available for work is given by *T,* and corresponds to the total time available less time allotted to rest and personal care. Therefore, $T = h + l$ where h and l are expressed in hours, and represent time dedicated to work and leisure respectively. Total hours worked, h, may be separated into hours worked at home h_a and outside the home h_o: $h = h_a + h_o$.

By assuming that time saved by eliminating work-related travel will be used fully or partially for work or leisure (sleep and personal care time increase less than the total time saved), T increases. There will therefore indeed be a potential increase in hours worked in the case of telecommuting. This possibility is illustrated in Figure 7.1 by a parallel upward movement of the time constraint T, which allows a shift to a higher indifference curve, with increases in time dedicated to leisure and work.

In addition, there may be an effect on the distribution of hours worked at home and away from home. For example, suppose that an individual initially works h^1 hours and spends l hours on leisure. Hours worked h^1 can then be divided into hours worked at home h_a^1 and outside the home h_o^1. If we posit that those who work outside the home have a lesser preference for leisure than do "traditional" workers, it is possible to show that an increase in the supply of work for these individuals, for example from h^1 to h^2, will increase the ratio of hours worked outside the home to hours worked at home ($h_o^1 / h_a^1 < h_o^2 / h_a^2$).

Figure 7.1 Links, leisure-work at home and away from home



Source: De Graaff & Rietveld, 2007

In addition to being informative about the effects of telecommuting on time allocation (work-leisure; telecommuting), this simple model illustrates that telecommuting can increase hours worked. In the next subsection we present the empirical studies that explore this possibility.

7.2 Telecommuting and productivity: empirical studies

As mentioned above, organizations that introduced telecommuting programs have been described in dozens of cases. More or less formal information from organizations and workers has thus become available regarding the success of these programs.

Much of this information comes from surveys. For example, a Bank of Montréal (BMO) survey found that in 2013, 65% of businesses that offer employees the possibility of working outside the office reported a positive impact on productivity, and 58% mentioned an improvement in the quality of work accomplished (BMO, 2013). A survey done in 2012 of 13,968 American full-time workers (Gallup, 2015), showed that 39% of employees who telecommuting said they work more hours per week than traditional workers do (46 *vs* 42 hours). Other information comes from specific case studies. For example, Pearce (2009) analyzed reports by businesses that experienced productivity gains following the implementation of a telecommuting program. He thus found that *IBM Canada* and *Compaq Computer Corp.* improved productivity by 15% to 50% for employees working in a telecommuting environment (*vs* at the office).

Nonetheless, although these data are interesting, Westfall (1998) and Bailey and Kurland (2002) emphasize that they must be considered prudently because they are based strictly on reports by employees and/or employers. As Bailey and Kurland (2002) mention, until the early 2000s very few empirical results had been obtained in objective scientific studies that clearly establish the existence of productivity gains from work.[26] Therefore, given these limits of specific organizational case studies, below we present studies published since 2000 in the form of scientific papers and research reports.[27] [28]

[26] For a review of the studies published before 2002, see Bailey and Kurland (2002) and Westfall (1998).
[27] Nonetheless, several cases compiled are mentioned in the scientific papers and research reports cited.
[28] We do not discuss the literature on telecommuting management. On this subject see Davis (2011) and Pinsonneault and Boisvert (2001).

De Graaff and Rietveld (2007) use the data from a Dutch time use survey done in 1995 to analyze the links between work supply at home and out-of-home, and modem possession.[29] They demonstrate that during normal work hours (e.g. 9 a.m. to 5 p.m.), Internet access increases both types of work supply, and that work at home and out-of-home are thus complementary. Outside these hours, the two types of work are mainly substitutes: a decrease in work time at the workplace is partly compensated by an increase in work at home. However, because the work supply during "normal" hours far outweighs that during other hours, the predominant effect is complementary. Internet access therefore increases hours worked in general. In a later study, De Graaff and Rietveld (2007) estimated a microeconomic model of time allocation. They thus associate access to ICT with having Internet access, and use data from time use surveys conducted in 1995 and 2000.[30] They confirm that the substitution effects between work at home and out-of-home are weak, and affirm that age and education are the main factors guiding the choice to work at home rather than outside the home. The results also show that working at home implies accepting a salary 3% lower (*vs* that paid for traditional work).

Rhee (2009) presents a model of spatial equilibrium where telecommuting lets households relocate and/or substitute some activities given the new time arrangements involved. He shows that: i) the impacts on travel are linked to relocations and substitutions engendered by telecommuting; ii) most of the commuting time saved by telecommuting is allotted to more work and has no impact on time spent on leisure; and iii) distances travelled by vehicle can increase for individuals who place high value on work carried out at the regular workplace.

Haddad *et al*. (2009) use survey data from 2007 for the United Kingdom to analyze the factors that explain the desire to work exclusively at home or partly at home and at the regular workplace, and at what frequency. Four main factors explain the desire to telecommuting: i) fewer interruptions at work; ii) elimination of time lost due to congestion; iii) appreciation of telecommuting by household members; and iv) higher number of work hours. The frequency of telecommuting is explained by support from the employer.

Bloom *et al*. (2015) present the results of a natural experiment on the effects of telecommuting done from December 2010 to August 2011 in the Chinese company Ctrip, a travel agency with 16,000 employees. The experiment was conducted in two departments with a total of 994 employees, to whom telecommuting was offered. 503 employees accepted the offer, 249 of whom were considered eligible for telecommuting based on pre-established criteria (e.g. employed for at least six months). These 249 workers were then divided into two groups according to their birthdays: 134 in telecommuting and 115 working at the office (control group). By keeping all the factors other than employee location constant, the authors measured the differences in productivity between the two groups. Telecommuters' performance in terms of production (measured with different variables) was 13% higher than that of traditional

[29] Modem possession is used to estimate access to ICT, which were much less widespread in 1995 than today. In the Netherlands, 14% of households owned a modem and 4% had Internet access. However, the data used do not allow us to determine the types of work done out-of-home (e.g. at the office, or coffee shops). Therefore, some people who work away from home should probably be considered telecommutingers. In fact, the data used in the estimates of the present report let us differentiate more precisely between workplaces: home, office, coffee shops, etc.

[30] Individual behaviour tends to vary; the sample is therefore not a control group. In addition, in 1995 ICT were much less widespread than today: 4% of Dutch household had Internet access at that time. Again, because the data do not allow us to establish the types of work out-of-home, workers outside the home were probably telecommutingers.

workers. Of this 13% increase, 9% was due to an increase in time worked and 4% to higher efficiency (production per hour). This success prompted the company to extend its telecommuting offer to all 249 employees selected, which translated into production gains of 22%. According to the authors, this increase is due to the self-selection process that lets employees choose the workplace that suited them best, and that thus boosted their productivity.[31] Lastly, the authors show that the possibility of doing telecommuting increases employee satisfaction with their work and favours staff loyalty.

Increases in employee satisfaction and in the employee retention rate are recognized effects of telecommuting. A report by the US Federal Government (Report to Congress, 2013) found that telecommuting contributes to employee empowerment and enhances job satisfaction. Telecommuting thus plays a prominent role in attracting and retaining employees. Employee retention is also the main reason to put in place work flexibility measures such as variable schedules or work at home (National Study of Employers, 2005, http://familiesandwork.org/site/research/reports/2005nse.pdf). In terms of recruitment, many US government agencies include telecommuting in their strategy (Report to Congress, 2013). Telecommuting can thus contribute to forming a more productive workforce than that without adoption of a telecommuting program, in addition to reducing the potentially high costs of employee turnover.[32]

Nonetheless, McCloskey and Igbaria (2003) affirm an inverted U relationship between the number of hours of telecommuting and workers' job satisfaction. This decline in satisfaction after a certain point would be due to decreased personal contact with colleagues. The fact that the positive effects of telecommuting can fade beyond a certain number of hours of work done outside the office has also been noted regarding commitment to the employer (e.g. sense of belonging) and to links to the business, which are lower for employees who telecommuting more than 50% of the time (Gallup, 2015). This result appears important given the positive correlation between individual commitment to work and the number of hours worked (Wallace, 1997). One possible explanation for the "decreasing marginal returns" of hours of work lies in the need to maintain ties with colleagues and the workplace. Indeed, social interactions with colleagues are an important determinant of the ability of telecommuting to enhance productivity (Neufeld & Fang, 2005).

The studies presented above show the potential effects of telecommuting on time allocation, but do not let us establish all of the potential explanatory variables of hours worked. Therefore, in the next subsection we review other explanatory factors linked to the labour market and to socioeconomic characteristics, some of which have been discussed above. As much as possible, according to the data used in the present report, these factors will be considered in the control variables included in our estimates.

7.3 Hours worked: Other determining factors

Salary is the main explanatory variable of work supply and demand. Because we lack data directly pertaining to salary, we use instead income reported by the respondents. Given that the income may originate from other sources than salaries (e.g. investment income, pensions), its inclusion as an explanatory variable has the advantage of

[31] The factors explaining employees' adoption of telecommuting are discussed in chapter 4. On this subject, also see Yen (2000).

[32] We estimate these costs at between 90% and 200% of the annual salary of the employee to replace (*Society for Human Resource Management*, 2010; http://www.shrm.org/research/benchmarks/documents/assessing%20employee%20turnover_final.pdf).

mitigating a potential endogeneity problem. In addition, individual income is only weakly endogenous to hours worked for a specific survey day. Lastly, we test the use of level of education rather than income in the other estimates. Although education is correlated with income, we cannot reasonably affirm that level of education is a function of hours worked because it precedes the hours worked on the survey day.

That said, we now briefly review the market factors other than salary and socioeconomic variables that, according to the data used, can be considered in our estimates.[33]

7.3.1 Supply factors

Isgut *et al*. (2006) assert that four main theories can explain variations in hours worked based on work supply.

First, some researchers (Alesina & La Ferrara., 2005; Fortin, 2003) argue that the disparities observed in hours worked are due to institutional labour market factors like those linked to unionization or regulation, which limit increases in hours worked (*e.g.* OHS, vacations). In addition, these factors have multiplying effects on all leisure time given that workers who choose to have more leisure hours may inspire other individuals to imitate them (*e.g.* friends, family). This effect is reinforced by the fact that workers' marginal productivity declines with the number of workers "on vacation," given that a rise in the number of these workers would decrease interactions, collaborations, etc. needed for production. In contrast, several studies show a positive relationship between union density and average hours worked per person (Bowles & Park, 2005; Faggio & Nickell, 2007; Causa, 2010). Because we have a variable on respondent unionization, we will therefore include it in our estimates.

However, we lack data that would let us directly consider the other institutional aspects of the labour market. We therefore factor in these aspects using binary provincial variables. Table 7.1 shows interprovincial variations linked to different aspects of the labour market that justify the use of binary variables. These variables also let us consider three other theories that explain variations in hours worked, for which we lack data:

1. Bell and Freeman (2001) link hours worked to salary level but also to wage disparity. More unequal wage distributions putatively lead workers to work more hours in order to achieve three potential gains: i) promotions; ii) salary raises and; iii) progress up the pay scale. Faggio and Nickell (2007) confirm the results related to wage inequality. This hypothesis was nonetheless criticized because it is not applied homogeneously according to workers' socioeconomic characteristics, and it suggests that wage disparities have positive effects on economic growth (Osberg, 2001; Heisz-LaRochelle-Côté, 2003).
2. Hours worked vary with household taxation. Therefore, *ceteris paribus*, higher marginal tax rates and government transfers may lead households to spend more hours on leisure to the detriment of hours worked. Prescott (2004) argues that this

[33] Although they may have important impacts in terms of number of jobs, hours worked etc., (Hamermesh, 1976), policies affecting the labour market are not considered in our analysis owing to the nature of the data used. Further, Avdagic and Salardi (2013) contend that the impacts of such policies are complex to estimate because they depend on regions, sectors, market characteristics and other public policies.

was the main explanation for differences in hours worked between the United States and Europe since the 1990s. Nonetheless, the influence of taxation on hours worked varies according to the measures put in place. For example, based on the Scandinavian model (high taxes and number of hours worked), Rogerson (2006) shows that the negative effect of taxation on hours worked is attenuated if government transfers to workers are disbursed according to the number of hours worked rather than as a lump sum.

3. The variations in work hours observed may also be due to cultural features, particularly preferences for work and leisure. For example, European workers mainly use long-term income growth to augment their leisure time and work less, whereas Americans tend to channel income growth into higher consumption (Osberg, 2001; Isgut *et al*., 2006; Blanchard (2004); Turner (2003); Huberman & Minns, 2007).

7.3.2 Demand factors

Cyclical factors affecting particular sectors or the economy as a whole may influence work demand and explain variations in hours worked (Bernal & Cardenas, 2004). Ross and Zimmerman (1993) affirm that the main determinant of variations in work demand is anticipation of market conditions. Burda and Hunt (2011) believe that this anticipation largely explains the effects of the recession on unemployment and hours worked. Cyclical factors may also affect sectors, job types, etc. in different ways. For instance, the decline in unskilled work in France between 1970 and 1993 is mainly due to an increase in income that led households to consume a larger share of goods and services that require a skilled workforce (Goux & Maurin, 1997). Given the constraints on our data, cyclical and sectoral factors will be reflected by variables associated with the respondents' job sectors and by binary provincial variables.

The inclusion of binary variables also lets us consider the fact that work demand in terms of hours worked may also be explained by:

1. Technological factors and increased investments in R&D, which stimulate work demand (Lindley & Machin, 2014; Ross & Zimmerman, 1993).
2. Labour costs, including wages but also employee benefits paid by the employer (Ross & Zimmerman, 1993). For example, in the United States, between 1979 and 1992 the work week of an employee covered by health insurance, paid fully and partially by the employer, increased on average by about 0.7 hours per week compared with the work week of an uninsured employee (Cutler & Madrian, 1998). This type of effect may be due to the employer's attempts to compensate for insurance costs by increasing the number of hours worked. Further, Cutler and Madrian (1998) show that higher employee benefit expenses related to overtime hourly rates increases overtime hours. Employee benefit expenses may also influence the allocation of work between full time and part-time employees. Montgomery and Cosgrove (1993) find that the share of hours worked by part-time employees decreases as the amount of employee benefits increases.

Table 7.1 Interprovincial differences, selected labour market determinants, 2010

	Québec	Ontario	BC	Atlantic	Prairies	Effects expected
Weight of taxation (% of GDP)[34]	37%	33.3%	30.6%	30.2%	26.4%	-
Weight of personal income taxes ($/habitant)[35]	$2,349 $	$3,468	$3,162	$2,508	$4,029	-
Weight of employee benefits						-
Unionization rate (% of employees)[36]	36.1%	26.5%	30.4%	30.4%	26.4%	+ or -
R&D expenses ($/inhabitant)[37]	$1,012	$1,039	$673	$487	$692	-
Income inequality (Gini coefficient after taxes)[38]	0.29	0.31	0.31	0.29	0.32	+ or -

7.3.3 Socioeconomic factors

Several studies show the important role of socioeconomic factors in the determination of hours worked. In terms of education, as Cutler and Madrian (1998) point out, university graduates work more hours than people with lower levels of education. This finding may be explained by the fact that stricter imposed work schedules have fewer negative impacts on hours worked for more educated workers with higher salaries (Wallace, 1997). Therefore, our estimates include variables related to respondents' income levels and education.

Further, stricter regulation of work hours has a greater negative impact on hours worked for females than for males (Wallace, 1997). This may be due to the fact that more flexible work schedules are particularly appealing to women with children. Having preschool-age children is negatively correlated with the number of hours of women's work (Wallace 1997). We therefore include binary variables concerning sex and having children at home.

Lastly, age may also play a role by hindering worker productivity for reasons such as adaptation to technologies, and concentration (Tang & MacLeod, 2006; Bhattacharya & Smyth, 2001). However, some studies find it difficult to clearly establish the relationship between age and productivity given the advantages and disadvantages linked to workers' age (van den Heuvel *et al.*, 2010). For example, older workers may have more experience, but be in poorer health. There is thus an important negative link between employees' health and their productivity *(*van den Heuvel *et al*., 2010). Given

[34] Chair in taxation and public finance (2016). *Bilan de la fiscalité au Québec, édition 2016*. Université de Sherbrooke. http://www.ledevoir.com/documents/pdf/bilan_fiscalite_2016.pdf.
[35] Institut de la statistique du Québec (2016). *Tableau statistique canadien, provinces et territoires, 2005-2015, Tableau 13.5*. http://www.stat.gouv.qc.ca/statistiques/economie/comparaisons-economiques/interprovinciales/chap13.pdf.
[36] Statistics Canada (2010). *Union membership and coverage by selected characteristics, Table 1*. Publication 75-001-X, Unionization 2010. https://www150.statcan.gc.ca/n1/pub/75-001-x/2010110/tables-tableaux/11358/tbl001-eng.htm.
[37] Statistics Canada (2010). Provincial statistics and their relationship to gross domestic expenditures on research and development, *Table 2*. Publication 88-221-X, Gross Domestic Expenditures on Research and Development in Canada (GERD), and the Provinces. https://www150.statcan.gc.ca/n1/pub/88-221-x/2012001/t063-eng.htm
[38] Statistics Canada (2015), Publication 75-202-X. http://www.statcan.gc.ca/access_acces/alternative_alternatif.action?l=fra&loc=t/709.ivt

the evidence above, hours worked would be explained notably by variables related to age and reported health status.

7.4 Hypothesis considered: potential effects of telecommuting on hours worked

The studies mentioned in this chapter clearly demonstrate that under certain conditions (e.g. number of hours of telecommuting), telecommuting can increase hours worked. The main hypothesis tested in this chapter therefore considers this possibility.

7.5 Data and method

The work time variable is operationalized by adding up the hours worked during the reference day. We use the variable "*Work for pay: main job"* (ACTCODE = 110) to design these measures. Although other categories of work exist (e.g. second job, coffee break, meals, waits), marginal numbers of episodes are recorded, which do not correspond well to our main interest. We therefore concentrate on the main job, which concerns the vast majority of the observations of work episodes. We analyze the work variables of the survey day according to the categorization of workers.

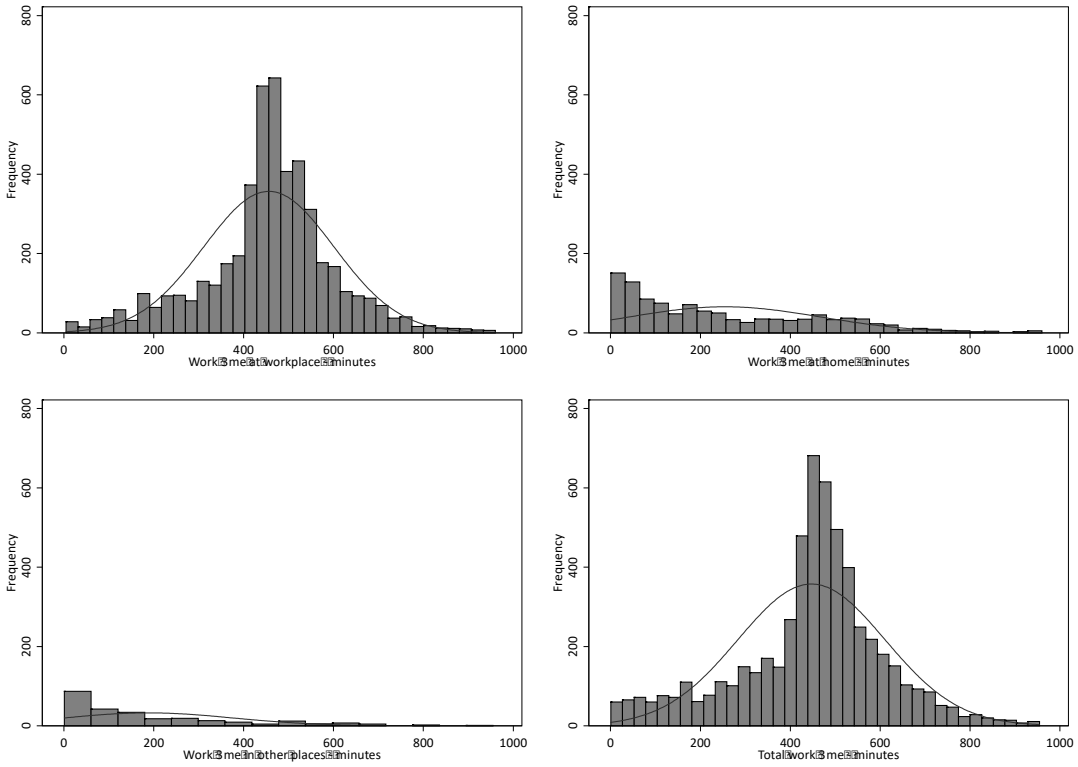
As discussed, several explanatory factors associated with the labour market could not be considered because none of our variables permitted this analysis. In addition, we cannot rule out the possibility that the decision about the form of work was made simultaneously with the number of hours of work in the survey day. For these reasons, we discuss the results in terms of correlations only.

7.6 Estimates and analysis

The sample corresponds to all the workers who reported work hours in the time use diary, and for whom data on all variables used are available.

Figure 7.2 shows that the total work time variable (histogram at the bottom right) is distributed approximately according to a normal curve with a mean of 447 minutes (7 hours, 27 minutes) and a standard deviation of 164 minutes of work. This total time may be broken down into a sum of work time reported for the various possible places. Therefore, in addition to work time at the regular workplace (top left), there is work at home (top right) and at other places (bottom left). Note in this figure that the majority of hours worked is at the regular workplace, and, as for the percentages of types of workers, the numbers of hours worked at home or in other places are generally much lower and do not follow a Gaussian distribution. However, the graphs presented show non-negligible contributions of telecommuting to total hours worked, used in the estimation of our models.

Figure 7.2 Distribution of the work time variable (minutes) for the survey day



For estimation purposes, we restricted the sample to 16 hours of work (960 minutes), which corresponds to a "double" work shift. Few observations (n = 32) exceed this number of hours. To characterize our results, reference categories were established for explanatory variables with more than two categories. Our results thus pertain to an employee who works at the regular workplace, was aged 15 to 29, and who was in the lowest income bracket of under $20,000. The reference categories for the other variables concerning information about the employee are: no children (*vs* have children), not living in a medium-sized or large city (*vs* CA and CMA), not being self-employed (*vs* being self-employed), working part-time (*vs* full-time) and not being unionized (*vs* unionized).

Given the nature and distribution of the hours worked variable, the analysis will be based on a linear regression estimated by the ordinary least squares method.[39] We are interested in the influence of individual, household and employment factors on the number of hours worked.

The dependent variables of the regression (Table 7.2) explain 26% of the variance in the observations ($R^2 = 0.26$) and demonstrate that beyond age and income, several other variables may explain the variations in hours worked. This value is nonetheless highly acceptable in the context of observation of individuals' behaviours.

The three models estimated present similar effects for all of the variables. The Québec model presents a few differences compared with the "Canadian" model, notably concerning the negative effect of working only at home (lesser effect on hours worked). In addition, greater negative effects on hours worked are associated with workers over

[39] A Shapiro-Wilk test confirmed the normality of the residuals. In addition, a Breush-Pagan test detected heteroskedasticity of the residuals. We therefore did the estimates with the *robust* command in Stata software to correct this problem.

age 60 and females. In contrast, the Québec model presents several variables with non-significant coefficients. Given the sample sizes and the nature of the survey, the Québec estimates should be considered prudently. In general, Québec respondents do not seem to differ significantly from those in the rest of Canada. Accordingly, the Canadian model without the provincial variables is that which seems to perform the best. We will base our subsequent analysis mainly on this model.

By taking employees who worked only at the regular workplace as the reference category, we note that work only at home is associated with a decrease of about 2 hours and 15 minutes in hours worked. Similarly, respondents who combine work at home and/or at the regular workplace with work at other workplaces are associated with a reduction in worktime of about 43 minutes.

In contrast, employees who work at home and at the workplace report nearly 49 minutes more work. Similarly, hours worked increase with income, and full-time workers work more hours than do part-time workers (by almost 2 hours).[40]

Lastly, being aged 60 or over, being female, having young children at home and having completed the activity diary during a weekend day tends to reduce hours worked. A similar pattern is seen for total travel time during the day: each additional minute of travel reduces minutes worked by about 45 seconds.

All the Chow tests indicate that there are no statistically significant differences ($p < 0.05$) between the coefficients of the Québec and Canadian models (tests by pairs and joint tests with or without a Bonferroni correction for multiple comparisons).

[40] We estimated the models by replacing the income variable with a variable on level of education, but this variable did not present a significant coefficient.

Table 7.2 Linear regression of time worked on the survey day (minutes)

	Québec		Canada		Canada / Regions	
	Coef.	Standard deviation	Coef.	Standard deviation	Coef.	Standard deviation
Categories of telecommuters						
Only at the workplace	[ref.]					
Only at home	-118.43***	(23.82)	-135.68***	(11.30)	135.86***	(11.30)
At the workplace and at home	40.19	(29.89)	48.39***	(10.67)	48.52***	(10.70)
Other places and workplace and/or home	44.38	(54.06)	-43.04*	(17.34)	-43.01*	(17.39)
Age						
15-29 [ref.]						
30-44	-2.23	(20.83)	-0.93	(8.59)	-1.11	(8.61)
45-59	-15.55	(17.44)	-11.04	(7.75)	-11.20	(7.78)
60+	-77.73**	(25.42)	-49.33***	(10.52)	-49.26***	(10.53)
Personal income ($)						
0 - 19,999 [ref.]						
20.000 - 39,999	18.49	(18.38)	17.31*	(8.73)	17.04	(8.73)
40.000 - 59,999	18.76	(19.81)	30.85***	(8.91)	30.74***	(8.93)
60,000 and over	22.26	(19.16)	38.81***	(9.01)	38.75***	(9.02)
Total travel time (minutes)	-0.54***	(0.08)	-0.46***	(0.04)	-0.46***	(0.04)
Female	-28.21*	(11.02)	-24.33***	(5.07)	-24.33***	(5.08)
Children at home	0.92	(15.59)	-16.27**	(6.30)	-16.12*	(6.31)
Weekend	-79.07***	(23.86)	-79.78***	(10.55)	-79.55***	(10.54)
Information on the employee						
Self-employed worker	17.59	(18.24)	7.05	(8.40)	6.93	(8.42)
Full-time worker	108.03***	(18.83)	113.49***	(8.38)	113.81***	(8.39)
Unionized employee	-24.54*	(11.37)	-14.11*	(5.70)	-14.23*	(5.77)
Urban area (CMA - CA)	-6.36	(15.13)	-11.03	(6.43)	-12.33	(6.63)
Region/province						
Atlantic Region					-8.94	(8.06)
Québec [ref.]						
Ontario					-0.60	(7.03)
Prairies Region					-4.83	(7.48)
British Columbia					0.57	(8.57)
Constant	440.74***	(29.48)	427.48***	(11.83)	430.26***	(13.41)
Observations	764		5,009		5,009	
F	11.7		54,9		44,6	
Prob > F	0.000		0.000		0.000	
R^2	0.26		0.264		0.264	
AIC	9,590.5		63,525.1		63,531.2	

Notes: Coef. = Coefficient; Significance: * p < 0.05; ** p < 0.01; *** p < 0.001; AIC = Akaike information criterion

To illustrate the potential effects of telecommuting on hours worked, Table 7.3 presents estimates of the marginal means of hours worked by category of telecommuters, in Québec and in the rest of Canada. The values are estimated with all the other variables kept at their respective mean. In both Québec and in the rest of Canada, people who worked only at home for the survey day worked on average 330 minutes (5 hours, 30 minutes), whereas those who combine work at home and at the workplace work on average 515 minutes (slightly more than 8 hours, 30 minutes), which is more than the time worked by workers who spent the day at their regular workplace, namely 466 minutes (7 hours, 46 minutes). To summarize, these results confirm those found in the literature (presented at the beginning of the chapter), which demonstrate that telecommuting may increase work hours if it is supplemented by hours worked at the regular workplace.

Table 7.3 Estimation of marginal means of time worked by category of telecommuters, Québec and rest of Canada (minutes)

	Québec		Rest of Canada	
	Mean (minutes)	Standard deviation	Mean (minutes)	Standard deviation
Categories of telecommuters				
Only at the workplace [ref.]	466.1	2.7	466.3	2.8
Only at home	330.4	10.7	330.6	10.6
At the workplace and at home	514.5	10.4	514.7	10.3
Other places and the workplace and/or home	423.0	17.1	423.3	17.0

8. Conclusion

This report analyzed the relationships between different forms of telecommuting and travel behaviours, measures of perceived health, and hours worked in Québec and Canada.

First we presented the technological context that fuelled the growth of telecommuting, along with the main effects on transportation, health and productivity found in the literature. We then estimated the size of the population of workers concerned in Québec and Canada. These estimates were compared with international experiences concerning the scope of telecommuting and the implementation of measures intended to develop and regulate it. Following this introduction we described telecommuting activity in Québec and Canada based on GSS data. Our estimates show that the number of telecommuters in Québec is close to the national average, but that when we control for several socioeconomic variables, the probability of observing telecommuting in Québec is greater than in the rest of Canada. In addition, compared with employees who work only at the regular workplace, telecommuters are on average more affluent and educated, more urban, live closer to or farther from the workplace and are less unionized.

Following the statistical characterization of telecommuting activities, we produced econometric estimates of the potential effects of telecommuting on: i) total travel time; ii) travel schedules; iii) reported health and stress levels; and iv) hours worked. The models estimated specifically took Québec into account, but demonstrate that there are generally no significant differences between respondents in Québec and in the rest of Canada. The direction and scope of the results obtained are the same for the Canadian provinces and regions. The smaller sample sizes used in the analyses specific to Québec may have caused effects to be less apparent owing to weaker statistical power

Our results show that, compared with work at the regular workplace (*e.g.* office) only, and depending on the forms it takes, telecommuting is associated with different potential effects on total travel time during the workday. For example, employees who work only at home travel on average 19 minutes less, whereas those who divide work between the home and the regular workplace have equivalent travel times to non-telecommuters. Employees working at several sites, including third places, travel for about 17 minutes longer per day on average. Further, telecommuting is generally linked to a reduction in rush hour travel.

Further, we found only a weak correlation between telecommuting and increased feelings of stress and being pressed for time, but no relationship with reported health. Lastly, depending on its form, telecommuting is associated with a higher or lower number of hours worked Compared with employees who work at the regular workplace only, only employees who worked both at home and at the regular workplace worked 49 minutes more on average. All other forms of telecommuting and their combinations (*e.g*. home only, other places) are associated with decreases in work time by about 43 minutes to 2 hours and 15 minutes for the survey day.

To summarize, our analysis suggests that the different forms of telecommuting cause distinct effects. For example, working only at home reduces hours worked, but has the advantage of decreasing overall travel time and rush hour travel. Conversely, the combination of work at home and at the regular workplace in the same day is positively correlated with work time, but is not related to total time allotted to travel, despite a lower mean probability of rush hour travel.

The results highlight the potential contribution of telecommuting to reducing social costs associated with transportation. Telecommuting can also augment private income

and government revenue. The benefits demonstrated can justify government implementation of measures to favour telecommuting. For example, in the public sector, efforts can be made to identify jobs conducive to telecommuting, ensure the availability of appropriate information technologies, and bolster employees' technical skills. Such measures can thus contribute to achieving objectives such as better work-life balance, reduced travel, and increased hours worked. To facilitate the implementation of telecommuting-related actions in the private sector, public policies could take the form of financial aid, or technical or managerial assistance. However, given the many potential effects caused by different forms of telecommuting, it is crucial to establish clear objectives regarding the results expected in specific areas, be it in terms of reducing travel or increasing hours worked. The American model is interesting in this respect because public organizations that deploy telecommuting measures are required by law (i.e. the *Telecommuting Enhancement Act*) to survey their employees to identify the effects of these measures on reducing travel. This type of measure can thus facilitate the determination of forms of telecommuting to favour, along with the necessary regulation of each form. Other incentive measures related to the dissemination of information have also been discussed, including the adoption of certification systems for organizations, production of a guide for telecommuters, and implementation of an awareness campaign. Telecommuting is also favoured by physical adjustments, particularly at the main workplaces of organizations (e.g. telepresence equipment) and in telecommuters' work space (e.g. IT equipment and network access). Lastly, financial compensation, for example tax benefits and reimbursement of expenses related to telecommuting, are other measures that can be put in place to encourage telecommuting within organizations.

Appendix – Accompanying tables

Table A1 Logistic model of work at home, all workers surveyed (Odds ratio)

	Québec Odds ratios	Canada Odds ratios	Canada / Regions Odds ratios
Age			
15-29 [ref.]			
30-44	1.22	1.61**	1.56**
45-59	0.86	1.37	1.33
60+	0.77	1.26	1.26
Personal income ($)			
0 - 19,999 [ref.]			
20,000 - 39,999	1.69	1.64**	1.60**
40,000 - 59,999	2.08	2.00***	2.07***
60,000 and more	4.55***	3.46***	3.64***
Distance from work (km)			
Less than 1	2.44	5.50***	5.74***
1 to 9.99 [ref.]			
10 to 49.99	0.86	0.98	0.98
50 to 99.99	1.33	1.37	1.44*
More than 100	3.37*	2.25***	2.31***
Female	0.66	0.92	0.93
Children at home	1.01	0.99	1.00
Information on the employee			
Self-employed worker	3.17**	4.89***	4.95***
Occupation with telecommuting potential	2.80***	2.56***	2.52***
Full-time worker	1.25	0.99	1.00
Permanent employee	0.58	0.89	0.90
Unionized employee	0.34***	0.48***	0.46***
Urban area (CMA - CA)	1.32	1.14	1.15
Region/province			
Atlantic			0.68**
Québec [ref.]			
Ontario			0.58***
Prairies			0.60***
British Columbia			0.75
Constant	0.06***	0.03***	0.04***
Observations	1,086	7,419	7,419
Wald $chi^2(20)$	138.1	678.6	672.9
Prob > chi^2	0.00	0.00	0.00
Pseudo R^2 (McFadden)	0.22	0.20	0.21
AIC	1,428.1	5,753.5	5,721.2

Note : Significance: * p < 0.05; ** p < 0.01; *** p < 0.001

Table A2 Tobit model of total travel time on the survey day (coefficients)

	Québec Coef.	Canada Coef.	Canada / Region Coef.
Categories of telecommuters			
Only at the workplace [ref.]			
Only at home	-21.48	-18.82**	-19.16**
At the workplace and at home	10.377	3.628	3.68
Other places and the workplace and/or home	-5.12	17.58*	17.13*
Personal income ($)			
0 - 19,999 [ref.]			
20,000 - 39,999	5.65	-0.67	-0.71
40,000 - 59,999	10.748	4.83	4.87
60,000 and more	19.58*	6.71	6.83
Age (years)			
15-29 [ref.]			
30-44	-4.18	-3.07	-3.21
45-59	-9.53	-0.33	-0.45
60+	-16.79	-5.17	-5.26
Other information			
Children at home	5.072	7.667**	7.781**
Urban area (CMA - CA)	4.95	12.733***	11.754***
Travel by public transport	23.956**	29.846***	29.487***
Distance from work (km)			
Less than 1	7.536	-4.944	-4.562
1 to 9.99 [ref.]			
10 to 49.99	27.39***	24.05***	23.93***
50 to 99.99	44.86***	56.92***	56.76***
More than 100	81.52	90.98***	91.25***
Region/province			
Atlantic			-6.71*
Québec [ref.]			
Ontario			-0.26
Prairies			-3.85
British Columbia			2.29
Constant	49.31***	48.29***	48.24***
Observations = 0	9	55	55
Observations ≥ 1	532	3,534	3,534
Number of observations	541	3,589	3,589
Significance	0.00	0.00	0.00
Pseudo R^2 (McFadden)	0.02	0.02	0.02
AIC	9,807.1	41,516.7	41,515.5

Notes: Coef. = Coefficient; Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$;
AIC = Akaike information criterion

Table A3 Multinomial logit of rush hour travel, Canada (coefficients)

Reference Day (9 a.m. - 3:59 p.m.)	Morning rush hour (7 a.m. – 8:59 a.m.)	Afternoon rush hour (4 p.m. – 5:59 p.m.)	Evening (6 p.m. – 10:59 p.m.)	Night-morning (11 p.m.– 6:59 a.m.)
	Coef.	**Coef.**	**Coef.**	**Coef.**
Categories of telecommuters				
Only at the workplace [ref.]				
Only at home	-0.48**	-0.58***	-0.62***	-0.88***
At the workplace and at home	-0.46***	-0.58***	-0.25*	-0.65***
Other places and the workplace and/or home	-0.82***	-0.67***	-0.44**	-0.84***
Full-time work	0.58***	0.53***	0.53***	0.69***
Personal income ($)				
0 - 19,999 [ref.]				
20,000 - 39,999	0.09	-0.09	-0.05	0.07
40,000 - 59,999	0.27*	0.17	0.14	0.23
60,000 and over	0.28*	0.29*	0.31*	0.39**
Age (years)				
15-29 [ref.]				
30-44	0.17	0.02	-0.20	-0.22
45-59	0.05	-0.16	-0.44***	-0.37**
60+	-0.151	-0.23	-0.83***	-0.72***
Other information				
Female	0.28***	0.21**	0.03	-0.27***
Children at home	0.07	-0.05	-0.23**	-0.14
Weekend	-0.57***	-0.69***	-0.59***	-0.31**
Type of travel				
Work [ref.]				
Household work	-2.97***	-0.14	0.97**	-0.43
Driving children or adults	0.20	0.32*	0.81***	-1.13***
Purchases and services	-1.83***	-0.06	0.63***	-1.90***
Restaurant dining	-1.45***	-0.65***	0.74***	-1.26***
Courses/studies	0.10	-0.35	0.43	-1.37*
Other	-1.16***	-0.08	1.55***	-0.11
Visits to friends/family	-1.93***	0.64***	2.02***	0.11
Urban area (CMA - CA)	0.03	-0.04	-0.06	0.00
Québec [ref.]				
Ontario	-0.07	-0.20*	0.11	0.07
Rest of Canada	-0.08	-0.125	0.003	0.01
Constant	-0.79***	-0.40**	-0.82***	-0.64***
Trips; individuals	17,410; 4,613			
Log-likelihood (base)	-29,859.9			
Log-likelihood (model)	-27,647.8			
Chi squared	1,705.2			
P value	0.00			
Pseudo R^2 (McFadden)	0.07			
Pseudo R^2 (Nagelkerke)	0.23			
AIC	55,487.5			

Notes: Coef. = Coefficient; Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; AIC = Akaike information criterion

Table A4 Multinomial logit of rush hour travel, Québec

Reference Day (9 a.m. - 3:59 p.m.)	Morning rush hour (7 a.m. – 8:59 a.m.)	Afternoon rush hour (4 p.m. – 5:59 p.m.)	Evening (6 p.m. – 10:59 p.m.)	Night-morning (11 p.m.– 6:59 a.m.)
	Coef.	**Coef.**	**Coef.**	**Coef.**
Categories of telecommuters				
Only at the workplace [ref.]				
Only at home	-0.33	-0.53	-0.45	-0.50
At the workplace and at home	-1.10***	-1.14***	-0.41	-0.77*
Other places and the workplace and/or home	-0.33	-0.62*	0.08	-0.41
Work full time	1.08***	0.78**	0.88**	0.84**
Personal income ($)				
0 - 19,999 [ref.]				
20,000 - 39,999	-0.12	-0.02	-0.30	-0.18
40,000 - 59,999	-0.15	-0.03	-0.08	0.18
60,000 and over	-0.02	-0.01	0.01	-0.14
Age (years)				
15-29 [ref.]				
30-44	0.11	0.17	-0.45	-0.31
45-59	-0.29	-0.09	-0.79***	-0.27
60+	-0.32	-0.03	-1.09*	-1.01*
Female	0.37*	0.37*	0.09	-0.22
Children at home	0.14	0.10	-0.26	0.05
Weekend	-0.68*	-1.21***	-0.84*	-0.39
Type of travel				
Work [ref.]				
Household work	-15.47***	-0.60	-0.87	0.32
Driving children or adults	0.15	0.31	0.43	-1.43**
Purchases and services	-1.81***	-0.10	0.62*	-1.84***
Restaurant dining	-1.92**	-0.18	0.93*	-1.68**
Courses/studies	0.12	1.03**	0.70	-0.96
Other	-1.05*	0.44	2.03***	0.66
Visits to friends/family	-3.14**	0.92*	2.09***	0.56
Urban area (CMA - CA)	-0.24	-0.40*	-0.60**	-0.37
Constant	-0.64	-0.43	-0.24	-0.38
Trips-individuals	2,309; 702			
Log-likelihood (base)	-6,417.31			
Log-likelihood (model)	-5,876.71			
Chi squared	2,258.2			
P value	0.00			
Pseudo R^2 (McFadden)	0.08			
Pseudo R^2 (Nagelkerke)	0.38			
AIC	11,929.4			

Notes: Coef. = Coefficient; Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; AIC = Akaike information criterion.

Table A5 Ordinal logistic regressions of perceived health (marginal effects at the mean for the Excellent health category)

	Québec		Canada		Canada / Regions	
	Marginal effects	**Standard deviation**	**Marginal effects**	**Standard deviation**	**Marginal effects**	**Standard deviation**
Occasional work at home	0.027	(0.02)	0.009	(0.01)	0.008	(0.01)
Age						
15-29 [ref.]						
30-44	-0.057*	(0.03)	-0.043***	(0.01)	-0.044***	(0.01)
45-59	-0.058*	**(0.03)**	-0.048***	(0.01)	-0.050***	(0.01)
60+	-0.034	(0.03)	-0.043**	(0.01)	-0.043**	(0.01)
Personal income ($)						
0 - 19,999 [ref.]						
20,000 - 39,999	-0.030	(0.03)	-0.002	(0.01)	-0.002	(0.01)
40,000 - 59,999	0.054	(0.03)	0.041**	(0.01)	0.042**	(0.01)
60,000 and over	0.095**	(0.03)	0.069***	(0.01)	0.070***	(0.01)
Female	0.002	(0.02)	0.010	(0.01)	0.010	(0.01)
Children at home	0.022	(0.02)	0.011	(0.01)	0.011	(0.01)
Full-time worker	-0.000	(0.03)	-0.010	(0.01)	-0.009	(0.01)
Self-employed worker	-0.025	(0.03)	0.013	(0.01)	0.013	(0.01)
Urban area (CMA - CA)	-0.017	(0.02)	-0.002	(0.01)	-0.003	(0.01)
Region/province						
Atlantic Region					-0.014	(0.01)
Québec [ref.]						
Ontario					-0.014	(0.01)
Prairies Region					-0.018	(0.01)
British Columbia					0.011	(0.01)
Number of observations	1,334		8,977		8,977	
Chi squared	41		81		90.2	
Significance	0.000		0.000		0.000	
Pseudo R^2 (McFadden)	0.013		0.005		0.006	
AIC	5,943.6		25,502.4		25,496/4	

Notes: Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; AIC = Akaike information criterion

Table A6 Ordinal logistic regressions, stress (marginal effects at the mean for the *Fairly stressful days* category)

	Québec		Canada		Canada / Regions	
	Marginal effects	**Standard deviation**	**Marginal effects**	**Standard deviation**	**Marginal effects**	**Standard deviation**
Occasional work at home	0.010	(0.03)	0.029**	(0.01)	0.027**	(0.01)
Age						
15-29 [ref.]						
30-44	0.107***	(0.03)	0.058***	(0.01)	0.057***	(0.01)
45-59	0.004	(0.03)	0.016	(0.01)	0.014	(0.01)
60+	-0.074	(0.04)	-0.078***	(0.01)	-0.078***	(0.01)
Personal income ($)						
0 - 19,999 [ref.]						
20,000 - 39,999	0.005	(0.03)	0.008	(0.01)	0.005	(0.01)
40,000 - 59,999	-0.038	(0.04)	0.000	(0.01)	0.001	(0.01)
60,000 and over	0.105**	(0.04)	0.056***	(0.01)	0.060***	(0.01)
Female	0.072***	(0.02)	0.076***	(0.01)	0.077***	(0.01)
Children at home	0.017	(0.02)	0.016	(0.01)	0.017	(0.01)
Full-time worker	0.112***	(0.03)	0.079***	(0.01)	0.079***	(0.01)
Self-employed worker	0.029	(0.04)	0.001	(0.01)	0.004	(0.01)
Urban area (CMA - CA)	0.014	(0.03)	0.019*	(0.01)	0.014	(0.01)
Region/province						
Atlantic Region					-0.078***	(0.01)
Québec [ref.]						
Ontario					-0.047***	(0.01)
Prairies Region					-0.066***	(0.01)
British Columbia					-0.064***	(0.01)
Number of observations	1,330		8,956		8,956	
Chi squared	127.6		448.6		505.6	
Significance	0.000		0.000		0.000	
Pseudo R^2 (McFadden)	0.039		0.027		0.03	
AIC	5,903		25,702.9		25,628.3	

Notes: Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; AIC = Akaike information criterion

Table A7 Ordinal logistic regressions, feeling pressed for time (marginal effects at the mean for the Everyday category)

	Québec		Canada		Canada / Regions	
	Marginal effects	**Standard deviation**	**Marginal effects**	**Standard deviation**	**Marginal effects**	**Standard deviation**
Works at home sometimes	0.026	(0.03)	0.037*	(0.02)	0.037*	(0.02)
Age						
15-29 [ref.]						
30-44	0.158***	(0.05)	0.097***	(0.02)	0.096***	(0.02)
45-59	0.046	(0.04)	0.032	(0.02)	0.032	(0.02)
60+	-0.189**	(0.06)	-0.165***	(0.02)	-0.166***	(0.02)
Personal income						
$0 - 19,999 [ref.]						
$20,000 - 39,999	-0.059	(0.04)	-0.015	(0.02)	-0.016	(0.02)
$40,000 - 59,999	-0.021	(0.05)	0.002	(0.02)	0.002	(0.02)
$60,000 and over	0.059	(0.05)	0.063**	(0.02)	0.062**	(0.02)
Female	0.086**	(0.03)	0.119***	(0.01)	0.119***	(0.01)
Children at home	0.119***	(0.04)	0.101***	(0.01)	0.101***	(0.01)
Full-time worker	0.082*	(0.04)	0.124***	(0.02)	0.124***	(0.02)
Self-employed worker	0.094*	(0.04)	0.043*	(0.02)	0.045*	(0.02)
Urban area (CMA - CA)	0.023	(0.04)	0.017	(0.01)	0.008	(0.02)
Region/province						
Atlantic Region					-0.024	(0.02)
Québec [ref.]						
Ontario					0.022	(0.02)
Prairies Region					-0.033	(0.02)
British Columbia					-0.017	(0.02)
Number of observations	1,330		8,965		8,965	
Chi squared	153.8		643.3		666.3	
Significance	0.000		0.000		0.000	
Pseudo R^2 (McFadden)	0.045		0.037		0.038	
AIC	6,195,4		26,839		26,822.8	

Notes: Significance: * p < 0.05; ** p < 0.01; *** p < 0.001; AIC = Akaike information criterion

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