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Mode choice in home-to-work travel in mid-size towns: The competitiveness of public transport when bicycling and walking are viable options

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Abstract

It is widely recognized that the transport system contributes significantly to current environmental problems such as global warming, as well as to health issues caused by emissions and lack of exercise. For the transport system to contribute to sustainable development, the link between economic growth and growth in motorized transport must be broken. Since high population densities and shorter distances provide greater potential for efficient public transport as well as for walking and biking, the highest potential for change is in urban areas. As a large proportion of urban travel consists of home-to-work travel, such travel will be our focus in this paper. More specifically, this paper aims to analyze the factors that determine mode choice in situations where bicycle and walking are competitive options and to contribute to the knowledge of the conditions under which public transport can be a competitive alternative to the private car. The results of this study could be used to devise policies for reducing car dependency in urban areas. The results show that even if it is possible to attract new passengers to public transport through changes in the public transport system (i.e., reduced fares or reduced travel time) few of these new passengers will be shifting from private car use. To achieve a shift from private car to walking, bicycling or bus riding, such policies must be combined with restrictions (and/or cost increases) on car use.

Keywords: Mode choice; Public transport; Car; Bicycling; Walking

1. Introduction

"The overall objective of the Transport Policy is to ensure an economically efficient and sustainable transport system for citizens and industry throughout the country" (Bill 2008/09: 93, p. 14). As part of the fulfilment of this goal for the Swedish transport system, it is said that the transport system should be (re)designed so that it contributes to reducing climate impact as well as improving public health. For such a redesign to be possible, a greater proportion of future travel must be made by bicycle, by foot or by public transport. This perspective is in line with that of Banister (2008; 2013), who discusses the need for urban societies to achieve more sustainable mobility solutions, along with the conditions required for these solutions to be possible. Similarly, Nakamura and Hayashi (2013) discuss strategies for low-carbon urban transport, in which encouraging a modal shift (in favour of public transport) plays an important role.

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However, at the local level, public transport use has been on the decline, both in absolute terms and in terms of the share of total transport trips. The market share that has been lost by public transport has primarily gone to the private car. This negative trend has been continuing since the 80s (Holmgren, 2005; Holmgren et al., 2008).

In both large and mid-sized cities, the living environment is negatively affected by car traffic. Noise, pollution, congestion and risk of accidents can be reduced if current drivers can be encouraged to use public transport instead of private cars and if the perceived need for owning cars can be reduced.

Many previous studies of mode choice focus on situations where the private car has a dominant market position (e.g., Hensher, 1998) and where non-motorized modes such as bicycles and walking play a marginal role, if they are included in the analysis at all. In such contexts, the natural competitor to the private car is public transport in all its forms; therefore, many studies focus on the choice between public transport and private car (e.g., Hensher, 1998; Meyer, 1999; Beirao and Sarsfield Cabral, 2007). For example, studies by Hensher (1998), Meyer (1999) and Hensher et al. (2013) also discuss methods for steering people towards increased use of public transport. They show that the most efficient way of achieving such a development is to increase the costs of car use and reduce the overall attractiveness of using a car. Hensher (1998) concludes that buses are a more flexible mode compared to trains for triggering a modal shift.

Although highlighting the choice between public transport and private car can give a good idea of the overall impact of different policies on public transport travel in the short run, it overlooks a very important issue. From an environmental and health-based point of view, we should also ask ourselves how travellers using different modes are reacting to different measures. One of the most common reasons for a traveller to choose to go by car instead of the bus is that it is quicker. It is important to note that certain types of policy measures aimed at attracting passengers to public transport (such as reducing fares) are likely to primarily attract former cyclists and pedestrians, a result that appears to be incompatible with the policy objectives for the transport system.

In order to enable the planning of future public transport systems that address health and environmental concerns, it is important to understand how the use of different modes of transport, including bicycling and walking, is affected by the design of the public transportation system. Such knowledge is particularly important for small and mid-sized towns where bicycling and walking have a large share of the total (local) travel.

The aim of this paper is to analyse the factors determining mode choice in situations where bicycles and walking are competitive options and to contribute to the knowledge of the conditions under which public transport can be a competitive alternative to the private car. A related objective is to discuss how car users could be won over to public transport without reducing the number of people bicycling and walking; this objective is directly linked to the policy objective of improving possibilities for choosing public transport, walking and bicycling. In this article, we study these factors using revealed preference (RP) data from a mid-size Swedish town with a substantial market share for walking and bicycling.

The knowledge presented in this paper could be used to determine measures to reduce long-term car dependency in favour of more sustainable modes of transport. The results of this paper can therefore be used in traffic and urban planning and can contribute to ensuring good communication and an efficient use of resources in the transport system.

2. Method and data

The demand for different transport modes has been extensively studied using different kinds of methods and data. For overviews of previous results concerning public transport demand, see Webster and Bly (1980), Oum et al. (1992), Goodwin (1992), Balcombe et al. (2004) and Holmgren (2007). Dargay (2001), Goodwin et al. (2004) and Espey (1998) analyse the demand for petrol and car use, while Daly (2013) provides an overview of the history of mode choice analysis.

Empirical studies of mode choice are based on two main types of data (Bateman et al., 2002; Freeman, 2003; Louviere et al., 2006; Haab and McConnell, 2003). In so-called revealed preference (RP) studies, people's actual behaviour is observed and used as data. At the individual level, data can be collected using questionnaires in which respondents' travel patterns are documented in detail. Data are then analysed using logit or (less commonly) probit models, in order to estimate the probabilities of individuals with different characteristics choosing a particular mode of travel. The choice is often assumed to be strongly influenced by the perceived total cost (generalized cost) of making a trip, with a particular mode where total costs include monetary costs as well as time costs.

The second type of (individual) data that can be the basis for studies of transport mode choice is stated preference (SP) data. These are obtained by having respondents in surveys face hypothetical choices. For example, they can choose between different modes of transport (car, bus, bicycle or walking) for situations with varying petrol prices, bus fares, trip length and weather. This type of data can then be analysed using the above-mentioned statistical tools. These types of models are often used in planning, usually as part of a larger multistage model. With the help of such models, it is possible to estimate how changes in a public transport system affect travel patterns for different types of individuals (Ben-Akiva and Lerman, 1985; Ortuzar and Willumsen, 2001; Ben-Akiva et al., 2004).

It has been common practice to use these types of models to analyse the choice between private car and public transport. Commuters have been a particularly common focus of study (see e.g., Espino et al., 2007; Bajić, 1984; Swait and Ben-Akiva, 1987; Dunne, 1984). Other studies have focused on which factors affect bicycling; however, these studies do not explicitly acknowledge the influence of the conditions under which other modes of transport are operating (Hunt and Abraham, 2007; Parkin et al., 2008; Ortuzar et al., 2000; Wardman et al., 2007).

There are also studies in which bicycling is seen as a complement to public transport and as a link in a complete travel chain. In these studies, bicycling (and walking) are seen as ways to get to and from bus stops and train stations. This perspective has been particularly acknowledged in the Netherlands, where it is very common for commuters to combine bicycle and train in order to carry out a complete trip (Martens, 2007; 2004; Rietveld, 2000; Debrezion et al., 2009). These studies show the importance of taking into account how walking and bicycling can be complements as well as substitutes for other modes, depending on the situation and destination.

In the present study, we use RP data in an investigation of how various factors affect the choice of transport mode for home-to-work travel. By including public transport, car, bicycling and walking among the selectable options, the risk of obtaining misleading results is reduced. The present study uses data from a small town (or mid-sized from a northern-Europe perspective), which will contribute to the usefulness of the results. In such locations, bicycling and walking constitute strong competitors to the private car and to public transport. The results will thus be of use to local decision makers and urban planners in small and mid-sized towns.

2.1. The data

In this case, the choice of travel mode was studied by sending questionnaires to a random sample of the population. Since we expected differences in the choice of travel mode to work (or to school) depending on the season of the year, we took two surveys. Survey 1 gathered data on mode choice for trips during the winter months. It was conducted during February and March 2013. Survey 2 examined travel behaviour during summer (i.e., non-winter) months and was conducted during August and September 2013. Both surveys tried to take into account the actual travel opportunities of the respondents and focused on actual travel behaviour as well as hypothetical behaviour. Both surveys were conducted in the town of Linköping, Sweden.

The object of this study is travel to work when car, bus and bicycle/walking are the possible travel mode options. Therefore, the population was defined as people who live and work in a delimited area where the investigated transport choices can be realistic travel mode options. Our chosen area of study is the 26 neighbourhoods defined as the densely built-up area in Linköping (Linköping municipality, 2013) together with 4 other nearby neighbourhoods.

The samples were drawn randomly among all persons aged 20–65 years living in a range of postcode areas. Some of these postcode areas partly include persons who live outside the 30 selected neighbourhoods, which led to some individuals being excluded from the sample since they did not live in the selected area and thus were not part of the population. In addition, people not working or studying within our selected area were not considered part of the population. Due to these corrections, defining the correct sample size, and therefore also the response rate, is difficult. Table 1 shows the number of persons in the original sample, the number of persons found not to be part of the samples, the number of usable answers and the response rate.

Table 1 Sample sizes, answers and response rates in the studies

Survey	Original sample	Persons known not to be part of the defined population	Usable answers	Response rate
October-March	1500	377	504	45 %
April-September	1500	335	519	45 %

In addition to some individuals being removed from the sample due to not living in the defined areas, those not working or studying were also excluded, as well as those working outside the defined area of interest (i.e., long-distance commuters). After these corrections of the sample, the response rate was 45 % in both surveys. Since some of those who did not respond most likely also should have been excluded from the sample due to not being part of the population, it could be argued that the response rate is in reality higher than 45%.

The primary purpose of the surveys was to collect information about the actual choice of travel mode to work or school, together with information about travel conditions such as time and expenses for travelling with different transport modes for each respondent, in order to be able to explain the choice of travel mode. Another purpose was to examine what factors would make persons presently travelling with other transport modes change to bus.

After an initial question about current employment, the respondent answered questions about how they actually travelled to their work or place of study in the previous week. The questions were about mode choice, frequency, the specific reason for the choice, and travel time. In survey 2, the respondent was also asked how he/she usually travels to work/studies on a normal day in April to September. In both surveys, questions about the availability of parking facilities at work or school, distance to bus stops, whether a bus change must be made on the way, and the time and cost of different modes of travel to work or studies were included.

2.2. A descriptive overview of mode choice for trips to work

In this article, the behaviour of those travelling to work will be analysed; that is, trips to school will not be included here. Table 2 shows the proportion of the respondents that are women and the average age of all respondents travelling to work.

Table 2 Gender and age of the respondents travelling to work

Survey (number of respondents)	**Share of women**	**Mean (median) age**
Winter (403)	52.1 %	46.3 (46.5)
Summer (434)	53.2 %	44.6 (45)

Table 3 shows the difference in mode shares between summer and winter.

Table 3 Travel mode to work last week

Survey	**Walk**	**Bicycle**	**Car**	**Bus**	**Other**
Winter	17.9 %	27.8 %	47.4 %	6.9 %	
Summer	12.7 %	50.2 %	30.8 %	6.1 %	0.2 %

In terms of travel mode choice, the proportion of bicycle users is less in winter and the share of other travel modes is higher. In particular, the proportion of car users is higher in the winter while the share travelling by bus seems to be almost unchanged between summer and winter.

There also appear to be some differences in seasonal behaviour according to gender, as seen in table 4.

Table 4 Choice of travel mode to work for women and men

	Walk	**Bicycle**	**Car**	**Bus**	**Other**
Winter (women)	21.3 %	28.4 %	39.8 %	10.4 %	
Winter (men)	14.1 %	27.1 %	55.7 %	3.1 %	
Summer (women)	14.2 %	51.6 %	27.6 %	6.7 %	
Summer (men)	10.7 %	49.2 %	34.0 %	5.6 %	0.5 %

Men appear to change from bicycle in the summer to car in the winter. For women, the shift from bicycle during the winter seems to be spread out more evenly over other modes. Therefore, when it comes to the bus, women are more frequent users in winter, while men appear to travel by bus even less in winter. The latter finding should, however, be interpreted with caution since it might be due to random variations in the sample.

3. Explaining Mode choice

In general terms, individuals are assumed to choose the mode of transport that maximizes their utility. The utility derived from using a specific mode depends on attributes of the mode in question as well as characteristics of the user. De Witte et al. (2013) provide a review of the literature on key determinants of mode choice. The indirect utility derived by individual i from choosing mode j can therefore be expressed as:

$$V_{i,j} = \beta' \mathbf{x}_{i,j} + \gamma' \mathbf{z}_i + \varepsilon_{i,j} \qquad (1)$$

where xi,j are the mode-specific attributes and zi are the user-specific characteristics. Since it is generally not possible to capture all attributes of the modes nor all characteristics of the users, a random term, $\varepsilon_{i,j}$, is included in the expression. The consumer is assumed to choose the alternative that maximizes her utility, and the probability of choosing mode j is therefore:

$Prob(V_{i,j} > V_{i,k})$ for all other $k \neq j$.

Making the common assumption that the error terms are independently and identically distributed following an extreme value distribution, this can be expressed as:

$$Prob(mode\ j) = \frac{exp(\beta' \mathbf{x}_{i,j} + \gamma' \mathbf{z}_i)}{\sum_{m=1}^{J} exp(\beta' \mathbf{x}_{i,j} + \gamma' \mathbf{z}_i)} \quad (2)$$

Table 5 shows the variables initially included in estimation of (2). The available choices are walking, bicycling, car or bus. The choice-varying attributes are the time it takes to travel (normally) between home and the workplace and the total cost of making that (one-way) trip. Both time and cost are part of the generalized cost of using a mode, and increases in monetary cost and/or time requirement for a specific mode are assumed to result in reduced probability of choosing that mode and increased probability of choosing other modes.

The characteristics connected to individuals include (disposable) income, of which the expected effect on the probabilities is uncertain. Higher income generally increases the probability of owning one or more cars, which naturally increases the probability of going to work by car. However, higher income is also correlated with higher education and there are studies indicating that people with higher education are, all other things being equal, more likely to choose biking or walking than those without higher education. Therefore, in an attempt to separate the effects of income and education and access to car, the number of cars owned by the family as well as whether or not the person making the choice has taken part in higher education are also included among the variables (in addition to income). Since it is reasonable to assume that taking a bicycle or walking to work is less likely in winter than in summer, a variable indicating the time of year in which the choice was made is also included in the model. Given the number of cars available to a family, increasing the number of family members is likely to reduce the probability of travelling by car; therefore, the number of family members is also included. Having children might result in a more complex route to and/or from work, since the trip might include a stop at the day care, school, or at other activities. It is assumed that such requirements make it more likely to choose car over other modes. Therefore, two variables describing the number of children in the family are included in the analysis: one indicating if the family has children below the age of 7 and one indicating if the family has children above that age.

Table 5. Variables initially included in the estimation of equation (2)

Variable	**Description**
Y (mode choice)	Walk, bicycle, car, bus
$\boldsymbol{X}_{i,j}$	
T	Door-to-door travel time for individual *i* with mode *j*
C	Total monetary cost per trip by mode *j* for individual *i*
z_i	
Ch	Change of bus needed for door-to-door trip by bus, 1=yes, 0=no
I	Disposable income per adult family member
G	1=woman, 0=man
E	1=education on university level, 0=education below university level
W	1=choice made in winter, 0=choice made in summer
Ca	Number of cars owned by family
F	Number of family members
Co	1=family has at least one child of age 7 or above living at home. 0=otherwise
Cy	1=family has at least one child under the age of 7 living at home. 0=otherwise

Since the z variables do not vary between alternatives, it is not possible to estimate their effect on the utility of different modes. It is, however, possible to estimate the differences in effects of a characteristic, such as gender, on the utility of different modes. The estimated effects are therefore expressed in relation to a normalizing mode that is used as a point of reference. In this study, the car is used as the reference mode, since it makes the results easy to interpret in relation to the official policy of reducing society's car dependency. Initially, all characteristics are included in the utility function of all (non-normalizing) modes, with the exception of the variable indicating if an individual has to change buses if going by bus to/from work. The change variable (Ch) is assumed to (potentially) affect the utility of using the bus only.

The initial specifications of the utility functions can be seen below:

$$V(Walk) = \alpha_0 + \alpha_1 T_{i,1} + \alpha_2 C_{i,1} + \alpha_3 I_i + \alpha_4 G_i + \alpha_5 W_i + \alpha_6 Ca_i + \alpha_7 F_i + \alpha_8 Co_i + \alpha_9 Cy_i + \alpha_{10} E_i + \epsilon_{i,1}$$

$$V(Bicycle) = \beta_0 + \beta_1 T_{i,2} + \alpha_2 C_{i,2} + \beta_3 I_i + \beta_4 G_i + \beta_5 W_i + \beta_6 Ca_i + \beta_7 F_i + \beta_8 Co_i + \beta_9 Cy_i + \beta_{10} E_i + \epsilon_{i,2}$$

$$V(Car) = \gamma_1 T_{i,3} + \alpha_2 C_{i,3} + \epsilon_{i,3}$$

$$V(Bus) = \delta_0 + \delta_1 T_{i,4} + \alpha_2 C_{i,4} + \delta_3 I_i + \delta_4 G_i + \delta_5 W_i + \delta_6 Ca_i + \delta_7 F_i + \delta_8 Co_i + \delta_9 Cy_i + \delta_{10} E_i + \delta_{11} Ch_i + \epsilon_{i,4}$$

Each of the non-normalizing modes also includes a mode-specific constant, and it is worth noticing that the specification allows for different parameters for the time variable (T).

Table 6. Results from estimation of Conditional Logit model

Variable	Estimated coefficient	Standard error
Walk		
Constant	4.98***	0.533
Time	–0.178***	0.0147
Cost	–0.167**	0.00696
Gender	0.818***	0.308
Number of cars	–1.28***	0.248
Bicycle		
Constant	1.8***	0.533
Time	–0.133***	0.0136
Cost	–0.167**	0.00696
Gender	0.363*	0.207
Education	0.721***	0.152
Winter	–1.05***	0.174
Persons in household	0.14**	0.0716
Number of cars	–1.4***	0.184
Car		
Time	–0.0319	0.0205
Cost	–0.167**	0.00696
Bus		
Time	–0.0458***	0.0126
Cost	–0.167**	0.00696
Gender	0.978***	0.359
Persons in household	0.523***	0.161
Small children	–0.796***	0.3
Number of Cars	–2.048***	0.325
Education	–0.494**	0.245

In estimating the model, variables not found statistically significant were eliminated one by one and then tested for re-entry into the model after each previous elimination of a variable. The result of this process is shown in table 6.

It can be seen that the estimated coefficients for the generalized cost components—time and monetary cost—all have the expected sign and that they, with one exception, are statistically significant. The coefficient for the time variable is not significant in the car alternative.

Gender is found to have a statistically significant impact on all alternatives, which should be interpreted as women, all other things kept constant, being more likely to choose other alternatives than the car (or that men are more likely to take the car to work). This effect is strongest in the bus alternative.

The number of cars owned by the family also has a significant impact on which mode of transport is chosen, in that the more cars a family owns, the higher the probability of a family member choosing to use a car. This finding is unsurprising.

Higher education appears to have a positive impact on the probability of using bicycle for work trips and a negative impact on the probability of choosing a bus.

During winter, the probability of choosing bicycle is reduced. Since the same effect cannot be seen for walking, it may be more related to safety and accessibility than to temperature.

Being a part of a larger family increases the probability of choosing to use bicycle, and the same goes for bus. This is not surprising, since the number of cars remains constant and more people per car should reduce availability. This effect is not present for the walking alternative, which could be interpreted as members of large families preferring to use bicycle or take the bus to walking when a car is not available.

Having small children is found to have a significant negative impact on the probability of taking the bus to and from work. This might be due to many parents having to drop off and pick up children on the way to and from work, since bus routes are not normally adapted for such errands (O'Fallon et al., 2004). The same effect is not present for walking and bicycling, which may be due to parents who live close to schools, day care or work using these alternatives, while those with longer journeys prefer car, and very few prefer the bus.

Since the estimated coefficients cannot be directly interpreted, it may be interesting to take a closer look at the elasticities with respect to the generalized cost components, as these are more under the direct control of policy makers. Table 7 shows the estimated elasticities with respect to time.

Table 7 Elasticities with respect to time

Elasticity wrt change of *X* in row choice on Prob[column choice]				
Time	**Walk**	**Bicycle**	**Car**	**Bus**
Walk	–7.9972	.4392	.4392	.4392
Bicycle	.8398	–1.7974	.8398	.8398
Car	.1826	.1826	–.2290	.1826
Bus	.0826	.0826	.0826	–1.3825

Not surprisingly, the elasticities vary considerably. A 1 % increase in walking time reduces the probability of choosing walking by almost 8 %. At the same time, increasing travel time by car by 1 % decreases the probability of choosing car by 0.23 %.

Focusing on the effects on car use and bus riding, it is clear that reducing bus travel time has only a small effect on the probability of using car, since the cross-elasticity for car probability with respect to bus travel time is only 0.08. For the bus alternative, reducing bus travel time appears to have the largest positive impact and increasing bicycle travel time the second largest. The largest effect for reducing car use appears to be the reduction of travel time by bicycle.

Table 8 shows the elasticities with respect to cost. Since walking and bicycling are considered to be without monetary cost, the elasticities are in these cases are zero.

Table 8 Elasticities with respect to cost

Elasticity wrt change of *X* in row choice on Prob[column choice]				
Cost	**Walk**	**Bicycle**	**Car**	**Bus**
Walk	.0000	.0000	.0000	.0000
Bicycle	.0000	.0000	.0000	.0000
Car	.1545	.1545	–.2305	.1545
Bus	.0205	.0205	.0205	–.3247

Increasing the cost of car use by 1 % reduces the probability of choosing car by 0.23 % and increases the probability of choosing the bus by 0.15 %. Lowering the monetary cost of using the bus by 1 % increases the probability of using the bus by 0.32 % and decreases the probability of using car by 0.02 %. The change in car use due to changed monetary cost in using public transport therefore appears to be small.

4. Concluding discussion

This study utilized RP data in order to investigate which factors influence the choice of transport modes for home-to-work travel. An elasticity with respect to time of –1.4 was found for public transport. Although this result might sound promising, at the same time, the cross-elasticity for car use with respect to public transport time was only 0.08. This result indicates that even if, in general, the probability of someone choosing public transport increases when travel times are reduced, this choice is much less likely if that person is a car user. The same pattern can be seen if reductions in fares are considered. The (own) price elasticity for public transport is found to be –0.32, while the cross-elasticity for car users is 0.02. Although reducing fares and/or travel times for public transport appears to increase the probability of travellers choosing public transport, the effect is greater for those currently walking or bicycling.

A robust result from the analysis is that having access to a car, or more specifically, the number of cars in the family, greatly reduces the probability of a person choosing any other mode of transport. This result might seem obvious, but it has important policy implications.

Alongside increased levels of income and traffic volume, car ownership has increased in Sweden as it has in most other countries. Since the mid-1960s, Swedish car ownership has increased by 190 %, and it is estimated to increase by another 55 % by 2030. Similar developments are expected in many other countries as well (Dargay et al., 2007). If this ongoing development is allowed to continue, it obviously bodes ill for environmentally friendly modes of transport. The importance of income for car ownership is well-established in the literature (e.g., Jansson and Shneerson, 1983; Jansson et al., 1986; Dargay et al., 2007; Caulfield, 2012; Holmgren, 2013). Since car owners are hard to influence into using more environmentally friendly modes of transport, breaking this link is especially important for the development of the future environmental impact of the transport sector. Therefore, future policy aiming in this direction should most likely include measures that reduce the relative attractiveness of owning a car, as well as measures reducing the attractiveness of using the car.

Breaking the link between income and car ownership can obviously be achieved by reducing the attractiveness of owning or using a private car, increasing the attractiveness of other modes or by a combination of these changes. Car use can often be linked to other motives than getting from A to B in the most efficient way. Status and other social motifs may also affect mode choice and the choice to own a car (Steg, 2005). Although there is evidence that reduced travel time and/or reduced public transport fares can increase public transport usage, the effect on current car owners is most likely limited. Therefore, as argued by Gärling and Schuitema (2007), in order to be effective, policies aimed at reducing car dependency may have to be coercive (see also Nurdden et al., 2007a; 2007b). Combining improved functionality of public transport and reduced fares with other measures aimed specifically at reducing the attractiveness of car use is required in order to achieve significant results. Such measures might include road pricing and increased parking fees (Ryley, 2008) as well as restricting access to parts (or even the whole) of the city.

An even broader take on the issue would include stressing environmentally friendly mobility in urban planning so that the constraints on mode choice (the need to transport children, running errands etc.) discussed by O'Fallon et al. (2004) could be relaxed. This might also include improved maintenance of infrastructure for bicycles as a means to reduce car use, as suggested by Bergström and Magnusson (2003). Information and campaigns to influence attitudes might also be part of a successful policy to reduce car use, as these might affect the social motifs for using a car as mentioned above. In addition, Shen et al. (2009) show that people experiencing deterioration in the environment are more likely to use public transport. Making the link between traffic and environmental problems clearer to travellers might therefore also affect behaviour, in the long run. Promoting bicycle use (Wardman et al., 1997; 2007) and walking (Ryley, 2008) or the use of bicycles in combination with public transport (Martens, 2007) might be particularly successful if combined with information and restrictions on car use.

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