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Version of Record: https://www.sciencedirect.com/science/article/pii/S0965856420308090
Manuscript_b6909576012da77fa302bff57963113d

Why do Gender Differences in Daily Mobility Behaviours persist among workers? [2]

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Abstract: Gender is commonly identified as a key explanatory factor for travel behaviour. Since women's role in societal structure has changed in the past few decades, the question arises as to whether the "gender" factor still plays a decisive role in differences in mobility within the working population. The aim of this paper is to extend the research on gendered differences in mobility by providing an in-depth analysis of how the main determinants of daily mobility affect male and female workers differently. Unlike previous research, our econometric models included terms that express the interactions between the explanatory variables (socioeconomic variables and transport mode access) and a dichotomous gender variable, to accurately identify the marginal impact of gender on mobility indicators. Based on the Rhône-Alpes regional household travel survey (2012-2015), which includes France's second largest urban area, the results show that even if gender differences in employment status and access to the private car are eliminated, differences in travel patterns between men and women would still be observed because the two genders do not have identical factor sensitivities. From a policy perspective, these results suggest that authorities have to adopt a gender perspective to ensure that in the future urban mobility policies provide gender equity in the context of the sustainable development of transport networks.

Keywords: Travel behaviour; Daily mobility; Commute distance and time; Car use; Gender differences; Gender interactions; Marginal effects; Bivariate tobit model; Zero-one inflated beta regression.

JEL Classification codes: R41, C34, J16, R40

Highlights:

- Regression models for daily mobility, commute distance, time and car use
- Traditional gender roles and relations remain operative in contemporary households
- Lower distances and time are due to women's job status and lower car access
- Evidence for the suitability of the gender interaction terms in our econometric models
- Working men and working women do not have the same sensitivity to mobility determinants
- Having a part-time job reduces home-to-work distance and time more for men than for women
- Educated women are better able to limit the constraints imposed by household responsibilities

[2] The authors would like to thank the Rhône-Alpes Region for allowing them access to the 2012-2015 regional travel survey data collected in Rhône-Alpes (Enquête Déplacements Région Rhône-Alpes 2012-2015, Conseil Régional). However, the authors are solely responsible for the contents of this paper.

1. Introduction

The pace of life of each citizen changes as society evolves. Societal changes may impact travel behaviours, which are shaped by a wide range of factors such as population ageing, family composition (e.g. stepfamilies), the value society places on employment and higher education, favourable attitudes towards new technologies leading to numerous opportunities for virtual relationships/online shopping, or the development of eco-friendly attitudes. As cities have expanded over the years, not only residential, but also commercial and job areas have spread across the main urban centres. These changes have significantly influenced travel behaviour, especially for people in employment (Pan et al., 2009). Public policy-makers need to consider living patterns in order to make informed planning decisions within an area. Moreover, an accurate knowledge of citizens' mobility practices is crucial in order to develop sustainable urban infrastructures.

In this context, the literature that focuses on differences between men and women in mobility patterns, which has become increasingly abundant over the last decades, has led to an understanding that gender[3] issues need to be incorporated within transport planning and policy making processes in order to implement efficient and equitable transport policies. Indeed, this literature highlights that women tend to have specific travel patterns in terms of mode choice, mobility levels (number of trips, travel distance and time) and trip purpose. Moreover, as women usually play a greater role in household activities and child care (including escorting trips) than their male counterparts (McGuckin et al., 2005; Bhat et al., 2005, Lee et al., 2007), their trip chains are more complex (Rosenbloom, 2006; Tilley and Houston, 2016; McQuaid and Chen, 2012). Hence, transport policies do not generate the same outcomes for men and women, as both genders face a different set of constraints. Policies which fail to consider these gender differences in travel patterns will not achieve their full potential impact.

However, the majority of gender-specific travel studies have focused on disparities in employment status (e.g. more female part-time job), the division of household roles and/or access to motorised transport to explain gender differences in travel patterns. Few such studies have examined whether the effects of the main socio-demographic factors of mobility indicators (e.g. age, educational level, occupational status, income level, etc.) differ to a great degree between genders (Saneinejad et al., 2012; Scheiner and Holz-Rau, 2017; Bourke et al., 2019). Nevertheless, this question is essential in order to understand why gender differences in travel patterns still persist despite the changes that have taken place in household composition models, the emergence of new forms of work and changes in women's place in labour market – with the implementation of policies promoting gender equality – and in society in general. Consequently, understanding the gender differences in sensitivity to these factors seems to be crucial to improve existing transport services, reduce some gender inequalities and help design more efficient transport policies.

Given this background, the main contribution of this study is to disaggregate mobility by gender to determine how socioeconomic factors (age, working time, occupation, etc.) and

[3] The gender differences refer here to differences between men and women due to social and cultural differences rather than biological ones. Gender should be understood as a social category that structures social relationships, power interaction, and inequalities (Chidambaram and Scheiner, 2020). We focus on the gendered character of travel behaviour.

variables associated with access to transport modes (having a driving licence, a private car available in the household or a public transport season ticket, etc.) affect men and women differently. According to previous studies, we can, for example, expect differentiated sensitivity to the presence of children (McGuckin et al. 2005; Fan, 2017; Scheiner and Holz-Rau, 2017), working hours (Kwan,1999) or income and education level (Cristaldi, 2005; Shearmur, 2006). We used data from a French regional household travel survey (2012-2015 Rhône-Alpes survey) to study how the sensitivity of six mobility indicators to the main determinants varied according to gender, by applying a variety of econometric models which included gender interaction terms. A negative binomial count data model was used to explain the number of reported daily trips. Two bivariate tobit models (Carlos and Cox, 2001) were used to explain the distance and time: one considered all the trips reported on the day before the survey regardless of their purpose at destination, and the other took account only of direct commute-to-work trips. Finally, a zero-one inflated beta regression, which is rarely used in transport economics (Ospina and Ferrari, 2012; Bayart et al., 2020), allowed us to model the proportion of daily trips made as a driver. We focused our study on people in employment, because we were interested not only in assessing gender differences in commuting, but also in identifying the gender-differentiated impacts of job factors on mobility indicators. Thus, our study allows us to better understand how employed women's travel behaviour differs from employed men's in France, in a context where, from an economic and social point of view, the two genders have become more equal over the last decades (Tilley and Houston, 2016).

The remainder of the paper is structured as follows. Section 2 reviews the gender differences usually observed in travel patterns and the main explanations that have been proposed for them in the literature. Section 3 presents the design of the regional travel survey and the econometric specifications used. We then present the data analysis in Section 4, exploring the gender disparities for six daily mobility indicators, focusing on the differences in gender sensitivity to sociodemographic factors. Sections 5 and 6 respectively discuss the implications of the results and suggest possibilities for further research.

2. Literature review

Gender-specific travel behaviour studies emerged in the 1970s (Rosenbloom, 1978). Their results have highlighted differences in daily mobility patterns according to gender in both developed and developing countries, even if these differences have been much less studied in the developing world (Elias et al., 2015). We shall present these stylized facts first, before going on to review the explanations advanced in the literature.

2.1. Gender differences in daily mobility patterns

According to most studies (Kwan and Kotsev, 2014; Beige and Axhausen, 2017; Scheiner, 2020), women's travel patterns differ from men's in many ways – in terms of mode choice, activity at destination, nature of trip chains or mobility level (number of trips, time and distance).

Gender differences in mode use have often been observed empirically, with women being more reliant on low-carbon, cheaper and slower transport modes, such as walking and public transport (Polk, 2004; Best and Lanzendorf, 2005; Pooley et al., 2006; Nurdden et al., 2007). Several studies have also highlighted the greater modal share of the private car for men (Dobbs, 2005; Vance and Iovanna, 2007; CGDD, 2010). While it is the case that men are more likely to have a driving license than women, this gender gap has tended to narrow in

recent years, especially among the younger generations (Bayart et al., 2020). Moreover, inequalities in access to a private car for daily trips persist despite their sharp decline in recent years. For example, in France, only 80% of licensed women are regular drivers, using a car several times a week, compared to 87% of men (Hubert et al., 2008). Scheiner and Holz-Rau (2012) have also shown that when fewer cars are available in a household, it is the men who use the vehicle more.

Another trend that has been widely documented in the literature is that women tend to travel less for work (both for commuting and business) than men, but they tend to travel more frequently for household maintenance activities, such as shopping, escorting family members, or family management (Craig and Van Tienoven, 2019; Best and Lanzendorf 2005; Rosenbloom, 1987). Gender differences in trip purposes have implications in terms of daily mobility patterns. Women tend to travel alone less often, they undertake more non-job-related trips and their travel patterns more frequently involve shorter distances and include destinations other than their workplace (shopping centres, schools, health centres, etc.). Therefore, women engage more frequently in complex trip chaining, while men more often exhibit linear travel patterns without interruptions (to and from work) (Rosenbloom, 2006; Pooley et al., 2006; McGuckin and Murakami, 1999; Wegmann and Jang, 1998; Turner and Niemeier, 1997; Levinson and Kumar, 1995; Rosenbloom and Burns, 1993). As a result, women also travel more outside rush hours (Levy, 2013).

Whilst women tend to make a greater number of trips (Lee et al., 2007), men tend to travel further (Hanson and Johnston, 1985; Turner and Niemeier, 1997; Law, 1999; Rosenbloom, 2006; Scheiner, 2010). This phenomenon is correlated not only with men's greater access to cars and their lesser involvement in household-serving trips (Boarnet and Hsu, 2015; Motte-Baumvol et al., 2017), but also with their greater commute distances (Madden, 1981; McLafferty and Preston, 1993; Best and Lanzendorf, 2005; McQuaid and Chen, 2012; Kwan and Kotsev, 2014; Elias et al., 2015; Olmo Sanchez and Maeso Gonzalez, 2016; Fan, 2017). Consequently, men have higher transport times than women (Kim et al., 2012; Kwan and Kotsev, 2014).

France is no exception to these general trends. Indeed, according to the national transport and development survey (CGDD, 2010), French women now make slightly more daily trips than French men (3.18 vs. 3.11 in 2008), while the opposite applied fifteen years earlier. As they report shorter distances (23 km/day on average vs. 28 km), women spend less time travelling than men (54 min/day versus 59 min). Yet women use slower travel modes, such as walking and public transport. This tendency needs to be qualified in the case of the Paris region, where the same proportion of men and women seem to use urban public transport, due to its density and efficiency, as well as the very pronounced urban sprawl. Moreover, several researchers have confirmed working women's shorter commuting distances (Baccaïni et al., 2007), particularly in the areas around Paris (Sari, 2011) and Lyon (Havet et al., 2020). In any case, these disparities in French mobility levels have decreased in recent years, illustrating that men's and women's lifestyles are moving closer together, especially among the working population (Craig and van Tienoven, 2019; Havet et al., 2020). Studies in other countries have also concluded that gender differences in daily mobility patterns are diminishing (Rosenbloom, 2006; Frändberg and Vilhelmson, 2011; McQuaid and Chen, 2012; Tilley and Houston, 2016).

2.2. Some explanations of gender impacts on mobility

The division of household roles and gender labour market dynamics

Gender differences in daily mobility patterns have largely been explained by men's and women's respective roles in society, which lead to different activity patterns. Indeed, numerous studies have highlighted that women spend more time on household-sustaining and child-rearing tasks (Rosenbloom and Burns, 1993; Scheiner and Holz-Rau, 2012) and also make more complex trip chains, with a greater number of daily trips and in particular non-job related trips (Scheiner, 2016, for Germany or Motte-Baumvol et al., 2017, for France). This gendered division of household production often results in lower employment rates and/or more limited job choices for women (Hanson and Johnston, 1985; Kwan, 1999; Assaad and Arntz, 2005). Women also tend to have spatially constrained job opportunities – they choose job locations that are easy to commute to/from so that they can manage their household and caregiving responsibilities – and are more likely to have part-time job. Yet the number of working hours is a major determinant of the mobility level for the working population. A part-time job increases the reported number of daily trips, because time that is saved can be used to pursue additional activities out of home, as has been shown in France, especially in the Paris region (Aguiléra et al., 2009). Conversely, a part-time job reduces daily distance, as these activities are often closer to home. The distance and time required for commuting are also significantly reduced, due to both fewer weekdays worked and shorter average home-to-work distances (Lyons et al., 2002; McQuaid and Chen, 2012). These shorter distances are consistent with the fact that for part-time jobs it is particularly important for job access costs to be moderate, so that the net income can be higher than the reservation wage (which includes associated costs and in particular travel costs). Working close to home is often essential in order for people to accept a low-paid job (Brueckner and Zenou, 2003; Blumenberg, 2004; de Meester and van Ham, 2009). Thus, part of the previously reviewed gender differences in mobility patterns may be attributable to the predominance of women among part-time workers, even if recent studies (Beck and Hess, 2016) have highlighted the larger heterogeneity in women's commuting preferences (income level, driving behaviour when carpooling, etc.).

These effects are exacerbated by gender differences in labour market outcomes. For example, women are less likely to be employed in intellectual, managerial and executive occupations. However, in the French context, the literature shows that travel patterns vary greatly according to socio-occupational category. On the one hand, the intellectual professions, executives and managers tend to have higher commuting distances and times (Baccaïni et al., 2007; Le Jeannic and Razafindranovona, 2009; Wenglenski, 2006; Sari, 2011), while, in contrast, employees and service workers tend to make more daily trips (Le Jeannic and Razafindranovona, 2009). The impact of occupational status is reinforced by an own income effect, as a substantial income allows people to perform more activities and involves, above all, people in employment (Preston and Rajé, 2007). International studies have also highlighted many inequalities in transport access between lower and higher income households (Lucas, 2012). Women are also at a disadvantage compared to men with respect to pay rates and income (Goldin, 2014). Moreover, women are in a worse position in developing countries as more entrenched gender roles mean their low income results in a greater reduction in mobility (Adeel et al., 2016; Craig and Van Tienoven, 2019; Shirgaokar, 2019).

Unequal access to motorised transport modes

The allocation of resources within households, especially with regard to private car use, has been widely analysed in transport surveys (Fan, 2017, Kawabata and Abe, 2018). Women's lower incomes tend to reduce their bargaining power within households for access to vehicles

and driving duties. Indeed, women walk and use public transport more than men, partly because they have less control of household assets, which of course includes vehicles (Scheiner and Holz-Rau, 2012; Adeel et al., 2016; Rahul and Verma, 2017). If there are more adults with a driving license than cars in a household, they will be used more by the men than the women, especially for commuting (Scheiner and Holz-Rau, 2012). This tendency reinforces gender inequalities, as the possibility of driving a car is very significantly and positively associated with the main mobility indicators (except for the commute time), as it increases average home-to-work distances for workers (Boarnet and Crane, 2001, for the USA; Dieleman et al., 2002, for the Netherlands; Bouzouina et al., 2016, for France).

Different sensivities to family status and transport modes

Thus, many studies have linked gender differences in travel patterns to differences in employment status, contributions to childcare and maintenance tasks and/or access to motorised transport modes. They have concluded that women may be excluded from certain activities because of their job, home responsibilities and time and distance constraints (Lucas et al., 2016). However, gender differences may also be related to different sensitivities to some characteristics, but little empirical work has been done on this issue. Admittedly, because of a gendered division of household production, studies have focused on the differentiated effect of the presence of (young) children on mobility behaviours. For example, they have concluded that having children reduces women's home-to-work distances, and the longest commutes are made by fathers (McGuckin et al., 2005, for the USA; McQuaid and Chen, 2012, for the UK; Motte-Baumvol et al., 2017, for France). The presence of children in a household also affects women's trip chaining more than men's: in two-worker households women are more likely to drop off or pick up children (McGuckin et al., 2005), leading to less flexible departure times and to an increase in their commute times (Fan, 2017). These findings have supplemented the research conducted by Kwan (1999), who found that a part-time job reduces commute distances and times for men much more than it does for women because it is more involuntary than chosen. Moreover, Tilley and Houston's study (2016) suggests that men and women do not have the same sensitivity to transport modes: having access to a car in the household increases men's mobility more than women's. The literature therefore requires a more in-depth analysis of how the main determinants of mobility affect men and women differently.

3. Materials and methods

3.1. Survey methodology

Our study is based on the regional travel survey that was conducted from October to March in the Rhône-Alpes region of France between 2012 and 2015 with each year an independent wave. The studied area has a central position within France and Europe: two of the nine European transport corridors pass through it and half of the region's population lives in one of its five main urban areas. Lyon conurbation (the second largest in France) has a strong attraction power over the whole Rhône-Alpes region. There are also other metropolitan areas like Grenoble, Saint-Etienne, Annecy, Annemasse but with a smaller attraction power than Lyon. Rhône-Alpes region is well-suited to various modes of transport and the efficient Lyon's public transport network is often presented as one of the best in France. In addition, in the last fifteen years, a considerable amount of investment has been made in order to develop dedicated infrastructures for active modes (self-service bicycle system, green lanes, etc.).

The Rhône-Alpes regional travel survey is similar to other French Household Travel Surveys conducted in major conurbations and medium-sized cities using a standard methodology (Certu, 2008). The survey was principally conducted by telephone, using Computer-Aided Telephone Interviewing (CATI) technique with interviews taking about 20 minutes per person. Either one or two members of the household were interviewed, depending on its size. The questionnaire contained three categories of questions: (1) questions about the household, (2) questions about the respondent and (3) questions about all the trips made the day before the interview was conducted. Only weekdays were included in the survey. The target population was the residents of all eight Departments in the Rhône-Alpes region, i.e. 5.17 million inhabitants living in 2,880 municipalities, aged 11 years and older. The sample of respondents was constructed by applying a geographically stratified random procedure, in order to be representative of the regional target population for each wave. At the end of the survey period, 35,945 individuals agreed to participate in this three-year survey about their daily mobility, with a response rate of 26.5%.

Only people in employment are considered in our analyses in order to evaluate gender differences in the sensitivity of mobility behaviour to job factors (full/part-time, occupational status) in addition to sociodemographic characteristics (age, income, educational attainment), household structure, residential location and access to certain modes of transport. In addition, we were interested in gender differences in commutes. The final sample consisted of 15,937 individuals, whose characteristics are presented in Table 1.

3.2. Econometric specifications

The travel patterns observed in this survey relate to daily mobility, as measured by six main indicators which are commonly considered in transport studies. These are: number of daily trips, total daily travelled distance and time, commute distance and time, and the proportion of daily trips made by car. We tested the relative influence of socioeconomic variables (age, education level, occupation, number of children in the household, household income, kind of dwelling and area of residence) as well as a variable that describes modal access (driving license, access to private cars and two-wheeled motor vehicles, bicycle ownership and having a public transport season ticket). Our models also all included terms that describe the interaction between these explanatory variables and a gender dichotomous variable (‘male’ or ‘female’), to establish whether the determinants of the dependent variables change according to gender. In our specifications, the coefficients associated with the explanatory variables capture the effects of the reference group, i.e. women. If the interaction term associated with a given explanatory variable is not statistically significant, it is deemed that the effect of this determinant on the studied mobility indicator does not vary according to gender. Conversely, if the interaction term is statistically significant, one can conclude that the effect of the determinant on the studied mobility indicator differs for men and women.

3.2.1. Number of reported daily trips

Poisson regression and the negative binomial model are two commonly-used approaches for modelling count data – here the number of reported daily trips (Cameron and Trivedi, 1998; Winkelmann, 2003). However, Poisson regression requires the familiar equidispersion assumption (the equality of the mean and the variance), while count data are often heteroskedastic, which means their variance increases with the mean (overdispersion). This overdispersion can also generate an underestimation of standard errors. The negative binomial model is therefore preferred in our case, since it accommodates the possibility of

overdispersion by introducing an additional parameter in the conditional mean. This parameter also controls for the unobserved heterogeneity of the dependent variable. More precisely, we assume that for an individual *i* the number of reported daily trips, ndt_i follows the Poisson distribution:

$$ndt_i \sim Poisson\ (\mu_i). \quad (1)$$

$$\mu_i = \exp(X_i\beta + \nu_i). \quad (2)$$

where X_i is a vector of covariates and ν_i is a random variable of unobserved heterogeneity, and exp (ν_i) is gamma distributed with mean 1 and variance α. The parameter α corresponds to the dispersion parameter. If α = 0, the negative binomial regression model is equivalent to the Poisson regression model. The probability that the number of daily trips takes on a specific value y_i is given as:

$$P\left(ndt_i = y_i \middle| X_i, \alpha\right) = \int_0^u f\left(y_i \middle| \nu\right) g\left(\nu\right) d\nu = \frac{\Gamma\left(y_i + m\right)}{\Gamma\left(y_i + 1\right)} \left(\frac{m}{m + \exp\left(X_i\beta\right)}\right)^m \left(\frac{\exp\left(X_i\beta\right)}{m + \exp\left(X_i\beta\right)}\right)^{y_i} \quad (3)$$

where m =1/α and Γ(·) denotes the gamma integral. The coefficients β associated with covariates and the dispersion parameter α are obtained by maximum likelihood estimation.

3.2.2. Distance travelled and time

The daily distance and time are analysed with a bivariate tobit model (Maddala, 1999; Carlos and Cox, 2001; Bouzouina et al., 2016), for two reasons. Firstly, we use a tobit specification because it is able to take account left-censored distributions and to handle corner solution problem, resulting from a significant fraction of zero observations. Indeed, some workers in our sample did not make trips the day before the survey, and thus reported zero daily distances and times. Thus, the proposed model structure has zero as a boundary, and does not allow negative values as a solution, which is called corner solution and censoring. The likelihood of a tobit model is in fact composed of a function of the censored data and a conditional function of the uncensored data (value of the distance or time given that at least one trip has been reported). Secondly, the bivariate form of the chosen model results from the fact that the distance travelled and the travel time are jointly estimated in order to take into account their possible interdependencies. The model has an SUR (seemingly unrelated regression) form in the sense that the error term of each dependent variable is not independent of the others, but jointly distributed: it adopts an error covariance structure, with a correlation coefficient ρ between the two simultaneous equations. This means it is possible to take account of the potential presence of unobserved factors that would influence both the distance travelled and the travel time, and to capture the own effect of each factor as well as possible. More precisely, the estimated bivariate tobit model is expressed as follows:

$$\begin{cases} dist_i = \begin{cases} dist_i^* & if\ dist_i^* > 0 \\ 0 & otherwise \end{cases} \\ time_i \begin{cases} time_i^* & if\ time_i^* > 0 \\ 0 & otherwise \end{cases} \end{cases} \quad (4),$$

where $dist_i^*$ and $time_i^*$ are two continuous latent variables with the following specifications:

$$\begin{cases} dist_i^* = Z_{1i}\gamma_1 + \varepsilon_{1i} \\ time_i^* = Z_{2i}\gamma_2 + \varepsilon_{2i} \end{cases} \quad (5),$$

with Z_1 and Z_2 the determinants of the distance travelled and the travel time.

The error terms $(\varepsilon_{1i}, \varepsilon_{2i})$ in the two latent equations in (5) are assumed to jointly follow a bivariate normal distribution given by:

$$\begin{pmatrix} \varepsilon_{1i} \\ \varepsilon_{2i} \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \Sigma = \begin{pmatrix} \sigma_{\varepsilon_1}^2 & \rho\sigma_{\varepsilon_1}\sigma_{\varepsilon_2} \\ \rho\sigma_{\varepsilon_1}\sigma_{\varepsilon_2} & \sigma_{\varepsilon_2}^2 \end{pmatrix} \right] \quad (6),$$

where $\sigma_{\varepsilon_1}^2$ and $\sigma_{\varepsilon_2}^2$ denote the variance of the error terms, ρ their correlation coefficient and Σ the variance-covariance matrix. The correlation between distance travelled and travel time is then partially explained by the common attributes Z as well as the covariance between ε_1 and ε_2.

The full information maximum likelihood (FIML) model can be estimated for the parameters of the above model. Since daily distances and travel times are either simultaneously null or simultaneously positive (depending on whether the individual has made a trip or not), the likelihood associated with this model is given by:

$$L = \prod_{i=1}^{n} \left\{ \left[1 - \Phi_2 \left(\frac{Z_{1i}\gamma_1}{\sigma_{\varepsilon_1}} . \frac{Z_{2i}\gamma_2}{\sigma_{\varepsilon_2}} \right) \right]^{1-d_i} . \left[\phi_2 \left(\frac{dist_i - Z_{1i}\gamma_1}{\sigma_{\varepsilon_1}} . \frac{time_i - Z_{2i}\gamma_2}{\sigma_{\varepsilon_2}} \right) \right]^{d_i} \right\} \quad (7)$$

where d_i is a dichotomous variable equal to 1 when the individual *i* made a trip the day before the survey and 0 otherwise, Φ_2 is the cumulative distribution function of the bivariate normal distribution of zero mean and variance-covariance matrix Σ, and ϕ_2 is the associated density function.

We estimate two bivariate tobit models. The first considers all the trips reported on the day before the survey, regardless of the purpose at destination, while the second considers only direct commute trips. In the second model, any non-professional trips reported by individuals on the day before are censored.

3.2.3. Proportion of daily trips made as a driver

The proportion of daily trips made as a driver is examined with a three-part model since in our sample of trip-makers the proportions of individuals who *did not* use a car for their trips or who *always* did so are significant (see Figure 2). We propose to estimate a *zero-one inflated beta regression* (ZOIB), which is a general beta regression model, rarely used in transport economics (Ospina and Ferrari, 2012; Bayart et al., 2020). The ZOIB model assumes that different underlying processes explain non-use of the car (0% of daily trips made as a driver), its exclusive use (100% of daily trips made as driver) and intermediate proportions. The probability density function of this model can be written as follows:

$$f(y_i, X_i, \beta_1, \beta_2, \beta_3, \phi) = \begin{cases} \pi_{0i} & if\ y_i = 0 \\ (1-\pi_{0i})(1-\pi_{1i}) f(y_i, \mu, \phi) & if\ 0 < y_i < 1 \\ \pi_{1i} & if\ y_i = 1 \end{cases} \quad (8),$$

where y_i is the proportion of daily trips that the individual *i* made as a driver, π_{0i} and π_{1i} are respectively the probabilities $P(y_i = 0|X_i)$ and $P(y_i = 1|X_i)$, and $f(y_i, \mu, \phi)$ is the beta distribution with parameters μ and ϕ ($0<\mu<1$ and $\phi > 0$), whose density function is given by:

$$f(y_i, \mu, \phi) = \frac{\Gamma(\phi)}{\Gamma(\mu\phi)\Gamma((1-\mu)\phi)} y_i^{\mu\phi-1} (1-y_i)^{(1-\mu)\phi-1} \qquad (9),$$

where $\Gamma(.)$ is the gamma function, μ is the distribution mean and ϕ plays the role of a precision parameter.

The probability parameters, π_{0i} and π_{1i}, and the mean parameters from the beta distribution are linked to observed explanatory variables via link functions. A common approach is to apply logit functions to π_{0i}, π_{1i} and μ. Consequently, $\pi_{0i} = \exp(X_i\beta_1)/[1+\exp(X_i\beta_1)]$ and $\pi_{1i} = \exp(X_i\beta_3)/[1+\exp(X_i\beta_3)]$ such that these two processes are run through well-known logistic regressions. The last process is run through a beta regression after considering $\text{logit}(\mu) = X_i\beta_2$, i.e. $\mu = logit^{-1}(X_i\beta_2) = \exp(X_i\beta_2)/[1+\exp(X_i\beta_2)]$. The three processes are also estimated simultaneously by maximizing the likelihood given by:

$$L(\beta_1, \beta_2, \beta_3, \phi|y_i, X_i) = \prod_{i=1}^{n} (\pi_{0i})^{d_{0i}}.(\pi_{1i})^{d_{1i}}.[(1-\pi_{0i}).(1-\pi_{1i})\, f(y_i, \mu, \phi)]^{(1-d_{0i}-d_{1i})}$$

where d_{0i} and d_{1i} are dichotomous variables respectively indicating whether the individual *i* *did not use* a car for their daily trips or *always* used one.

4. Results

We shall first present descriptive statistics from the sample (4.1), before analysing the results from the econometric models (4.2).

4.1. Descriptive statistics

4.1.1. Sample characteristics

Table 1 presents some descriptive statistics of the sample of people in employment, distinguishing between men and women. The average age is 45 years (SD=10.3; min=18; max=80), with a higher proportion of women (53.6%). Almost half have been educated to post-secondary level and 30% did not attain the Baccalauréat (equivalent to British A levels). Most of the respondents lived in a house (55%), 59% resided in a major urban centre, 24% in the outskirts of a major urban centre and 17% in other areas. Almost all had a driving licence and access to a private car (93%), but only 12% were in possession of a public transport season ticket.

These descriptive statistics also highlight the fact that men and women in employment do not have exactly the same characteristics. For example, women have a higher level of education, a greater tendency to have a part-time job (28.5% vs 6.8%) and are less likely to be executives, managers (19.4% vs 26.8%) or blue-collar workers (3.6% vs 12.7%) than men.

Table 1. Sample Characteristics

	All	Women	Men
Age:			
<25 years	4.5%	3.8%	5.2%
25- 40 years	25.8%	25.5%	26.2%
40-50 years	33.4%	32.9%	33.9%
>50 years	36.3%	37.8%	34.7%
Education level:			
Primary	1.8%	1.8%	1.8%
Secondary	29.6%	26.4%	33.3%
Baccalauréat	18.2%	19.1%	17.2%
Short post-secondary education (Baccalauréat +2)	18.1%	18.4%	17.7%
Bachelor's degree and +	32.3%	34.3%	30.0%
Working Hours:			
Full-time	81.6%	71.5%	93.2%
Part-time	18.4%	28.5%	6.8%
Occupational status*:			
Agricultural workers	1.6%	0.9%	2.4%
Artisan, retail trader, company head	6.0%	4.3%	8.0%
Intellectual professions, executives and managers	22.8%	19.4%	26.8%
Intermediate professions (technicians and associate professionals, clerks)	8.6%	10.0%	6.8%
Employee, Service workers	53.2%	61.8%	43.3%
Blue-collar workers	7.8%	3.6%	12.7%
Number of children in the household (mean)	0.8	0.8	0.8
Monthly income of the household:			
<1,000 euros	2.8%	3.2%	2.4%
[1,000 – 2,000[Euros	20.3%	21.5%	18.9%
[2,000 – 3,000[Euros	26.5%	26.5%	26.5%
[3,000 – 4,000[Euros	20.3%	19.1%	21.8%
4,000 Euros and above	16.8%	16.2%	17.4%
Not reported	13.3%	13.5%	13.0%
Dwelling:			
Apartment	45.2%	45.9%	44.4%
House	54.8%	54.1%	55.6%
Residence:			
Major urban centre	59.0%	59.7%	58.2%
Outskirts of major urban centre	23.7%	23.4%	24.0%
Other	17.3%	16.9%	17.8%
Driving Licence & Car ownership:			
No Driving Licence	4.4%	5.2%	3.3%
Driving Licence & car unavailable in the household	2.2%	2.2%	2.3%
Driving licence and car available in the household	93.4%	92.6%	94.4%
Season ticket for public transport	12.4%	13.6%	11.0%
Two-wheeled motor vehicles in the household (mean)	0.22	0.20	0.26
Bicycle in the household (mean)	2.01	1.97	2.05

Number of observations	15.937	8.548	7.389

Source: 2012-15 Rhône-Alpes regional travel survey (authors' calculations).

Note: * The respondent's occupation is aggregated into six categories using the French classification of occupations and socio-professional categories (PCS), which is very similar to the International Standard Classification of Occupation (ISCO).

4.1.2. Mobility behaviours and gender-based differences

On average, our employed respondents made 4.4 trips per day, which represents a daily distance of 28.5 km and a daily time of 81 minutes (Table 2). Less than 4% made no trip on the day before their interview (Figure 1). Among the trip makers, direct commute trips accounted for almost 50% of the total distance travelled and 47% of the total time. Finally, 27,4% of workers did not report a direct commute because they engaged in more complex trip chaining between their home and work place (escorting children, grocery shopping, etc.).

Table 2. Average daily mobility indicators among workers, according to gender

	All	**Women [W]**	**Men [M]**	**Gender gap [W-M]**
Number of total trips (all purposes)	4.42 (2.6)	4.55 (2.7)	4.27 (2.4)	0.28, p-value<0.001
Total distance (all purposes, km)	28.48 (36.5)	24.52 (30.4)	33.05 (42.0)	-8.53, p-value<0.001
Total time (all purposes, min)	80.77 (71.0)	76.61 (60.4)	85.60 (81.4)	-8.99, p-value<0.001
Total distance (commuting, km)	13.72 (23.4)	10.38 (18.8)	17.59 (27.3)	-7.21, p-value<0.001
Total time (commuting, min)	33.16 (35.6)	28.59 (32.7)	38.45 (37.9)	-9.86, p-value<0.001
Number of observations	15,937	8,548	7,389	

Sample: employed individuals
Source: 2012-15 Rhône-Alpes regional travel survey (authors' calculations).
Note: Standard deviation in parentheses

Table 2 confirms that even among workers, daily mobility patterns still differ significantly according to gender in the French Rhône-Alpes region. While the reported number of daily trips was on average higher for women (4.55 vs. 4.27; p-value<0.001), their total distances and times were lower than men's (respectively by 8.5 km and 9 min per day). The gender gap was even greater in the case of distances and times resulting from direct commute trips. Figure 1 shows that the proportion of no-trip makers is similar for men and women (3.8%; p-value=0.860), whatever the trip purpose, while a higher percentage of women did not report any direct commute trips (33% vs. 21% for men; p-value<0.001). This difference is probably due in part to the fact that men often display standard and linear travel patterns (to and from the workplace, without interruptions), while women frequently make more complex trip chains (McGuckin and Murakami, 1999): direct commute trips account for only 45% of the daily distance and 43% of the daily time of female workers.

Figure 2 shows that females in employment use the car less for their daily trips than their male counterparts. Indeed, 24% of women did not use a private car for their trips and 50% of them used this mode for all their trips (vs. 21% and 53% respectively for men).

Figure 1: Distributions of the total number of trips (1a) and of direct commute trips (1b), among people in employment

1a: Trips for all purposes *1b: Direct commute trips*

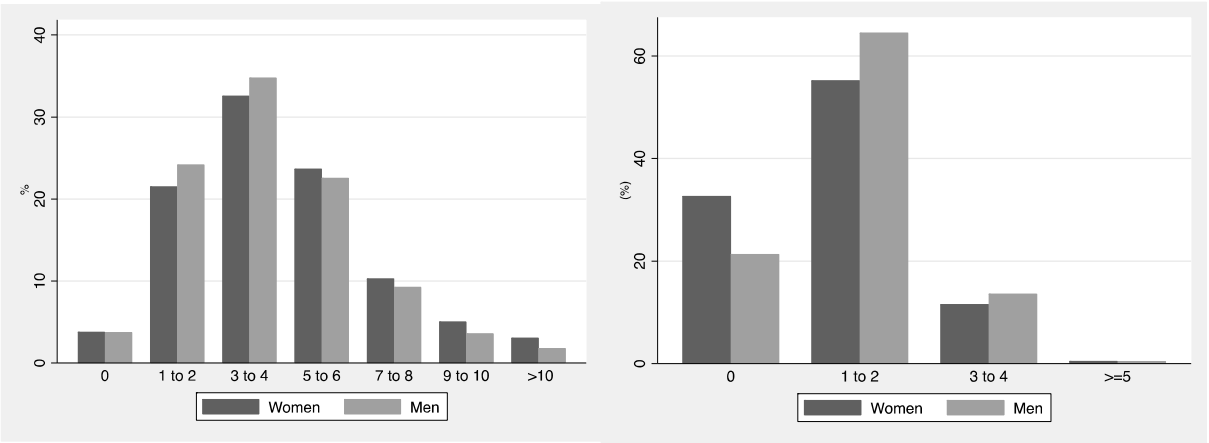
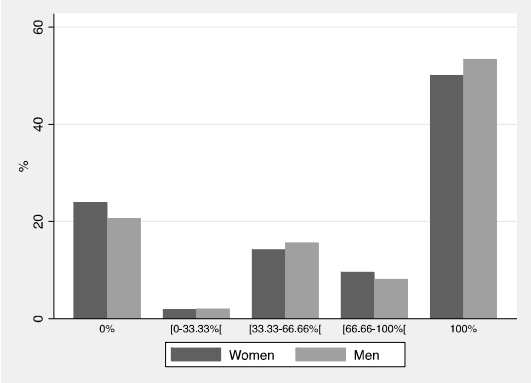


Figure 2: Distributions of proportions of daily trips made as a driver for men and women



4.2. Econometric results: determinants of mobility and gender impacts

Our use of econometric models enabled us, firstly, to examine whether the differences in mobility identified above persisted once we controlled for the differences between men and women in terms of job type, car access and socio-demographic characteristics. Secondly, we investigated, by means of interaction terms, which determinants had distinct effects on mobility patterns according to gender.

Table A.1 in the Appendix displays the results of the negative binomial model, giving the number of trips reported per day, and those of the zero-one inflated beta regression, that

provides the proportion of daily trips made as a driver. Table A.2 in the Appendix displays the results of the bivariate tobit models, explaining the distances and travel times, for all purposes at destination and for direct commute trips alone. Table A.1 shows that the use of the negative binomial model is justified by the significance of the parameter α ($p<0.001$), which confirms over-dispersion in the data. Table A.2 shows that the use of the bivariate Tobit models is justified by the significance of the parameters ρ ($p<0.001$). This means that some unobserved factors influence both the distances and travel times. Consequently, the estimation of a system of simultaneous equations is necessary to accurately assess the impact of each determinant on these variables. Furthermore, the contribution of the ZOIB is shown by the fact that different sociodemographic characteristics do not influence the non-use, partial or exclusive use of the car in the same way.

Since all our econometric models are not linear, marginal effects had to be calculated to quantify the impact of each covariate on the studied mobility indicators. The gender interaction terms included in the regressions allowed us to distinguish between these marginal effects for men and women. The main marginal effects are reported in Table 3.

Table 3. Marginal effects by gender for the main determinants of mobility patterns

	Binomial Negative Model		Bivariate Tobit Model				Bivariate Tobit Model			
	No. of trips		Total distance (km)		Total time (min)		Commuting distance (km)		Commuting time (min)	
	W	M	W	M	W	M	W	M	W	M
Number of children in the household	0.48	0.27	NS	NS	NS	NS	-1.21	-0.48	-3.76	-1.11
Working Hours:										
Full-time	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref	Ref
Part-time work	0.29	0.29	-2.73	-2.73	NS	NS	-2.07	-4.33	-3.60	-9.22
Occupational status:										
Blue-collar and agricultural workers	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Artisan, retail trader, company head	0.36	0.36	NS	NS	NS	16.23	NS	NS	NS	NS
Intellectual professions, executives	NS	NS	NS	8.83	NS	14.85	2.43	5.79	6.80	6.80
Intermediate professions	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Employee, service workers	0.21	0.21	NS	NS	NS	12.09	NS	NS	NS	NS
Education level:										
Primary-Secondary level	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Baccalauréat	0.18	-0.07	NS	NS	4.12	4.12	1.60	1.60	2.56	2.56
Short post-secondary education (Baccalauréat +2)	0.25	0.25	3.54	3.54	4.15	4.15	1.43	1.43	1.74	1.74
Bachelor's degree and +	0.22	0.22	5.36	-0.89	12.38	-3.30	1.73	0.02	1.08	1.08
Monthly income of the household										
<2,000 Euros	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
[2,000-3,000[Euros	NS	0.23	NS	1.71	NS	5.13	NS	NS	NS	NS
[3,000 – 4,000[Euros	NS	0.19	NS	4.90	NS	8.88	NS	2.51	NS	NS
4,000 euros and above	NS	0.35	NS	6.81	NS	10.63	NS	NS	NS	NS
Not reported	-0.31	0.004	-2.44	1.64	NS	8.01	NS	NS	NS	NS

Residential location										
Other	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Major urban centre	NS	NS	-6.40	-6.40	NS	NS	-2.34	-2.34	NS	NS
Outskirts of major urban centre	NS	NS	NS	NS	NS	NS	1.80	1.80	2.84	2.84
Driving licence and car available in the household	0.30	0.30	6.27	6.27	NS	NS	2.60	2.60	NS	-3.76

Notes: W: Women; M: Men; NS: not significant at the 5% level.

	Zero-one Inflated beta regression					
	Non-use of the car (% pt)		Partial use of the car (% pt)		Exclusive use of the car (% pt)	
	W	M	W	M	W	M
Number of children in the household	-2.80	-2.80	0.17	0.43	NS	NS
Woking Hours:						
Full-time	Ref	Ref	Ref.	Ref.	Ref.	Ref.
Part-time work	NS	NS	NS	NS	-4.47	-4.47
Occupational status:						
Blue-collar and agricultural workers	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Artisan, retail trader, company head	6.93	6.93	NS	NS	NS	NS
Intellectual professions, executives	NS	NS	NS	NS	NS	NS
Intermediate professions	NS	NS	NS	NS	NS	NS
Employee, service workers	NS	NS	NS	NS	NS	NS
Education level:						
Primary-Secondary level	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Baccalauréat	-5.10	-5.10	NS	NS	NS	NS
Short post-secondary education (Baccalauréat +2)	-12.60	-2.29	NS	NS	NS	NS
Bachelor's degree and +	-11.43	3.74	NS	NS	-5.95	0.61
Monthly income of the household						
<2,000 Euros	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
[2,000-3,000[Euros	NS	NS	NS	NS	NS	NS
[3,000 – 4,000[Euros	NS	-9.67	NS	NS	NS	NS
4,000 Euros and above	NS	-12.46	NS	NS	NS	NS
Not stated	NS	NS	NS	NS	NS	NS
Residential location						
Other	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Major urban centre	NS	NS	NS	NS	NS	NS
Outskirts of major urban centre	NS	NS	NS	NS	2.36	2.36
Driving licence and car available in the household	---	---	---	---	---	---

Notes: W: Women; M: Men; NS: not significant at the 5% level.

4.2.1. Gender-based differences in mobility between male and female counterparts

Apart from the case of the model explaining the number of daily trips, the coefficients associated with the gender variable (direct effects) are not statistically significant (Tables A.1 and A.2). This means that, all other things being equal, male workers had total and commute distances, associated travel times and private car use that are statistically similar to those of employed women. These results may at first sight seem to be inconsistent with the descriptive statistics presented in Table 2 and Figure 2. In fact, they rather suggest that on average men have higher distances and travel times and private car use than women, but such differences disappear when one compares men and women with the same characteristics (age, education, occupation, place of residence, *etc.*). Thus, whether for total daily mobility or work-related trips, the gender-based differences in distances and times and car use observed in the previous section are more due to job-related, socioeconomic and motorisation variables than to a direct gender-specific effect.

Indeed, according to our models (Table A.2), part-time work greatly reduced distances (both total and home-to-work), commute times and the exclusive use of the car for daily trips. However, women were more likely to be in part-time jobs (28.5% versus 6.8%, Table 1). Similarly, our regressions show that, all other things being equal, commute distances and their associated travel times were highest for the intellectual professions, executives and managers, occupations in which women were proportionally under-represented (19.4% versus 26.8%, Table 1). In the same way, total and home-to-work distances increased with ownership of a driving licence and the availability of a car in the household, two conditions that women were less often able to meet (92.6% versus 94.4%, Table 1).

Conversely, the coefficient of the gender variable ("male") is significant and positive in the model explaining the number of daily trips (Table A.1). More precisely, with the same characteristics (i.e. "all other things being equal"), men in work on average reported about 1.9 more trips per day than women in work (taking into account only direct effects and not gender-interaction effects which we shall look at more closely in the next section). So, the higher average number of trips reported by women in Table 2 (4.55, vs. 4.27) is partly due to the fact that more women than men work part-time or as employees than men (61.8% versus 43.3%, Table 1), two factors that strongly and positively influence mobility level. The fact that women have less access to the private car reinforces this effect.

Overall, gender seems to have more impact on the determinants of mobility than mobility itself, as several gender interaction terms turn out to be significant in our regressions. They highlight a different sensitivity to variables that influence mobility patterns between men and women in employment.

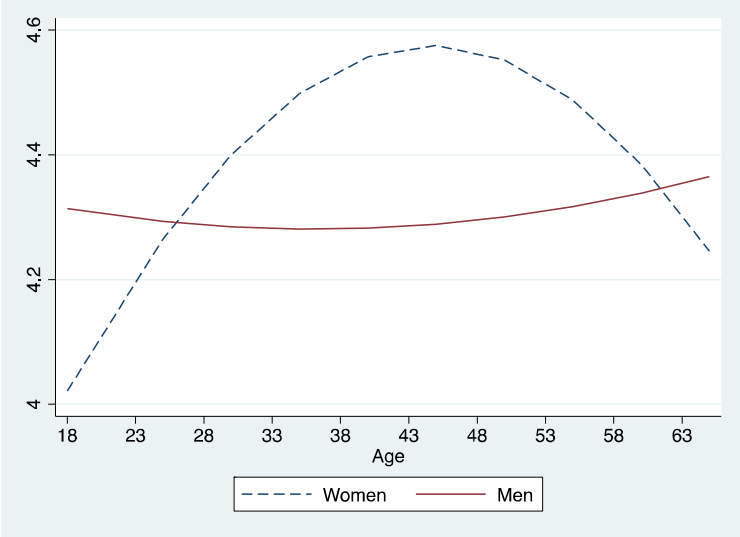
4.2.2. Women's greater sensitivity to the presence of children, occupational status, age and education

The number of children and part-time work did not influence the mobility pattern of working men and women in the same way. Our results highlight that the number of children in the household reduced the commute distance and travel time for women more than for men (by 1.21 km per child for women versus 0.48 km for men and 3.76 min per child for women versus -1.11 min for men, Table 3). In addition, having children increased the total number of daily trips, but much less for men than for women (0.48 additional trips per day per child for women, compared to 0.28 for men, Table 3). Having children also increased the proportion of

daily trips made as a driver, but this time with a stronger effect for men than for women. Part-time work had similar effects for both genders on the studied mobility indicators, with the exception of those associated with direct commuting: part-time work reduced the commuting distances and travel times much more for men than for women (respectively by 4.3 km, vs. 2.1 km and 9.2 min vs. 3.6 min).

Our regressions reveal gender-differentiated effects that are greater than those found in the existing literature. Firstly, the impact of occupational status was much more pronounced for men than for women. For example, the difference in the commute distance between a blue-collar or an agricultural worker and an intellectual worker, executive or manager was about 2.4 km for women and 5.8 km for men, all other things being equal. Furthermore, among women, the total distances and travel times are not statistically different between socio-professional categories. On the contrary, among men, an executive travelled on average 8.8 km and 14.9 min more than a blue-collar worker, all other things being equal. Secondly, the impact of age on daily mobility also differed between men and women. The significance of this variable as well as its quadratic form can be observed in the results of the Negative Binomial model explaining the number of daily trips (Table A.1). However, its effect is more U-shaped for men and inverted U-shaped for women. Figure 3 shows the average number of trips predicted for our sample as a function of age. Among people in employment, the number of trips is lower for women up to the age of 26, becomes higher than for men between 26 and 61 years, and then becomes lower again. However, age seems to have a similar effect for both genders on private car use: the likelihood of not using a car for daily trips decreases at a decreasing rate with age.

Figure 3. Distributions of the predicted average number of daily trips according to age, all other things being equal



Thirdly, our results show that even once differences in occupational status are controlled for, educational attainment has a significant effect on mobility patterns, but again this impact has to be differentiated according to gender. The number of daily trips and the commuting distance increased with education level, but less so for men than women. Moreover, being educated to bachelor's degree level or higher reduced men's total daily distance and associated daily travel time compared to workers educated to just primary or secondary level (respectively by 0.89 km and 3.30 min), while the opposite is observed for women (an increase of 5.36 km and 12.38 min). Similarly, education level has opposite effects on men

and women on the non-use and the exclusive use of a private car for daily trips. For women, being educated to bachelor's degree level or higher reduced the probability of always using the car for daily trips by 6 percentage points, and that of non-use of the car by 11.4 percentage points. However, it increased the probability of car use by 0.6 percentage points for men, as well as the probability of non-use by 3.7 percentage points. We can note, however, from Table 3, that men's lower sensitivity to education level was offset by a greater sensitivity to income. For example, the number of daily trips and the total distance increased strongly with income for men. On the contrary, women's mobility behaviour does not seem to be significantly influenced by household income, all other things being equal.

Finally, our results show that only two variables have a similar effect for men and women: residential location and access to a private car. The impacts of these determinants are in agreement with the literature on urban structure and transport. Regardless of gender, living in the outskirts of a major urban centre is associated with much higher distances and travel times for commuting (respectively 1.80 km and 2.84 min higher) and a greater likelihood of exclusive car use for daily trips (by 2.36 percentage points). In the same way, variables reflecting the individual's potential facilities or constraints for using a private car clearly had, all other things being equal, a strong impact on workers' level of mobility. Holding a driving license and the availability of a private car in the household increased the number of reported trips (+0.3) and distances (+6.27 km whatever the purpose at destination and +2.60 km for commuting trips).

5. Discussion

A better understanding of the factors that influence individual travel behaviour can provide insights into existing mobility patterns, improve transport planning and help public authorities design and implement efficient transport policies. Previous studies have long identified age, household composition, income and car ownership as the socio-demographic factors with the greatest impact on mobility patterns. The emergence of gender-specific studies then helped to show that gender is also a key variable. Despite differences according to the development and culture of countries, it appears that women are more likely to travel shorter distances (total and commute distances), to make more trips per day, to chain trips and to make greater use of walking and public transport as a transport mode. These gender differences in mobility patterns have mainly been explained by the gendered division of work in the household (a greater share of domestic responsibilities for women), differences in employment status (lower employment and pay rates, more part-time work and fewer executive occupations for women) and in access to motorized transport modes. Against this background, our article makes two main contributions: firstly, even if men and women have more similar roles, some differences in mobility patterns still persist and, secondly, the sensitivities of factors explaining the level of mobility vary by gender.

5.1. A lower women mobility still explained by differences in job status and private car access…

By focusing on the employed population of the second most populous French region, our study allows us to take an overview of the differences in mobility patterns that still persist in France today. Indeed, it is interesting to quantify these differences at a time when men and women in France have more similar roles at work and home than ever before and when the

gender-based differences in access to driving licences and private cars are gradually narrowing (Bayart et al., 2020; Havet et al., 2020). Furthermore, Tilley and Houston (2016) recently observed, using British data, what they called "the gender turnaround", i.e. that young adult women in Britain have come to travel further than their male counterparts over the last decade, which is a significant break with the findings of previous studies.

Our analysis confirms the stylized facts from the empirical literature of gender-specific studies for the Rhône-Alpes region over the period 2012-2015. On average, female workers have shorter daily travel distances (total and commutes), lower travel times and lower rates of private car use for their daily trips, but they make a greater number of daily trips (Table 2). However, once we control for men and women with equivalent characteristics (thanks to our econometric models that control for differences in job, socio-demographic characteristics and in access to transport modes), only the difference in the number of daily trips is significant and it is in the opposite direction to the descriptive statistics. All other being equal, male workers make around two additional trips per day than their female counterparts. This result could, at least in part, be explained by gender differences in terms of lunchtime habits. Working women eat much more often than men in break rooms (one third more according to the 2014 Regionsjob survey[4]) while working men report eating out more at lunchtime (21% versus only 8% for women, again according to Regionsjob, 2014). Our results suggest that not only the higher average number of trips reported by women (Table 2) but also their lower total and commute daily distances and associated travel times are entirely attributable to women's job status – which is strongly linked to the gendered division of household roles – and to their lower access to a private car, in accordance with the explanations put forward in the literature. Nevertheless, in our sample of employed individuals, we did not find the phenomenon of "gender turnaround" observed by Tilley and Houston (2016) for young people.

5.2. … but also by differences in sensitivity to determinants of mobility

Even if gender differences in employment status and access to the private car were to be eliminated, differences in men's and women's travel patterns would continue to be observed because the two genders do not have identical factor sensitivities. Indeed, our results highlight that women's mobility behaviours are only slightly impacted by socio-occupational category or household income, whereas these factors strongly influence men's total or commute distances.

5.2.1. Opposite influence of children and part-time job

The presence of children in the household has a stronger impact for women than for men (except for private car use), whereas the opposite is true for part-time work. Having children increases the number of trips more markedly for women and further reduces their commuting distances. In contrast to McGuckin et al. (2005) and McQuaid and Chen (2012), we do not find that having children increases men's commuting distance – it reduces it as for women, but to a lesser degree. This is probably a sign of the increase in the father's involvement in childcare over the last decades, even if the division between men and women is still unequal. In line with Kwan (1999), we find that having a part-time job reduces the commute distance and travel time for men much more than it does for women. We can assume that this is related to the nature of part-time work, which for men is much more constrained than chosen. Indeed,

[4] https://www.hellowork.com/wp-content/uploads/2014/09/Regionsjob-Enquete-Vie-de-bureau-sept14.pdf

in 2011, 37% of men with part-time jobs in France had them because they could not find a full-time job, while the corresponding figure for women was 31% (Pak, 2013). These gender-differentiated effects on mobility behaviour may of course be partly due to the gendered division of roles in households: "Gender order is a relation of power based on everyday practices that reproduce ideas about what is described as male or female" (Connell, 1987).

5.2.2. Great impact of individual characteristics like age and education

Moreover, the impact of age on daily mobility can also be partly explained by the gendered division of responsibilities within households. The number of daily trips among female workers increases up to 45 years old and decreases thereafter (Figure 3), when children have grown up and do not need escorting to pursue their activities, but this trend is not observed for their male counterparts. Although we are unable to rule out the influences of internalized gender differences (e.g., preference theory) and gendered cultural (Craig and Mullan, 2011) and structural contexts (e.g., labour market segmentation), our findings suggest that traditional gender roles and relations remain operative in contemporary households in the Rhône-Alpes area.

The most surprising result of our study is the significant and gender-specific effect of education level on mobility behaviours, for given socio-occupational category, working hours and income. The most educated women (Bachelor's degree level or higher) are undoubtedly the most likely to be able to limit the constraints of household responsibilities, by subcontracting some of them. This results in greater differences in total distances travelled and commute distances between highly educated and non-educated women than between males in these two groups. At the same time, a high level of education further accentuates moderate car use among women: the difference in car non-use between individuals who are highly educated (Bachelor's degree level or higher) and less educated (primary and secondary education) is less pronounced among men than among women, yet fewer women use the car for all their daily trips. Since the time lost in travelling has a far more detrimental impact for women, less educated women often opt for a more limited employment area, due to time constraints.

5.3. Gender perspectives in urban mobility policies have a future

By helping to better understand the different mobility patterns across gender, our results could be useful for planning measures to foster sustainable mobility policies and equity. One may wonder whether authorities have to adopt a gender perspective in urban mobility policies or implement measures to ensure equality in access to employment opportunities and the sharing of household responsibilities for men and women. According to our study, probably both. Gender-sensitive transport policies seem a promising way of reducing economic and social inequalities and supporting more environment-friendly development. They could consist in adapting the planning of transport services (accessibility, safety, comfort…) in response to gender needs. For example, creating a safe built environment for active modes (green lanes, cycle paths) may mean children can travel alone. Such measures could simplify women's tours and reduce the time they spend on escorting activities. Such a reduction in constraints would enable them to access more distant job areas (Elias et al., 2015). However, some differences will persist for work-related trips as long as inequalities concerning types of employment and household chores persist, even if the French law promulgated in 2014 intends to reduce gender inequalities.

6. Conclusion

It has been established that gender is a major explanatory factor for travel behaviour. This paper proposes a deeper analysis of potential gender differences with respect to work and overall daily mobility and demonstrates the need to modify transport planning policies. Based on recent mobility data gathered in the Rhône-Alpes region between 2012 and 2015, we have shown that among the working population there is no direct "gender specific" impact on daily total and commuting distances, the associated travel times and private car use. Gender differences in travel patterns appear to be as much related to differences in job characteristics or in access to the car as to different sensitivities to various factors that strongly influence mobility (age, number of children, level of education, income, for example).

Further research should focus on the influence of urban structure on immobility, through population/employment density and public transport accessibility. Travel behaviours are reinforced by the dynamics of densification and improvements to public transport accessibility. The age of children should also be considered - as the proportion of escorting trips (and thus the impact of escorting on women's time allocation) is a decreasing function of their age - as should the complexity of tours because commuting patterns are becoming more complex and women seem more likely to trip chain than men. Another avenue of research would be to obtain a better understanding of the changes in travel behaviour that have taken place in the last three decades. This will make it possible to estimate the impact of women's increasing access to the job market, a driving licence and a private car on mobility.

7. Acknowledgement

The authors would like to thank the Rhône-Alpes Region for giving them access to the 2012-2015 regional travel survey data collected in Rhône-Alpes (Enquête Déplacements Région Rhône-Alpes 2012-2015, Conseil Régional). However, the authors are solely responsible for the contents of this paper.

8. Conflict of Interest

All the authors state that they have no conflict of interest

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