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1. Introduction

In their continuous *battle* against congestion and pollution, governments nowadays promote rail as an environmentally friendly Single Occupant Vehicle (SOV) alternative. For comparison, the energy consumption per person kilometre for rail is 0.14 kWh/pkm while that for a car is 0.48 kWh/pkm (Boussauw and Witlox, 2009), and electric trains have no direct emissions of air pollutants like PM₁₀ and NO_x. Modal shift policies often target the daily commute since home to work travel is concentrated in the congested peak hours and commuters' travel behaviour is more regular. This regular character seems to fit well with the scheduled nature of rail, and the central location of railway stations fits with the relative concentration of jobs in congested cities (Riguelle et al., 2007). Furthermore, both cities and public transport are predominant in the sustainable mobility paradigm (Banister, 2008). Therefore, the location of jobs in city-regions and the link with rail use, are at the core of our analysis. Besides environmental objectives, employment concerns motivate governments to invest in railways. Indeed, rail can keep jobs in city centres accessible. This indicates that rail can contribute to all three dimensions of sustainability and sustainable transport, the environmental, the social and the economic dimension (Boschmann and Kwan, 2008).

Robèrt (2009) stresses the role that large companies can play in sustainable transport policies and focuses on the potential of commuting programmes. He states that (in Sweden) '*employee travel is often the most energy- and emission-intensive activity*' (p.2.). Accordingly, a workplace perspective on commuting and mobility management is logical for transport researchers and professionals. However, most research on commuting focuses on (residential) characteristics of individual commuters or on geographical areas, like census tracts or counties (Taylor et al., 2009). Given the importance of the workplace, and the identification of rail as a sustainable commuting alternative, the present paper focuses on the distribution of rail use among workplaces in Belgium and on the promotion of rail at these workplaces. Furthermore, a workplace orientation is suggested by the fact that most transport-related problems (congestion) are concentrated around job locations, and that employers can promote rail use among employees.

Governments can urge companies to invest in mobility management, but even without government incentives, employers can benefit from an employer transport plan (Robèrt, 2009). While stressing the importance of the business community in transportation demand management (TDM) policies, Meyer (1999, p.578) lists ten 'business reasons' for participating in TDM programmes. These are: (i) increased (employee) health (less stress and pollution); (ii) increased regional competitiveness (improvement in regional mobility); (iii) enhanced customer access; (iv) possible links with core business (e.g. technology for telecommuting); (v) less parking and congestion; (vi) extended hours of service (alternative work schedules); (vii) being an attractive employer; (viii) less office space; (ix) less investments in access infrastructure for new developments; and (x) improved productivity (telecommuting). We can add to these ten business reasons the greening of the company image and the more productive use of travel time by rail users compared to other modes of transport (Lyons and Urry, 2005). Despite these

reasons, Roby (2010) reports that most companies in her UK survey mention a planning obligation as original motivation to implement a travel plan. Other reported motives are a lack of parking space, congestion, and corporate social responsibility (CSR, including environmental reasons). Ongoing research for Belgium (e.g. Van Malderen et al., 2010) indicates that a (supposed) obligation is often cited as motivation, and to a lesser extent CSR, environmental concerns, image, and demand of the workforce.

The influence of employers on the daily commute is also interesting from a policy perspective. Current sustainable transport policies, frequently named mobility management (Europe) or transportation demand management (TDM, USA), often target employers as key players to influence the travel behaviour of their employees. Common mobility management measures are bicycle facilities, carpool databases, and to promote rail, the reimbursement of public transport tickets. It is our aim to analyse the share of rail use at large workplaces in Belgium and to identify the role employers can play in a modal shift towards rail.

This paper is organised as follows. Section 2 gives an overview of the main determinants of rail use. Apart from the rail network and the schedule itself, also individual, workplace and contextual characteristics are mentioned in the literature. We will focus on the workplace. To this end, we used a dataset containing information on the worksites of all major employers in Belgium, the database Home To Work Travel (HTWT), which we will introduce in Section 3. Subsequently, two methodological issues are treated. The first is the measurement of the rail accessibility of a worksite; the second the definition of an appropriate model structure to incorporate both workplace and contextual factors. We argue that multilevel regression models fulfil this condition. Section 4 presents the results of these models. Finally, Section 5 addresses conclusions and further comments, particularly on the policy relevance of mobility management.

2. The determinants of rail use

The determinants of rail use for commuting can be subdivided in (i) characteristics of the rail service itself, (ii) characteristics of commuters, (iii) workplace factors, and (iv) the elements of the neighbourhood that influence travel behaviour. These four types of factors are discussed below and the choice for a focus on the workplace level is explained.

2.1. Rail services

Public transport in general and rail in particular are determined by the location of stops (stations) and the schedule. An important difference with car use is that a commuter first has to travel to a railway station, and usually needs another additional displacement to the final destination after the rail trip; a journey by rail is thus a chain of journeys (Givoni and Rietveld, 2007; Brons et al., 2009). Therefore, travel time is subdivided in access and egress time, waiting time and in-vehicle time, while a car trip without trip chaining is limited to one trip between an origin and a destination. As a consequence, the generalised cost of public transport use contains next to the fare, also the value of in-vehicle, access, egress and wait times. This subdivision is relevant since commuters perceive e.g. waiting and in-vehicle time differently (Vansteenkoven and Van Oudheusden, 2007). As Iseki and Taylor (2009) show, an extra *transfer penalty* must be added to the generalised cost when a traveller has to make a transfer. This cost of transfer depends on factors like reliability, waiting/transfer environment and information provision.

The supply of rail services is not only characterised by time and other service-related factors, but also by its price. Public transport fare elasticities differ among studies (e.g. Wardman and Tyler, 2000; Bresson et al., 2003; Paulley et al., 2006) for several reasons, like the differences between short-run and long-run, cities and rural areas, and countries (see Hensher (2008) for an overview). In general, fare elasticities for rail use are low, especially for commuters. In

countries where rail allowances are common (e.g. Belgium), the most distinctive factor seems to be who pays the commuting expenses. Indeed, in most cases observed by De Witte et al. (2008) it is the employer who pays (part of) the costs related to commuting, and not having to pay the full price of the train ticket is mentioned as one of the main reasons for commuters to choose the train. In the Netherlands, Van Exel and Rietveld (2009) found a considerable effect of who is paying for the trip. Travellers who pay for their trip themselves appear to have a broader consideration-set, while travellers who get their trip paid by their employer tend to be more inert and stick to the promoted mode. Unfortunately, the same holds for company cars and fuel cards which stimulate employees to use their car for commuting.

2.2. Commuter characteristics

Apart from rail supply, individual characteristics like income and commuting distance influence rail use. In Belgium and many other countries, rising incomes (increasing car ownership) together with increased motorization have discouraged the use of public transport (Bresson et al., 2003); yet there is a difference between types of public transport. Individuals from high-income households are unlikely to use the bus, however, they perceive rail in a more positive way (Bhat and Sardesai, 2006). Furthermore, rail is an alternative for longer commutes, while bus, tram and metro fit better with shorter distances (Brons et al., 2009). The scheduled nature of transit suits less with complex trips, like the trip chaining caused by the drop-off of children at school, or shopping (Bhat and Sardesai, 2006). The place of residence of a commuter is at stake since distance to a railway station, and accessibility in general, influence rail use. With that, the attractiveness of access modes matters. Relevant factors are parking facilities for bikes, the risk of bicycle theft, and the frequency of bus services (Rietveld, 2000; Givoni and Rietveld, 2007). Finally, (subjective) preferences of commuters matter, also in their choice of residence and workplace. To a certain extent, employees choose both their place of residence and workplace considering their travel preferences. In short, people (households) who like

travelling by train will choose to live close to a train station and look for job opportunities close to railway stations. Such residential and professional self-selection is relevant when investigating individual commute behaviour (van Ommeren et al., 1999; van Wee, 2009), but is difficult to grasp in research which uses aggregated data (as in the present study).

2.3. Workplace-related factors

Commuting distance and income are in the first place characteristics of an individual commuter (or a household), but they depend also on the work location and on other attributes of the workplace. Organisational factors, like work schedules, are important workplace-related factors since they affect the activity patterns of employees and thus their commuting behaviour (Hung, 1996; Brewer, 1998). In the context of public transport, Bhat and Sardesai (2006) note that commuters with an inflexible work schedule value reliability more than commuters with a flexible work schedule. In the case of carpooling, flexitime is less beneficial than a regular work schedule, due to the fact that it is less easy to find carpool partners with the same working hours (Hwang and Giuliano, 1990; Hung, 1996; Rye, 1999b). Public transport on the other hand, benefits from flexible work schedules since employees can adapt their work schedule to the rail service. Flexible work arrangements also allow a more efficient use of (public) transport infrastructure, since it flattens out peak demand.

Van Exel and Rietveld (2009) stress the role that employers can play in promoting public transport use, for the reimbursement of tickets significantly influences mode choice. Employer travel plans seem thus a promising tool in transport planning. Moreover, transport plans are politically attractive since employers invest in mobility management measures, which serve government policies without a direct cost for the public budget. In addition, employers reach all employees with the same commuting destination, and a corporate culture can contribute to

positive attitudes towards SOV alternatives (DeHart-Davis and Guensler, 2005). In a survey reported by Rye (1999a), employers indicated the promotion of public transport as an acceptable measure. However, employers prefer low cost measures, like the promotion of public transport at the workplace by making information and tickets easily available. The subsidizing of public transport tickets and/or services to and from the site on the other hand, requires higher levels of resources (Rye, 1999b).

Information on public transport travel times, quality, schedules and options can change the perceptions of potential users, but large impacts on modal choice are not expected (Van Exel and Rietveld, 2009). Besides information provision, travel choice is also influenced by other employer initiatives, particularly by the delivery of free parking and company cars (O'Fallon et al., 2004). For Brussels, De Witte et al. (2008) report that the odds of train use decrease by 96.6% when a commuter possesses a company car. The availability of parking is a major advantage to recruit and retain employees. Consequently, a parking shortage is often the initiator for the establishment of an employer transport plan (Rye, 1999a). However, the importance of parking in human resources makes of parking charges and restrictions a rarity in employer transport plans, despite their high degree of effectiveness (Giuliano et al., 1993; Rye, 1999a, 1999b; Potter et al., 2006).

2.4. Contextual factors

Besides the aforementioned commuter and workplace-related characteristics, the literature also points to contextual factors for rail use determinants. In general, rail is more attractive in high-density areas, which have good public transport facilities and suffer from congestion and parking problems (Limtanakool et al., 2006). In large cities, fare elasticities for rail are also lower. Possible explanations are the longer average commuting distances, which suit better with rail and reduce the number of travel alternatives, and the congestion and parking problems which makes commuting to cities by car less attractive. In Amsterdam, Van Exel and Rietveld

(2009) found that congestion and parking costs tend to be considerably more important in explaining rail use than the benefits of public transport itself. The size of a city seems also to be important, since service elasticities are greater in large than in small cities, probably due to the stronger modal competition in larger cities (Bresson et al., 2003; Paulley et al., 2006).

The accessibility of railways stations is an important factor to attract commuters for entry and exit are usually the weakest parts of the transport chain (Rietveld, 2000; Givoni and Rietveld, 2007). Brons et al. (2009) noted that the quality of access facilities is more important for infrequent rail passengers and has thus a potential to attract new passengers. Finally, other facilities than transport-related ones, like a store near a railway station, can attract passengers (Bhat and Sardesai, 2006).

3. Data, Variable construction and Method

Above, we listed several factors that influence commuting by rail. In what follows, we explain the share of rail in the commuting modal split at worksites located in Belgium. The workplace seems to be an appropriate unit to analyse aggregated commuting behaviour since congestion is mostly destination-related, employers influence employee travel behaviour both purposefully and unintentionally, and characteristics of the work end seem to be stronger mode determinants than those of the residential origin (Limtanakool et al., 2006; Chen et al., 2008; Maat and Timmermans, 2009).

3.1. Data

Belgium is a country in north-western Europe with 10.5 million inhabitants (2005) on an area of 30 528 km². It has a dense railway and road network which connects several major cities like Brussels, Antwerp, Ghent, Liège and Charleroi. However, a car-friendly fiscal regime,

suburbanisation, loose town planning policies and the resulting urban sprawl make that the private car is the dominant commuting mode (Verhetsel et al., 2009; Verhetsel and Vanelslander, 2010; Boussauw et al., 2011), despite the dense rail network. Examples of an employer focus in Belgian transport policy are the third payer agreements with private companies. Since 2005, employers can make season tickets free for employees, while paying only 80% of the costs as the government pays the remaining 20%. The federal government itself, in its role as employer, provides since 2007 *free* public transport for all civil servants (De Witte et al., 2008). Note that it is mandatory for employers to pay the equivalent of about three quarters (dependent on the commuting distance and the activity sector) of a railway season ticket to commuters, regardless of the chosen mode. However, for car commuters, this employer contribution is not tax exempt.

For the purpose of our analysis we make use of a database called Home To Work Travel (HTWT). This database enables us to analyse rail use at the workplace level. This database contains the results of a mandatory questionnaire, sent to all employers located in Belgium with at least 100 employees. The questionnaire had to be filled in for every single workplace with at least 30 employees, which resulted in a set of 7460 observations. The Federal Public Service Mobility and Transport estimated the response rate at 85-90 % (FOD Mobiliteit en Vervoer, 2007). The survey was first conducted in 2005 and contains questions about mobility management measures, modal split and accessibility problems. In total, 1 342 119 employees commute to the sites covered by this questionnaire, which is nearly one third of the total number of employed people in Belgium. The main advantages of the dataset are its mandatory character (in terms of data coverage) and the focus on the workplace level, while the main disadvantages are the lack of data on company cars, small enterprises and individual commuter characteristics (Van Malderen et al., 2009; Vanoutrive et al., 2009). Regarding the quality of the data, it is important to note that the questionnaire needs to be discussed with the employee

representatives in the works council. This discussion can be regarded as an important quality check. The focus on large companies has the advantage that the questionnaires are in general organised more professionally by dedicated human resources staff (which are in general closely associated with the completion of the questionnaire). Furthermore, (partial) reimbursement of public transport tickets is widespread in Belgium, as a result, human resources departments usually have accurate data on rail use at their disposal. For an extensive discussion on the database HTWT, see also Vanoutrive et al. (2010).

3.2. Variables

The variable of interest is the share of rail at a workplace in 2005. On average, 6.7% of the employees on a worksite use the train as main commuting mode, while 9.4% of the total number of employees in our dataset is a rail commuter. The difference between these two numbers indicates that rail is more popular in case of larger worksites. Figure 1 shows a map with the average share of rail at a worksite per municipality. Cities, with better connections to the rail network, prove to have higher shares of rail use. However, data aggregated at the municipality level only delivers general information and neglects the differences in rail accessibility between sites within the same municipality. Therefore, the present study enriches the analysis by using data measured at the worksite level. Figure 2 indicates that this approach better grasps factors like rail accessibility, of which we explain the calculation method in Appendix A.1. The advantage of measuring rail accessibility at the workplace level is illustrated by the fact that in some large municipalities, like Ghent and Antwerp, both well-accessible (top 10 %) and workplaces with low rail accessibility (worst 10 %) can be found. At this scale, also workplaces with a low accessibility seem to be located in the proximity of the rail network. However, especially outside cities, the density of stations is lower, fewer trains per day do stop in stations, and a distance of a few kilometres between a workplace and a station is for most commuters

too long to bridge. A last advantage of data at the worksite level is that information on work regimes, worksite size and mobility management initiatives can be part of the analysis.

Insert Figure 1 here

Insert Figure 2 here

The choice of the workplace as level of analysis requires an appropriate measurement of the accessibility by rail. We calculated for each worksite the rail accessibility based on the concept of generalised travel time, and used both frequency (trains/day) and egress distance. Appendix A.1 illustrates and discusses the construction of the rail accessibility measure.

Besides rail accessibility, the regression model (Section 3.3) includes the number of employees, the number of parking places per employee, the economic sector, some mobility management related variables and car accessibility (an overview of the variables is given in Appendix A.2). The maximum of the number of parking places per employee is set to one to avoid the influence of large customer parking of supermarkets and the like. To account for differences between economic sectors, a set of dummy variables indicate some distinct sectors. Note that different sectors have different location preferences (Riguelle et al., 2007), but we control for location by using accessibility variables. As stated earlier, work schedules influence the travel behaviour of employees. Therefore, the percentage of staff with respectively fixed or flexible schedules or shifts form the next three variables. Next, four dummy variables mark mobility management initiatives at the site: a public transport fee for rail commuters on top of the fee accepted in the collective labour agreement; the delivery of information on public transport alternatives; the promotion of public transport for work trips; and the provision of bicycles at the railway station. The last variable, car accessibility, is measured at the municipality level and estimates the

number of people that can reach the area by car (Vandenbulcke et al., 2009). This variable is a measure for activity-based accessibility, and is thus also an indicator for density and centrality.

3.3. The model

In the previous paragraphs, we listed the selected variables, including our rail accessibility construct. The following step is the definition of a proper regression model to investigate rail use at workplaces. As stated earlier, the modal split is not only explained by characteristics of the workplace itself, but also by factors related to the wider environment. In other words, workplaces in the same area have more in common than sites located in different areas. Therefore, multilevel regression models are used to incorporate higher geographical scales (Langford et al., 1998; Groenewegen et al., 1999; Subramanian et al., 2001; Manley et al., 2006; Schwanen et al., 2004). In our case, the models account for the fact that worksites (level i) are located in a certain municipality (level j). An important advantage of a multilevel model is that variables measured at a higher level can be used statistically correct. Indeed, just attributing the same value for a certain variable to all workplaces within one municipality without an appropriate model structure, may cause erroneous standard errors. A multilevel model removes these biases by adding an extra error term for each higher level (u_{0j}), next to the common error term (e_{0ij}). Equations (1) and (2) illustrate this for a simple two-level model (Goldstein, 1995; Hox, 2002; Rasbash et al., 2005).

$$y_{ij} = \beta_{0ij} + \beta_1 x_{ij} \quad (1)$$

$$\beta_{0ij} = \beta_0 + u_{0j} + e_{0ij} \quad (2)$$

with i = worksite level, j = municipality level

On 3229 sites (out of 7460), no staff commutes using rail. When using the share of rail in the commuting modal split of a site, a so-called (*excess*) *zero problem* arises since the assumption of a normally distributed dependent variable is severely violated by the large number of zeros (Burger et al., 2009). Therefore, our model contains two parts. The first part analyses the difference between sites without any and sites with at least one rail commuter using a binary logistic regression. In the second part, only the sites with at least one rail commuter are modelled. In this second part, the share (%; logarithm) of rail in the modal split of the workplace is the (continuous) dependent variable. This method is applied by among others Duncan et al. (1996). However, in contrast with that paper, the dependent variable in our model is a proportion and as a consequence censored, i.e. it takes by definition a value between 0 and 1. Less than 0.1% of the workplaces has a share of rail of above 90%, the censoring at the right tail of the distribution seems thus not to be an issue. At the left side, the large amount of zero values creates a problem, but this is covered by separating the zero values from the rest of the observations. Note that for technical reasons, an artificial level 1 is created below the workplace level (level 2) to create a two-response model (Duncan et al., 1996; Rasbash et al., 2009).

4. Results

Table 1 shows the results of the multilevel model. These results enable us to answer three questions, (1) how well did we explain rail use at Belgian worksites and which factors do matter, (2) did we measure the rail accessibility of a workplace in a proper way, and (3) what are the advantages of multilevel modelling for analyses at the worksite level.

Insert Table 1 here

The multilevel and multivariate structure complicates the measurement of the goodness of fit of the models as this can be measured for each level. To have an indication of the model fit, we modelled the right-hand column in Table 1, without simultaneously modelling the categorical part. For this 'continuous' model (see Appendix A.3, Table A.3) we could calculate an R^2 equivalent on the basis of the reduction in variance between the empty and the full model (Hox, 2002). At the workplace level, the variance decreases from 0.237 to 0.139, which means that the model explains 41% of the variance between worksites. At the municipality level, the variance decreases from 0.084 to 0.025 ($R^2 = 0.70$), indicating that the explanatory variables explain most differences in rail use between municipalities. Note that the dataset only contains data aggregated at the workplace level and thus no information about the individual employees. As a consequence, the workplace variance contains also the employee-level variance which we could not model in detail (Tranmer and Steel, 2001).

The variances at the different levels discussed above are part of the random part of a multilevel model, while the fixed part contains the parameter estimates as we know from standard regression analysis. The fixed parts reveal that large sites, high shares of flexible and, to a lesser extent, regular (fixed) work schedules are beneficial for rail, in contrast with places where people work more often in shifts. Rail is also more popular at universities and central government offices, in the financial sector and unsurprisingly, at workplaces of the railway company itself. The primary sector, the local public sector, retail and public transport companies other than rail, all have lower shares of rail. The more parking space per employee an employer provides, the less rail is used as commuting mode. The mobility management variables do not result in significant estimates. Finally, car accessibility is positively correlated with rail use, as stated earlier, this is an indicator for city-related factors, like density and centrality.

A first methodological issue was the measurement of rail accessibility at the worksite level. The construct we made on the basis of the generalised time concept explained an important part of the success of rail. Moreover, this variable proved to be superior to measures like the distance to the nearest railway station. Indeed, when changing our rail accessibility variable in the model in Annex A.3 by distance to the nearest station the deviance increased (-2 loglikelihood: 4029.98 instead of 3890.14, without a change in degrees of freedom). Moreover, the variance at both the workplace (0.143) and the municipality level (0.028) was higher than in a model with the rail accessibility variable (respectively 0.139 and 0.025). In short, taking into account more railway stations than the nearest one and incorporating the number of trains per day, improved the estimations of rail use at Belgian worksites.

The second methodological issue was the use of a multilevel model structure. We argued the use of such a structure by stating that we could not ignore contextual effects, i.e. characteristics of the area where the worksite is located. To measure the importance of the different levels (workplace and municipality), the Variance Partition Coefficient (VPC) calculates the intraclass correlation, i.e. the percentage of the total variance which can be attributed to each level (Goldstein, 1995; Browne et al., 2005). The VPC values in Table A.3 reveal significant differences in rail use between municipalities. Indeed, one quarter (26%) of the variance in rail use could be attributed to the municipality level. It was thus the right choice to opt for a multilevel structure since ignoring the impact of higher geographical scales (municipality) could cause biased estimates.

5. Discussion and conclusion

We analysed rail use at the workplace level, using the Belgian questionnaire Home To Work Travel (HTWT). The availability of data at the workplace level opens perspectives for mobility

research (e.g. Giuliano et al., 1993), especially since transport policy makers often focus on employers and home to work travel. The use of multilevel modelling allowed us to take into account the context in which workplaces are located by simultaneously modelling the workplace and municipality levels. A next methodological concern was the measurement of rail accessibility at the workplace level, for which an own constructed variable proved to be a good estimate.

The results confirm that larger office-type settings suit better with the rail alternative. Central government, the financial sector and universities are the main examples of such settings and are historically located near railway stations. Flexible work schedules fit better with rail since employees can gear their work schedules with the rail service. Work schedules are also an indicator for the type of activities, flexible and fixed work schedules are typical for offices, while flexitime is less suitable for sites where the coordination of activities is crucial, like in manufacturing (Hung, 1996). The size, measured by the number of employees, also positively influences rail use. A first reason is the larger average commuting distance at larger sites, as rail is a long distance alternative. Larger sites can also have better connections with the railway station by bus and can promote rail more actively due to scale effects (Rye, 1999b). However, the mobility management variables did not detect a significant relation between measures and rail use.

This mobility management variables bring us to the policy relevance of the present paper. Indeed, policy makers want to know if employer transport plans are effective and which measures look most promising. In the scientific community, some authors (e.g. Möser and Bamberg, 2008) criticise others (e.g. Cairns et al. 2008) that they overestimate the potential of 'soft' transport policy measures like employer transport plans. Although our model includes dummy variables that indicate the presence of mobility management measures at a workplace,

the model design is not directed towards the measurement of the effectiveness of these measures. Indeed, using one moment in time cannot deliver solid evidence about the effectiveness of mobility management initiatives. Furthermore, the model cannot exclude the possibility that employers took measures because there is a significant number of rail commuters in the workforce (see e.g. Dujardin et al., 2009 for a more methodological discussion on this endogeneity issue). In contrast with 'pure' effectiveness studies, our contribution, is related to the generalisability of empirical evidence. Indeed, one must be cautious when extrapolating the results of some successful transport plans to the whole population. Thanks to the extensive dataset, we could estimate the *natural* modal split of a site, i.e. the expected number of rail users at a site, taking into account economic sector, size and location, rail accessibility included. Hence, the results help to detect the sites where is room for improvement and the workplaces which perform well. Despite the diversity among sites, we are thus now able to make comparisons between large workplaces.

Despite discussions on the effectiveness of (employer) mobility management, both the optimistic (Cairns et al., 2008) as the more nuanced literature (Marshall and Banister, 2000; Rye, 2002) support the establishment of employer transport plans. Sustainable mobility needs the packaging of policy measures, of which the four measures in our model, and employer travel plans in general, are only examples. Since the (partial) reimbursement of public transport tickets is widespread in Belgium for institutional reasons, the related variable does not compare a complete reimbursement with the complete absence of an employer contribution. Other measures, like information provision, may be effective to let other measures work, but are presumably not effective on their own. In combination with car discouraging initiatives (e.g. parking restrictions), these initiatives can make a contribution to a modal shift.

Policy packaging also means that policy making is not limited to one group of actors, like employers, on which we focus in this paper. The case of rail clearly illustrates that employers are dependent on other actors, as it is the government who organises rail transport and regulates land use. The model confirms the importance of accessibility to explain the share of rail in the commuting modal split. Offering good public transport services and a land use policy that locates large workplaces near stations, are competences of governments. Logically, these policies should take into account the differences in location preferences of different activity sectors. The results also reveal the importance of organisational factors (work schedules and differences between activity sectors). Furthermore, organisational challenges to reward the productive use of travel time by rail commuters, remains an intriguing topic for further research. Given the importance of job location and work organisation, employers thus remain a key actor to develop sustainable cities.

Besides policy packaging, Banister (2008) stresses the importance of the support of all stakeholders, and public acceptability in general. Stead (2008) reports that the public is in favour of investments in public transport to solve problems related to traffic congestion (although strategic behaviour of respondents softens the importance of the observed enthusiasm on public transport investments). For employers, the promotion of public transport seems to be an acceptable mobility management measure (especially with government incentives). Summarising, especially at central locations, public transport remains a key tool to develop sustainable cities.

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Appendix A.1: Measuring rail accessibility

Accessibility by rail is calculated on the basis of the concept of generalised travel time. The total travel time is the sum of in-vehicle, walking and waiting time, while the excess (out-of-vehicle) time is the sum of the latter two (Blauwens et al., 2008, p.271). As the accessibility of a worksite by public transport is of our interest, the excess time can be used as an accessibility measure (Vandenbulcke et al., 2007, p.199-229). As we lack information on the actual journeys made by individual commuters, and on their place of residence, we approximate the accessibility by rail of a workplace in general (and thus not for each commuter individually).

To calculate the generalised time as accessibility measure while incorporating several stations, we add the average walking time to a station, to the average waiting time divided by the number of stations. This was done for the nearest, the two nearest, up till the five nearest stations. The lowest of the five computed values, multiplied by -1, is taken as accessibility measure for rail. This accessibility variable is used as a relative measure; therefore, the absolute values of speed and frequency are of no importance. For computational ease, we set the egress speed at 10km/h and searched for the frequency for which the highest correlation between rail use and the accessibility variable is found (i.e. 25 divided by the number of trains per day in a station). Using these parameters, on average 37% of the generalised time is waiting time.

The first step to measure rail accessibility is the calculation of the distance between each worksite and the five nearest railway stations. We used ArcGIS (Network Analyst) with the Belgian road network (NAVstreets). Since it is most unlikely that many people will use a private car to travel from the worksite to the railway station, highways are excluded. The resulting distances are an estimate of the egress time between a worksite and a railway station. Next, we needed to assess the waiting time. The frequency divided by two is often used as average waiting time. As mentioned earlier, up to five stations are taken into account, since commuters

can use other stations than the nearest one. Especially stations with a high frequency (many trains per day) can improve the accessibility of a site, even if there is a closer station. Note that stations with a high daily frequency of trains will also receive more fast intercity trains. Also for this reason, the frequency is a measure of the attractiveness of a station (especially for long-distance commuters).

Insert Figure A.1 here

Figure A.1 illustrates the method for one particular location (the (former) offices of Belgian Science Policy (Belspo) in Brussels). The nearest station (Brussels-Luxembourg; at 695m; labelled '1' on map A.1) has a frequency of 224 trains/day, which is similar to the frequency of the second nearest station (Brussels-Schuman at 1.4km; 219 trains/day; '2' on map). However, the Central railway station of Brussels (at 1.5km; '3') increases the accessibility by rail of this offices, since it welcomes more than 1000 trains per day. In the case of Belspo, the fourth and fifth nearest stations, respectively Brussels-Congres (4) and Brussels-Chapelle (5) do not increase the accessibility since only 50 trains per day do stop in this places. As a consequence, in this example, only the three nearest railway stations are used to compute the rail accessibility. Increasing the maximum of 5 stations does not seem useful since egress distances will be higher, and in places with a high station density (e.g. Brussels), nearer stations will offer at least the same level of service (in the example of Belspo, stations 6 (Brussels-North) and 7 (Brussels-South) offer the same service as station 3).

Table A.1 shows that only for a minority of worksites (2974 out of 7460), *only* the nearest station was used to compute the rail accessibility. For example, for 1960 worksites, the maximum value for rail accessibility was found when taking into account *both* the nearest and the second

nearest railway station, for 1309 sites the addition of the third nearest station further improves the computed accessibility.

Insert Table A.1 here

The major advantages of the proposed rail accessibility indicator are the incorporation of both distance and frequency in one measure while on top of that, several railways stations are taken into account. One can discuss the assumption that the waiting time is the frequency divided by two, since commuters often adapt their working hours to the public transport time schedule. Furthermore, the number of trains per day does not tell anything about the number of possible destinations, nor about the in-vehicle time. However, the proposed generalised time indicator offers an appropriate measure to define the rail accessibility of a site in general. As a consequence, the rail accessibility measure should be understood rather as a relative than as an absolute measure. Moreover, the absence of in-vehicle time in the calculation of the rail accessibility is no major shortcoming because the value of a unit in-vehicle time is perceived lower than a unit waiting or walking time (Iseki and Taylor, 2009). In addition, commuters attribute a positive utility to in-vehicle time which can then be considered as productive time (Lyons and Urry, 2005; van Wee et al., 2006; Lyons and Chatterjee, 2008). The access time at the home end of the rail trip is not part of the model, but again, this trip is less important than the trip from the worksite to the railway station. Indeed, for several mode choice explanatory factors, the destination is more important than the origin (Limtanakool et al., 2006; Chen et al., 2008; Maat and Timmermans, 2009).

Appendix A.2

Insert Table A.2 here

Appendix A.3

Insert Table A.3 here

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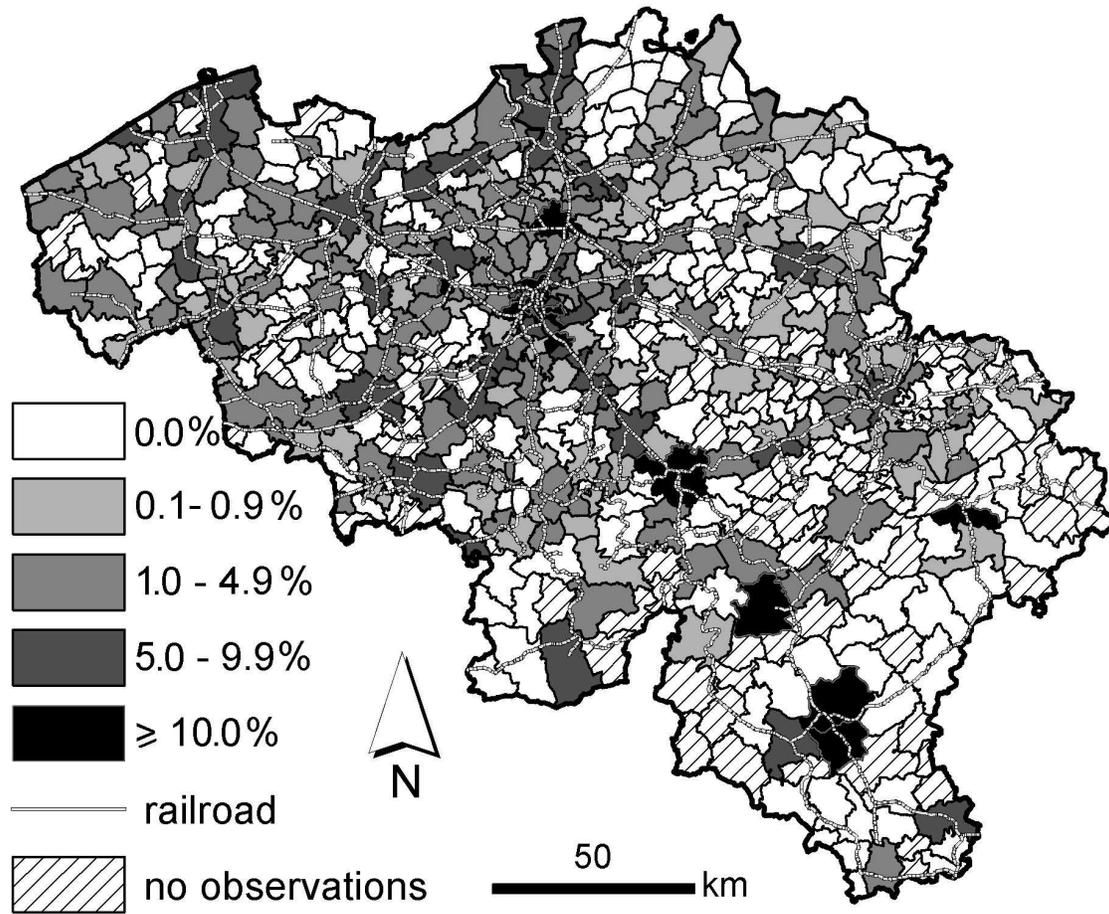


Figure 1: Average % rail commuters at Belgian worksites (share of rail at workplaces aggregated at the municipality level). Categories based on natural breaks (with manual rounding offs) (source: database HTWT 2005; cartography by the authors) 499x408mm (

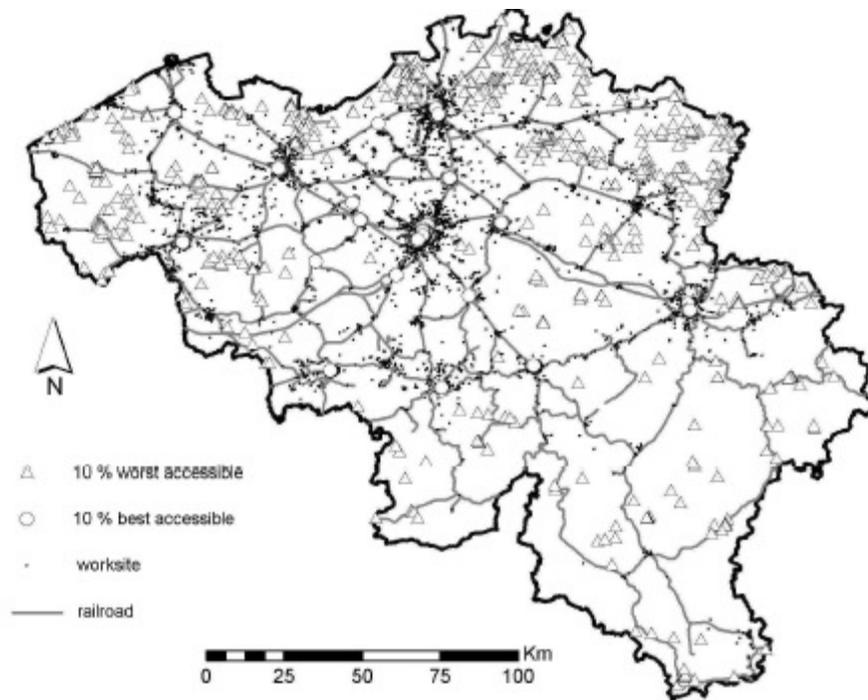


Figure 2: Rail accessibility (passenger) of workplaces in Belgium (Source: database HTWT 2005; cartography by the authors)
496x397mm

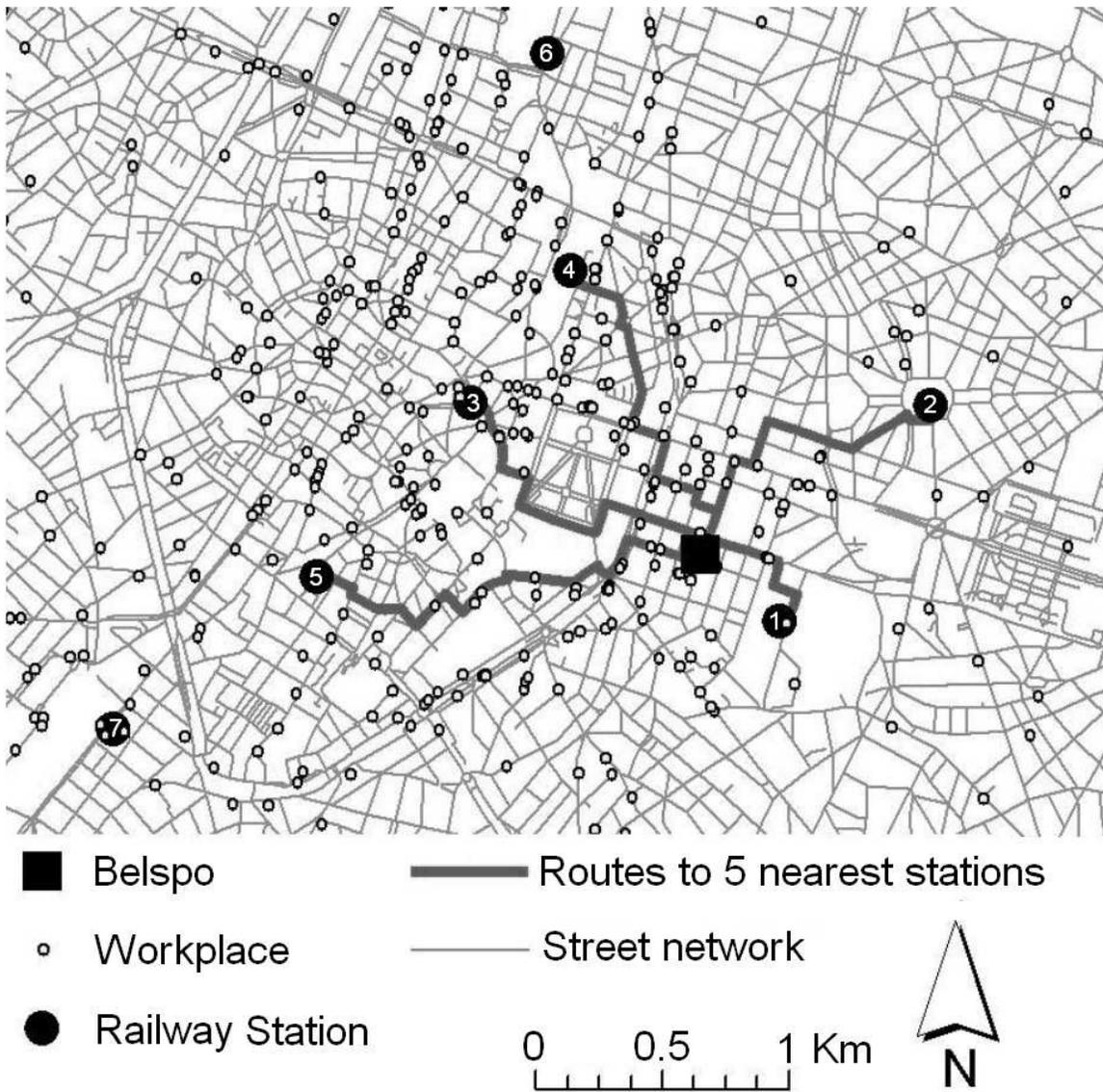


Figure A.1: Railway stations in the neighbourhood of Belspo
245x245mm

Table 1: Estimation results of the multilevel model
fixed effects categorical continuous
intercept -0.201 (0.089) -0.140 (0.029)
rail accessibility 2.715 (0.398) 2.821 (0.137)
car accessibility 0.538 (0.322) 0.441 (0.105)
size 0.281 (0.070) -0.123 (0.019)
parking 0.068 (0.076) -0.146 (0.023)
regular schedule 0.014 (0.083) 0.078 (0.024)
flexible schedule 0.002 (0.088) 0.169 (0.025)
shifts -0.054 (0.128) -0.153 (0.040)
extra fee publ. trans. 0.011 (0.061) 0.024 (0.017)
information publ. trans. 0.039 (0.090) 0.042 (0.025)
publ. trans. work trips -0.019 (0.106) -0.009 (0.029)
bicycles at station 0.057 (0.309) 0.087 (0.089)
retail -0.095 (0.090) -0.249 (0.028)
local public sector 0.110 (0.097) -0.205 (0.022)
primary & -0.098 (0.089) -0.253 (0.028)
secondary sector
other publ. trans. comp. -0.216 (0.222) -0.024 (0.066)
universities/high educ. 0.061 (0.129) 0.206 (0.034)
finance -0.094 (0.165) 0.241 (0.042)
central government 0.110 (0.097) 0.383 (0.026)
railway company 0.193 (0.196) 0.809 (0.050)
random effects variance
level 3 (municipality)
intercept 2.850 (0.202) 0.281 (0.021)
covariance 0.871 (0.062)
level 2 (workplace)
intercept - 0.249 (0.005)
level 3: n = 490 311
level 2: n = 7460 4231
dependent variable dummy variable log(%rail)
0: no rail commuters
1: at least 1 rail user

Table A.1: Number of railway stations taken into account for the calculation of the rail accessibility indicator

Number of stations taken into account Number of observations

1	2974
2	1960
3	1309
4	742
5	475

Notes: waiting time = 25/#trains; egress speed = 10 km/h

When taking into account more than one station, all nearer stations are still used in the calculation

Table A.2: Description of the variables

statistics statistics

categorical continuous

submodel submodel

n = 7460 n = 4231

variable mean st. dev. mean st. dev. source description

dependent variable	dummy; n = 4231	database HTWT 2005	dummy indicating whether or not rail use is present at site
dependent variable	0.73 0.58	database HTWT 2005	share of staff which commutes by rail (main mode), log
rail accessibility	0.99 0.14 1.05 0.07	own calculation	described in the text of the paper (Appendix A.1)
car accessibility	1.17 0.25 1.24 0.24	Vandenbulcke et al., 2009	activity-based accessibility by car: potential number of people that can reach the municipality by car (in millions)
size	2.03 0.38 2.10 0.40	database HTWT 2005	number of employees; logarithm (log)
parking	0.49 0.36 0.44 0.35	database HTWT 2005	number of parking places per employee; all values >1 are made equal to 1
regular schedule	0.37 0.39 0.35 0.39	database HTWT 2005	share of staff with a fixed work schedule
flexible schedule	0.25 0.38 0.32 0.41	database HTWT 2005	share of staff with a flexible work schedule
shifts	0.12 0.24 0.09 0.21	database HTWT 2005	share of staff which works in shifts
extra fee publ. trans.	dummy; n = 1776	dummy; n = 1140	database HTWT 2005 a public transport fee for rail commuters on top of the fee accepted in the collective labour agreement
information publ. trans.	dummy; n = 728	dummy; n = 474	database HTWT 2005 delivery of information on public transport
publ. trans. work trips	dummy; n = 505	dummy; n = 337	database HTWT 2005 promotion of public transport for work trips
bicycles at station	dummy; n = 48	dummy; n = 28	database HTWT 2005 bicycles available at the railway station
economic sector	database BELFirst		and semi-automated assignment of sectors on the basis of company names
primary & secondary sector	dummy; n = 1224	dummy; n = 438	primary and secondary economic sector
local public sector	dummy; n = 1412	dummy; n = 680	local government
retail	dummy; n = 877	dummy; n = 363	retail
universities/high educ.	dummy; n = 340	dummy; n = 300	universities and other higher education institutions
railway company	dummy; n = 128	dummy; n = 119	national Belgian railway company
other publ. trans. comp.	dummy; n = 103	dummy; n = 52	regional public transport companies (metro, tram and bus)
central government	dummy; n = 752	dummy; n = 663	central government
finance	dummy; n = 184	dummy; n = 172	financial sector

Table A.3: Estimation results of the separately modelled continuous multilevel model (right-hand column in Table 1)

fixed effects empty model VPC full model

intercept 0.462 (0.022) -1.615 (0.124)

rail accessibility 2.215 (0.114)

car accessibility 0.228 (0.056)

size -0.171 (0.015)

parking -0.159 (0.019)

regular schedule 0.074 (0.020)

flexible schedule 0.170 (0.021)

shifts -0.152 (0.034)

extra fee publ. trans. 0.023 (0.014)

information publ. trans. 0.038 (0.020)

publ. trans. work trips -0.005 (0.023)

bicycles at station 0.071 (0.072)

retail -0.232 (0.024)

local public sector -0.195 (0.019)

primary & -0.237 (0.023)

secondary sector

other publ. trans. comp. 0.015 (0.055)

universities/high educ. 0.196 (0.026)

finance 0.259 (0.032)

central government 0.366 (0.020)

railway company 0.784 (0.038)

random effects variance

municipality level variance 0.084 (0.011) 26% 0.025 (0.004)

workplace level variance 0.237 (0.005) 74% 0.139 (0.003)

municipality level: n = 311 311

level: n = 4231 4231

dependent variable log(%rail) log(%rail)

-2loglikelihood 6268.795 3890.143

Notes: empty model: model without any independent variables, but with multilevel structure;

full model: model with independent variables and multilevel structure

empty and full model are modelled separately

VPC: Variance Partition Coefficient; 26% = $0.084/(0.084 + 0.237)$; 74% = $0.237/(0.084 + 0.237)$