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Segmentation of the current levels of passenger mileage by car in the light of sustainability targets – The Swedish case

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ABSTRACT

There is a clear need for debate about targeted policies to address individual behaviour and car mileage. In this study, the point of departure is that we need more knowledge regarding travel behaviour focusing on the needed reduction in car mileages. The study illustrates a series of travel behaviour analyses that can be applied in any other country striving for more detailed knowledge of the challenges ahead regarding reductions in car mileage. The focus is on passenger mileage by car in relation to the level of passenger mileage by car estimated by the Swedish Transport Administration for a sustainable transport system by 2050. Four distance categories are defined and used. The results indicate that on an average day, the overwhelming majority of total passenger mileage by car (>90%) is produced by a minority of the population (25%) and only approximately half of the population use a car on an average day. There are differences between rural and urban areas, but for the category of high passenger mileage by car, the difference is not remarkable.

1. Introduction

To reach global climate goals, the industrialised world needs to reduce its greenhouse gas emissions by about 80 percent by 2030 and about 95 percent by 2050 compared to 2004. Transport is responsible for almost 25 percent of global energy-related greenhouse gas emissions (IPCC, 2007). In Sweden, this share is even higher (33%), primarily because electricity generation and heating in Sweden is less dependent on fossil fuels (Swedish Environmental Protection Agency, 2015).

To meet the threat of climate change and limited oil resources, there must be drastic reductions of fossil fuel use (IPCC, 2007). In developed countries, the transport sector must contribute significantly to carbon reduction if the ambitious future targets are to be met. In the United Kingdom Climate Change Act (2008), the UK government set a binding commitment to decrease CO2 emissions by 80 percent (at 1990 levels) by 2050 through the Climate Change Act (2008). Another example is the national vision of Sweden, which is more ambitious and has the target of achieving zero net emissions of CO2 by 2050 (Commission on Fossil-free Road Transport, 2013).

Both in Sweden and globally, transport is increasing its share of emissions (Swedish Environmental Protection Agency, 2015; European Environment Agency, 2015). Efforts have been put into finding solutions and measures to reduce the environmental impact of the transport sector. As a result, the predominant approach in most developing countries is focusing on a shift of the vehicle fleet to electric or hydrogen-fuelled vehicles powered by renewable energy (Barbour and Deakin, 2012). Yet it is important to note that it is not only the technical aspects of the transport infrastructure that need to change, but also transport behaviour (Nilsson et al., 2013; Moriarty and Honnery, 2013; Nissinen et al., 2015). There is largely a consensus among transport researchers on the need for levels of transport to be reduced in order for the sector to contribute to more sustainable development (Johansson, 2009; Åkerman, 2011; Gudmundsson, 2008).

The Swedish Commission on Fossil-Free Road Transport was tasked with identifying possible courses of action to reduce the emissions and the fossil fuel dependence of the transport sector in line with the target of achieving zero net emissions of CO2 by 2050, illustrated in Fig. 1 based on Swedish Transport Administration (2016). The conclusion was that by 2050, there is a need of reduction in vehicle kilometre (freight and person) besides technological developments such as switch of fuel and

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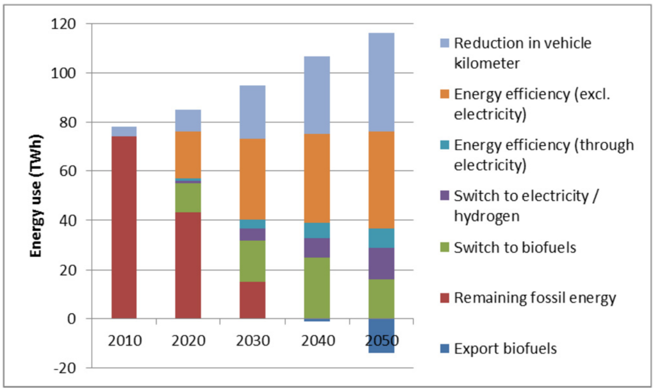

Fig. 1. Swedish road transport use of fossil energy with and without actions (TWh). Source: Swedish Transport Administration (2016).

increased energy efficiency. There are measures targeting the freight transports and, though freight is important and constitute a large share of the CO2 emissions from road transports in Sweden (37%, Commission on Fossil-free Road Transport (2013)), the major focus and share of CO2 emission from road transports, is on emissions from person transport (63%, Commission on Fossil-free Road Transport (2013)). The report of the Commission, express the need for reduction as a reduction in *passenger mileage by car* by 10–20 percent compared to forecasted levels based on predicted growth in transport and the existing policies and measures including investments decided on until 2011. Similar, the UK government's technical advisory committee on climate change suggests a need for a 5 percent reduction in car travel by 2020 even if all anticipated technological advances are delivered (Committee on Climate Change, 2012).

Numerous studies have demonstrated the unevenness of territorial-based travel carbon emissions at the national, regional and city levels (Scholl et al., 1996; Greening et al., 1997; Duro and Padilla, 2006). A number of studies have focused on travel carbon emissions variations at the household and individual levels in an attempt to find targeted and effective mitigation measures for high emitters, for example Brand and Boardman (2008) and Wang and Liu (2015). Another example is Brand and Preston (2010), who summarised the 60/20 rule, which suggests that the top 20 percent of emitters are responsible for 60 percent of travel carbon emissions in the UK. Similarly, 10 percent of the population is responsible for almost half of the total CO2 emissions from transport in the Netherlands (Susilo and Stead, 2009). Ko et al. (2011) revealed that the top 10 percent of emitters account for 63 percent of the travel carbon emissions in the Seoul metropolitan area. Collectively, these studies have confirmed the existence of heterogeneous population-based travel carbon emission distributions in different mobility cultures and urban/rural contexts.

To be able to find policies that efficiently target needed reductions in mileages by car, decision-makers need to know enough about travel behaviour and variations in the population. A series of researchers, for example Anable et al. (1997), Greening (2004) and Brand et al. (2013) have examined whether, and how, demographic, socio-economic and other individual and environmental characteristics are associated with land-based passenger transport and associated CO2 emissions. Chatman (2009) and Wang and Liu (2015) have shown that residential variations (e.g. location, population density, land use and transport accessibility) affect passenger travel and its carbon emissions. The quality of available transport options is also of importance. For instance, Mugion et al. (2018) show that user perceptions related to service quality in urban public transport systems induce the adoption of more sustainable behaviours for mobility purposes. Anable (2005), Stradling et al. (2008) and Clements (2013) show that personal preferences and attitudes are highly influential and play an important role in explaining variation in behaviour. Also, travel patterns and behaviour further vary according to environmental consciousness and energy costs (Nilsson and Kuller, 2000).

The importance of analysing travel carbon emission distributions and profiling the main contributors has become increasingly recognised in making travel emissions mitigation policies (Xiao et al., 2016). Analysing travel carbon emission variations helps in deriving policy implications to encourage different stakeholders to take common and different responsibilities for reducing travel carbon emissions. The impacts of relevant policies on these groups can be analysed to make future policies more effective, efficient and equitable (Fawcett, 2010; Ko et al., 2011). These policy improvements would benefit municipal authorities who lack sufficient knowledge and policy guidelines to balance the effectiveness and equitability of transport policies.

Individual travel carbon emission variations emphasise the need to adopt measures that target population segments with the highest travel carbon emissions (Druckman and Jackson, 2009). Some innovative policies, such as personal carbon trading and cap-and-share schemes, have been tentatively implemented in the UK (Fawcett, 2010). At the theoretical level, these policies might be far more effective in reducing CO2 emissions than one-size-fits-all regulation policies (Shammin and Bullard, 2009).

Access to a car has become almost essential to reach a wide range of essential and leisure activities (Power, 2012). Different social groups exhibit diverse travel behaviours and will thus experience very different outcomes in adapting to any changes to the transport system. People often choose a residential location that matches their residential attitudes and that also reflects their travel attitudes (Handy et al., 2005; Bhat and Guo, 2007; Mokhtarian and Cao, 2008).

In Sweden, policy discussions on measures to reduce the transport sector's emissions often lack the individual perspective. Instead, there is a focus on the target set for total CO2 reduction without a discussion regarding the distribution of the travel behavioural change in the population, for example (Swedish Government, 2009 and Swedish Transport Administration, 2012). Detailed calculations on the reductions needed per capita in order to achieve the climate target as well as the effects of suggested actions for individuals in different contexts and with different conditions, are missing. In addition, calculations recognising that with an increasing population, a larger per capita reduction is required, are also absent.

The point of departure in this study is that we recognise the need for more knowledge regarding travel behaviour focusing on the needed reduction in passenger mileage by car, as expressed by the Swedish Transport Administration. The aim of this study is thus to analyse statistics on travel behaviour and personal characteristics applying a segmentation structure based on distance category (car mileage per person and day). The targeted level of passenger mileage by car as estimated by the Transport Administration is used as one of the segmentation levels. Distances below this value are regarded as sustainable levels of passenger mileage by car and distances over this value as unsustainable levels.

We are asking and elaborating on the following questions:

- How large a proportion of the population (based on the Swedish National Travel survey) falls into the category estimated to have an unsustainable passenger mileage by car level per capita?
- What is the share of the total passenger mileage by car contributed by this segment?

The result is retrieved for the Swedish context. However based on similarities in car use and car ownership with other European countries, for example the UK and Netherlands (Eurostat data) the results are also of importance for other countries in order to seek for effective policy measures in order to meet climate targets. The study thus illustrates a series of travel behaviour analyses that can be applied in any other country striving for more detailed knowledge about the challenges ahead regarding reductions in passenger mileage by car.

2. Data and method

The government bill '*A Coherent Swedish climate and energy policy – Climate*' (Swedish Government, 2009) outlined the *strategic priority* for Sweden to have a vehicle fleet independent of fossil fuels by 2030 and the *vision* for Sweden to have a sustainable and resource-efficient energy with no net emissions of CO2 to the atmosphere by 2050. The committee on transport issues appointed by the Swedish Government (Swedish Transport Administration, 2012; Commission on Fossil-free Road Transport, 2013) was commissioned to identify possible courses of action and identify measures to reduce the transport sector's emissions and dependence on fossil fuels in line with the vision for 2050. In the climate scenario, the need for reduction in the total passenger mileage by cars (in addition to conversion of vehicle fleet and fuel) was estimated at 12 percent by 2030 compared to 2010 and at 18 percent by 2050 (Swedish Transport Administration, 2012:224, p 37) compared to 2010.

These reductions, in passenger mileage by car, form the base of the segmentation used in this study. Using the average passenger mileage by car by 2010, the necessary reduction by 2030 and 2050 are calculated. Data on passenger mileage by cars in Sweden are collected from the Swedish National Travel survey (RVU Sweden 2011–14), which addresses people's daily travel, the dates and times when they travel, the modes of transport used and the purposes of the trips. The most recent study was conducted on a daily basis during the period 2011–2014 and encompassed the entire Swedish population between the ages of 6 and 84, and was conducted through telephone interviews. The survey was conducted on a daily basis for four years and includes 39,280 interviews, corresponding to a response frequency of 42 percent. The database includes 57,577 car trips, 11,523 trips by public transport, 7074 by bike, 23,835 by foot and 1554 by other modes adding up to a total of 101,563 trips. The data is weighted in order to represent the population in Sweden and to serve as a base for national analyses, research and decision support for various administrations and agencies.

According to the National Travel Survey RVU Sweden 2011–14, the average passenger mileage by car per capita is 28.2 km per person per day including mileage both as driver and passenger. We use this data as an approximation for 2010 as being the baseline year used for the national target. We use this value as an approximation for the average of passenger mileage by car by year 2010 since the previous one only covered the period 2005–2006. Using the average passenger mileage by car of 28.2 for 2010, a 12 percent reduction by 2030 would mean an average passenger mileage by car per person and day of 24.6 km and 23.0 km per person and day by 2050 with a reduction of 18 percent; see Table 1. This is without considering the population growth, though. If the population growth is included, the reduction level per capita will be higher since the target is set for the total national volume. We therefore estimate the level including the forecasted population growth according to Statistics Sweden (2016) as shown in Table 1. The calculation shows that the average passenger mileage by car per person per day would need to average no more than 21.8 km per person a day by 2030 and just over 19.2 km per person a day by 2050, assuming an equal distributed reduction of the passenger mileage by car in the population (Table 1).

Table 1
Estimated climate sustainable average mileage (kilometre) by car per person and day.

	Population	Reduction per capita	Estimated sustainable passenger mileage per capita
2030 if no population growth from 2010	9,415,570	12%	24.6
2050 if no population growth from 2010	9,415,570	18%	23.0
2030 if population growth according to estimations	*10,660,344*	22%	21.8
2050 if population growth according to estimations	*11,287,749*	32%	19.2

Based on the calculations presented in Table 1, this paper continues with a focus on passenger mileage by car in relation to the estimated level needed for a sustainable transport system by 2050. In order to segment the data set of the national travel survey, we define four distance categories based on the current average passenger mileage by car per person and day (28 km), the passenger mileage by car per day corresponding to the estimated sustainable level for 2050 (19 km) and the fact that some do not travel by car on an average day.

The distance categories for passenger mileage by car used are: 0 km, up to 19 km, between 19 and 28 km and above 28 km per person and day. The distance segment of passenger mileage by car over the average distance travelled today by car per person and day (28 km) is of interest since these passenger mileages by cars could be in focus when discussing reductions in kilometres travelled by car. The distance segment between 19 and 28 km per person and day is likewise interesting to analyse since the distances are below the average distance of today but still over the sustainable level. The two last distance segments constitute of trips that already today are below the sustainable level where the last segment consists of persons that make no trips at all an average day. The distance categories are used to segment the data and estimate the shares for different categories of average daily car use.

3. Results

3.1. Total daily mileage

From a sustainability perspective, mileage travelled by different modes is the primary figure of importance, rather than number of trips or share of modes. Starting with total average mileage (all modes) for the full data set (ages 6–85), Swedes on average travel a total of 46.9 km per person and day (Table 2). The car dominates with 28.2 km and day accounting for 60 percent of the total mileage.

Table 2
Total average mileage by mode per person and day. Source: RVU Sweden 2011–14.

	Distance travelled (passenger mileage)					
	Car[a]	Public transport	Cycle	Walk	Other	TOTAL
Average						
Man	*33.3*	*6.6*	*.8*	*.9*	*10.47*	*52.0*
Woman	*23.1*	*6.5*	*.5*	*1.0*	*6.0*	*37.2*
Average all	28.2	6.5	.7	1.0	8.2	44.6
Mode share	63%	15%	2%	2%	18%	100%

[a] Both as driver and passenger.

Table 3
Average and share of total passenger mileage (kilometres) by car per person and day, segmented by distance travelled by car. Source: RVU Sweden 2011–14.

Distance segment	All persons (incl. zero passenger mileage by car)	Persons with passenger mileage by car		
	Share of persons	Share of persons	Share of total passenger mileage by car	Average passenger mileage by car per day
>28 km	25%	52%	91%	102.5
19–28 km	5%	10%	4%	22.6
0–19 km	18%	38%	5%	8.7
Zero km	52%	–	–	–

Table 4
Average passenger mileage by car per day and trip purpose, segmented by distance travelled by car (share of distance per trip purpose is within parenthesis). Source: RVU Sweden 2011–14.

Distance segment	Distance travelled by car (km)					
	Work/ school	Business/ study trips	Shopping/ service	Leisure	Other	TOTAL
>28 km	22.8 (22.2)	9.9 (9.6)	17.1 (16.7)	44.4 (43.3)	8.4 (8.1)	102.5
19–28 km	6.4 (28.3)	0.7 (3.3)	5.7 (25.1)	8.4 (37.3)	1.4 (6.0)	22.6
>0–19 km	2.4 (27.7)	0.1 (1.7)	2.5 (292)	3.1 (36.1)	0.4 (5.2)	8.6
Total data set (incl. 0 car km)	*4.3 (15)*	*8.3 (29)*	*3.1 (11)*	*5.2 (19)*	*7.2 (26)*	*28*

It is noteworthy that daily travel distances on average differ greatly between men and women. The greatest differences in mileage were found for car together with cycle and mode 'other'. Specifically, for the total, the differences in mileage by car and 'other' add up to the same (14.6 km) as the total difference (Table 2). Women show close to an average passenger mileage by car in line with the estimated sustainable level for 2050 (Table 2).

3.2. Passenger mileage by car

Table 3 presents the share of total passenger mileage by car and average for different distance categories (motivated in the previous section) on an average day.

According to the results presented in Table 3, 52 percent of the population does not use a car at all on an average day. The results also show that 18 percent travels less than 19 km a day, thus indicating that as much as 70 percent travels less than 19 km by car on an average day – the estimated climate-sustainable level for 2050. However, the results in Table 3 also reveal that of those who do use a car on an average day (48 percent of the population), 62 percent travel further than 19 km a day – the climate-sustainable level for 2050 and just over half (52 percent of the population) travel more than 28 km, leaving 38 percent of those traveling by car on an average day having mileage below the estimated sustainability levels for 2050.

The share of mileage produced by the category traveling more than 28 km a day, is 90.6 percent of the total passenger mileage by car; in the data set, the average mileage by car is 102.5 km. The data set is highly skewed, including observations with very long travel distances by car (maximum of 1400 km).

When one is to consider what needs to be done in Sweden to achieve the climate target (reduce total passenger mileage by car per capita by 32% by 2050 with population growth considered; see Table 1), a focus on cases with less than 28 km by car a day seems to have a minor effect since they add up to less than 10 percent of the total passenger mileage by car.

3.3. Passenger mileage by car and trip purposes

In Table 4, the total distance travelled by car per day is separated per trip purpose (corresponding to the far right column in Table 3). The trip purposes used are: work or school, business or study trips, shopping or service, leisure and other.

The distribution of passenger mileage by car per trip purpose is similar between the distance segments defined. For all distance categories with passenger mileage by car, the trip purpose of Leisure has the longest distance per day, followed by the distance travelled for work or school (slightly longer trips for shopping/service for the distance group below 19 km, though). When comparing these results with the ones calculated for the whole data set, including those with zero passenger mileage by car, the result is quite different. The car seems to have a greater importance for the access to leisure activities and work or school than other transport modes.

If the entire national total reduction in passenger mileage by car should be carried out in the distance segment with average passenger mileage by car above 28 km a day, this group needs to reduce its average passenger mileage by car by 35 percent, thus coming very close to the average reduction (32%) calculated for the whole data set as presented in Table 1. This is naturally due to this category standing for such a dominant share of the national total passenger mileage by car, but the result underlines the importance of investigating this segment of car users further with passenger mileage by car above today's average, if targets are to be met.

3.4. Passenger mileage by car and residential location

Considering the dominant share of national total passenger mileage by car (91%; see Table 3) produced in the distance segment of above 28 km (first row in Table 4), we are further considering the type of residential regional location. This analysis is being carried out since the availability of other transport modes than car is very much dependent on whether one is living in a rural or an urban area. We also separate the distance travelled for this distance category per trip purpose in the same way as in Table 4. In summary, this analysis gives an indication of what trip purposes should be targeted to meeting the climate goal.

The total passenger mileage by car produced by this distance segment is calculated and presented as a variation of standard Marimekko charts using number of total passenger mileage by car on the y-axis instead of percentage as normally used (Fig. 2) as well as the figures in Table 5. The types of residential areas studied are major city (the three largest cities in Sweden having more than 200,000 inhabitants), urban/city areas (other cities than the three major cities) and remaining areas classified as rural. Using the average passenger mileage by car per day in each type of residential region and multiplying by the share of the data set living in these areas, we get the full picture of the magnitude of each group.

The results reveal that approximately 30 percent of this distance segment lives in rural areas, 45 percent in one of Sweden's three major city areas and 25 percent in urban areas outside major cities. The distribution for the total population is 37 (major city), 42 (urban/city) and 22 percent (rural), meaning that rural population is overrepresented among those with more than 28 km and those living in the major cities underrepresented. Even though the residents in major cities produce less passenger mileage by car for

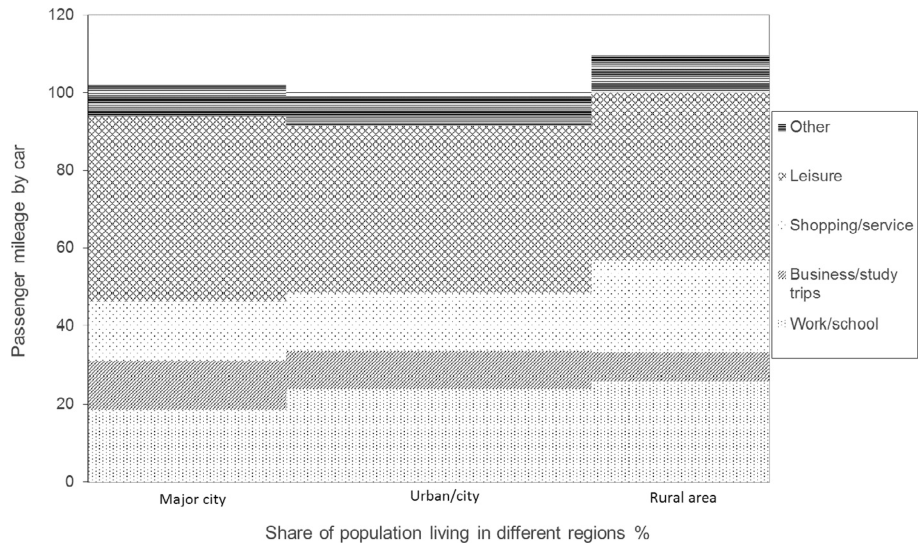

Fig. 2. Total mileage by car contributed by the distance segment above 28 km by car per person and day, separated by type of region (shares in sample > 28 km being 30% in major city, 45% in urban/city and 25% in rural areas) and trip purposes. Source: RVU Sweden 2011–14.

Table 5
Total mileage by car contributed by the distance segment above 28 km by car per person and day, separated by type of region and trip purposes. Source: RVU Sweden 2011–14.

Region type	Share of data set	Total distance travelled (passenger mileage by car)				
		Work/ school	Business/ study trips	Shopping/ service	Leisure	Other
Major city	30.2%	18.5	12.6	15.0	48.0	8.0
Urban/city	44.8%	24.0	9.7	14.9	42.8	7.7
Rural area	24.9%	25.9	7.3	23.5	43.2	9.9

commuting and service, they contribute with more passenger mileage by car for business and leisure purposes in total. At the same time, the passenger mileage by car for leisure activities is pronounced, irrespective of region. The large share of individuals living in urban/city regions underlines the importance of measures directed to these areas. The illustration however also makes it clear that it will not suffice to find car-reducing measures for urban areas only. It is also vital to find effective and accepted measures for rural areas, which often receive less focus in policy discussions, e.g. Commission on Fossil-free Road Transport (2013).

4. Discussion

This research contributes to the growing body of transport research focusing on the needed change in individual travel behaviour rather than relying on the quiet hope that technology will fix the climate change problem for the transport sector. By providing insights into the distribution profile of passenger mileage by car, this study gives clues to the levels and proportions of passenger mileage by car per capita to be reduced to sustainable levels to achieve climate targets by 2050. The results presented here for the Swedish context may be argued as also being highly relevant for some countries. There are several countries (mainly in Europe) with similar characteristics regarding mileage by car and number of cars per capita, for example Netherlands and the UK (Eurostat database).

The study examines the share of the Swedish population traveling 28 km and longer, between 19 km and 28 km, and shorter than 19 km per person and day by car. The segment levels are based on the average distance travel today (28 km) and the estimated distance that makes it possible to reach the climate targets (below 19 km per person and day). Using these segment levels, the research questions asked concern the proportion of the population (based on the Swedish National Travel survey) estimated to have an unsustainable passenger mileage by car level per capita (above 28 km) and the shares of the total passenger mileage by car by this segment. The study reveals that on average, 25% of the population travels 28 km or longer by car on an average day, 5% travel 19–28 km and 70% travel distances shorter than 19 km or not at all. On an average day, 52% of the population does not use a car at all. 18% travel by car but shorter distances per day and person than the distance estimated as needed in order to reach the climate targets (taking into account forecasted population growth) by 2050. The average distance travelled for those traveling more than 28 km by car, is 103 km, which means that this group accounts for more than 90% of the total passenger mileage car. For all distance segments, the longest trips are made for leisure trips followed by trips to work and studies (longer trips for shopping and service for the segment traveling distances below 19 km though). The study has also shown that for the distance segment above the average of today (28 km), the population carrying out these trips are not concentrated to a specific type of region. There are larger shares in both areas classified as major cities, urban/cities and rural areas.

The results of this study are in line with, for example Brand and Boardman (2008) and Brand et al. (2013) and demonstrates a huge variation in the amount of travel and consequently in the resulting CO_2 emissions. The results indicate that the market mechanisms have failed to reduce the passenger mileage, both overall and for those responsible for the largest share of travel by car. Further, the results indicate that policy interventions aiming at those producing a high share of the total mileage by car could be very effective and in fact are necessary. Susilo and Stead (2012) argue that a reduction of CO_2 emissions in the upper quintile by a given proportion, say 10 percent, will lead to a larger reduction of CO_2 emissions than a reduction of CO_2 emission by the same proportion for all other four quintiles. We find much the same. Even eliminating all passenger mileage by car for the category with sustainable passenger mileage by car levels on an average day will reduce total mileage by less than one tenth compared to the needed level of one third. At the same time, it ought to be noted that on an average day, as much as 70 percent of the Swedish population have sustainable travel behaviour in line with the estimated average passenger mileage by car for reaching the stated climate targets by 2050. Fifty two percent of the population do not use a car on an average day and one may argue that this is a high figure considering the car dependency structure of the society of today.

The result indicates that the market mechanisms so far have failed to reduce the vehicle mileage as needed. Kroesen et al. (2017) suggests an implementation of regulations or pricing mechanisms rather than for example information campaigns since the effects from behaviour on attitudes are greater than the reverse. Achieving reductions in the mileage by car requires an approach using policies that are specific to the characteristics of the individuals in this category (e.g. regular car users). This would include e.g. systems for shared vehicle ownership, reducing speed limits and fiscal incentives for using alternative modes of transport. Among the policy responses that have been suggested, road pricing has been given much attention and there is a growing interest in cap-and-trading with domestic tradable quotas or personal carbon allowances (e.g. Raux, 2004; Dogterom et al., 2017). Although cap-and-trade programmes have been implemented in various sectors, e.g. the EU Emission Trading Scheme, their application on car use has so far only been theoretically analysed and discussed.

Furthermore, in policy discussions much focus is put on measures for urban areas, which is understandable since the alternatives, and therefore efficiency of measures, in urban areas are multiple compared to rural areas, as well as capacity is a never-ending issue. However, looking at the somewhat even distribution between different region types of the population in the distance segment above 28 km per person and day, rural areas need to be included and targeted though these areas probably need different and adjusted solutions compared to the ones created for urban conditions.

There is a clear need for debate about the targeted policies to address individual behaviour and car mileage. This must address also trip purposes beyond commuting. There is a challenge finding ways to affect travel distances for leisure activities, in urban as well as in rural areas. Most recent analyses of global transport envisage vehicular passenger travel continuing its growth of recent decades, for example ITF (2017). The lack of significant progress in both vehicular fuel efficiency and penetration of low carbon fuels stresses the long-term frames needed for fundamental changes in energy and transport technology as well as infrastructure to achieve a sustainable transport sector, for example Nilsson et al. (2013) and Nissinen et al. (2015). The discrepancy between different groups' contribution to the problem and the lack of success of technology to solve the overall emissions leads to the conclusion that a new approach to transport policies is needed, one that recognises produced mileage as a mainly derived demand and thus something to be contested. The implementation of sustainable policies for reducing transport carbon emissions poses a common challenge for authorities worldwide. Even more so does the task of reducing car mileage. Investigating car mileage for different distance categories provides a new perspective for understanding segment-based variation in different geographical contexts.

In the long term, we cannot avoid the discussion about how the individual ‘burden’ to achieve the climate goals can and should be distributed among residents. Can and should everybody contribute equally (equal amount or equal share of reduction in mileage by car)? Is one person's need for mileage by car greater and of greater importance than another's? In the end, this is likely to be a political question where we must seek help from various disciplines, such as economics, political science and philosophy.

5. Conclusions

We have shown that a rather small share of the population contributes to an overwhelming majority of total passenger mileage by car. On an average day, the majority of total passenger mileage by car (>90%) is produced by a minority of the population (25%) and only approximately half of the population use the car on an average day. This is a giant actual challenge, as well as a communicative one, since it shows the need to refocus efforts to find effective measures.

There are differences between rural and urban areas, but for the category of high passenger mileage by car, the difference is not remarkable (even if residents in rural areas are overrepresented and major cities underrepresented). If targets for climate are to be met, rural areas will need measures to be able to reduce passenger mileage by car as well. The results present an urgent need to find measures targeting the ‘above average mileage producers’ beyond improving commuting alternatives since other errands, especially leisure, represent a significant share of total passenger mileage by car. The policy implication of this paper is thus that suggested policies need to target high emitters by seeking out differences amongst the population, identifying the causes and targeting these causes directly. But also, that the effects of measures suggested need to be more thoroughly analysed, identifying individuals, trip distances and trips purposes that are likely to be affected/unaffected in order to have a full understanding of the effectiveness of suggested policies.

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