Gender Differences in Daily Mobility Behaviours among workers

A longer version of this paper has been submitted to a peer-reviewed journal and is still being reviewed.
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Abstract: Gender is commonly identified as a key explanatory factor for travel behaviours. As part of econometric estimates, our approach consists in improving the characterization of the determinants of mobility level by considering gender impacts. As these determinants may vary according to the purpose at destination, we propose a focus on commute to work trips and compare the results with those concerning the wide weekly mobility. We consider the number of trips and daily distance and time budgets declared by respondents to the household travel survey, conducted by phone in the Rhône-Alpes region, between 2012 and 2015. Compared with previous research, econometric models take into account interaction between gender and other socioeconomic variables, thus enable to identify exactly the impact of gender on the level of mobility.

Keywords: Household travel survey; Mobility level; Gender impact; Multivariate Tobit.

1. Context

Gender has proven to be a major factor explaining travel behaviour: men are generally more mobile than women (Best and Lanzndorf 2005; Olmo Sanchez and Maeso Gonzalez 2016; Fan 2017). The different daily travel patterns between men and women have long been justified by the lower employment rate of women and by their more moderate access to motorized modes of transport (Hanson and Johnston, 1985). Therefore, it seems interesting to know whether these gaps also exist today for the employed population, once employment characteristics and access to private car have been controlled in econometric models. The objective of this article is to determine if French men and women continue to exhibit significantly different mobility behaviours when they have more similar roles at work and home than ever before. Our study will focus on how gender affects

commuting between home and work. As daily trips are often heterogeneous, we consider not only the number of trips, but also the daily distance and time budgets declared during the survey, to characterise the level of individual mobility. Few studies have highlighted the interaction of gender with other socioeconomic factors. We will determine whether women's mobility is more sensitive to certain variables such as age, working time, occupation, by integrating gender interaction terms into econometric specifications. To do this, we use the Rhône-Alpes regional travel survey (2012-2015), which contains socioeconomic information on respondents and information about their journeys made the day before the survey was conducted. Overall, econometric analyses will answer the following questions: Are the factors that explain commute to work trips the same as those influencing the weekly mobility, or can we isolate specific factors for each type of behaviour, with or without differences according to gender?

2. Methodology

Our study is based on the regional travel survey conducted annually from October to March in the Rhône-Alpes region of France between 2012 and 2015. 35,945 individuals aged 11 years and older agreed to participate in this three-year survey about their daily mobility, which represents a response rate of 26.5%. The phone was used as the principal data collection (CATI). Our analysis of daily mobility focuses only on people in employment, i.e. a sample of 15,937 individuals, in order to compare daily mobility for any purpose at destination and for commute to work.
We estimate multivariate econometric models in order to explore gender differences in daily mobility, by proposing a focus on direct home-work trips. Three types of econometric models are used: a count data model (negative binomial regression) to explain the number of reported daily trips and two bivariate Tobit models, jointly modelling distance and time budgets. The first bivariate model refers to all declared trips, regardless the purpose at destination, while the second focuses on commute to work trips. We use specifications with simultaneous equations since distance and travel time decisions are concomitant and interdependent. Given that a significant proportion of employed respondents (about 4%) have not declared any trips the day before the survey, we use a Tobit specification for each of the simultaneous equations to take into account of this left censoring at zero.

3. Results

The average age of respondents is 45 years (SD=10.3; min=18; max=80), with a higher proportion of women (53.6%). Almost half have a post-secondary education level, and 30% did not attain Baccalauréat (ie. British A levels). Most of the employed respondents live in a major urban centre (59%), 24% in the outskirts of a major urban centre and 17% in other areas. Almost all have a driving licence and access to a private car (93%), but only 12% are in possession of a public transport season ticket. Descriptive statistics also highlight that men and women in employment have not exactly the same characteristics (women have higher education, work more in part-time jobs and less as executives or managers than men).
On average, employed respondents made 4.4 trips per day, representing daily distance-budget of 28.5 km and daily time-budget of 81 minutes. Less than 4% were no-trip makers the day before their interview. Even among employed people, daily mobility patterns differ significantly according to gender (Table 1). While reported number of daily trips is on average higher for women (4.55 vs. 4.27; p-value=0.000), their total distance and time budgets are lower than for men

(difference of 8.5 km and 9 min per day). The gender gap was even greater when examining distance and time budgets resulting from direct home-work trips. The proportion of no-trip makers is similar for men and women (3.8%; p-value=0.860), whatever the purpose at destination, whereas there is a higher percentage of women that does not declare any direct home-work trips (33% vs. 21% for men; p-value=0.000). This difference is probably due in part to the fact that men often display standard and linear travel patterns, while women frequently make more complex travel chains (McGuckin and Murakami 1999). However, as gender differences in travel patterns can be linked to several socioeconomic characteristics (income level, job type, and access to transport modes…), the real impact of gender on mobility can only be measured accurately thanks to econometric models.

Table 1. Average daily mobility indicators among employed individuals, according to gender

	All	Women	Men
Number of total trips (all purposes)	4.42 (2.6)	4.55 (2.7)	4.27 (2.4)
Total distance budget (all purposes, km)	28.48 (36.5)	24.52 (30.4)	33.05 (42.0)
Total time budget (all purposes, min)	80.77 (71.0)	76.61 (60.4)	85.60 (81.4)
Total distance budget (commuting, km)	13.72 (23.4)	10.38 (18.8)	17.59 (27.3)
Total time budget (commuting, min)	33.16 (35.6)	28.59 (32.7)	38.45 (37.9)
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 displays the Bivariate Tobit model, explaining the distance and time budgets for direct home-work trips only. There are significant gender differences for direct commuting distances and time budgets. Men work far from home and therefore have higher transport time than their female counterparts. Many international studies have shown that women work closer to home than men do (Motte-Baumvol et al. 2014), but few have probed the reasons for this persistent result. Here, observed gender gaps cannot be only explained by job differences, since these factors are controlled in econometric models. One of the most convincing explanation has to be found in the division of roles in the labour market and in the family. Women spend on average much more time in unpaid housework and care work for children and dependent adults, including dropping them off/picking them up (McGuckin and Murakami 1999). Shorter commuting distances would thus enable women to better reconcile their higher level of household responsibilities. The coefficient of the gender variable ("male") is significant and positive in the model explaining the number of daily trips (Table 2). With the same characteristics, employed men make on average about 1.9 more trips per day than employed women (taking into account only direct effect).

By including gender interactions terms, our econometric regressions also show a different gender sensitivity to variables that affect the level of mobility. For example, the number of children increases the total number of trips but much less for men than for women, since the gender interaction terms with this variable is significant and negative (+0.47 additional trips per day per child for women compared to +0.29 for men). Moreover, it appears that direct commuting distances are shorter for women on Wednesdays, while the opposite is true for men. The significance of the age as well as its quadratic form can be observed in the results of the Negative Binomial model, explaining the number of daily trips (Table 2). However, its effect is more U-shaped for men and inverted U-shaped for women. For the direct commute to work trips, the age effect on distances

and time budgets is negative and linear for women, while it is quadratic for men (Table 3). The impact of occupational status is much more pronounced for men than for women. For example, the gap in home-work distance between a blue-collar worker and a manager is about 4.8 km for women and 9.1 km for men, all other things being equal. Moreover, this difference is about 3.8 km for women and 9.7 km for men, if we consider the daily distance budget, whatever the purpose at destination (Table 2). In addition, part-time work does not have the same impact on mobility according to gender.

Table 2. Econometric models explaining the number of trips and the distance and time budgets per day, workers for all purposes

	Daily trips		**Total distance budget**		**Total time budget**	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Constant	0.788***	0.000	9.373	0.184	21.826	0.120
Male	0.445***	0.002	-10.491	0.272	11.549	0.543
Age	0.017***	0.001	0.220	0.487	0.846	0.179
Age2	-0.001***	0.001	-0.004	0.262	-0.008	0.246
Male*Age	-0.020***	0.003	0.684	0.127	0.011	0.990
Male*Age2	-0.002***	0.004	-0.009*	0.086	-0.003	0.802
Education level (Ref: Primary-Secondary Level)						
Baccalauréat degree	0.015	0.253	2.270**	0.010	4.685***	0.008
Short Post-secondary education (Baccalauréat +2)	0.058***	0.000	4.622***	0.000	4.751***	0.009
Bachelor and +	0.051***	0.000	3.540***	0.000	6.345***	0.000
Part-time Work	0.077***	0.000	-2.606***	0.004	1.755	0.331
Male*Part-time	-0.037	0.207	-2.841	0.147	-5.246	0.179
Occupational status (Ref: blue-collar and agricultural workers)						
Artisan, retail trader, company head	0.118***	0.003	2.545	0.346	5.267	0.327
Intellectual professions, executives and managers	0.016	0.618	3.758*	0.085	9.383**	0.030
Intermediate professions	0.039	0.255	1.783	0.440	10.842**	0.018
Employee, service workers	0.064**	0.030	0.324	0.869	4.857	0.214
Male*(Artisan, retail trader, company head)	-0.081*	0.093	0.713	0.828	12.105*	0.063
Male*(Intellectual professions, executives and managers)	0.007	0.861	5.935**	0.019	4.257	0.397
Male*(Intermediate professions)	0.016	0.728	3.604	0.231	4.284	0.474
Male*(Employee, service workers)	-0.036	0.313	4.205*	0.072	8.681	0.062
Number of children in the household	0.108***	0.000	-0.021	0.968	1.389	0.182
Male*(Number of children)	-0.042***	0.000	0.039	0.958	0.840	0.566
Number of adults in the household	-0.032***	0.000	-1.123**	0.019	-0.239	0.802
Monthly income of the household (Ref: [2,000-3,000[euros)						
<2,000 euros	-0.016	0.235	-0.112	0.899	-1.403	0.425
[3,000 – 4,000[euros	-0.009	0.505	2.656***	0.003	1.985	0.257

4,000 euros and more	0.008	0.556	4.181***	0.000	3.825*	0.053
Not declared	-0.057***	0.000	-1.164	0.236	-0.408	0.835
Residence (Ref: Other)						
Major urban centre	0.013	0.312	-8.356***	0.000	1.070	0.530
Outskirts of major urban centre	-0.035**	0.011	2.247**	0.015	5.445***	0.003
Availability of modes of transport						
Driving licence and car available in the household	0.085***	0.001	9.343***	0.000	6.384*	0.051
Male*(Driving licence and car available in the household)	-0.027	0.503	-1.052	0.682	-4.808	0.346
Subscription for public transport	-0.081***	0.000	2.489**	0.044	19.046***	0.000
Male*(Subscription for public transport)	0.020	0.485	-2.199	0.244	-6.983*	0.063
Two-wheeled motor vehicles in the household	-0.016	0.159	0.695	0.368	2.568*	0.095
Male*(Two-wheeled motor vehicles in the household)	0.032**	0.036	0.759	0.466	-2.179	0.294
Bicycle in the household	0.028***	0.000	-0.014	0.962	0.730	0.212
Male*(Bicycle in the household)	-0.006	0.329	0.652	0.113	-0.417	0.611
Week day (Ref: Monday)						
Tuesday	0.063***	0.001	0.700	0.577	5.031**	0.044
Wednesday	0.047***	0.012	0.476	0.707	4.776*	0.058
Thursday	0.045**	0.016	0.176	0.890	4.010	0.113
Friday	0.116***	0.000	3.118**	0.013	10.352***	0.000
Male*Tuesday	0.003	0.918	1.921	0.297	3.007	0.412
Male*Wednesday	0.021	0.452	3.848**	0.038	9.146**	0.013
Male*Thursday	-0.001	0.976	4.630**	0.012	3.488	0.344
Male*Friday	0.036	0.179	1.940	0.288	4.358	0.231
Alpha	0.065***	0.000				
Rho			0.616***	0.000		
Log-Likelihood	-35.538			-16.1636		
Number of observations	15.937			15.937		

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

Table 3. Econometric models explaining the distance and time budgets per day for direct home-to-work journeys, workers

	Home-work distance		**Commuting time budget**	
	Coefficient.	p-value	Coefficient.	p-value
Constant	-18.563	0.004	-13.040	0.151
Male	0.820***	0.005	1.314***	0.001
Age	-0.011***	0.002	-0.015***	0.001
Age2	0.136	0.739	-0.414	0.469
Male*Age	-0.002	0.706	0.005	0.437

Male*Age2	0.820***	0.005	1.314***	0.001
Education level (Ref: Primary-Secondary Level)				
Baccalauréat degree	2.559***	0.001	3.508***	0.002
Short Post-secondary education (Baccalauréat +2)	2.344***	0.005	2.326**	0.046
Bachelor and +	1.368*	0.095	1.120	0.328
Part-time Work	-6.905***	0.000	-8.131***	0.000
Male*Part-time	-8.174***	0.000	-11.501***	0.000
Occupational status (Ref: blue-collar and agricultural workers)				
Artisan, retail trader, company head	-3.460	0.168	-5.527	0.114
Intellectual professions, executives and managers	4.844**	0.015	7.771***	0.005
Intermediate professions	-1.931	0.364	-1.685	0.570
Employee, service workers	-0.774	0.667	0.509	0.840
Male*(Artisan, retail trader, company head)	1.965	0.515	4.045	0.337
Male*(Intellectual professions, executives and managers)	4.294*	0.061	3.969	0.217
Male*(Intermediate professions)	4.747*	0.084	1.827	0.635
Male*(Employee, service workers)	4.326**	0.042	3.904	0.190
Number of children in the household	-5.221***	0.000	-8.769***	0.000
Male*(Number of children)	4.129***	0.000	7.050***	0.000
Number of adults in the household	0.616	0.156	2.158***	0.000
Monthly income of the household (Ref: [2.000-3.000[euros)				
<2.000[euros	0.218	0.787	-0.229	0.839
[3,000 – 4,000[euros	2.094***	0.009	2.244**	0.046
4,000 euros and more	2.082***	0.021	1.570	0.214
Not declared	0.029	0.974	0.164	0.896
Residence (Ref: Other)				
Major urban centre	-3.281***	0.000	2.233**	0.041
Outskirts of major urban centre	2.650***	0.002	3.753***	0.002
Availability of modes of transport				
Driving licence and car available in the household	4.770***	0.002	0.209	0.921
Male*(Driving licence and car available in the household)	-0.246	0.917	-4.662	0.153
Subscription for public transport	4.509***	0.000	20.349***	0.000
Male*(Subscription for public transport)	-1.142	0.505	-2.100	0.379
Two-wheeled motor vehicles in the household	0.891	0.215	0.838	0.404
Male*(Two-wheeled motor vehicles in the household)	-0.521	0.583	-0.520	0.696
Bicycle in the household	-0.179	0.513	-0.247	0.517
Male*(Bicycle in the household)	0.656*	0.080	0.625	0.234
Week day (Ref: Monday)				
Tuesday	0.953	0.409	2.431	0.132
Wednesday	-3.974***	0.001	-4.417***	0.007
Thursday	-0.069	0.953	1.320	0.419

Friday	-1.961*	0.091	-2.113	0.191
Male*Tuesday	0.084	0.960	-1.229	0.599
Male*Wednesday	5.703***	0.001	6.421***	0.007
Male*Thursday	3.026*	0.072	1.711	0.467
Male*Friday	0.680	0.683	0.500	0.830
Rho	0.871***	0.000		
Log-Likelihood		-112.870		
Number of observations		15.937		

3. Discussion

Despite having a similar role at work and home than ever before, men and women continue to exhibit different daily travel patterns (Olmo Sanchez and Maeso Gonzalez 2016; Fan 2017). Gender differences in mobility have been much studied and have long been justified by a lower employment rate for women, due to a greater share of home responsibilities and a moderate access to motorized modes (Scholten et al. 2012). Our work is a contribution to the empirical literature on the estimation of the determinants of level of mobility, by comparing weekly trips to commuting trips to highlight gender impact on mobility. It aims to quantify the influence of gender within the employed population on different mobility indicators, after taking into account income levels, job characteristics, access to transport modes and some socio-demographic variables, using econometric models. Thanks to recent mobility data gathered in the Rhône-Alpes area between 2012 and 2015, we show there is no "gender specific" impact on daily distance and time budget if we consider all purposes at destination (work, leisure, shopping, escort…). Among the working population, the gender difference occurs only for work-related trips. Working women have weaker commuting distance and time budget than men with similar characteristics. By including gender interactions terms, our econometric regressions also show a different gender sensitivity to variables that affect the level of mobility.

By helping to better understand the different mobility patterns across gender, results could be useful for planning measures favouring sustainable mobility policies and equity. One may wonder whether authorities have to adopt a gender perspective in urban mobility policies or to implement measures to ensure equality in access to employment opportunities and sharing of household responsibilities for men and women. Further research should focus on the influence of the urban structure, through the population/employment density and the public transport accessibility, on immobility. Another avenue of research would be to better understand changes in travel behaviour in the last three decades. This will allow to estimate the impact of increasing women's access to job market, driving licence and private car on mobility.

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