The spatial dimensions of immobility in France

Benjamin Motte-Baumvol, Olivier Bonin

Motte-Baumvol, B., Bonin, O. The spatial dimensions of immobility in France. *Transportation* **45,** 1231–1247 (2018). https://doi-org.inshs.bib.cnrs.fr/10.1007/s11116-017-9763-5

The spatial dimensions of immobility in France

Benjamin Motte-Baumvol
benjamin.motte@u-bougogne.fr
+33 3 80 39 57 35
THEMA, UMR 6049
CNRS, Université Bourgogne Franche-Comté
4 boulevard Gabriel
F 21000 Dijon,
France

and

Olivier Bonin
olivier.bonin@ifsttar.fr
LVMT, UMR-T 9403
École des Ponts, IFSTTAR, UPEM, UPE
6 - 8 avenue Blaise Pascal
Champs-sur-Marne
F 77455 Marne-la-Vallée cedex 2
France

Abstract: In travel surveys, immobility is often approached as a technical issue that needs to be dealt with in order to measure mobility more accurately. By covering mobility patterns over a full week, the 2008 French Travel Survey allows immobility to be analysed other than as a marginal and random phenomenon. For working days alone, 28.8% of the adults in the survey had experienced one or more immobility episodes. By considering the intensity of immobility, and by introducing latent variables into Structural Equation Modelling (SEM), we have been able to propose a model with reasonable explanatory power. Our findings agree with previous studies and also show that within suburban or rural areas, access to shops or the type of local residential fabric are also factors that influence the number of immobile days. In addition, our findings show that the effects of the determinants differ between categories of individuals, notably between working adults and students on the one hand, and between retired and non-working people on the other.

Key-words: Immobility, mobility, spatial analysis, travel survey, France, structural equation modeling

INTRODUCTION

According to the 2008 French Travel Survey (FTS), every day 15% of the population aged 6 or over is immobile, in the sense that these individuals do not leave their house and/or garden for an entire day. This degree of immobility matches the values found across Europe from Travel Surveys (TSs) or Time-Use Surveys (TUSs), which range from 10% to 26%, depending on the countries, sources and types of population studied (Hubert et al. 2008). In Victoria, Australia, Richardson (2007) also observed a 15% level of immobility from the local TS. In the literature, this finding is primarily seen as the result of a problem of survey methodology called "soft refusal". Madre et al. (2007) estimate, on the basis of the 1993–1994 FTS, that immobility levels should lie between 8 and 12%, rather than the 16% measured.

The processing of non-travelling individuals in travel surveys is a high-stakes issue insofar as these individuals are included in calculations of mobility indicators, generally averages or quantiles, that are therefore potentially distorted. So the number of trips per person is calculated by an average that is slanted downwards by the 15% of the population who report no trips, only a fraction of whom may have been genuinely immobile. It is also an important issue because TSs are used to calibrate models, such as traffic or Land-Use/Transport Interaction models, which often employ synthetic populations and work-based mobility models. In a disaggregated approach, made possible by the proliferation of data and massive computing power, the question of immobility needs to be included both to calibrate the models correctly and to reflect mobility behaviours accurately.

In the 2008 FTS, the questionnaire was changed and survey subjects were asked about the incidence of one or more immobility episodes (one day without travel) in the previous seven days, before being asked any questions about the previous day's trips. Immobility was therefore no longer deduced from the absence of travel but asked about directly, which should have minimised the phenomenon of soft refusal. Moreover, since the question about immobility related to the previous seven days, the 2008 FTS provided information about the incidence of episodes in an entire week, including working days, weekends and public holidays. The first analyses of the FTS revealed that 28.8% of adults had experienced at least one episode of immobility in the previous five working days. Immobility is therefore not restricted to a marginal section of the population and to weekends. In light of the extent of immobility, it seems appropriate to re-examine the determinants, both to understand the social phenomenon and to introduce these determinants into the models. Actually, immobility is often seen as an indicator or marker of social inequality, those who do not travel often being considered more isolated or excluded from society than those who move (Jouffe et al., 2015). Yet immobility remains a great unknown to the extent that is little studied in these terms.

While individual characteristics and, in particular, type of activity, are the primary determinants of immobility, our aim is also to investigate its spatial determinants in greater detail. The findings of Madre et al. (2007) reveal that immobility is greater in low-density areas. It would seem important, in tackling the spatial dimension of immobility, to move beyond this highly aggregated spatial approach and consider whether some areas are more conducive to immobility, as shown by Motte-Baumvol et al. (2015). However, constructing an explanatory model of immobility from a TS is complex, as it is probable that the real determinants of immobility are variants that are not present in the survey, such as differences in lifestyle, less need for mobility in particular occupations, or else difficulties in travelling for different physical or financial reasons. As a result, there is a high risk of endogeneity in statistical models because of missing variables. That is why we adopt Structural Equation Models (SEM) as our modelling framework, in order to introduce latent variables and relations between those variables. Our findings, obtained from the analysis of the 2008 FTS, agree with the previous studies and also show that within suburban or rural areas, access to shops or the type of local residential fabric are also factors that influence the number of immobile days. In addition, our findings show that the effects of the determinants differ between categories of individuals, notably between working adults and students on the one hand, and between retired and non-working people on the other.

LITERATURE REVIEW

Depending on the sources and the countries concerned, the level of immobility measured in the surveys ranges from 10% (Hubert et al. 2008) to 46% in Brazil (Motte-Baumvol and Nassi 2012). Immobility is therefore far from trivial in the measurement of day-to-day mobility, although the literature generally ascribes a proportion of this immobility to methodological problems. According to the 2008 FTS, almost 15% of individuals aged over 6 in France did not leave their house on any working day (Quételard, 2010). Immobility was even higher at weekends, standing at 19% on Saturdays and 31% on Sundays. The percentage of people immobile on a working day was slightly below that observed in 1994 (16%).

Tackling immobility as a measurement issue

In the few studies that have been made of immobility, questions of measurement and definition receive the most attention, as if immobility were primarily a technical rather than a social issue. Indeed, the measurement differences vary greatly between sources, as Hubert et al. (2008) show in comparing the results obtained from TSs and TUSs. In Europe in general, immobility as measured by TSs tends to be higher than that measured by TUSs (though with the exception of France), because of the particular methods employed in TUSs. Hubert et al. (2008) conclude that TSs overestimate the level of immobility because of the phenomenon of soft refusal. In a TS, soft refusal refers to the survey subject's failure to declare one or more trips, in order to complete the mobility questionnaire more quickly. Moreover, immobility is not directly surveyed, but deduced from the absence of travel or activities outside the home.

Madre et al. (2007) estimate that the immobility values could lie between 8% and 12% without soft refusal, rather than the 16% calculated from the 1993–94 FTS. In mobility surveys covering several days, soft refusal becomes an even bigger problem, potentially undermining the utility of this type of survey compared with single-day surveys. Soft refusal was therefore studied in relation to the Swiss Mobidrive survey covering a period of six weeks (Axhausen et al. 2007; Axhausen et al. 2002). The studies by Madre et al. (2007) and Axhausen et al. (2007) provide a better grasp of soft refusal in TSs, allowing it to be tackled retrospectively. It is also possible and undoubtedly preferable to address the issue at an earlier stage, by changing either the completion method or the questionnaire. As regards completion, self-administered, online or telephone surveys are those that record the highest level of immobility, by contrast with face-to-face surveys where non-declaration is lowest (Armoogum et al. 2005), since the interviewer can double check. The collection of data by GPS is not more reliable than face-to-face surveys (Armoogum et al., 2014). GPS limitations are of different natures including signal, battery, the equipment itself or its manipulation by respondents (Drevon et al., 2014).

The existence of a reward for participating in the survey also tends to increase the level of immobility declared (Richardson 2007). With a reward, the questionnaire return rate is higher, but respondents subsequently seem to be less rigorous in their answers. Conversely, it might be postulated that the answers to the questionnaire were rigorous and that the reward encouraged participation from people who would not usually respond. The implication of this is that non-respondents to TSs without rewards are more likely to be immobile. This hypothesis is now being studied very seriously by the national working group on TSs in France, following additional studies carried out on survey methods. Nevertheless, no scientific finding has yet emerged to support this hypothesis. Apart from sampling methods, the questionnaire can also be altered to tackle soft refusal. For example, specific questions about immobility can be asked before those about travel. This was the choice made in the 2008 FTS, which might explain why the level of immobility fell marginally but significantly between 1993–94 and 2008. Nonetheless, even this would not seem to completely remove the effect of soft refusal as currently assessed.

The determinants of immobility

Although Madre et al. (2007) reveal "a large random element in the choice to be immobile", corresponding to soft refusal, their study nevertheless identifies a number of factors associated with immobility. The main determinants of immobility are old age, retirement and disability. Living in an area of low density, working at home, being unemployed, or having a non-fixed workplace, are also among the chief determining factors. Other factors play a minor role, such as lack of access to a vehicle or low income. In other countries and in quite different contexts, the determinants that explain variations in the level of immobility are largely the same (Motte-Baumvol and Nassi 2012; Richardson 2007). Backing up the findings of Madre et al. (2007), Motte-Baumvol and Nassi (2012) emphasise the determining role of work on immobility, with working adults and students on the one side with low levels of immobility, and on the other side the unemployed, retired people, homemakers and other non-working people, with high levels. The other factors – such as income, age or household size – play a minor role. Women are also identified as having a greater propensity for immobility than men, as also emerges in the work of Belton-Chevallier (2015).

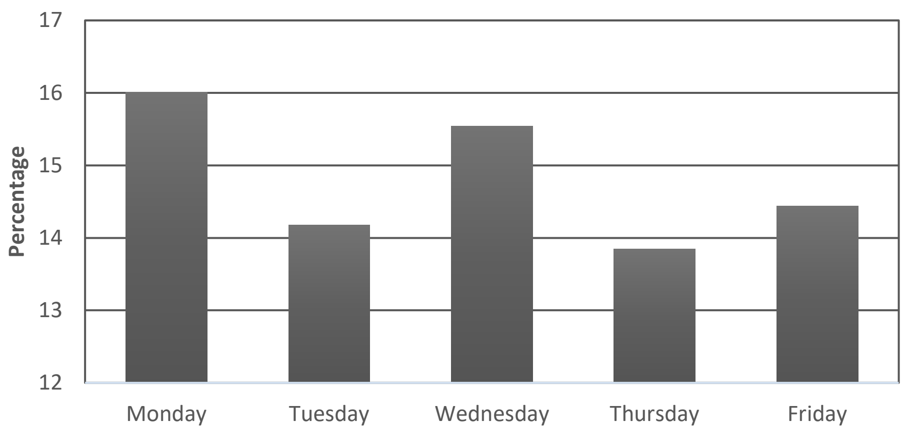
Beyond individual and household characteristics, spatial characteristics have also been identified as important determinants of immobility. Low-density areas, small towns and the outer suburbs are more conducive to immobility (Madre et al. 2007). For example, the rate of immobility is only 8% in Paris, 13% on average in urban centres with more than 100,000 inhabitants, 15% in the periurban communities around these centres and finally more than 20% in rural areas (Armoogum et al. 2010). On a more close-grained scale, Motte-Baumvol et al. (2015) show the effects of local accessibility on immobility in a study of Rio de Janeiro, where districts with poor access to jobs, shops and services have the highest levels of immobility. Moreover, this study demonstrates differences in spatial effects between categories of individuals, based on their activity. Working people show little sensitivity to spatial context whereas non-working and retired people manifest increased levels of immobility in neighbourhoods marked by poor access to shops and services. These findings in settings very different from the French context would need to be verified.

DATA: IMMOBILITY IN THE 2008 FTS

The 2008 FTS contains changes from the previous survey, and includes a specific question on immobility, rather than drawing conclusions from the absence of travel declarations. Respondents were asked: "For a week, are there any days on which you do not come out of your home (or your garden)?" As noted above, this limits the effect of soft refusal. Another change in the FTS is that it asked respondents about immobility over the last seven days. Usually, immobility as measured by TSs corresponds to an isolated episode. In general, TSs only provide a snapshot of a single day in the mobility of individuals, ignoring living patterns and arrangements over several days, which can give a better picture of individual mobility (Axhausen et al., 2007; Axhausen et al., 2002). For example, an individual who is immobile on one day may be mobile every other day of the week. Some surveys that explore the mobility of individuals over several days of the week reveal levels of immobility, over the whole period studied, that range between 5% and 8% (Axhausen et al., 2007; Axhausen et al., 2002; Chlond et al., 1999).

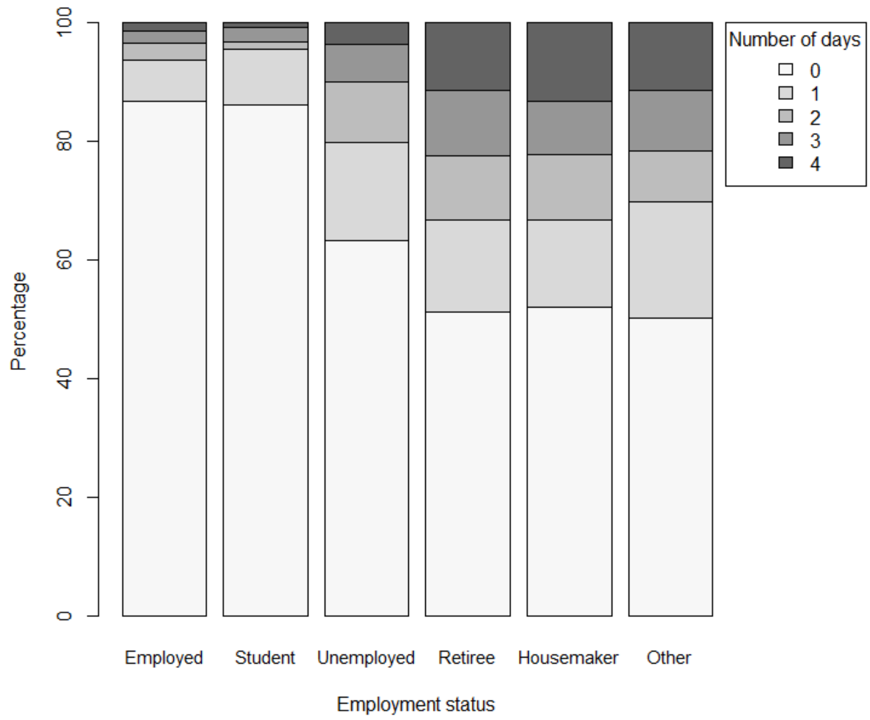
This research looks only at immobility on working days, corresponding to the days generally studied by TSs. Moreover, since weekend immobility is much higher and reveals specific patterns (Madre et al. 2007), it seems that it would need either to be studied separately or to be excluded from the scope of analysis. We chose the latter solution. Another question was whether to exclude public holidays from the analysis, days on which immobility levels are close to those observed on Sundays (Dargirolle 2014). Since the exact date of the survey was known for each individual, it was possible to separate public holidays from working days. The survey data also include a variable indicating whether the survey was conducted during the school holidays. This variable was used in our analyses, given that immobility tends to be higher during vacation periods (Richardson 2007), particularly in summer (Madre et al. 2007). Finally, this research looks only at the adult population, since minors are not as autonomous in their travel practices. It seemed interesting to limit the scope of this study to days and people for whom there are no marked and generalized restrictions on their activity programmes, such as the closure of many businesses and services on Sundays or capacity limitations for minors.

Figure 1: Percentage of adults immobile on a working weekday



Source: Calculated by the authors from FTS 2008

Figure 2: Relative frequency of immobile working days by employment status



Source: Calculated by the authors from the 2008 FTS

From the 2008 FTS, therefore, it is possible to conduct a precise and rich analysis and measurement of immobility that is unprecedented in France. From this analysis of working days, the following findings emerge.

Episodes of immobility are more frequent on Mondays and Wednesdays, whatever the category of individuals concerned. However, the differences between the days of the week are not very marked (Figure 1). The low degree of contrast between the different days of the week is explained by the high proportion of immobile individuals, notably retirees, who have several days of immobility. For the latter, additional analyses reveal that the differences between working weekdays are very small. By comparison, the contrasts are more marked in the case of working people who had been immobile for only one day in the previous week, with higher levels of immobility on Mondays and Wednesdays than on the other days of the week.

When immobility is considered for all working days, one finds that 28.8% of adults had experienced one episode of immobility (one working day or more) in the course of a week. If people who are limited in their mobility to the point of being unable to leave the house alone are removed from the sample, immobility is found in 27% of individuals. Of this 27%, more than half were in fact immobile for two days or more. One-day confinement to home is therefore widespread in the population and recurrent in the case of a number of individuals. Immobility rates vary greatly from one category of individuals to another. Working adults show the lowest levels of immobility, whereas retirees have the most frequent episodes (Figure 2). Immobility thus rises to more than 50% for retired people, whereas it stands at only 15% for people in work, with the exception of homeworkers or individuals on long-term sick leave. So the proportion of working people who are immobile is small, whereas working people form a large majority of the mobile population (Table 1).

MODEL AND METHOD

We try to explain the immobility observed in the 2008 FTS by a statistical model that employs standard socio-economic variables, housing-linked variables (i.e. describing the characteristics of the housing itself, whatever its location is), and finally variables associated with the residential environment (i.e. the spatial location of the housing). As we have seen, the reasons for immobility can be varied, and are not directly reducible to socio-economic variables. In addition, the risk of endogeneity as a result of variables omitted from the model is high.

When a single case of endogeneity is identified, it is generally possible to construct instrumental variables to overcome this problem. Previous studies have shown that no combination of variables from existing surveys can be used to predict immobility correctly, revealing that many correlations exist among these variables. We therefore chose to use the Structural Equation Modelling (SEM) framework for our model. The SEM approach focuses on correlations rather than simple causations. It is possible to introduce latent variables, thus generalizing the two-stage least squares. Both characteristics are important for our attempt to explain immobility observed in the 2008 FTS, as we need higher-level variables than those from the survey, and we need to deal explicitly with many correlations between the observations and between the variables. To our knowledge, there is no other work that uses SEM to study immobility. But there are a number of works on mobility using SEM. We drew on some of those works to develop our model and in particular the definition of latent variables (Cao et al., 2007; Jahanshahi et al. 2015; Kim, 2003; Schwanen et al., 2007). Based on this previous work, we have introduced two latent variables, one which synthesises an individual need for mobility ("individual" effect) and one which synthesises the spatial conditions for the implementation of the mobility programme ("space" effect), measured by the socio-economic variables in the FTS. The main advantage of this type of model is that it links immobility to the concepts of "individual mobility needs" and "spatial conditions of mobility implementation", which are not variables in the survey, but may be determinants of immobility as measured in the survey. In addition, we chose in the model to measure the number of days without travel, which is a variable that ranges from 0 to 5 (only working days are considered). We tried to use a binomial variable with a logit link (which lavaan supports fully since version 0.5), but, given that there are five possible levels for this variable, we finally chose to treat it as a continuous one.

The introduction of latent variables is a reasonable approach to avoiding the problem of endogeneity between variables arising from the omission of variables. Indeed, while there is a correlation between car ownership and levels of mobility, it is impossible to decide between the hypotheses that the car diminishes immobility, or that high mobility encourages people to acquire a vehicle. The fact is that one or more variables relating to lifestyle are missing, which influences both the number of immobile days and the probability of having a car. For example, an individual from a well-off suburban household is very likely to own a car, and to use it for work, children's transport and leisure, without his or her immobility depending directly on car ownership (or vice versa).

Figure 3: Path diagram of the model

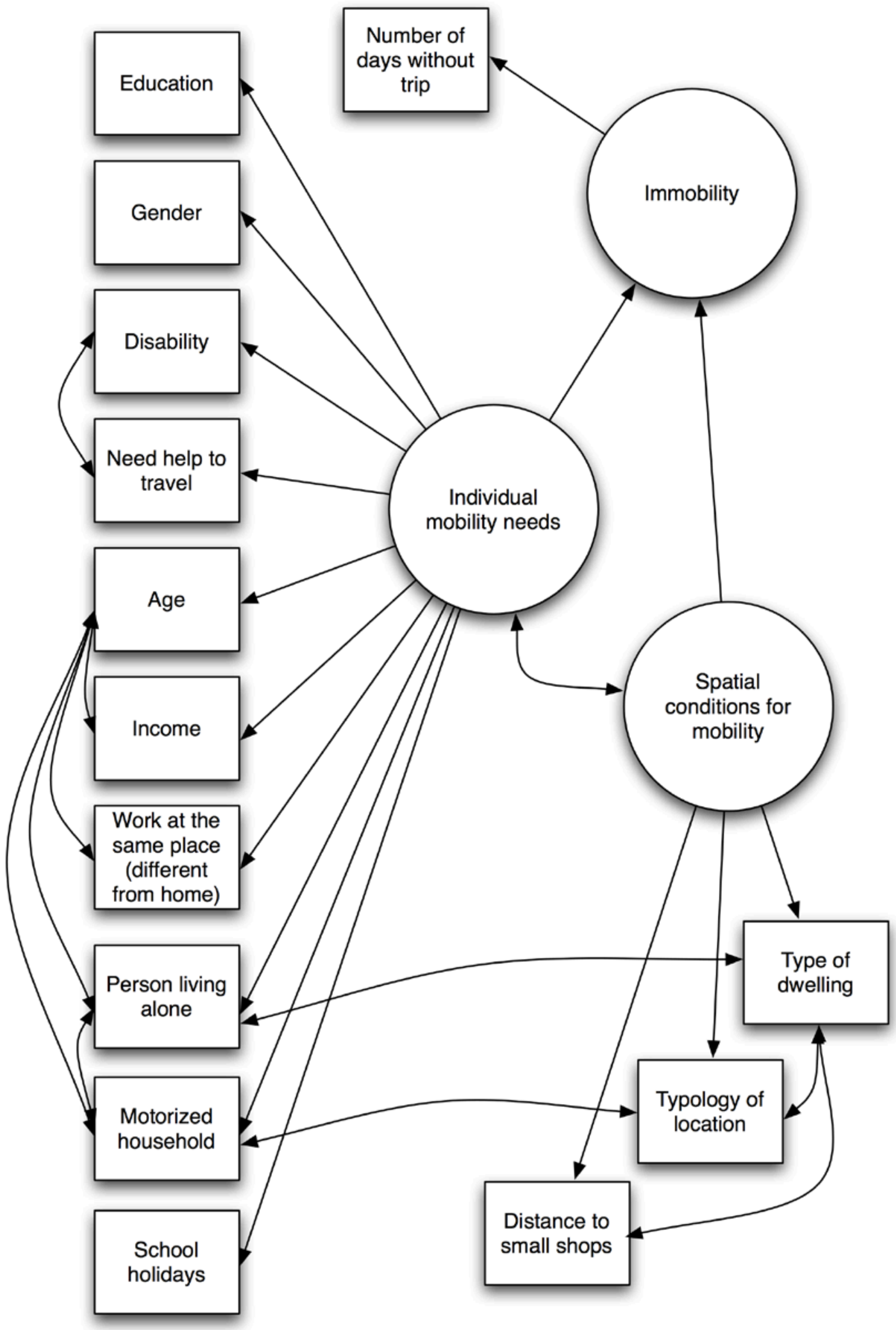


Figure 3 represents the links between the latent variables and the measurements, constructed from the socio-economic variables available in the FTS. The SEM framework also makes it possible to take account of correlations between the latent variables, as well as residual correlations between the measurements. The observations (variables from the FTS) are in boxes, whereas the variables are in circles. A double arrow indicates a correlation, and a single arrow indicates a measurement relation (from a circle to a box) or a regression (from one circle to another). The absence of an arrow means a covariance set to zero. Here, we use many measurements to construct two latent variables: mobility needs and spatial conditions for mobility that are correlated, and both cause (via regression) immobility, as observed in the FTS.

We postulate that the immobility observed in the survey can be explained, by means of latent variables, on the basis of determinants of the need for mobility, such as age, disability, income or household size, as well as by determinants of mobility conditions, such as living in a detached house or in a rural area.

Given the very high degree of difference in immobility observed between working people and students, on the one hand, and non-working people and retirees on the other, we took advantage of the possibilities offered by the lavaan library (Rosseel 2012) in the R software to introduce different groups into the model. The lavaan library can be used to transform the path diagram into a model and to estimate it via several algorithms. The first group contains working people and students likely to travel often because of their activity (though not necessarily, since some work from home), and the second those who have no immediate need to be mobile. In this way, the same model is adjusted to each of the groups, with no constraints on the values of the parameters between the groups. Then, we check whether the members of the active group work in a set location outside the home. The same model is estimated in both groups. As a factor is systematically fixed in each group, estimates can be compared between groups.

Finally, to ensure that the sample weighting is properly accounted for, we use a lavaan extension, the lavaan.survey package (Oberski 2014), which forces us to treat the number of days of immobility as a continuous variable and not as a discrete variable with five values.

The variables employed in the model

The description of the variables employed in the model, which distinguish mobile from immobile individuals, reveals that the characteristics of the immobile individuals differ clearly from those of their mobile counterparts in several respects (Table 1). First, the immobile group contains only one quarter of employed people and students. With regard to the variables of individual mobility needs, we again find a much larger proportion of individuals with a disability and reduced mobility in the immobile group. Also, the latter group contains a greater percentage of women and individuals surveyed during school holiday periods. And finally, it contains fewer high-income individuals, fewer individuals from motorized households and more individuals without qualifications.

With regard to the variables related to spatial conditions, we find that a smaller proportion of immobile individuals live in a large urban centre, and conversely that they are most heavily represented in the outer suburbs and rural areas. Brutel and Lévy (2011) present and analyse these spatial categories generally used in France (public data and policies) and which are mobilised in this work. In terms of neighbourhood, immobile individuals are most present in areas primarily made up of isolated houses and less present in city apartment blocks. Finally, on average, they live further from small shops. The distance from home to small shops is a variable computed in the FTS.

Table 1: Description of the variables employed in the model

		Mobile (N 11.900, % 71.2)		Immobile (N 4.825, % 28.8)		All (N 16.725, % 100)	
Variable	**Modality**	**N**	**%**	**N**	**%**	**N**	**%**
Activity type	*Unemployed, homemaker, retiree*	4 006	33.7	3 619	75.0	7 625	45.6
	Employed, Student	7 894	66.3	1 205	25.0	9 099	54.4
Individual needs							
No qualifications	*dummy*	2 635	22.1	2 324	48.2	4 959	29.7
Aged over 60	*dummy*	2 035	17.1	2 330	48.3	4 366	26.1
Male	*dummy*	5 438	45.7	1 725	35.8	7 163	42.8
Solo mobility	*difficult*	497	4.2	521	10.8	1 018	6.1
	on certain routes	220	1.8	359	7.4	579	3.5
	not at all	59	0.5	451	9.4	510	3.0
	yes	11 125	93.5	3 493	72.4	14 618	87.4
Person with disabilities in the household	*dummy*	1 014	8.5	1 350	28.0	2 363	14.1
Richest 20% (census)	*dummy*	4 226	35.5	1 064	22.0	5 290	31.6
School holidays	*dummy*	2 613	22.0	1 641	34.0	4 254	25.4
Person living alone	*dummy*	3 981	33.5	1 890	39.2	5 871	35.1
Fixed workplace outside the home	*dummy*	6 049	50.8	-	-	-	-
Motorized household	*dummy*	9 893	83.1	3 539	73.4	13 422	80.3
Spatial conditions							
Type of location	*Big urban centre*	7 919	66.5	2 553	52.9	10 472	62.6
	Suburbs of a big urban centre	1 822	15.3	896	18.6	2 718	16.3
	Suburbs of Paris	265	2.2	97	2.0	362	2.2
	Outer suburbs of a big urban centre	522	4.4	295	6.1	817	4.9
	Small urban centre	473	4.0	260	5.4	733	4.4
	Other outer suburbs	507	4.3	392	8.1	900	5.4
	Rural	392	3.3	330	6.8	723	4.3
Type of neighbourhood	*Isolated house*	1 563	13.1	1 024	21.2	2 587	15.5
	Other and mixed houses	6 778	57.0	2 893	60.0	9 671	57.8
	City apartment block	3 559	29.9	907	18.8	4 466	26.7
Dist. From small shops	- 600 m	7 870	66.1	2 588	53.6	10 459	62.5
	600 m to 1 km	1 246	10.5	595	12.3	1 841	11.0
	more than 1 km	2 784	23.4	1 641	34.0	4 425	26.5

Source: Calculated by the authors from the 2008 FTS

RESULTS: THE SPATIAL DIMENSIONS OF IMMOBILITY

Unsurprisingly, the models have limited predictive power (CFI of 0.758 and 0.748, TLI of 0.695 and 0.680). The CFI (comparative fit index) and TLI (Tucker-Lewis Index) compare the model to an independent model, i.e. a model with no correlation. This fact is consistent with previous models from the literature that exhibit very small R^2 or McFadden pseudo R^2 values. Our model is nevertheless very well adjusted to the data (RMSEA of 0.049 and 0.038), which means that it can be used to interpret them. Indeed, the Root Mean Square Error of Approximation is the square root of the mean of the covariance residuals. A value close to zero reveals that the model captures the correlations between the variables very well, which is what we are interested in for this analysis.

Table 2: The model

		Employed, Student			Unemployed, homemaker, retiree		
Comparative Fit Index (CFI)		**0.758**			**0.748**		
Tucker-Lewis Index (TLI)		**0.695**			**0.680**		
Root Mean Square Error of Approximation (RMSEA)		**0.049**			**0.038**		
Variable	**Modality**	**Est.**	**Std.Err**	**P(>|z|)**	**Est.**	**Std.Err**	**P(>|z|)**
Individual needs (latent variable)							
No qualifications	*dummy*	1.000			1.000		
Aged over 60	*dummy*	0.094	0.032	**	0.789	0.043	***
Male	*dummy*	-0.039	0.106		-0.332	0.035	***
Mobility difficulty (ref: none)	*Difficulty travelling without help*	0.085	0.033	**	0.117	0.022	***
	Travels without help on certain routes	0.025	0.015	.	0.207	0.021	***
	Unable to travel without help	0.011	0.008		0.407	0.030	***
Person with disability in the household	*dummy*	0.311	0.058	***	0.682	0.038	***
Richest 20%	*dummy*	-1.724	0.247	***	-0.619	0.031	***
Surveyed during school holidays	*dummy*	0.011	0.088		0.508	0.039	***
Person living alone	*dummy*	0.367	0.114	***	0.601	0.043	***
Fixed workplace outside the home	*dummy*	-0.808	0.131	***	-0.002	0.003	
Motorized household	*dummy*	-0.686	0.100	***	-0.959	0.046	***
Spatial condition (latent variable)							
Spatial category (ref: urban centres)	*Suburbs of a big urban centre*	1.000			1.000		
	Suburbs of Paris	0.004	0.015		0.058	0.019	**
	Outer suburbs of a big urban centre	0.222	0.037	***	0.181	0.045	***
	Small urban centre	0.051	0.024	*	-0.038	0.041	
	Other outer suburbs	0.299	0.035	***	0.561	0.063	***
	Rural	0.173	0.029	***	0.293	0.048	***
Local housing type (ref: housing estate)	*Isolated house*	1.782	0.102	***	2.298	0.159	***
	Apartment housing	-1.379	0.078	***	-1.328	0.101	***

Distance to small shops (ref: - 600 m)	*600 - 1km*	-0.504	0.036	***	-0.958	0.076	***
	more than 1 km	2.738	0.154	***	3.972	0.281	***
Regressions							
Immobility intensity	*Individual needs*	0.962	0.193	***	2.876	0.140	***
	Spatial conditions	0.687	0.107	***	2.532	0.273	***
Variances (latent variables)							
Individual needs		0.013	0.002	***	0.061	0.004	***
Spatial conditions		0.015	0.001	***	0.009	0.001	***
Covariances							
Disability	*Difficulty travelling without help*	0.009	0.002	***	0.051	0.003	***
	Travels without help on certain routes	0.002	0.001	***	0.034	0.002	***
	Unable to travel without help	0.000	0.000		0.034	0.002	***
Aged over 60	*Richest 20%*	0.003	0.001	***	0.029	0.003	***
	Person living alone	0.000	0.000		0.022	0.004	***
	Fixed workplace outside the home	-0.002	0.001	**	-0.001	0.001	*
	Motorized household	0.000	0.000		0.015	0.003	***
Motorized household	*Person living alone*	-0.043	0.003	***	-0.064	0.004	***
	Isolated house	0.002	0.001	*	0.009	0.002	***
	Apartment housing	-0.034	0.002	***	-0.027	0.003	***
	Suburbs of Paris	0.001	0.000	***	0.001	0.001	**
	Outer suburbs of a big urban centre	0.003	0.001	***	0.002	0.001	.
	Other outer suburbs	0.002	0.001	***	0.004	0.001	***
	Rural	0.002	0.001	**	0.003	0.001	***
Isolated house	*Person living alone*	-0.006	0.002	***	-0.002	0.002	
	Distance to small shops more than 1 km	0.008	0.001	***	0.011	0.002	***
	Suburbs of Paris	-0.002	0.000	***	-0.002	0.000	***
	Outer suburbs of a big urban centre	0.002	0.001	*	0.003	0.001	*
	Other outer suburbs	0.005	0.001	***	0.007	0.001	***
	Rural	0.005	0.001	***	0.007	0.001	***
Apartment housing	*Person living alone*	0.050	0.003	***	0.031	0.003	***
	Distance to small shops more than 1 km	-0.018	0.002	***	-0.020	0.002	***
	Suburbs of Paris	-0.002	0.001	***	-0.001	0.000	*
	Outer suburbs of a big urban centre	-0.004	0.001	***	-0.007	0.001	***
	Other outer suburbs	-0.006	0.001	***	-0.005	0.001	***
	Rural	-0.004	0.001	***	-0.003	0.001	***
Individual needs	*Spatial conditions*	-0.001	0.000		-0.001	0.000	**

Source: Calculated by the authors from the 2008 FTS

*Note 1: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

Note 2: The correlation between the presence of a person with disabilities in the household and the degree of difficulty in travelling without help is proven; it is the only correlation that proved significant and was therefore retained in the model. This makes it possible to check the effects of endogeneity between the two variables in the model.

We find evidence of the importance of the two latent variables introduced (individual mobility needs and spatial conditions for implementation of mobility). These variables make possible to order the importance of the effects between the two groups of individuals included in the model. The group of active individuals (students and employed) differs markedly from the inactive group. These variables have significant variances, and contribute to regressions. In the case of the active group, it is the individual effect that greatly exceeds the spatial effect, whereas for the inactive group the individual effect and spatial effect are of similar force. In addition, it is apparent that the variance is smaller in the case of the inactive group, since it contains individuals who are forced into immobility, such as dependent older people and a proportion of disabled people with very reduced mobility: these individuals report a very large number of days of immobility compared with the rest of the population. Conversely, in the active population, the episodes of immobility – except in the case of homeworkers – are necessarily less frequent. Both groups yield statistically different models. The introduction of restrictions on the loadings (same loadings in both groups) is acceptable, but not restrictions on intercepts and means, which sharply degrade the fit. The smaller effects of spatial conditions on the immobility of active individuals may reflect the fact that the latter are subject to greater constraints. The reasons that may result in immobility for one or more working days are more likely to be part-time or home-based work, illness, looking after sick children, vehicle breakdown, etc., than significant structural problems such as living a very long way from work locations or in an isolated house. Indeed, since we control the effect of partially home-based workers, the remaining immobility is probably accidental, or a result of under-reporting (soft refusal).

Individual effects in the active group reveal a rise in the number of immobile days with age, and a net effect of disability and problems in travelling without help. A higher standard of living and a car diminish the number of immobile days for employed individuals. Finally, active individuals living alone are slightly less immobile. In the inactive population, we find very similar individual effects with, in addition, a tendency to lower mobility amongst women.

However, we also see the emergence to a greater degree, amongst retired and non-working people, of a spatial effect that reveals greater immobility in the areas outside urban centres and even more so in rural and isolated areas. Conversely, immobility is lower in the big urban centres, including Paris. Inside these spatial categories, the type of residential fabric and the distance from local shops shows an even more pronounced link with immobility. This means that the link between space and immobility occurs at an even finer scale. For example, the type of local residential fabric is closely correlated with the number of immobile days: individuals are markedly more immobile when they live in an area dominated by detached housing than when their residential area includes mixed housing, and even more so in the case of city centre apartment buildings. Finally, individuals who live a long way from shops show lower mobility in the survey. The number of immobile days is therefore greater in low-density rural areas, away from shops and essentially characterised by a fabric of detached housing. Conversely, the number of immobile days is lowest within large urban centres, in apartment buildings and near shops. These spatial effects have the same impact on working individuals, though to a much lesser degree.

The links between individual effects and spatial effects are only detectable in the model for the category of employed individuals, which also confirms our hypothesis that individuals in this category may be prompted to relocate if necessary more than those in the non-working category. Indeed, having no strong incentive for mobility, such as the need to go to work or to classes, members of the non-working group have greater flexibility in their use of time, and can deliberately choose to concentrate a number of activities into a single day. This means that immobility is not the outcome of a constraint, but rather of the optimisation of a schedule of activities in the course of the week. This possibility of optimisation is reflected in the absence of a link between individual effect and spatial effect: the spatial constraints on carrying out a schedule of activities do not change the mobility needs, but at the most lead to a reorganisation over a week or a month. Conversely, for active individuals, a rural residential location increases the vulnerability to vehicle breakdown, causing an episode of immobility, whereas residential location in a dense urban area offers the possibility of alternative transport modes.

Because of the SEM approach and the introduction of latent variables, certain other factors linked to the number of immobile days advanced in previous studies were not significant in the present model. This was the case of car ownership, or indeed the variable that describes the general frequency of car use. We argue that these variables were highly dependent on other variables, and potentially subject to endogeneity problems. The mobility determinants introduced into the SEM capture the main effects, without calling on variables that are trickier to check. This is also the case with the weather, where rain may indicate difficult mobility conditions, but also with a geographical location or period in the year that is not explicitly included in the model.

DISCUSSION – CONCLUSION

In travel surveys, immobility is often approached as a technical issue, which needs to be dealt with to arrive at a more accurate measurement of mobility. Partly characterised as non-response, the aim is to reduce its role as much as possible. In the FTS, the questionnaire was designed to minimize soft refusal as much as possible, with existing methods and survey tools. With 15% of individuals per day, it seems that immobility measured by FTS has only a residual share of soft refusal and is one of the lowest values measured by TSs in countries with similar levels of density and close urbanization. Soft refusal does not therefore appear to cause a strong disturbance in our analysis, especially as our work focuses on the determinants of immobility and not a measure of mobility. Also, it is not demonstrated that soft refusal is not randomly distributed among individuals. This means that soft refusal is only a residual disturbance on the study of the determinants of immobility.

Social arguments also tend to consider immobility as a technical question. The analysis of general mobility behaviours, both in surveys and through semi-directive interviews, shows that French people demand the same way of life wherever they are located. There is no such thing as a rural way of life that leads to specific mobility needs that are very different from those associated with an urban lifestyle. On the other hand, the practical fulfilment of these mobility needs takes different forms, depending on the spatial distribution of amenities, transport networks and more generally the geographical context. So immobility, although it is not evidence of particular ways of life, can have determinants that are both individual (in particular disability) and spatial.

By covering mobility patterns over a full week, the FTS allows immobility to be analysed other than as a marginal and random phenomenon: we have shifted the question of immobility towards that of low weekday mobility. The FTS also allows working days to be studied separately from weekends. For working days alone, 28.8% of the adults in the survey had experienced one or more immobility episodes. By considering the intensity of immobility, and by introducing latent variables into a SEM, we have been able to propose a model with reasonable explanatory power. The findings obtained from the 2008 FTS largely confirm those obtained by Madre et al. (2007) on the basis of the results of the 1993–94 FTS, despite the differences in the survey methodology and the questionnaire. According to the findings of Madre et al. (2007), the main individual determinants of immobility are retirement and disability. Other determinants such as a non-fixed workplace or homeworking and low income, figure in our findings as they do in those of Madre et al. (2007).

With regard to the spatial dimension of immobility, our results go further. Indeed, the issue of the spatial dimension of immobility was more specifically studied. Our findings should be transposable to all types of areas, and take into account the reality of the different sizes of urban spaces or rural areas, which influence the fulfilment of mobility schedules. The use of latent variables in a SEM showed its relevance by highlighting the importance of the spatial dimension of immobility. In more traditional modelling, on the one hand it would have been difficult to incorporate all the spatial variables mobilised because of their endogeneity. On the other hand, it would have been difficult to demonstrate the interactions between these variables and conclude that the spatial dimensions of immobility should be understood at a close grained scale. Thus, the findings show that the propensity of individuals to be immobile differs between territories depending on the size of the urban area in which they are located, the density of the territory and its access to shops or transport facilities. So the populations with the lowest levels of immobility live in big urban centres, in the areas of highest density and near shops and public transport services. Conversely, individuals who live in very low-density rural areas, a long way from urban amenities, are those with the greatest propensity to immobility. Furthermore, proximity to local shops is a greater determinant of the likelihood of being immobile than living in the inner city compared with the suburbs. The importance of the spatial effects may explain why the level of immobility remains relatively high in France, a European but low-density country.

This research also enabled us to establish differences between categories of individuals in the impact of the determinants of immobility. Spatial inequalities have a greater impact on retired people, non-working people and the unemployed, than on people in work. So retirees living in a rural community away from urban amenities are more likely to be immobile than their counterparts living in the centre of a mid-sized or large city. For working people, the impact of spatial inequalities shows the same trend as observed for retirees, non-working people and the unemployed, but to a much smaller degree.

In a society that values mobility (Rémy 1996), being immobile could mean finding oneself excluded and be a sign that a society is functioning poorly. Our results point to a stronger immobility for the poorest households reflecting that immobility remains a manifestation of social inequality, at least partly. Another result is of interest for public policymaking and strengthens immobility as a manifestation of socio-spatial inequalities: immobility is also related to the location of the residence and to the level of motorisation. This tends to highlight that mobility inequality is higher in areas of low densities and low accessibility. However, our results show that this is not the case for a majority of individuals experiencing one day of immobility. First, immobility is not a marginal practice. Then immobility is particularly marked among the inactive, not just for the unemployed, but especially for homemakers or retirees. For these individuals, an immobile day still appears as a different form of weekly activity programme, with higher variability between weekdays, unlike the employed whose weekly activity programmes are structured by commuting, as shown by Susilo and Axhausen (2014). For authors who promote the mobility turn, immobility is seen as a breathing time of mobility, a mooring that allows intensive mobility (Hannam et al., 2006).

Thus, immobility appears be an interesting input to work on the variability of daily activity programmes, which recent studies, based on the Mobidrive and Thurgau data, have shown to be relevant as a research question (Schlich and Axhausen, 2003; Tarigan and Kitamura, 2009; Susilo and Axhausen, 2014). A continuation of this work on immobility could focus on the link between episodes of immobility and characteristics of the work programmes of mobile days, now that the characteristics of immobility episodes are better known.

References

Armoogum, J., Castaigne, M., Hubert, J.-P., Madre, J.-L.: Immobilité et mobilité observées à travers les enquêtes ménages de transport ou d'emploi du temps. In: Xèmes journées de méthodologie statistique. INSEE, Paris, France (2005).

Armoogum, J., Hubert, J.P., Roux, S., Le Jeannic, T.: Plus de voyages, plus de kilomètres quotidiens: une tendance à l'homogénéisation des comportements de mobilité des Français, sauf entre ville et campagne. In: La mobilité des Français, panorama issu de l'enquête nationale transports et déplacements 2008. pp. 5–24. Commissariat Général au Développement Durable, La Défense, France (2010).

Armoogum, J., Bonsall, P., Browne, M., Christensen, L., Cools, M., Cornélis, E., Diana, M., Guilloux, T., Harder, H., Hegner Reinau, K., others: Survey Harmonisation with New Technologies Improvement, SHANTI. IFSTTAR, Marne-la-Vallée, France (2014).

Axhausen, K.W., Löchl, M., Schlich, R., Buhl, T., Widmer, P.: Fatigue in long-duration travel diaries. Transportation. 34, 143–160 (2007).

Axhausen, K.W., Zimmermann, A., Schönfelder, S., Rindsfüser, G., Haupt, T.: Observing the rhythms of daily life: A six-week travel diary. Transportation. 29, 95–124 (2002).

Belton-Chevallier, L.: Prendre en compte l'immobilité dans les imaginaires de la mobilité. SociologieS. (2015).

Brutel, C., Lévy, D.: Le nouveau zonage en aires urbaines de 2010. 95% de la population vit sous l'influence des villes. Insee première. 1374, 1-4 (2011).

Cao, X., Mokhtarian, P.L., Handy, S.L.: Do changes in neighborhood characteristics lead to changes in travel behavior? A structural equations modeling approach. Transportation. 34, 535–556 (2007).

Chlond, B., Lipps, O., Manz, W., Zumkeller, D.: Auswertung zum Deutschen Mobilitäts-Panel 1998/1999: Haushaltsbefragung zur Alltagsmobilität in verschiedenen Raumtypen. Final report FE-Projekt. 70569, 98 (1999).

Dargirolle, R.: Les exclus de la mobilité: de l'observation à la décision. PhD Thesis, Université de Bourgogne, Dijon, France (2014).

Drevon, G., Jambon, F., Chardonnel, S., Christophe, S., André-Poyaud, I., Davoine, P.-A., Lutoff, C. : Évaluation comparée de l'apport de l'assistance GPS aux enquêtes de mobilité. Netcom. 28, 13–34 (2014).

Hannam, K., Sheller, M., Urry, J.: Editorial: Mobilities, immobilities and moorings. Mobilities. 1, 1–22 (2006).

Hubert, J.-P., Armoogum, J., Axhausen, K.W., Madre, J.-L.: Immobility and Mobility Seen Through Trip-Based Versus Time-Use Surveys. Transport Reviews. 28, 641–658 (2008).

Jahanshahi, K., Jin, Y., Williams, I.: Direct and indirect influences on employed adults' travel in the UK: New insights from the National Travel Survey data 2002–2010. Transportation Research Part A: Policy and Practice. 80, 288–306 (2015).

Jouffe, Y., Caubel, D., Fol, S., Motte-Baumvol, B. : Faire face aux inégalités de mobilité. Tactiques, stratégies et projets des ménages pauvres en périphérie parisienne. Cybergeo: European Journal of Geography 26697, online (2015).

Kim, S.: Analysis of elderly mobility by structural equation modeling. Transportation Research Record: Journal of the Transportation Research Board. 81–89 (2003).

Madre, J.-L., Axhausen, K.W., Brög, W.: Immobility in travel diary surveys. Transportation. 34, 107–128 (2007).

Motte-Baumvol, B., Bonin, O., David Nassi, C., Belton-Chevallier, L.: Barriers and (im)mobility in Rio de Janeiro. Urban Studies. Online first (2015).

Motte-Baumvol, B., Nassi, C.D.: Immobility in Rio de Janeiro, beyond poverty. Journal of Transport Geography. 24, 67–76 (2012).

Oberski, D.L.: Lavaan. survey: An R package for complex survey analysis of structural equation models. Journal of Statistical Software. 57, 1–27 (2014).

Richardson, T.: Immobility in urban travel surveys. In: 30th Australasian Transport Research Forum. Crawley, Australia (2007).

Rosseel, Y.: lavaan: An R package for structural equation modeling. Journal of Statistical Software. 48, 1–36 (2012).

Schlich, R., Axhausen, K.W.: Habitual travel behaviour: Evidence from a six-week travel diary. Transportation. 30, 13–36 (2003).

Schwanen, T., Ettema, D., Timmermans, H.: If you pick up the children, I'll do the groceries: spatial differences in between-partner interactions in out-of-home household activities. Environment and Planning A. 39, 2754–2773 (2007).

Susilo, Y.O., Axhausen, K.W.: Repetitions in individual daily activity–travel–location patterns: a study using the Herfindahl–Hirschman Index. Transportation. 41, 995–1011 (2014).

Tarigan, A., Kitamura, R.: Week-to-Week Leisure Trip Frequency and Its Variability. Transportation Research Record: Journal of the Transportation Research Board. 2135, 43–51 (2009).