Telework and Commuting Patterns. An Empirical Study of Workers in Flanders, Belgium

Jente Versigghel (*)
Ghent University, Department of Geography, Ghent, Belgium
jente.versigghel@ugent.be

Jonas De Vos
University College London, Bartlett School of Planning, London, UK
jonas.devos@ucl.ac.uk

Frank Witlox
Ghent University, Department of Geography, Ghent, Belgium
University of Tartu, Department of Geography, Tartu, Estonia
frank.witlox@ugent.be

(*) corresponding author

Abstract

This study examines the relationship between teleworking frequency and commuting patterns in East Flanders, Belgium. We analysed data from an online survey conducted between October 2023 and January 2024, targeting workers in this region. We used Welch ANOVA and a chi-square test of independence to compare commute distance, duration, mode and number of commute trips between non-teleworkers, infrequent and frequent teleworkers. Additionally, we perform a Poisson regression to analyse the impact of commute characteristics, as well as sociodemographic, household, occupational, and residential variables, on telework frequency. Our findings reveal that teleworkers make fewer weekly commute trips but have longer commutes compared to non-teleworkers, with no significant difference in commute mode choice. The regression analysis indicates that higher teleworking frequency is associated with being older, working more days per week, and having longer commute durations.

Keywords

Teleworking, Commute, Travel behaviour, Rebound effect, East Flanders (Belgium)

1. Introduction

With the widespread enforcement of teleworking – defined here as performing paid work from home during work hours – during the COVID-19 lockdown periods, many workers experienced this alternative work arrangement for the first time (van Wee & Witlox, 2021). After the relaxation of travel restrictions, a portion of these workers continued to integrate teleworking into their schedules.

The sharp rise in teleworking adoption emerged as a response to the pandemic, but the potential of home-based teleworking as a strategy for reducing motorised travel, greenhouse gas emissions and traffic congestion has been discussed in the literature for a longer time (Chakrabarti, 2018; Choo et al., 2005; Lachapelle et al., 2018; Ory & Mokhtarian, 2006; van Lier et al., 2012). Teleworking has the potential to reduce travel, and several earlier studies found evidence of home-based teleworking replacing and thus reducing travel (Choo et al., 2005; Ory & Mokhtarian, 2006; Helminen & Ristimäki, 2007). However, recent studies often reveal nuanced results, indicating various rebound effects, including increased non-work travel or residential relocation, which counterbalance the substitution effect of teleworking (Macias et al., 2022; Wöhner, 2022). Home-based teleworkers make, on average, fewer commute trips (Budnitz et al., 2020; Wöhner, 2022), but this substitution effect might be compensated for by teleworkers experiencing longer commute times and distances (de Vos et al., 2018; Motte-Baumvol & Schwanen, 2024; Zhu, 2013). The relationship between teleworking and modal choice is less straightforward. On the one hand, some studies found that (full-day) teleworkers are more likely to use active travel modes (Elldér, 2020; Lachapelle et al., 2018). On the other hand, Elldér (2022) found that teleworkers are less likely to bike to work, and Silva and Melo (2018) state that teleworkers also make more trips by car.

We explore the relationship between teleworking prevalence and commuting characteristics. We use Welch ANOVA to assess whether statistically significant differences exist between the commute distance, commute duration, and weekly number of commute trips among different groups of teleworkers (non-teleworkers, infrequent teleworkers, and frequent teleworkers). We also investigate whether there is a significant association between the teleworker group and the commute mode choice using a chi-square test of independence. Lastly, we examine the impact of commute, sociodemographic, household, occupational, and residential characteristics on teleworking frequency.

The remainder of this paper is structured as follows: In Section 2, we discuss the definition of the term ‘teleworking’ and how it was defined in our research. This is followed by a review of the relevant, recent literature on teleworking and commuting patterns. Subsequently, we provide an overview of the telework situation in East Flanders, Belgium. Section 3 outlines our data collection strategy, and the methods and variables used in the analysis. We also present the teleworking landscape in our study area using descriptive statistics. The results regarding the associations and differences between the commuting patterns of different groups of teleworkers, and the results of the regression analysis of telework frequency, are discussed in Section 4. Finally, the last section offers a summary of the main findings, along with a discussion of the study’s limitations and suggestions for further research.

2. Background

2.1 Defining teleworking

Teleworking, also known as telecommuting or working from home, is a familiar term, but there is no uniform definition of the concept in the literature. Teleworking encompasses a diverse range of situations and conditions regarding location (at home, at a telecommuting centre, nomadic workers), type of employment (self-employed or employees, full-time or part-time), schedule (full-day, part-day, overtime, outside workdays), and frequency (regular or sporadic) (Aguilera et al., 2016; Budnitz et al., 2020; Lachapelle et al., 2018).

We define teleworking as performing paid work from home during working hours. We specifically focus on home-based teleworking, excluding teleworking performed in satellite offices or on public transport, as we examine the travel behaviour of individuals (partly) working from home compared to office workers. Additionally, our definition is limited to formal arrangements, excluding after-hours teleworking, informal work, and voluntary work. Both full-day and part-day teleworking are included in the analysis.

2.2 Teleworking determinants

Many factors influence whether and how often an employee will telework. First, both individual and household characteristics can affect the likelihood of teleworking (He & Hu, 2015; Walls & Safirova, 2004; Zhang et al., 2020). Multiple studies have found that people who are highly educated and have higher incomes are more likely to telework (Budnitz et al., 2020; He & Hu, 2015; Noonan & Glass, 2012; Vilhelmson & Thulin, 2016). The role of age, gender, marital status, and the presence of children in the household is less straightforward (Zhang et al., 2020; Silva, 2022). Some studies state that older people are more inclined to telework than young people, while other studies found the opposite (Peters et al., 2004; Ravalet & Rérat, 2019; Silva, 2022; Zhang et al., 2020). Concerning gender and household dynamics, Walls & Safirova (2004) conclude that parents with children are more likely to telework (frequently). In contrast, Noonan and Glass (2012) state that parents have the same likelihood of teleworking as the rest of the population, and Zhang et al. (2020) found that people with children are less likely to telework. According to Zhang et al. (2020), the presence of children is an important factor in teleworking behaviour. In households without children, males and singles are more likely to telework, while in households with children, women and partnered parents are more likely to telework. Additionally, occupation characteristics play a role in teleworking frequency (Beck & Hensher, 2021; Noonan & Glass, 2012). The nature of the job and the requirement to be physically present in the workplace often determines teleworking behaviour (Thompson et al., 2022). The likelihood of teleworking can also be related the residential and job location of workers. Less favourable commute characteristics, such as long commute distances, are often associated with an increased probability of teleworking (Mokhtarian et al., 2004; Silva & Melo, 2018; Zhu & Mason, 2014). However, not all studies find similar conclusions, and the direction of the relationship between teleworking and residential/job location choice is still unclear (Caldarola & Sorrell, 2022; Silva, 2022).

2.3 Teleworking and travel

Teleworking has been proposed and discussed as a sustainable work arrangement due to its potential to reduce trips and vehicle distance traveled, and hence traffic congestion and greenhouse gas emissions (Choo et al., 2005; Ory & Mokhtarian, 2006; Walls & Safirova, 2004). Early studies on teleworking found evidence supporting it as a travel-reducing measure (Choo et al., 2005; Ory & Mokhtarian, 2006; Helminen & Ristimäki, 2007). However, recent studies have often found more complex relationships, concluding that various effects of teleworking offset each other, resulting in a neutral or even complementary impact on travel (Chakrabarti, 2018; Wöhner, 2022; Zhu & Mason, 2014).

Working from home influences travel behaviour of people in multiple ways. First, teleworkers typically record fewer commute trips than non-teleworkers (Budnitz et al., 2020; Elldér, 2020; Wöhner, 2022). The lower commute frequency of teleworkers indicates a negative effect of teleworking on commute travel. However, this substitution effect is often offset by an increase in trips made for non-work purposes (Budnitz et al., 2020; Wöhner, 2022). Wöhner (2022) found that individuals in Switzerland who telework part-time make fewer commute trips than non-teleworkers. Nevertheless, the increase in non-work travel by part-time teleworkers offsets their commute travel savings, resulting in a net-zero effect on travel. This finding, that teleworkers have higher weekly or daily total travel compared to non-teleworkers due to a combination of longer commutes and additional non-work travel, was also observed in multiple other studies (Caldarola & Sorrell, 2022; Zhu & Mason, 2014).

Second, teleworkers have, on average, a longer commute distance and commute duration compared to non-teleworkers (Caldarola & Sorrell, 2022; de Vos et al., 2018; Helminen & Ristimäki, 2007; Ravalet & Rérat, 2019; Zhu, 2013). Motte-Baumvol and Schwanen (2024) found that the travel time for both work and non-work trips in the UK is longer for teleworkers than for non-teleworkers. This effect is mainly explained by the socio-economic and demographic characteristics of teleworkers. This group is more likely to have higher income, commute by train, live in London, and hold professional or managerial positions.

Furthermore, the type of teleworking arrangement influences the relationship between teleworking and travel, leading to different travel effects for infrequent and frequent teleworkers, as well as for full-day and part-day teleworkers (Chakrabarti, 2018; Elldér, 2020; Hu & He, 2016; Stiles & Smart, 2021). In his research on the travel impacts of teleworking in Sweden, Elldér (2020) found that full-day teleworkers, people teleworking the entire survey day, make significantly fewer trips and have significantly shorter total travel distances compared to their non-teleworker counterparts. In contrast, respondents who teleworked part of the survey day (part-day teleworkers) make significantly more trips and travel further compared to non-teleworkers. Comparable results were found in the United States by Stiles and Smart (2021). In their research, full-day teleworking was associated with a decrease in daily travel duration, while part-day teleworkers showed no reduction in travel duration. Additionally, a study by Hu and He (2016) in Chicago, US found that infrequent teleworkers have on average longer one-way commute distances than both non-teleworkers and frequent teleworkers. Lastly, according to a study by Caldarola and Sorrell (2022), English teleworkers make fewer trips, but their total weekly travel (work and non-work) is higher compared to non-teleworkers. This difference is explained by teleworkers having longer commute

distances and making additional trips for non-work purposes. Additionally, the analysis revealed the presence of a tipping point. While infrequent teleworkers, those who telework one or two days per week, have higher weekly total travel than non-teleworkers, the total travel of frequent teleworkers, those who telework three or more times a week, is smaller than that of non-teleworkers. The total weekly travel distance of frequent teleworkers was found to be 7% lower than that of non-teleworkers.

The association between working from home and modal choice has been studied by multiple researchers, but their findings are mixed. Lachapelle et al. (2018) conclude in their research on the sustainability potential of telecommuting in Canada that teleworking is linked with an increased likelihood of using non-motorised transport modes. A similar pattern was observed by Chakrabarti (2018) in the United States, and Elldér (2020) when studying the situation in Sweden between 2011 and 2016. The latter study found that working from home promotes active travel. On teleworking days, full-day teleworkers are more likely to only use a bicycle or walk, and are less likely to use a car compared to non-teleworkers (Elldér, 2020). In a second study, Elldér (2022) concludes that teleworkers in Sweden generally walk more but are also less likely to cycle compared to non-teleworkers. First, teleworkers walk more when teleworking for a full day, as well as on non-teleworking days. Second, Swedish teleworkers walk more for service purposes, whether they are teleworking all day, part of the day, or not at all. Additionally, teleworkers are more likely to walk when commuting on part-day telework days. When considering cycling, opposite results were found. Non-teleworkers are more likely to commute by bicycle and to cycle on days when they are not working than teleworkers. Finally, Silva and Melo (2018) found that in single worker households in Great Brittain, an increase in teleworking frequency is related to an increase in all travel modes, with the relationship being strongest for car use, followed by active modes. In dual-earner households, teleworking frequency is positively related to car trips.

2.4 Teleworking in East Flanders, Belgium

East Flanders is one of the ten provinces in Belgium, located in the northwest of the country (Figure 1). It is a densely populated area with 520 inhabitants per square kilometer and has a population of more than 1.5 million inhabitants (Provincies in cijfers, 2024). With almost 30% of the employees usually teleworking in 2021, the province is one of the top European regions in terms of teleworking adoption (Eurostat, 2022).

Due to the COVID-19 crisis, the rate of people teleworking at least one day a week nearly doubled in Belgium between 2018 and 2022 (Federale Overheidsdienst Mobiliteit en Vervoer, 2022). In East Flanders, the number of employed people usually working from home[1] increased by over 20% between 2019 and 2021 (Eurostat, 2022). Given these significant changes in the teleworking landscape, we also anticipate changes in the commuting patterns of workers in East Flanders.

[1] "Usually working from home" was defined as doing at home any productive work related to the current main job for at least half of the days worked in a reference period of four weeks (Eurostat, 2022).

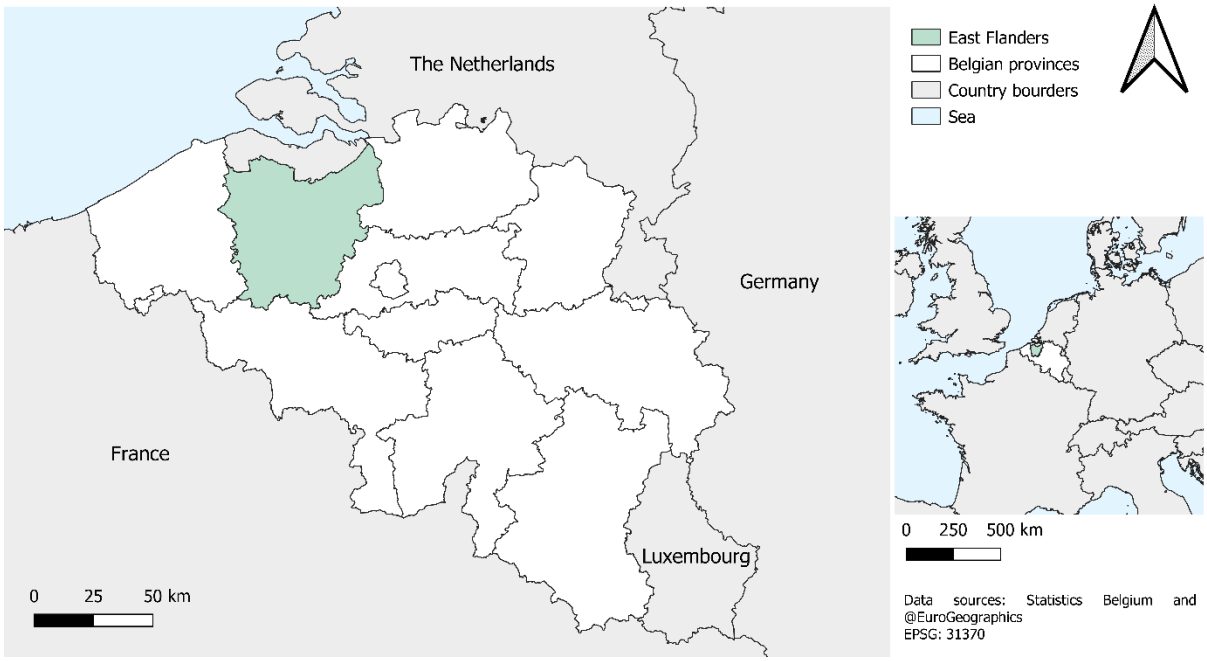

Figure 1. Study area

3. Data and method

3.1 Data sources

We collected data using an online survey on teleworking, travel and well-being, targeting workers in East Flanders. The questionnaire was designed in Qualtrics, and invitations to participate in the online survey were distributed to the personnel of Ghent University, the City of Ghent administration, employees of the Province of East Flanders, and several private companies located in the Province of East Flanders. We first reached out to these institutions and companies. If they were interested in sharing the survey, they could distribute the link to their employees.

The survey comprised five main parts. It started with questions on respondents' socio-demographics. The second part of the survey focused on working and teleworking habits. Respondents were asked about their job status, their current, pre-COVID and preferred teleworking frequency, and their teleworking circumstances. In the third part, respondents specified their travel options and commute characteristics. This section also assessed people's commute satisfaction using the Satisfaction with Travel Scale (Ettema et al., 2011). The fourth part of the survey evaluated the respondents' residential neighbourhood and their intentions to relocate or change jobs. The final part of the survey concentrated on telework perceptions and motivation, and on changes in daily time use due to teleworking. It also assessed the effect of teleworking on respondents' well-being through statements on its impact on their mood, work productivity, motivation and satisfaction, relationships with co-workers, employer and family members, as well as on stress and mental-health.

3.2 Characteristics of the sample

The data collection ran between 16 October 2023 and 15 January 2024, resulting in 1290 responses. After initial data cleaning, where we removed invalid or incomplete responses, 1029 responses remained in the dataset. The majority of the institutions and companies that shared the survey work in the domain of research or public governance. This explains some of the characteristics and overrepresentations in the data sample (Table 1). First, highly educated people are overrepresented in the sample. 92.6% of the respondents hold a bachelor's degree or higher, which is notably higher than the 37.1% of the population aged 25 to 64 in East Flanders who hold a higher education degree (Statbel, 2024). The respondents are also rather prosperous, the majority have a monthly household income over 4,500 euros. In terms of demographics, women are overrepresented in the sample. 64.3% of the respondents identified as women, compared to 50.5% in East Flanders. Furthermore, all respondents are between the ages of 22 and 65. The median age of the sample is 40 years, which is comparable to the median age of the population in East Flanders, which is 42 years. Regarding household composition, almost three in four respondents live together with their partner, 18.9% live as singles. Only a small percentage of the respondents indicated living with relatives (4.4%), friends (2.1%), or others (0.9%). Lastly, almost half of the respondents live in a household with children.

Table 1. Sample characteristics

Variable	Category	n	%
Gender	Female	662	64.3
	Male	359	34.9
	Other/prefer not to say	8	0.8
Age	18-24	48	4.7
	25-49	720	70.0
	50-64	260	25.3
Household type	Living with partner and children	435	42.3
	Living with partner, without children	324	31.5
	Single, living with children	51	5.0
	Single, without children	143	13.9
	Living with relatives	45	4.4
	Living with friend(s)	22	2.1
	Other	9	0.9
Children	Yes	511	49.7
	No	518	50.3
Education degree	Secondary education or less	76	7.4
	Bachelor	223	22.6
	Master	477	46.4
	PhD	243	23.6
	0 to 1500 euros	2	0.2

	2501 to 3500 euros	75	7.3
	2501 to 3500 euros	143	13.9
Income	3501 to 4500 euros	138	13.4
level	4501 to 5500 euros	257	25.0
	> 5500 euros	324	31.5
	Prefer not to say	90	8.7
Job status	Civil servant	535	52
	Wage earner	394	38.3
	Other	100	9.7

Next, we will focus on the working and teleworking habits of the respondents. Almost 80% of the respondents work full-time. The non-teleworkers, those who do not work from home on a regular workweek, make up 15.5% of the respondents. About a quarter (26.4%) of the respondents indicated teleworking once per week, and 34.0% telework twice per week. These form the infrequent teleworker group. A quarter of the respondents telework three times or more per week and make up de frequent teleworker group. Overall, full-day teleworking is more common than part-day teleworking. Friday, Wednesday, and Monday are the most popular days for teleworking. Tuesday and Thursday are the days when most people travel to the workplace (Figure 2).

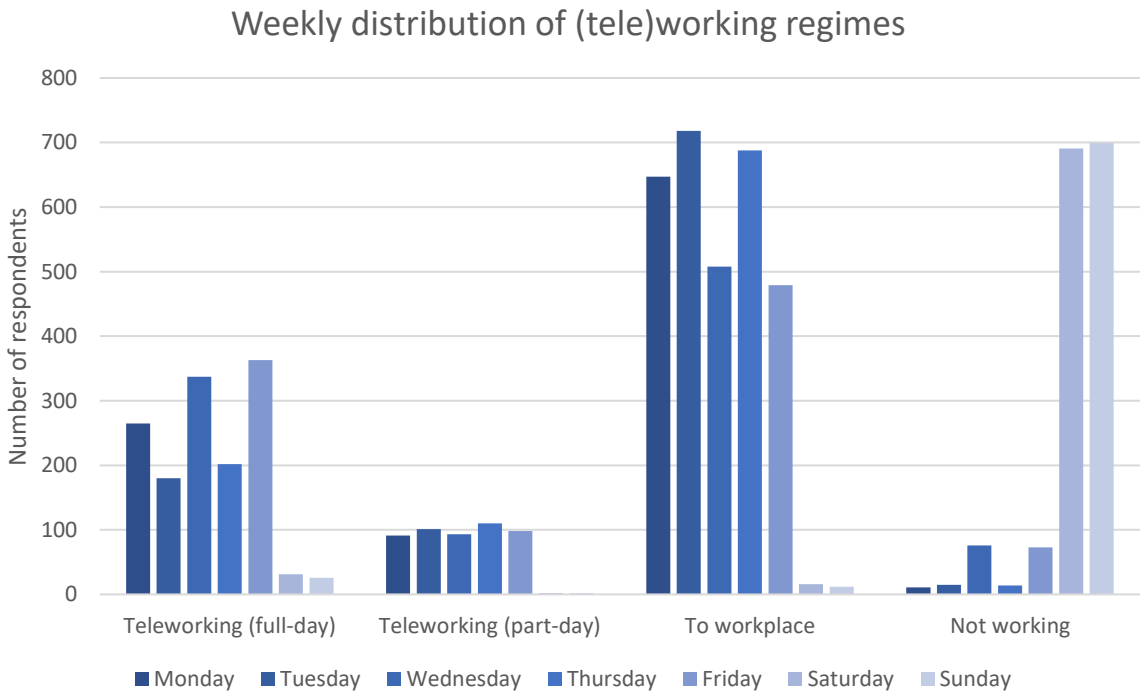

Figure 2. Teleworking distribution

3.3 Statistical approach and variables

The first set of research questions aims to explore the association between the prevalence of teleworking and the main: 1) one-way commute distance, 2) one-way commute duration, 3) weekly number of commute round-trips, and 4) commute mode. To answer these questions,

we defined three distinct groups of teleworkers: non-teleworkers, infrequent teleworkers and frequent teleworkers. The groups were defined in line with a study by Wang et al. (2023). Both full-day teleworking (working from home the entire day) and part-day teleworking (combining working from home and working at the workplace) were considered when counting the weekly teleworking frequency of the respondents.

We estimated three separate ANOVA models to assess whether there is a significant difference in the main: 1) commute distance, 2) commute duration and 3) number of commute trips among the different groups of teleworkers. We cleaned the dataset, removing missing values and outliers, and transformed the independent variables to meet the assumption of normality. There was a wide range in the sample sizes of the three teleworking groups (non-teleworker: 148; infrequent teleworker: 610; frequent teleworker: 249), leading to a violation of the homogeneity of variances assumption. Therefore, a Welch ANOVA was performed to determine if there are differences between the three teleworking groups, and a Games-Howell test was used as a post-hoc test to identify which groups differed from each other.

Additionally, we performed a chi-square test of independence to understand the association between teleworking prevalence and 4) commute mode choice. Respondents indicated their main commute mode in the survey, choosing from the following options: Walking, Bicycle, Electrical bicycle, Moped/scooter/motorbike, Bus, Tram/metro, Train, Car, Other. Respondents were limited to choosing one answer. Some of the original groups had expected counts lower than 5, which violated one of the assumptions of chi-square test of independence. Therefore, we merged the 'Bus' and 'Tram/metro' group into one larger group 'Bus, tram, metro', and removed the categories 'Moped/scooter/motorbike', 'Walking', and 'Other' from the analysis.

We also performed a Poisson regression to determine whether commute characteristics influence teleworking frequency. While we focus on commute characteristics, the literature shows that sociodemographic and household characteristics, working conditions, and residential characteristics can also influence the tendency to telework (Ravalet & Rérat, 2019). Therefore, we included several of these factors in the regression analysis, depending on data availability (Table 2). We cleaned the dataset and checked if the data met all the assumptions of Poisson regression. The data indicated slight underdispersion, but we did not expect an apparent violation of the equidispersion assumption[2]. The overall fit of the model is good, the omnibus test shows that the model represents a statistically significant improvement in fit compared to the null model.

Table 2. Variables Poisson regression analysis

[2] One of the assumptions of Poisson regression is that the mean and variance of the dependent variable are equal (equidispersion). If the variance is substantially lower than the mean, underdispersion is likely, which can lead to biased parameter estimates.

Variable	Explanation	Min.	Max.	Mean
Telework frequency	Number of days per week the respondent teleworked	0	5	1.76
Socio-demographics				
Female	Respondent is female	0	1	.63
Age	Age (years) of the respondent	23	64	40.00
Higher education	Respondent obtained a bachelor degree or higher = 1	0	1	.92
Monthly household income (ref. category = > €5500)				
€3501 - €5500	Income between €3501 and €5500	0	1	.42
< €3500	Income under €3500	0	1	.23
Household characteristics				
Children	Number of children living in the household	0	5	.95
Children under 12	Number of children under the age of 12 living in the household	0	4	.41
Two worker household	Respondent lives in a household with two people working	0	1	.68
Occupation				
Working fulltime	Respondent works fulltime	0	1	.80
Work frequency	Number of days per week the respondent is working	1	5	4.77
Travel characteristics				
PT subscription	Respondent has a public transport (PT) subscription	0	1	.29
Driver's license	Respondent has a driver's license	0	1	.93
Commute duration	Usual one-way commute travel time (in minutes)	3	120	34.26
Commute mode (ref. category = car)				
E-bike	Electrical bicycle as main commute mode	0	1	.19
Bicycle	Non-electrical bicycle as main commute mode	0	1	.29
Train	Train as main commute mode	0	1	.17
Tram, bus, metro	Tram, bus or metro as main commute mode	0	1	.05
Residential characteristics				
Neighbourhood	Very rural (0) to very urban (100) residential neighbourhood, as perceived by the respondent	0	100	61.77
Home owner	Respondent is a homeowner	0	1	.77
Single family home	Respondent lives in a single family home	0	1	.80

4. Results and discussion

4.1 Teleworker groups and commute characteristics

We ran three separate Welch tests to model the differences in mean one-way commute distance, mean one-way commute duration, and mean weekly number of commute round trips between non-teleworker, infrequent teleworker and frequent teleworker groups. The results show a statistically significant ($\alpha = 0.05$) difference in the mean commute distance, duration, and trips among the different teleworker groups.

When analysing the descriptives, the mean one-way commute distance of frequent teleworkers (22.2 km) and infrequent teleworkers (19.8 km) is higher than that of the non-teleworker group (16.0 km). The commute distance of frequent teleworkers is, on average, higher than that of infrequent teleworkers, although the difference between these two groups is smaller. The results of the Games-Howell test in Table 3 show a statistically significant difference between the mean one-way commute distance of non-teleworkers and both infrequent and frequent teleworkers. The difference between the infrequent and frequent teleworker groups is not significant.

The analysis of the commute duration variable shows similar results. The mean one-way commute duration of the non-teleworker group is 29.2 minutes. This value is lower than that of infrequent and frequent teleworkers, which have similar mean values (35.2 and 35.9 minutes). This observation is supported by the Games-Howell test results in Table 3, which show a statistically significant difference in the mean commute duration between the non-teleworker group and both the infrequent and frequent teleworker groups. The difference in mean commute duration of infrequent and frequent teleworkers is not statistically significant.

Lastly, the mean number of commute trips is highest for the non-teleworker group, with a weekly average of 4.9 commute round-trips. Infrequent teleworkers have a mean of 3.7 weekly commute trips. Frequent teleworkers make on average the fewest commute trips (3.0 weekly round-trips). According to Table 3, the differences between the means of the three teleworker groups are statistically significant.

Table 3. Multiple Comparisons using Games-Howell post-hoc test

	(I) Telework groups	(J) Telework groups	Mean Diff. (I-J)	Std. Error	Sig.
Log (Commute distance)	Non-teleworker	Infrequent teleworker	-.157*	.046	**.002**
		Frequent teleworker	-.159*	.053	**.008**
	Infrequent teleworker	Non-teleworker	.157*	.046	**.002**
		Frequent teleworker	-.003	.037	.997
	Frequent teleworker	Non-teleworker	.159*	.053	**.008**
		Infrequent teleworker	.003	.037	.997
	Non-teleworker	Infrequent teleworker	-.097*	.028	**.002**

Log (Commute duration)		Frequent teleworker	-.086*	.032	**.021**
	Infrequent teleworker	Non-teleworker	.097*	.028	**.002**
		Frequent teleworker	.011	.022	.872
	Frequent teleworker	Non-teleworker	.086*	.032	**.021**
		Infrequent teleworker	-.011	.022	.872
Sqrt (Commute trips)	Non-teleworker	Infrequent teleworker	.288*	.029	**<.001**
		Frequent teleworker	.518*	.041	**<.001**
	Infrequent teleworker	Non-teleworker	-.288*	.029	**<.001**
		Frequent teleworker	.230*	.034	**<.001**
	Frequent teleworker	Non-teleworker	-.518*	.041	**<.001**
		Infrequent teleworker	-.230*	.034	**<.001**

We performed a chi-square test to understand the association between the type of teleworker and the chosen commute mode. The crosstabulation table (Table 4) shows that the car is the most common mode for the frequent teleworker group, with 38.1 % of them commuting by car. The car is also the most common mode for infrequent teleworkers (31.1%), although the percentage is lower compared to frequent teleworkers. In addition, infrequent teleworkers are more likely to use an e-bike or train for commuting compared to the other groups of teleworkers. Lastly, the bicycle is the most common commute mode for non-teleworkers. Compared to teleworkers, non-teleworkers are less likely to use the car as their main commute mode. Nevertheless, the model shows a p-value larger than the significance level ($\alpha = 0.05$). Therefore, we can conclude that teleworking prevalence is not associated with the main travel mode used when commuting.

Table 4. Commute mode & Teleworking frequency Crosstabulation

		Teleworking frequency			Total
		Non-teleworker	Infrequent teleworker	Frequent teleworker	
E-bike	Count	25	114	37	176
	Percentage	18.0	19.2	15.7	18.2
	Expected Count	25.3	107.7	43.0	176.0
Bicycle	Count	53	155	60	268
	Percentage	38.1	26.2	25.4	27.7
	Expected Count	38.6	164.0	65.5	268.0
Car	Count	36	184	90	310
	Percentage	25.9	31.1	38.1	32.1
	Expected Count	44.6	189.7	75.7	310.0
Train	Count	22	110	37	169
	Percentage	15.8	18.6	15.7	17.5
	Expected Count	24.3	103.4	41.3	169.0
Tram, metro, bus	Count	3	28	12	43
	Percentage	2.2	4.7	5.1	4.5
	Expected Count	6.2	26.3	10.5	43.0

Total	Count	139	591	236	966
	Expected Count	139.0	591.0	236.0	966.0

4.2 Teleworking frequency determinants

We examined the impact of sociodemographic, household, occupation, travel, and residential characteristics on telework frequency using a Poisson regression. Table 5 shows the results of the analysis. The variables age, work frequency, and commute duration are statistically significant. The variable age is positively related to telework frequency. For every extra year in age, we expect an 8% increase in telework frequency. Similarly, work frequency is positively related to telework frequency. A one-day increase per week in working is associated with a 14,3% increase in telework frequency. Lastly, commute duration is also positively associated with telework frequency. For every minute increase in commute duration, we expect a 6% increase in telework frequency.

Table 5. Parameter estimates Poisson regression

Parameter	B	Std. Error	Hypothesis Test			Exp(B)
			Wald Chi-Square	df	Sig.	
(Intercept)	-.546	.371	2.160	1	.142	.579
Socio-demographics						
Female	-.034	.056	.358	1	.549	.967
Age	.008	.003	7.555	1	**.006**	1.008
Higher education	-.104	.100	1.091	1	.296	.901
Monthly household income (ref. category = > €5500)						
€3501 - €5500	-.045	.064	.487	1	.485	.956
< €3500	-.110	.100	1.200	1	.273	.896
Household characteristics						
Children	-.042	.031	1.821	1	.177	.959
Children under 12	.025	.043	.336	1	.562	1.025
Two worker household	-.008	.077	.012	1	.914	.992
Occupation						
Working fulltime	-.083	.089	.867	1	.352	.921
Work frequency	.134	.062	4.747	1	**.029**	1.143
Travel characteristics						
PT subscription	.003	.098	.001	1	.979	1.003
Driver's license	.141	.123	1.308	1	.253	1.151
Commute duration	.006	.002	10.608	1	**.001**	1.006
Main commute mode choice (ref. category = Car)						
E-bike	-.094	.080	1.380	1	.240	.910
Bicycle	-.072	.083	.766	1	.382	.930
Train	-.247	.134	3.409	1	.065	.781
Tram, bus, metro	.067	.157	.180	1	.672	1.069
Residential characteristics						

Neighbourhood	.001	.001	1.863	1	.172	1.001
Home owner	.094	.085	1.230	1	.267	1.099
Single family home	-.022	.087	.066	1	.797	.978
(Scale)	1[a]					

Dependent Variable: Telework frequency

a. Fixed at the displayed value.

5. Conclusions

The teleworking landscape has changed drastically during the past years, leading to many changes in how, when and where people work and travel. In this study, we seek to understand the relations between these two factors. We thereby focused on East Flanders, a region that faced a sharp increase in teleworking during the past years.

The ANOVA models showed that the mean commute distance and duration for teleworkers is significantly higher than those for non-teleworkers. These findings are in line with studies from the UK (Caldarola & Sorrell, 2022), United States (Mokhtarian et al., 2004; Zhu, 2013), Switzerland (Ravalet & Rérat, 2019), and The Netherlands (de Vos et al., 2018), which also found longer commute distances and durations for teleworkers compared to non-teleworkers. When comparing frequent and infrequent teleworkers, we found small and non-significant differences in mean commute distance and duration. This contrasts somewhat with the study by Hu and He (2016) in Chicago, US, which found that less-frequent teleworkers have longer one-way commute distances than both non-teleworkers and frequent teleworkers. The difference in outcome with our study might be due to different definitions of frequent and infrequent teleworkers between the studies. Second, the results indicate that both frequent and infrequent teleworkers make significantly fewer weekly commute trips than non-teleworkers. Additionally, frequent teleworkers make significantly fewer commute trips than infrequent teleworkers. This aligns with expectations and findings from other studies (Budnitz et al., 2020; Ravalet & Rérat, 2019; Wöhner, 2022). Lastly, the analysis of commute mode choice showed differences between frequent, infrequent and non-teleworkers. Car is found to be the most common commute mode for teleworkers, while bicycle is the most popular for non-teleworkers. This make sense, as non-teleworkers have lower average commute distances, making cycling more feasible. However, none of the differences in commute mode choice between the teleworker groups were found to be significant.

The regression analysis showed that age, the number of workdays per week, and one-way commute duration are positive related to telework frequency. The finding that older people telework more frequently aligns with several studies (Peter et al., 2004; Ravalet & Rérat, 2019; Zhang et al., 2020), although some studies found opposite or non-significant effects (Silva, 2022). The positive effect of age on teleworking can be explained by following factors; older people are more likely to hold senior positions where teleworking is more feasible, and several studies showed a decline in the willingness of younger people to telework due to the COVID-19 period (Ravalet & Rérat, 2019; Silva, 2022). Additionally, a study by Moens et al. (2022) found that older workers in Belgium were more satisfied with teleworking during the

COVID-19 period than other employees, which supports our findings. The relation between working frequency and telework frequency is also in line with our expectations. It is evident that employees who work more days tend to telework more days. The observation that teleworking frequency increases with longer commutes is consistent with several studies (Helminen & Ristimäki, 2007; Ravalet & Rérat, 2019; Silva, 2022). Teleworking and long commutes seem to go together. However, the causal direction of the relationship – whether a long commute leads to teleworking or teleworking leads to residential relocation away from the workplace - is still unclear (Silva, 2022). Lastly, although some studies found other factors, such as gender and education level, to determine teleworking frequency, we did not find significant results for these variables.

This leads to one of the weaknesses of the research, namely the representativeness of the sample. When distributing the survey, we targeted companies where most employees had teleworking opportunities, which resulted in a sample biased towards people who were highly educated and had high incomes. This makes it harder to generalize our findings. Second, the survey might be biased due to the self-selection of respondents, as those already teleworking or with a stronger opinion on teleworking might be more eager participate.

In summary, teleworking and commuting characteristics of employees are inherently related. In East Flanders, teleworkers are more likely to make fewer, but longer and less sustainable (although this effect was non-significant) commute trips. This implies that a rebound effect might exist, counteracting the positive effects of teleworking on reducing travel, traffic congestion and greenhouse gas emissions (Macias et al., 2022). Other potential rebound effects of teleworking are additional trips for other purposes and residential relocation (Macias et al., 2022). This study only focused on commute trips, but to obtain a complete picture of the relationship between teleworking and travel (and possible rebound effects), it might be interesting to also study non-work trips and residential location choices. Furthermore, in our analysis, we distinguished three groups of employees based on their teleworking frequency. However, other differences in telework arrangements, such as full-day versus part-day teleworking, can also lead to different travel effects, and might therefore be interesting to study.

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