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Daily (im)mobility behaviours in France: An application of hurdle models☆

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ABSTRACT

Our approach consists in improving the characterisation of the determinants of reported mobility without eliminating individuals who made no trip during the reference period. Sociodemographic factors that influence the decision to be mobile (vs. not making a trip) are not necessarily the same as those that influence the intensity of mobility among mobile individuals. This paper contains an assessment of hurdle models in comparison to simpler regression models. For two-part decision econometric models (hurdle and type II models), we focus on the factors influencing, firstly, the decision to travel, and secondly, the level of mobility. We consider the number of trips and the daily distance budget stated by respondents to the household travel survey which was conducted by phone in the Rhône-Alpes region between 2012 and 2015. The aim is to improve our understanding of the determinants of immobility and to estimate a function that links daily mobility level to socioeconomic characteristics given that a significant proportion of the survey population (9%) reported making no trip.

1. Introduction

Transport is one of the major urban policy challenges. Knowing citizens' mobility practices accurately is crucial for developing sustainable urban infrastructures. But immobility (i.e. no-trip makers) is a recurring problem in travel surveys, even if it is rarely studied as a subject in itself. Most of the time, research focuses on measuring the proportion of no-trip makers rather than analysing their characteristics and the causes of this behaviour (Motte-Baumvol, 2017). In a travel survey, a no-trip maker is someone who did not report making a trip during the reference period (Axhausen, 2003). Immobility is a complex notion, as there are several reasons why people may choose not to travel during the survey period. For example, one wonders how many people do not leave their home in order to travel because they are unable to. Only a tiny proportion of the target population seems to be affected (about 1%). Other people are temporarily unable to get out (1%), have to stay at home (1%) or do not want to go out because of the weather forecast (Madre et al., 2007). A significant proportion of no-trip makers may also be "soft refusals", i.e. respondents who want to avoid spending time answering, and who state at the beginning of the interview that they had not made any trips during the reference period. According to Madre et al. (2007), the proportion of no-trip makers in household travel surveys should vary from 8% to 12% for a standard one-week diary. Christensen et al. (2014) took this analysis further and noticed that the immobility level is very

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sensitive to the country which is considered and the data collection methodology (from 9% to 28% in national travel surveys conducted in Europe between 2005 and 2011). Immobility is correlated with several socioeconomic factors. The most significant of these are old age, retirement, and economic inactivity. But household characteristics and spatial variables should also be considered. A low density residential area, a low level of household income and the lack of a private car seem to increase the proportion of no-trip makers (Madre et al., 2007).

Immobility poses a problem for analysts. To study mobility patterns in-depth, they have to answer two questions separately: How do we explain the fact that some people travel while others make no trips during the reference period? Once a decision to travel has been taken, what drives some people to travel more than others during a given period? The literature has often focused on the determinants of mobility level, without establishing whether the factors that determine mobility are the same as those that influence its intensity (Bayart and Bonnel, 2012). At the present time, we are not aware of any two-stage applications that explain not only the decision to travel, but also the level of people's daily mobility. Until now in the field of transport, models with a double decision process have been more often used to provide separate explanations for the possession of a car and the extent of its use (measured by fuel expenditure) (e.g., Mannering and Winston, 1985; Asensio et al., 2003; Eakins, 2016).

The aim of this article is to identify the determinants of reported mobility without eliminating from the sample people who were no-trip makers during the reference period. We shall explore the factors that may explain immobility and try to understand if they are different from those that may explain the level of mobility for mobile persons, within the framework of the Rhône-Alpes regional travel survey. As the collected trips are often heterogeneous, we have to consider not only the number of trips, but also the estimated daily distance budget in order to characterise the level of individual mobility. We shall develop two different econometric models, according to the nature of the dependent variable. We shall use a Hurdle Negative Binomial model to model count data (i.e. number of trips). This combines a binary model that explains the mobility (vs. immobility) decision with a zero-truncated count data model to analyse trip-makers' level of mobility. We shall propose a Type II Tobit model to model continuous variables (i.e. distance budgets), which allows different specifications for the mobility decision and mobility intensity processes. These econometric analyses will answer the following questions: do the same factors explain the decision to travel and the mobility level (in terms of the number of daily trips or the distance budget), or can we isolate specific factors for each type of behaviour?

2. Materials and methods

2.1. Survey 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. This survey is similar to other Household Travel Surveys (Enquête Ménages Déplacements) conducted in major conurbations and medium-sized cities using a standard methodology (Certu, 2008). The target population is the residents of all 8 Departments in the Rhône-Alpes region, i.e. 5.17 million inhabitants living in 2880 municipalities, aged 11 years and older. The sample of respondents was built by applying a geographically stratified random procedure in order to be representative of the regional target population. 35,945 individuals agreed to participate in this three-year survey about their daily mobility, which is a response rate 26.5%.

The phone was used as the principal data collection method and the survey was computer-assisted (CATI). The questionnaire was slightly shorter than in the standard CERTU survey, taking about 20 min per person. One or two members of the household could be interviewed, according to the size of the household. The questionnaire contained three categories of questions: (1) questions about the household, (2) questions about the respondent, (3) questions about all the journeys made the day before the survey was conducted. Only weekdays were included in the survey.

2.2. Econometric specifications

We have estimated multivariate econometric models in order to explore the possible determinants of daily (im)mobility. We will retain two main indicators: the number of reported daily trips and the distance travelled. For each of these, zero values require particular attention in the econometric analyses. Not only do zero responses represent a significant proportion of the whole sample (9%, see the Results section), but also the factors that explain immobility behaviour are not necessarily the same as those that explain the number of daily trips or the distance travelled.

(i) Number of reported daily trips

Two common approaches to modelling count data – here the number of reported daily trips – are Poisson regression and the Negative Binomial model (Cameron and Trivedi, 1998; Winkelmann, 2003). But, Poisson regression requires the familiar equidispersion assumption (equality of the mean and the variance), while count data are often heteroskedastic, meaning their variance increases with the mean (overdispersion). This overdispersion can also generate an underestimation of standard errors. The Negative Binomial model is therefore often preferred, since it accommodates the potential 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:

$$ndt_i \sim Poisson\ (\mu_i), \tag{1}$$