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Cycle commuting in Belgium: Spatial determinants and 're-cycling' strategies

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ABSTRACT

This paper attempts to explain the spatial variation of the use of a bicycle for commuting to work at the level of the 589 municipalities in Belgium. Regression techniques were used and special attention was paid to autocorrelation, heterogeneity and multicollinearity. Spatial lag models were used to correct for the presence of spatial dependence and a disaggregated modelling strategy was adopted for the northern and southern parts of the country. The results show that much of the inter-municipality variation in bicycle use is related to environmental aspects such as the relief, traffic volumes and cycling accidents. Town size, distance travelled and demographic aspects also have some effect. In addition, there are regional differences in the effects of the structural covariates on bicycle use: the impact of variables such as traffic volume and cycling accidents differs substantially between the north and the south of the country. This paper also suggests that high rates of bicycle use in one municipality stimulate cycling in neighbouring municipalities, and hence that a mass effect can be initiated, i.e. more cycle commuting encourages even more commuters in the area to cycle. These findings provide some recommendations for decision-makers wishing to promote a shift from car to bicycle use.

1. Introduction

Most developed countries face environmental and mobility problems as a consequence of widespread car use. Partly due to long-term trends such as the increase in per capita income, car ownership has increased substantially since 1950 (Pooley and Turnbull, 2000; Rietveld, 2001). This has induced many changes, and made our societies more car dependent, leading to the progressive development of new low-density residential estates as well as commercial and industrial activities in peripheral locations (peri-urbanisation). Individuals now have higher levels of mobility and they travel more often, over larger distances, and carry out more complex trips (i.e. they undertake several activities in one trip) (Jensen, 1999; Knowles, 2006). This has various negative impacts upon society and the environment: congestion, air pollution, noise, vibrations, health problems (e.g. due to a lack of physical activity or the inhalation of polluting agents), accidents, growing infrastructure costs, and accessibility problems for low-income groups (Dobruszkes and Marissal, 1994; EC, 2000; Kingham et al., 2001; Bergström and Magnusson, 2003; Witlox and Tindemans, 2004; Knowles, 2006; EEA, 2007).

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The promotion of public transport and/or non-motorised modes of transport is intended to address such environmental and mobility problems. More particularly, cycling is a "green" alternative to commuting by car (Chapman, 2007; Woodcock et al., 2007). It is also a space- and energy-efficient mode of transport and is affordable for a large majority of households (Pucher et al., 1999; Rietveld, 2001; Gatersleben and Appleton, 2007; Woodcock et al., 2007). Thus a substantial shift from car to bicycle could reduce urban congestion as well as the environmental harm caused by air and noise pollution. Moreover, cycling to work provides health benefits (if performed on regular basis) (de Geus et al., 2008a,b, 2009) and may help to allay some of the growing concerns about the physical inactivity (which is the second major cause of premature death in industrial countries, after tobacco (BMA, 1992; Pucher et al., 1999; WHO, 2002a,b)).

In Belgium, while approximately 21% of commuters live within cycling distance (i.e. less than 5 km) of their work, and 39% make trips of less than 10 km, only 6% of all commuting trips are carried out with a bicycle as the main method of transport (Verhetsel et al., 2007). The percentage of people who live within 5 km of their work who commute by bicycle is relatively low (19%), and the majority (more than 53%) use their car. There is hence great potential for a shift from car to bicycle for short commutes. However, there are several societal, economic and environmental factors that dissuade people from cycling. These include a lack of cycling infrastructure, the topography, weather, road accidents, and company-related constraints. They need to be clearly identified to help policy makers to mitigate them and to promote bicycle use in Belgium. Such findings could then support the implementation of adequate policies in favour of a modal shift from car to bicycle commuting, at least for short distances.

Within this framework, we aimed to examine which factors have the greatest influence on bicycle use for commuting in Belgium. We therefore carried out multivariate analyses out at the scale of all 589 municipalities (the smallest administrative unit) in the country. A large set of "explanatory" variables was included in the analysis, with specific attention to environmental variables as well as demographic components. Spatial autocorrelation, heterogeneity and multicollinearity problems were diagnosed and treated, with the aim of improving the results.

The structure of the paper is as follows. A thorough review of the literature on the factors that have a potential impact on bicycle use is given in Section 2. The third section presents the spatial context. Section 4 describes the objectives of the paper and the data (dependent variable and explanatory variables) in more detail. The methodological approach used to deal with multicollinearity, heterogeneity and spatial autocorrelation is presented in Section 5. The results of the multivariate analyses are reported in Section 6. Potential pro-cycling strategies are discussed in Section 7, on the basis of the results. Finally, in Section 8, our concluding remarks underscore the importance of accounting for multicollinearity, spatial dependence and spatial heterogeneity to achieve reliable statistical inferences.

2. Identifying the main determinants of bicycle use

2.1. Demographic and socio-economic determinants

Socio-economic and demographic determinants include age, income, gender, education, professional field and status, and family commitments (e.g. having young children). Young commuters (<25 years) generally have low/medium income and often cannot afford a car, which has a clear impact on their choice. Moreover, some of them do not have a driving license and have to use public transport or non-motorised forms of transport when they travel to work. The physical abilities of individuals also depend on their age: young commuters are more likely to enjoy good physical health and to cycle more. Gender has an influence on the decision on whether or not to cycle: on average, men cycle to work more often than women, although women travel shorter distances than men (Ortúzar et al., 2000; Dickinson et al., 2003; Vandenbulcke et al., 2009; Heinen et al., 2010). Among other factors, women tend to give their personal security as a reason for not using a bicycle, and often make more complex trips than men due to family commitments (Pooley and Turnbull, 2000; Dickinson et al., 2003; Rietveld and Daniel, 2004; Gatersleben and Appleton, 2007).

Education also has a strong influence on bicycle use, but this depends on the area being studied. In North America a high educational level is positively associated with cycling (Noël, 2003; Plaut, 2005; Zahran et al., 2008), whereas the opposite effect is observed in Santiago (Chile) (Ortúzar et al., 2000) and Belgium (Hubert and Toint, 2002). Lastly, the professional field and status play a role (SSTC, 2001; Titheridge and Hall, 2006; Parkin et al., 2008; Heinen et al., 2009, 2010). For instance, Pucher et al. (1999) showed that in San Francisco lots of messengers are immersed in a cycling culture and use their bicycles in spite of the hilly topography. Bicycle use for commuting is generally high in academic towns (Martens, 2004; Rodríguez and Joo, 2004).

2.2. Cultural and societal determinants

The literature often mentions that societal and cultural factors influence bicycle use (see e.g. Jensen, 1999; Pucher et al., 1999; Ortúzar et al., 2000; Rietveld, 2001; Dickinson et al., 2003; Rietveld and Daniel, 2004; Plaut, 2005; Pucher and Buehler, 2006; Zahran et al., 2008; Heinen et al., 2010). A low societal status often tends to be associated with commuter cycling, especially in countries where the car is dominant (e.g. US); utilitarian cycling is often considered as a fringe activity and suffers from a renegade image (Pucher et al., 1999; Moudon et al., 2005). However, the cycling culture is quite developed in some Northern countries of Europe (e.g. the Netherlands and Denmark). Such differences between countries, regions or