Institute of Transport Economics
Norwegian Centre for Transport Research

Summary:

Urban structure and travel behaviour

TØI Report 1178/2011
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Oslo 2011, 64 pages Norwegian language

Travel behaviour in urban areas is determined by people's daily activities, spatial organization and the built environment. Car use is greatest in small and medium-sized urban areas, particularly if they are less self-sufficient in terms of jobs, shopping, and so on. Car use is lowest in densely built-up large urban areas. Variations in travel behaviour are greater within large urban areas than between urban areas of different size and density. Location, land use, public transport services and parking restrictions affect the number of people who choose to walk or travel by public transport in their daily activities. The survey shows that an urban planning strategy emphasizing densification and an efficient public transport system can contribute to reducing car traffic in major urban areas.

Interurban and intraurban differences in travel behaviour

The report examines travel behaviour in urban areas, including settlements of 200+ inhabitants, i.e. in accordance with Statistics Norway's definition[1]. However, the main focus is on urban areas of at least 50 000 residents (half of the urban population in Norway).

The report has two main perspectives: (i) interurban analysis focusing on differences in travel behaviour across the urban hierarchy, and (ii) intraurban analysis on differences in travel behaviour in relation to land use, location patterns and accessibility within the limits of the urban area. While the former deals with the entire urban hierarchy, the latter includes only urban areas with at least 50 000 inhabitants.

Data sources and methods

The analysis is based on data from the National Travel Survey 2009 (Vågane et al. 2011) with integrated data on urban areas (delimitation, number of inhabitants and area) and local population densities, location of shops and workplaces and other

[1] According to the Office of National Statistics UK, an urban area is defined as land use which is irreversibly urban in character with an extent of at least 20 hectares and at least 1500 residents (Office for National Statistics 2004). In Norway, an accumulation of buildings has to be registered as an urban settlement if it is inhabited by at least 200 persons. The distance between the buildings must not exceed 50 m (with a few exceptions). (Statistics Norway http://www.ssb.no/.) According to the Norwegian definition, Norway has 936 urban areas (2011): 70 percent have fewer than 1500 residents. However, 98 percent of the urban areas with less than 1500 residents extend to more than 20 hectares (the first criterion in the UK definition). 90 percent of the urban population live in urban areas with 1500 residents or more.

land use information relevant to each geographic point in the travel survey. The survey forms a time-geographic model where the start and endpoints of trips and the respondent's residence and work site are geocoded by geographical coordinates (street address coordinates) or by reference to basic statistical units[2]. Geographical information science is used to integrate data from registers and databases with the same geocodes[3].

The pulse of the city

The daily rhythm is the same in all major urban areas. On workdays, three-quarters of travel is in carrying out routine activities such as commuting, business, trips to/from campus, shopping, errands and accompanying children to day care centres. Thirty-seven percent of travel is people on their way to/from work, school or university, or on business. Many stop at the day care centre or somewhere to do shopping on their way to/from work. In travel surveys, stops such as these are usually defined as separate travel purposes, but in Figure S.1 they are defined as part of the work trip.

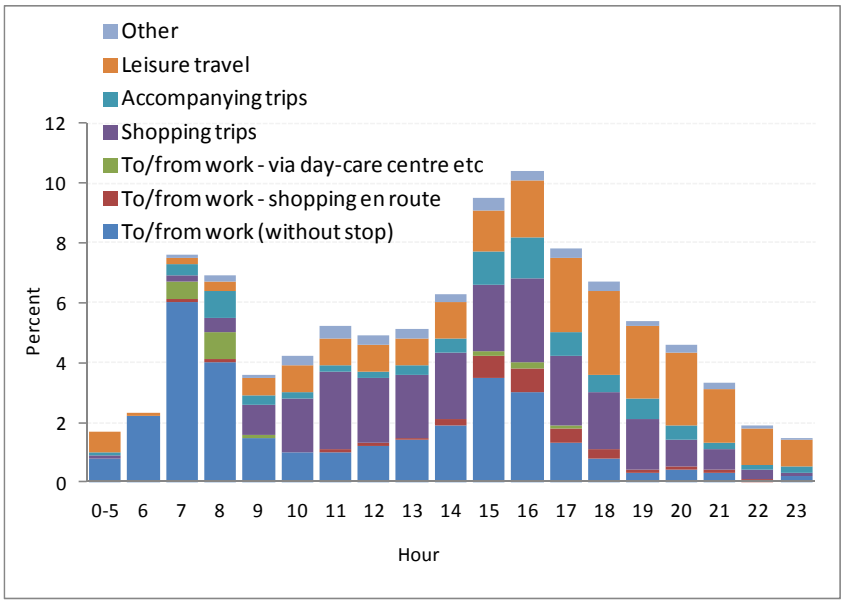

Figure S.1: Trip distribution during workdays. Fredrikstad/Sarpsborg urban area, Oslo urban area, Drammen urban area, Tønsberg urban area, Skien/Porsgrunn urban area, Kristiansand urban area and Trondheim urban area (percent).

It is in length of travel and mode of transport that differences between urban areas can be found. With the exception of the Oslo urban area[4], the car is the dominant

[2] Basic statistical units are used by Statistics Norway to provide stable and coherent geographical units for regional statistics at a low geographical level. Norway is divided into approximately 14 000 such units, most of which include only 100 inhabitants. In urban areas, most of the units cover no more than a few blocks or less than 1 km^2 built-up land.

[3] Primary data sources: Addresses and buildings, residents in basic statistical units, employment data at the basic statistical unit level, address coordinates for grocery stores and shopping centres and road network data.

[4] "Oslo urban area" or just Oslo refers to the continuous urban area (Greater Oslo urban area) based around the municipality of Oslo (the city of Oslo). The Greater Oslo urban area covers

mode of transport in all the major urban areas. The conurbations Fredrikstad/Sarpsborg and Porsgrunn/Skien stand out with the highest proportion; 70 percent of trips on weekdays in these areas are by car. In the Oslo urban area the car is used on fewer than half of trips. Public transport varies even more. In Oslo, more than one-third of motorized trips are by public transport. The other urban areas have far lower shares (Figure S.2).

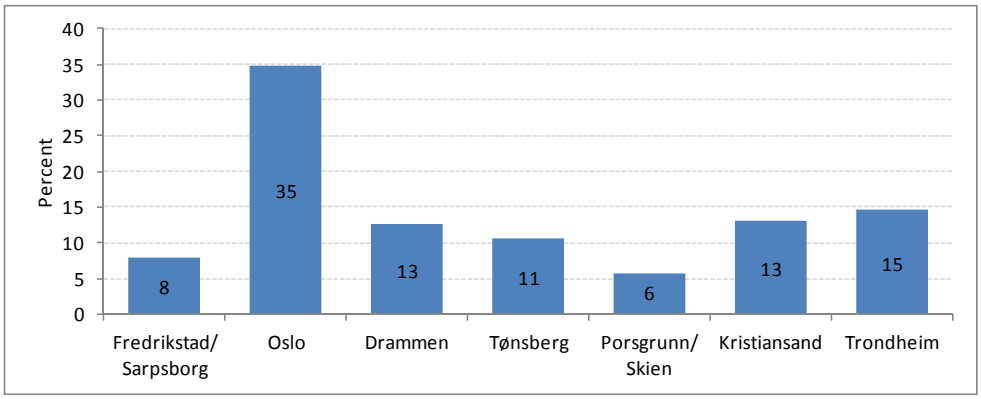

Figure S.2: Travel by public transport as a share of all motor transport in selected urban areas. Monday to Friday (percent).

Car use varies with the purpose of the trip, but driving children to/from school, kindergarten or to different activities is highest, both on separate trips and on trips to/from work.

Urban hierarchy and travel behaviour

Across the urban hierarchy, the largest urban areas (100 000 inhabitants or more) show significantly higher proportions of walking and travel by public transport than is observed in small and medium-sized urban areas (Figure S.3). Large urban areas have a greater supply of jobs, shops, services and culture, which, on average, means shorter distances and more likelihood of getting to places on foot. The large urban areas are also a market for a relatively extensive public transport system, the effects of which are enhanced with increasing population density (Figure S.4).

settlements within 10 municipalities in addition to the municipality of Oslo and has about 910 000 inhabitants (2011). Of these, 600 000 live in the municipality of Oslo (Statistics Norway http://www.ssb.no/).

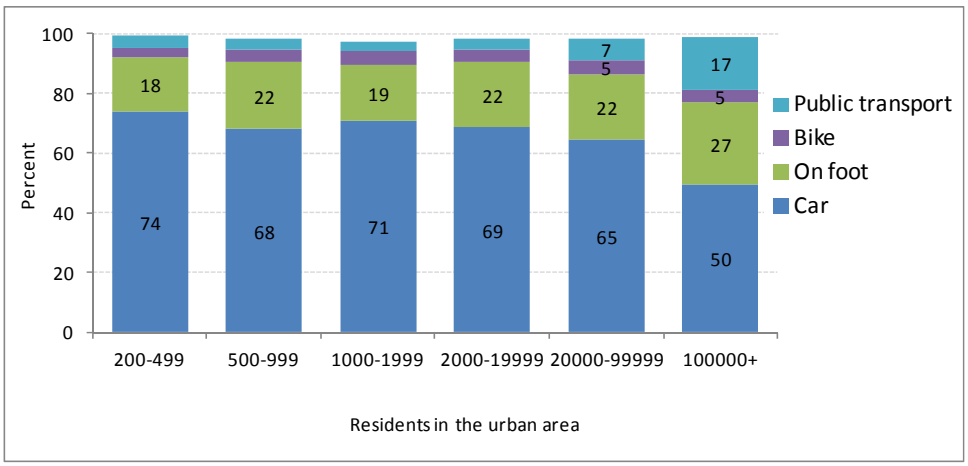

Figure S.3: Transport mode of residents in the urban area where the trip starts (percent).

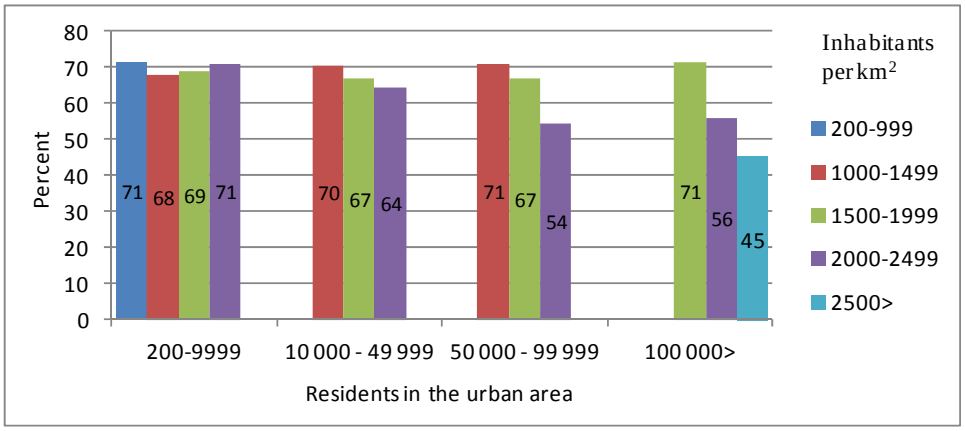

Figure S.4: Car use by number of residents and density in the urban area where the trip starts. Trips of less than 100 km (percent).

However, there are no clear effects of density for the smallest urban areas. The less self-sufficient these urban areas are in terms of jobs, shopping, and so on, the greater the interaction with other (larger) urban areas and the higher the average daily mileage of private cars per capita. Overall, this shows that the size, density and regional function of urban areas has to be taken into account when explaining interurban variations in travel behaviour across the urban hierarchy. In Figure S.5, urban self-sufficiency is measured as the proportion of the working population that commute to jobs outside the urban area (percent commuting out).

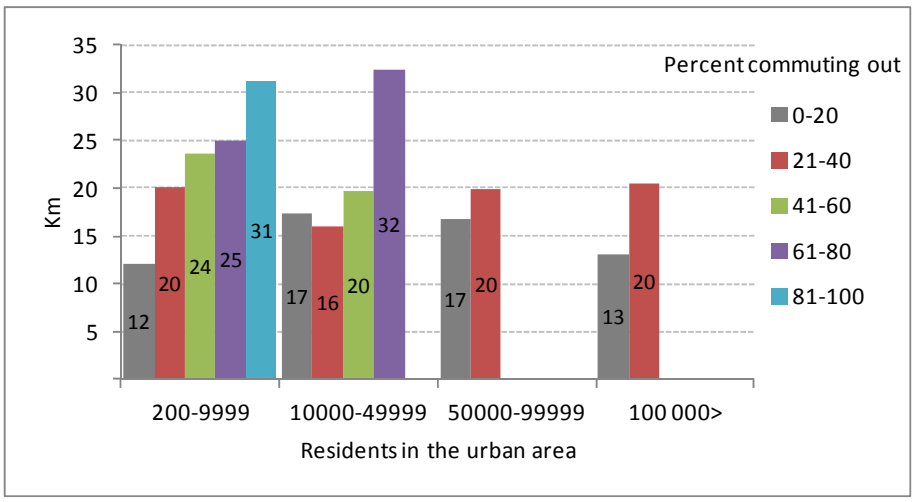

Figure S.5: The residents' average daily mileage (km) by private car by number of residents in the urban area and by proportion of the working population who commute to jobs outside the urban area. Trips of less than 100 km (km).

Urban structure and travel behaviour

Variations in travel behaviour are greater within the large urban areas than they are between urban areas of differing size and density. An example is the spatial variations in car use on trips starting or ending at home (Figure S.6). Car use is lowest in residential areas close to downtown and in some enclaves of high density. The proportion of car use is highest in residential areas on the outskirts of urban areas.

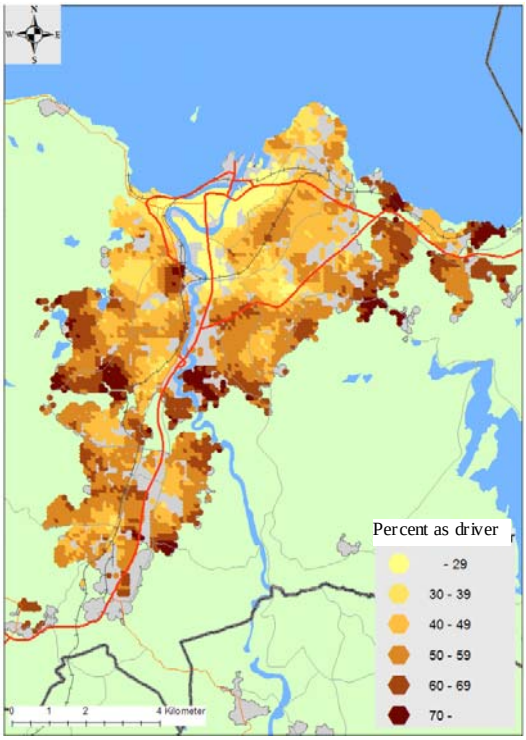

Figure S.6: Percent by car (driver). Trips of less than 50 km starting or ending at travellers' homes in Trondheim urban area. Persons older than 17 years (percent).

The decision on mode of travel and traffic generation is to a large extent related to internal differences in population density, job density, service density, intra-urban centrality and proximity to the central business district (CBD). The higher the population density (Figure S.7), the more jobs there are (Figure S.8), the greater the range of services in residential areas and the shorter the distance to the city centre (Figure S.9), the more likely travellers are to opt to walk or use public transport in carrying out daily activities. The result is fewer car trips and lower average daily mileage of private cars per capita.

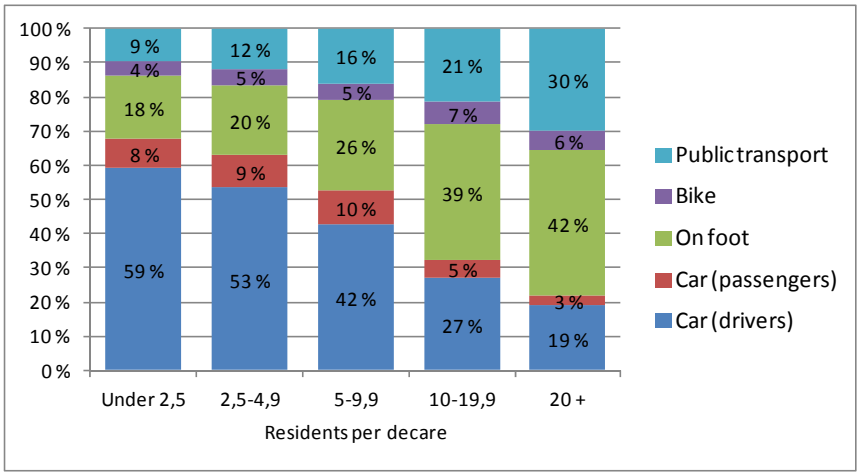

Figure S.7: Transport mode by population density on trips of less than 50 km starting in residences in urban areas with at least 50 000 residents. Persons older than 17 years (percent).

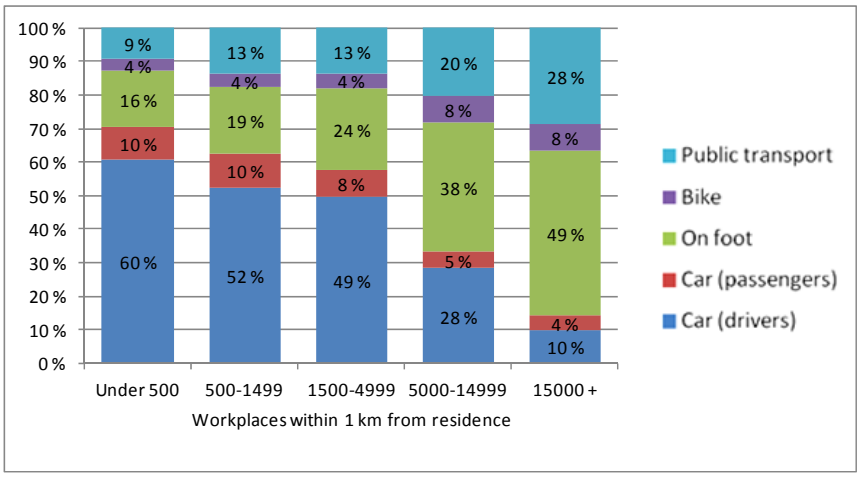

Figure S.8: Transport mode by job density on trips of less than 50 km starting in residences in urban areas with at least 50 000 residents. Persons older than 17 years (percent).

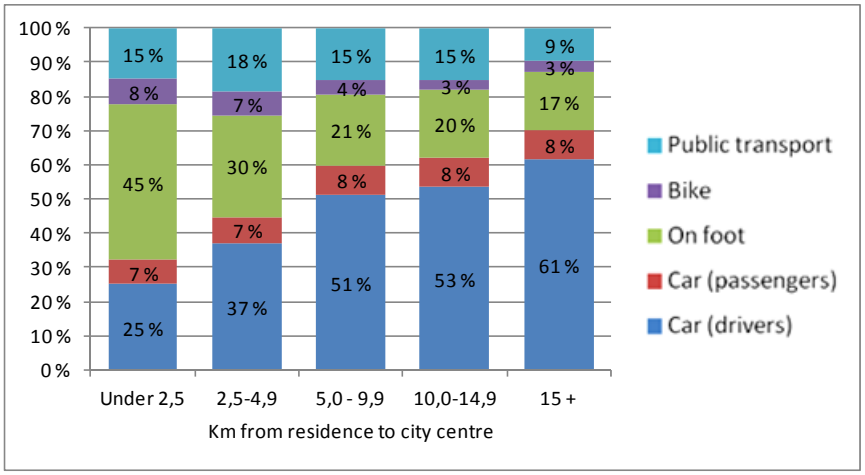

Figure S.9: Transport mode by distance to city centre on trips of less than 50 km starting in residences in urban areas with at least 50 000 residents. Persons older than 17 years (percent).

On the basis of knowledge of population density, workplace density and proximity to the city centre, we can use logistic regression to estimate the likely proportion of drivers on trips starting or ending at home (Figure S.10). The model indicates that it is first and foremost population density and the density of workplaces that affect the probability of the car (as driver) being used as mode of travel from/to residential areas. This means that a lower proportion of car use can be expected in densely built-up areas, even if located some distance from the city centre.

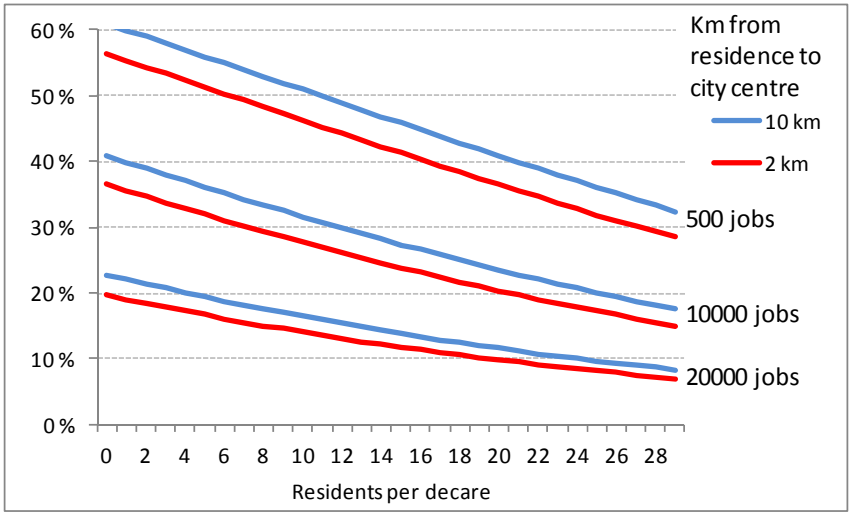

Figure S.10: Percent as driver by population density, job density and distance to city centre on trips of less than 50 km starting at travellers' homes in urban areas with more than 50 000 inhabitants. Persons older than 17 years (percent).

High density (Figure S.11) and proximity to the CBD (Figure S.12) at destinations reflect less car use. An example is the Trondheim urban area (Figure S.13), where travel is mainly by car (as driver) to areas along the major road network outside the city centre, while public transport has its largest market share on travel to the CBD and the two university campuses in the city (Gløshaugen and Dragvoll).

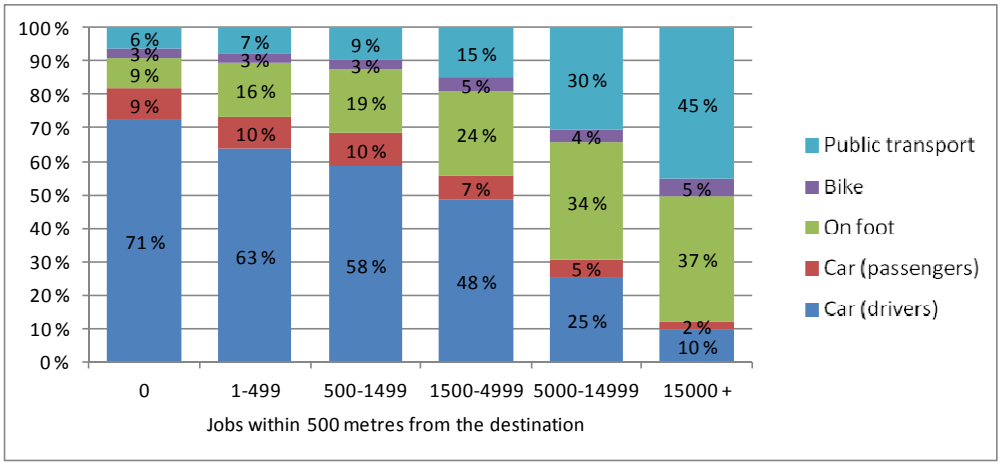

Figure S.11: Travel of less than 150 km that ends in urban areas with at least 50 000 inhabitants by job density at the destination. Travel to the respondents' own homes not included. Persons older than 17 years (percent).

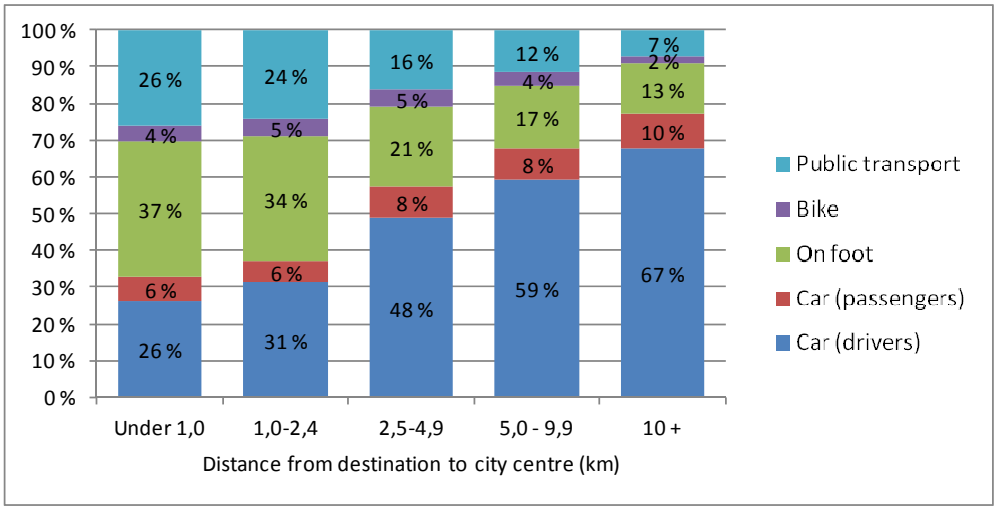

Figure S.12: Travel of less than 150 km which ends in urban areas with at least 50 000 inhabitants by distance from the destination to the city centre. Travel to the respondents' own homes not included. Persons older than 17 years (percent).

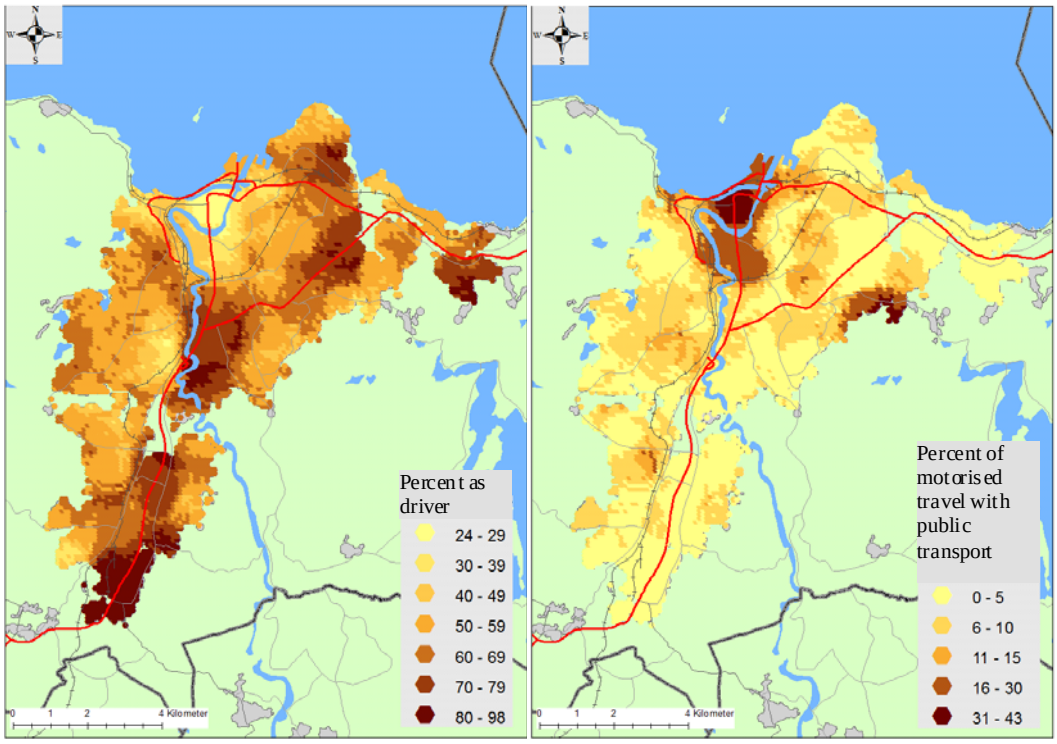

Figure S.13: Percent of all travel as driver and percentage of motor travel by public transport. Trips of less than 150 km ending in Trondheim urban area. Travel to the respondents' own homes not included. Persons older than 17 years (percent).

Based on our knowledge of workplace density and proximity to the city centre at destinations we can use logistic regression to estimate the likely proportion of drivers and of public transport use on trips to these areas (Figure S.14). The model indicates that location and the density of businesses have approximately equal effects on the decision concerning mode of travel. The results document a link between land use, location and mode of travel.

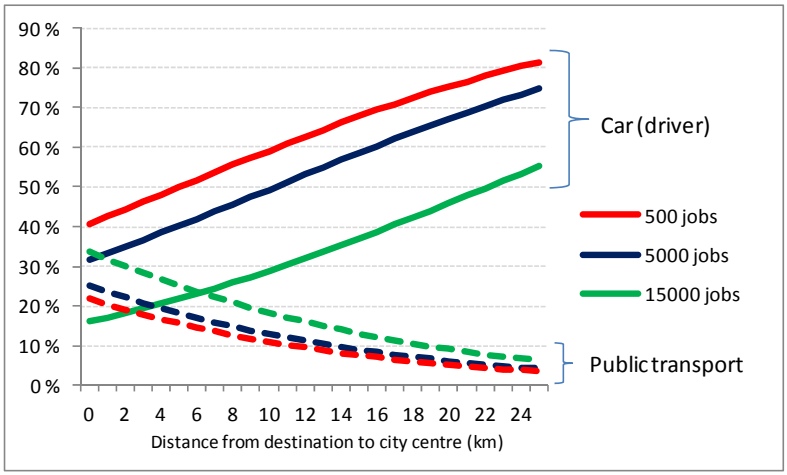

Figure S.14: Percent of travel as driver and percent by public transport by number of jobs within 500 m of the destination and distance from the destination to the city centre. Trips of less than 150 km which end in urban areas with at least 150 000 inhabitants. Trips to the respondents' own homes not included. Persons older than 17 years (percent).

What lies behind the high proportion of travel by public transport to the CBD and to areas with a high density of businesses? The answer is the relationship between

accessibility by public transport and the ease with which it can be reached by car. A public transport system with high frequency and a route network designed for a city with dense land use and concentrated localization of important functions means travel times by public transport that can compete with the car. In addition, high density and heavy traffic make it more difficult, or less attractive, to use the car. When travel time by public transport is at the level of travel time by car (or faster), there are many who choose to travel by public transport to work, especially if there is no free parking at the workplace (Figure S.15).

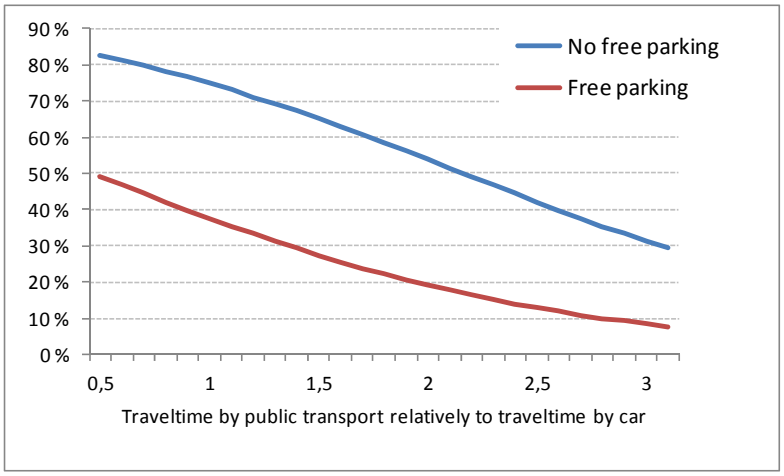

Figure S.15: Probable share of motorized travel with public transport by relative travel time (public transport in relation to car) and access to free parking at the workplace. Travel to work in urban areas with at least 150 000 inhabitants (percent).

Urban densification and regional distribution

In modern urban planning, densification is often mentioned as an objective for area development and therefore means more intensive land use, i.e. more housing, services and jobs, usually close to nodes in the public transport system. The purpose is to reduce transport needs and the volume of traffic. Urban planning is therefore based on the hypothesis that travel behaviour can be influenced by land use planning.

Our study supports this hypothesis. The results show that an urban strategy with emphasis on urban densification, combined with an efficient public transport system, can help reduce car traffic in major urban areas.

It is also important to focus on the regional level, however, where the entire commuting area is taken into account. Many small and medium-sized urban areas have a regional function as satellites of larger urban centres. Such places are dependent on jobs and services offered elsewhere (particularly in the region's main centre), which means much car use.