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Changing cycling mode-share: analysis of drivers based on Danish travel survey data 1996-2013.

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Cities around the world have increasingly turned to cycling as a sustainable travel mode providing mobility while also having beneficial effects on public health. Denmark is known as Europe's second cycling nation with a mode share hovering around 15%. The mode share was found to be decreasing through the 1990s into the 2000s, paving the way for substantial investments and promotional efforts from the late 2000s. However, few studies have looked into the time trends in cycling and their associated drivers - as a background for policy development and assessment of interventions. The paper assembles and exploits Danish micro-level travel survey data series covering 1996-2013 to analyze the trend in cycling as main or access mode, as well as the significance of background variables representing key spatial and societal trends. In addition to a time trend the analysis considers age, occupation, form of residence, household type, gender, income, urban density and regional location, weather, and ticket and fuel price indicators.

The methodology is based on joint use of Danish National Travel survey data 1992-2003 and 2006-2014 to support the analysis of trend changes and interactions. Access to spatial data and cost indicators limits the available time series to the period 1996-2013 (including 1996 and 2013, but excluding two years in the middle: 2004 and 2005). Travel survey data was extended with measures of urban size, density and distance to the largest regional centers based on the municipality of residence of the respondents. Precipitation and temperature data from weather stations was added based on location and survey day and/or preceding time-windows (3 and 7 days up to the day of travel). Indicators of motor-fuel and public transport travel costs were retrieved from a monthly index.

The results point to effects of gender, age, income, city size, regional location, weekday, form of residence, ownership of residence, occupation, and weather on cycling. Vehicle fuel and public transport ticket cost variables are both positively correlated with the probability of cycling but only the costs of public transport appear to be statistically significant. Increasing public transport travel costs increases cycling mode share. As

national monthly indexes both cost indicators are in poor spatial and temporal resolution for micro-level analysis and the results are sensitive to changes in the model specification. This is an important 'topic' for the analysis as not all variables are available for the full time-series. For instance data on education is only available in the second half of the time-period, but is known to be strongly correlated with cycling. Thus testing of the robustness of the conclusions given different lengths of time-series and control-sets has been carried out.

The analysis confirms that the general trend in cycling from 1996 to 2013 was negative – irrespective of statistical control for socio-economics, ageing, location, weather etc. Estimation of effects on a yearly basis confirms a relatively monotonous decline in the *ceteris paribus* time-effect on the probability of cycling on a trip.

Analysis of interaction effects points to an increasing significance of city size for cycling over time as well as changes to the effect of location vis-à-vis the largest urban centers. The differences in cycling between large urban areas and the more rural areas is growing substantially over time - additionally the peripheries of the largest metropolitan areas experiences decreasing cycling over time, due to increasing travel distances and integration into a larger urban region. Thus, cycling growth in the largest cities is paralleled by a 'backside' of absolute and relative decline in rural areas and other parts of the growing functional regions.

Other interaction effects points towards decreasing negative effects of retirement/ageing on cycling as well as decreasing negative effects of income levels. Thus retirees are generally cycling less than younger adults but the difference is decreasing. One likely explanation for this is that the average health condition of a retiree has improved over the years. For income high earners are generally less likely to bicycle than others but this effect has also decreased over the years. This may again indicate that the high earners have responded stronger to the recent years efforts to promote and sustain cycling in the Danish population.

The data and methodology present supports general analysis of trend changes in transport mode choice as well as (when relevant data is made available) effects of broad campaigns and interventions such as the Danish governments programme 'Cykelpuljen' to support cycling infrastructures and promotion from 2009 onwards.