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Travel trends among young adults in Germany: increasing multimodality and declining car use for men

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ABSTRACT

After decades of growth in motorization and car use, recent trends suggest stagnating travel demand in Germany. This paper focuses on travel trends of young German adults between 18 and 29. For decades these young adults represented one of the most car oriented age groups. Until the 1990s car use increased for all age groups in Germany, including young adults. Based on a range of primary and secondary data sources this paper finds that since the turn of the millennium car use among young adults has decreased. We identify two important underlying trends. First, an increasing share of young drivers also uses alternative modes of transport, thus indicating a rise in multimodal travel behavior. Second, gender differences in car travel have largely disappeared among young Germans—mainly because young men reduced car ownership and driving more than young women. These trends have led to an overall decrease of automobile travel by young adults and contributed to an increase of travel by other modes of transport. Decreasing automobile travel by young adults helps explain the stagnation of aggregate travel demand in Germany, since declining car use among young adults offsets increases in automobile travel of older individuals.

1. Introduction

Like other industrialized countries, Germany has experienced increasing automobile ownership and use during the second half of the 20th century. For decades, young Germans dreamed of getting a driver's license and owning their first car as soon as they turn 18—driving age in Germany (Schmucki, 2001; Wolf, 1986). The age group between 18 and 29 which is the focus of this paper used to be one of the most car-oriented groups in German society, serving as a bellwether for a trend towards more car-oriented lifestyles of all groups of society (DIW, 2003).

However, after decades of growth in automobile travel demand in Germany, overall per-capita travel demand has stagnated since the mid 1990s (Zumkeller et al., 2004). Travel trends differ by age group, however. Per-capita automobile use of elderly travelers has been rising as the first highly motorized generation of Germans born after WWII reaches retirement age (BMVBS, 2010a,b). In contrast, trends in travel demand for young adults indicate decreasing car use, particularly for the age group between 18 and 29.

This study provides evidence on how diverging travel trends of different demographic groups contribute to the phenomenon of stagnating travel demand (also called 'peak travel') in industrialized countries. Without the decrease in automobile travel of young adults, aggregate travel demand in Germany may still be rising—mainly due to increasingly mobile and auto-oriented senior citizens. Thus, our examination of declining car travel demand among young adults adds an important facet to the understanding of 'peak travel'.

The next section of this article relates mobility of young adults to the literature on travel and societal trends in Germany and internationally. Based on a broad range of data sources the remainder of the paper documents changes in young Germans' travel patterns in recent years. We first present our data sources, discuss their strengths and weaknesses, and describe our approaches to overcoming some of the shortcomings of the data. Next, the paper presents travel trends by mode of transport and age group for the last four decades – with a focus on changes in travel behavior of young adults. We specifically highlight two trends that have shaped travel behavior of young adults: diminishing gender differences in car use and increasing multimodal travel behavior. Next, we discuss potential explanations for decreasing car use among

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young adults in order to provide a basis for further research of the issue. The conclusions of this paper summarize the most important findings and highlight implications for understanding the current and future development of young adult's travel.

2. Review

After decades of strong increases in aggregate travel demand–fuelled mainly by increasing car use—there are signs for stagnation in travel demand in many industrialized countries (Litman, 2006; Millard-Ball and Schipper, 2011). Particularly, automobile travel demand seems to decrease, stagnate, or grow only slowly in Western Europe and North America (Newmann and Kenworthy, 2011; Puentes and Tomer, 2008; Le Vine et al., 2009). Germany was one of the countries where stagnating travel demand or 'peak travel' was first documented (Zumkeller et al., 2004). The literature suggests several reasons for 'peak travel' including increasing costs of energy; sluggish national economic growth; slow increases or even declines in road and parking supply (Millard-Ball and Schipper, 2011); constrained individual time budgets and shrinking monetary budgets for individuals (Zumkeller et al., 2004; Metz, 2008, 2004), and the impact of new technology on travel demand (Litman, 2006).

Even though some researchers point to the important role of demographics (Litman, 2006; Zumkeller et al., 2004) the unique contribution of specific age and gender groups to the stagnation of aggregate travel demand has received only limited attention. In fact, some age groups show continued growth in travel demand. For example, per-capita automobile use of elderly travelers in Germany is still on the rise—since the first highly motorized generation of Germans born after WWII reaches retirement age (FGSV, 2006; Dejoux et al., 2010; Ottmann, 2010; Buehler and Nobis, 2010).

Moreover, many European countries have seen strong growth in motorization and car use for women (Sicks, 2011; Axhausen, 2003; Rosenbloom, 2004; Hjorthol, 2008). Growth in motorization for women contributed to diminishing gender differences in car use and automobile access (Scheiner, 2010). However, most studies about gender and mobility in Germany center around differences of car use within families—with a special focus on gender roles, employment, and child rearing (Best and Lanzendorf, 2005; Chlond and Ottmann, 2007; Knoll und Szalai oeg, 2008). The limited research on gender differences in travel behavior of young adults prior to starting a family or professional career finds that young German men are more car-oriented than young women (Flade, 1999; Schönhammer, 1999). Some studies speculate that gender differences in car use among young adults were related to mobility experiences during childhood—e.g. being chauffeured by their parents (Barker, 2008). As discussed in detail below, this paper finds that in 2009 young men and women in Germany had comparable levels of car ownership and automobile travel, predominantly because young men have changed their mobility patterns.

Another significant trend identified in this paper is the increasing tendency of young adults to use multiple modes of transport during a day or week. This phenomenon is known as "multimodality" (Chlond and Lipps, 2000; Nobis, 2007) and has received increasing research attention in the recent years (Block-Schachter, 2009; Carrel et al., 2011). There are two main reasons: first, suitable multiday travel data have become available (Kuhnimhof, 2009); and second, multimodal travelers constitute an attractive potential market for public transport in face of shrinking population shares of captive riders (Kuhnimhof et al., 2006). Within this body of research, little attention has been paid to the multimodality of young people – a phenomenon which also contributed significantly to decreasing car use by young adults.

Besides Germany (Deutsche Shell GmbH, 2001; Zumkeller et al., 2009; BMVBS, 2010a,b), other industrialized countries also report reduced car-orientation of young adults. For example, the share of licensed drivers among young adults has decreased in Norway (Ruud and Nordbakke, 2005), Sweden (Frändberg and Vilhelmson, 2011), Great Britain (Noble, 2005), and the USA (FHWA, 2010). Moreover, Frändberg and Vilhelmson (2011) show that travel among young Swedes has been decreasing.

3. Data sources

Our study draws on primary and secondary data sources. In our analysis of secondary data, we evaluate published reports based on national travel surveys and publicly available aggregate statistics from various German federal government agencies. The analysis of primary data relies on four datasets. Two German national household travel surveys (NTS) serve as main sources for travel data. The Kontiv 1976 ("Kontinuierliche Verkehrserhebung") (BMV, 1976) provides a historic baseline for long term trends. Analysis of short term trends relies on the MOP 1995–2009 dataset ("Deutsches Mobilitätspanel") (BMVBS, 2010a,b). Additionally, primary data from the German Income and Expenditure Survey (EVS) are analyzed for the years 1998 and 2008 (Destatis, 2010a). EVS data help identify trends in car availability of young adults.

3.1. KONTIV and MOP household travel surveys

The Kontiv 1976 survey is the only reliable national travel survey (NTS) for Germany prior to 1980. We use Kontiv 1976 as baseline data to establish long term travel trends between the 1970s and the 1990s. The Kontiv 1976 survey reports travel of respondents during an assigned 24 h period. The 1976 sample included about 28,000 households, with 41,000 individuals making 113,000 trips. The survey was representative for Germany and for all seasons of the year 1976. National travel surveys with a comparable format were conducted in 1982, 1989, 2002, and 2008 (DIW, 1993; infas and DLR, 2010a). However, changes in data collection methods, sampling, and survey design between the 1989 and 2002 surveys limit the comparability of long term trends (Holz-Rau and Scheiner, 2006). This paper includes published results from the 2002 and 2008 surveys in the analysis of short term trends, since these two surveys employ comparable methods.

The "German Mobility Panel" (MOP) is a multiday and multiperiod travel survey that has been conducted every year since 1995. In our study the MOP serves to identify travel trends since the mid 1990s. The MOP comprises a 7-day trip diary and repeated participation of the same respondents in three consecutive years. In this type of panel study, each year one third of participants are replaced by a new set of respondents—keeping two thirds of last year's respondents in the sample. The annual sample size of the MOP is about 750 households with 1800 individuals. Participants report their trips for an entire week. Thus the annual database contains about 45,000 trips.

The MOP data for the years between 1995 and 2009 cover the entire time frame during which significant changes in young people's travel behavior emerged. Moreover, the MOP uses the same methodology each year and is therefore suitable for generating reliable time series data for our comparison. Finally, the MOP can be used to investigate travel behavior throughout an entire week and therefore allows for the identification of multimodal travel behavior, i.e. the usage of multiple modes during a multiday period (Kuhnimhof et al., 2006).

One disadvantage of MOP data is the relatively small annual sample size. In order to overcome this shortcoming, we pooled MOP data for five consecutive years. Thus, MOP-results presented in this paper are labeled as 1997 (for data from years 1995–1999) and 2007 (for years 2005–2009). By pooling the data for 5 year increments the analysis looses detail in changes in travel behavior from year to year. However, pooling several years

increases sample size, controls for outliers, yields more robust estimates, and allows for more disaggregate analysis than would be possible for individual years.

The comparability of travel statistics estimated from Kontiv 1976 and MOP is likely affected by differences in survey methodology. In order to mitigate this problem we selected key travel indicators that are less likely to be affected by survey methodology. First, all key travel statistics presented in this paper refer to trip makers only, i.e. persons who leave their home during the travel day. We excluded individuals who stayed at home, because the share of trip makers has been found to be particularly sensitive to survey methodology (Armoogum et al., 2008). Including respondents who stayed at home may have biased travel indicators per person per day. Second, we focus our discussion of long term trends on 'distance traveled per day'. Compared to trip-based statistics, daily distance travelled has been found to be less affected by selective-recall-error—i.e. individuals forgetting to report short trips (Kuhnimhof et al., 2009). Finally, everyday travel surveys are not well suited to capture extraordinary events in long distance travel. Therefore, international travel is excluded from our analysis of Kontiv and MOP data.

Changes in travel between 1976 and 1995 serve as rough indicators for long term trends in travel behavior prior to the mid 1990s. Part of the observed differences in travel behavior between 1976 and the mid 1990s may be due to differences in methodology between Kontiv and MOP. However, changes in travel behavior between 1976 and the mid 1990s were large and our estimates are in line with data reported by other official government data sources and statistics (BMVBS, 2011). Thus we are confident that changes in travel behavior are real and occurred irrespective of potential comparability issues in our data (Buehler, 2009; DIW, 1993).

3.2. EVS income and expenditure survey

The EVS (Einkommens- und Verbrauchsstichprobe) income and expenditure survey records incomes, expenditures, savings, possession of durable consumer goods, and the housing situation of German households. The survey is conducted every 5 years by the German Federal Statistical Office and is representative for the German population. The most recent data are available for 2008. For our study of trends over time we used the data sets for the years 1998 and 2008.

Participation in the EVS survey is voluntary. The number of selected households in each survey year equates roughly to 0.2% of all households in Germany. The 1998 data set comprises approximately 50,000 households and the 2008 data set approximately 44,000 households. There were only minor changes in survey methodology between the two surveys that should not affect our comparisons between the 1998 and 2008 data sets.

The EVS survey includes questions asking about the household possession of durable consumer goods, such as cars and bicycles. Moreover, the survey reports on socio-economic and demographic characteristics of households and individuals. Each participating household also reports all incomes and expenditures during a 3 months period. For our study we analyzed car ownership of households with household members in the age group 18–29.

4. Travel demand in Germany by mode and age group since 1976

From 1976 to 1997, average daily travel distance per person in Germany rose from 26 km to 34 km (BMVBS, 2011; Zumkeller et al., 2009). The number of cars per 1000 persons increased from about 300 to about 500 (The World Bank, 2010), and the share of trips by car increased from 45% to 60% (Buehler, 2011). During this time travel demand and motorization per capita increased significantly for all age groups. Figs. 1 and 2 highlight this growth in travel demand measured as total daily travel distance by mode of transport.

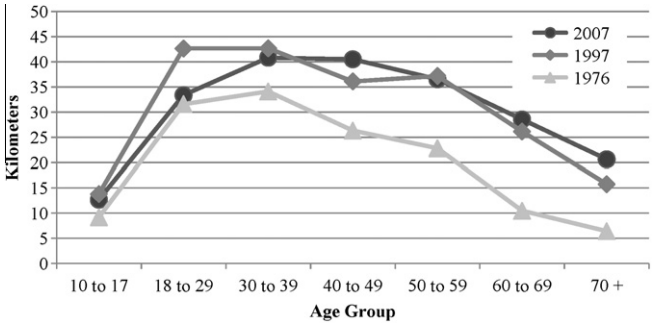

Fig. 1. Automobile travel distance (driver and passenger) per trip maker and day by age in Germany, 1976–2007. *Sources*: authors' analyses on the basis of Kontiv 1976, MOP 1995–2009.

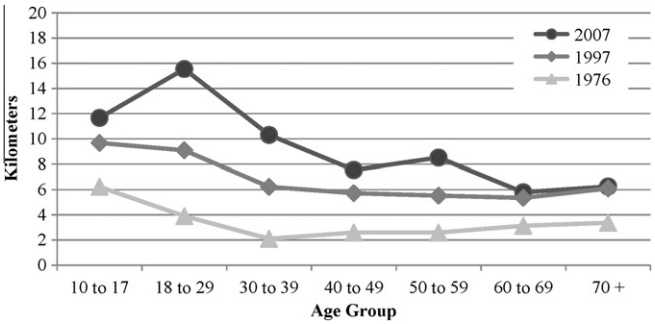

Fig. 2. Public transport travel distance per trip maker and day by age in Germany, 1976–2007. *Sources*: authors' analyses on the basis of Kontiv 1976, MOP 1995–2009.

The figures also disaggregate trends by age group. In 1976 and 1997 adults under 40 traveled more kilometers per person per day by car than any other age group. However, since 1997, daily kilometers of automobile travel for individuals aged between 18 and 29 dropped by over 20%. At the same time automobile travel stagnated for the population between 30 and 70 and increased slightly for individuals older than 70.

In contrast to trends in car use, kilometers of public transport use of 18–29 year olds almost doubled since 1997 (Fig. 2). In 2007, young adults between 18 and 29 rode public transport more than 10–17 year olds—who are largely captive public transport riders since driving age is 18 in Germany. Other age groups showed modest or no increases in public transport usage since 1997. Compared to changes in car and public transport use, changes in non-motorized travel were small and estimates are less reliable. However, according to the MOP, daily distances walked and cycled increased slightly for all age groups between 1997 and 2007.

In summary, all age groups in Germany witnessed strong growth of travel demand until the late 1990s. Since then there has been little change in aggregate travel demand (Zumkeller et al., 2004, 2009). However, travel trends and car use diverge between age groups. Growth in car use among seniors is offset by decreasing car use among young adults. In the following we analyze these changes in travel trends among young adults.

5. Changes in travel of young adults

5.1. Trends in car ownership and share of licensed drivers

In line with the growth in car use between 1976 and 1997, the share of licensed drivers among the 18–29 year olds increased

from 70% to 87% according to our Kontiv 1976 and MOP analysis. Since then, however, all German household travel surveys report stagnating shares of licensed drivers (around 87%) for this age group (BMVBS, 2010a,b; DIW and infas, 2003; infas et al., 2010b). This stagnation is also confirmed by a new government database on driver's licensing for young adults (KBA, 2010b). According to that database the share of licensed drivers among young Germans between 18 and 24 has remained at 67% for males and at 70% for women since 2006 (this statistic does so far not cover other age groups).

While the share of licensed drivers among young Germans has stagnated, car ownership has declined. This is in contrast to overall motorization levels in Germany, which continued to increase and reached 570 cars per 1000 people in 2010 (The World Bank, 2010). Official car registration statistics (KBA, 2010a) show that motorization among young adults in Germany has diverged from the general trend since the late 1980s (Fig. 3). Registered cars per capita for men aged 25–29 started to decline in the late 1980s and have been falling almost continuously since then. Car registrations per capita for men in their early 20s and young women stagnated or only increased slightly until 2000. Since then the number of registered cars per 1000 persons has been falling for young men and women alike.

Car registration statistics presented above may hide actual car access for young adults who register cars in their parent's name—for example, to avoid higher insurance rates for young drivers. However, also our analysis of the German Income and Expenditure Surveys (EVS) 1998 and 2008 suggests that car access has been decreasing for young adults. Fig. 4 compares the share of young people who lived in a household with at least one car in 1998 and 2008. The figure shows that car access declined most for people in the early twenties. Further EVS analysis focusing on young households (no household member older than 29) reveals

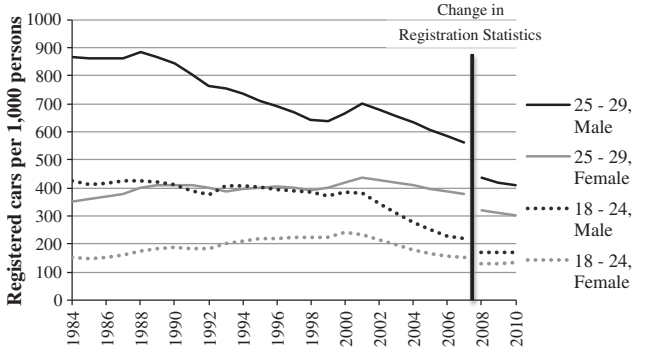

Fig. 3. Vehicle registrations of young drivers in Germany 1984–2010. *Sources*: authors' representation on the basis of data by Kraftfahrtbundesamt (KBA, 2010).

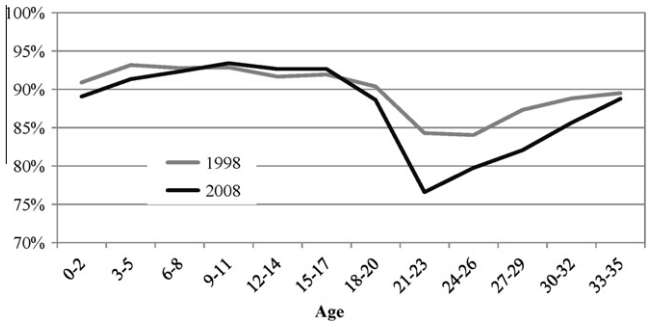

Fig. 4. Share of young population living in a household with car by age 1998 and 2008. *Sources*: authors' analyses on the basis of EVS 1998, EVS 2008.

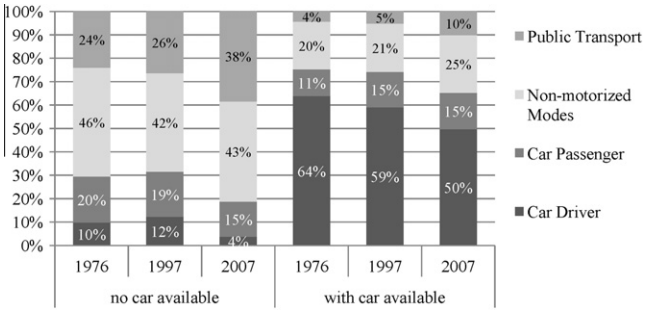

Fig. 5. Mode share of travelers aged 18–29 by car availability. *Sources*: authors' analyses on the basis of Kontiv 1976, MOP 1995–2009.

that the number of cars per adult has dropped most for single person households (1998: 0.63; 2008: 0.57). In contrast, the number of cars per adult is unchanged for young couples with children (1998: 0.57; 2008: 0.57).

Overall, this suggests that car access has declined significantly for young adults who have left their parents' household and have not yet started their own family. These findings are confirmed by results from a tri-annual expenditure survey among German students. In 1991, 53% of German students reported automobile-related expenditures. This share had fallen to 34% in 2009 (BMBF, 2010). In summary, car ownership of young Germans has been decreasing and the share of licensed drivers has stagnated. This is also reflected in the MOP data: In 1997, 78% of travelers aged 18–29 had a drivers' license and lived in a household with car. This share had fallen to 71% in 2007.

5.2. Increasing multimodality

Reduced car ownership is only one possible reason for the decrease in automobile travel among young adults. Changes in mode choice by young drivers represent another important factor. Fig. 5 tracks mode shares of trips by young adults with and without access to a car since the mid 1970s. Mode shares in both groups changed only minimally between 1976 and 1997. Since 1997, the car mode share has fallen significantly in each group, along with a strong increase in public transport use and more moderate increases for non-motorized modes.

Declining car use among individuals with car access indicates increasing multimodality. Results from two other surveys (MiD 2002 and 2008) support declining car use and more multimodality among 18–29 year olds during the last decade (DIW and infas, 2003; infas et al., 2010b). Fig. 6 shows that the share of those who used a car at least once a month remained almost unchanged

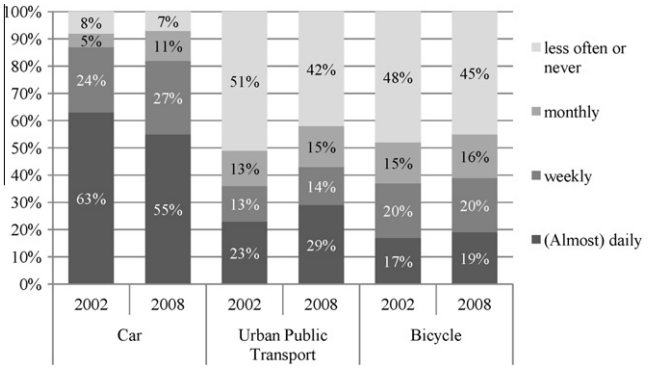

Fig. 6. Shares of mode users based on self-estimated mode use frequency (travelers aged 18–29). *Sources*: authors' representation on the basis of MiD 2002 and MiD 2008.

between 2002 and 2008 at about 92%. However, the share of those using a car on a daily basis decreased. At the same time, the shares of daily and weekly public transport and bicycle users increased.

Besides a 24 h travel diary the MiD surveys only ask additional questions about travel behavior during typical weeks and months. In contrast, the MOP records a person's travel for a 7 day period. Thus MOP may be more reliable than the self-reported data from MiD presented above. The MOP was used to analyze weekly frequency of mode use by young car owners aged 18–29 between 1997 and 2007. In this group, the share of those who drove at least once a week remained stable at roughly 90%. However, the share of young car owners who drove on at least 5 days a week decreased significantly from 62% in 1997 to 47% in 2007. In contrast, the share of young car owners who rode public transport at least once a week has increased from 25% in 1997 to 40% in 2007. The share of daily public transport riders among car owners remained stable at roughly 10%.

In summary, multimodality has increased among young adults. This specifically applies to travelers with car availability who increasingly use other modes of transport as well.

5.3. Mode shifts in regional and long distance travel

Only 5% of daily trips by young Germans are longer than 50 km. However, these trips represent an important aspect of young adults' travel behavior, since long trips account for about half of all kilometers travelled (Kuhnimhof and Last, 2009). Hence, changes in mode choice for regional and long distance travel can disproportionally influence total kilometers travelled by mode as shown in Figs. 1 and 2 above.

Based on the MOP we analyzed regional and long distance travel which is typically accomplished by car or train. The data show a decrease of the car mode share for trips over 50 km by travelers aged 18–29. Young adults covered 79% of their trips over 50 km by car in 1997. This share fell to 62% in 2007. In contrast, the share of trips by train increased during this time from 17% to 31% (the remaining trips are made by bus and other modes). Controlling for car ownership, this shift away from the car and to the train could also be observed. Young travelers with car access decreased their car mode share on trips over 50 km from 80% in 1997 to 72% in 2007 and increased their train mode share (1997: 15%; 2007: 22%). These results suggest that shifting mode choice in long distance travel contributes to the observed increase in multimodality.

Moreover, we analyzed mode choice trends in young Germans' tourism travel based on a designated tourism survey. The mobility diary surveys presented above do not provide reliable information about multiday travel for tourism purposes. Due to the age class breakdown in the analyzed tourism, survey results for tourism travel are only available for the age group 16–35. In 1997, 50% of multiday holiday journeys were by car. This share fell to 47% in 2007. In contrast, air travel for holiday journeys increased from 36% to 45%. This shift in mode share went along with a trend towards more distant holiday destinations. In 1997, 16% of young Germans' holiday destinations were outside of Europe. This share increased to 21% in 2007 (F.U.R., 1999, 2007). In summary, over the last two decades young Germans increasingly opted for the train for national long distance travel and air travel for tourism and international travel.

5.4. Disappearing gender differences and decreases in car use among young men

As discussed above, during the last 40 years men were more likely than women to own and use automobiles. For example, Kontiv survey data for 1976 show that the share of men between 18 and 24 years who held a driver's license was 68% compared to 59% for women. In the age group 25–29 the difference was even larger with 91% licensed drivers among men compared to 72% for women. The official German government database on licensing shows that this gap has disappeared for the age group 18–24—where in 2010 women were slightly more likely than men to have a driver's license (KBA, 2010b).

The gender gap in vehicle ownership has decreased as well. As shown above, the decline in vehicle registrations was more pronounced among young men than women (see Fig. 3). There are still more vehicles registered for young men, but this may be attributed to the fact that young couples tend to register cars in the man's name.

The income and expenditure survey EVS confirms that decreasing car ownership is more pronounced for young men. Fig. 7 illustrates that in 1998 young single men with low incomes (<€1000) were more likely to own a car than single women in the same income category. By 2008 this difference disappeared. Only 28% of young single male households with low incomes owned a car—almost the same share as for women. Other income groups also display diminishing gender differences in car availability between households of single males and females.

The diminishing gender gap with regard to holding a driver's license and owning a car is also reflected in automobile travel demand by young men and women. Fig. 8 shows kilometers of travel by mode of transport for young male and female travelers since 1976—differentiating between the age groups of 18–24 and 25–29. Gender differences in kilometers of travel were evident for both age groups in 1976. By 1997, differences in automobile travel had disappeared for the 18–24 year old. Between 1997 and 2007, both, men and women of this age group reduced their automobile travel demand. In 1997, men still drove more than women in the age group 25–29. In 2007, however, the gender gap had almost closed–mainly because men of this age group have reduced their automobile travel significantly while young women's automobile travel has remained largely unchanged between 1997 and 2007.

To test for statistical significance of the observed trends and to decompose the trends we conducted a multiple regression analysis of the MOP data. Table 1 presents results of two models with two different dependent variables: weekly kilometers of automobile travel and weekly kilometers traveled in total (including all modes). The analyses include individuals between 18 and 29 years and are based on MOP data from 1998 to 2009—the time period for which behavioral changes were most evident in the descriptive analysis above. The MOP is a panel survey with the same respondents reporting their travel for three subsequent years. Therefore

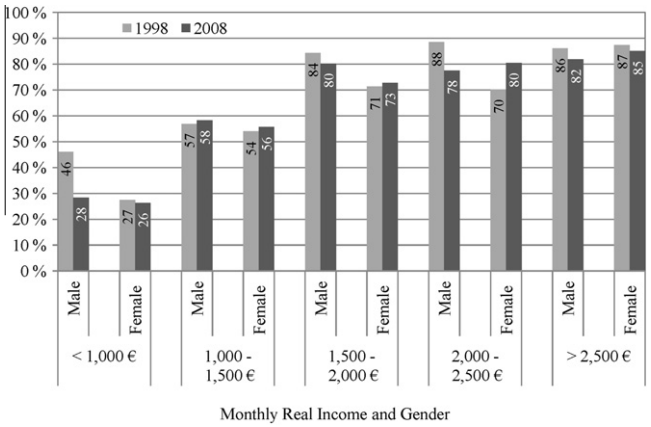

Fig. 7. Share of households with car among single person households (age 18–29) by monthly real income and gender. *Sources*: authors' analyses on the basis of EVS 1998, EVS 2008.

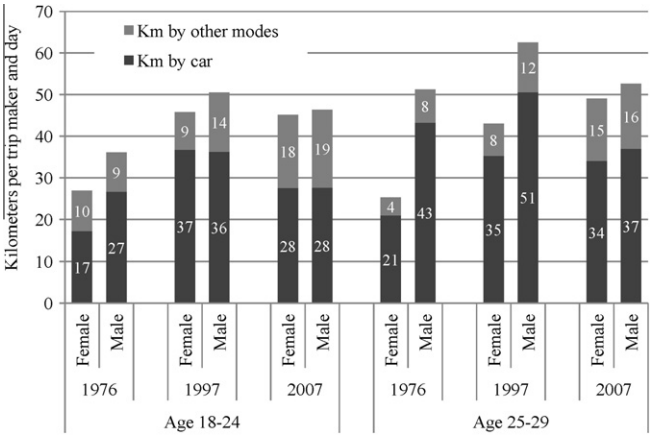

Fig. 8. Kilometers per trip maker and day by gender (ages 18–29). *Sources*: authors' analyses on the basis of Kontiv 1997, MOP 1995–2009.

Table 1
Results of multilevel regression of weekly distance by mode 1998–2009 (age 18–29). Data source: MOP 1998–2009.

Weekly kilometers travelled by…	Car		All Modes	
	Estimate	*P*>|*t*|	Estimate	*P*>|*t*|
Intercept	264.7	*0.000*	333.4	*0.000*
Year (passed since 1995)	−4.4	*0.245*	−0.7	*0.860*
Male	70.5	*0.003*	79.2	*0.002*
Male ∗ year	−6.5	*0.081*	−8.1	*0.046*
Urban	−94.1	*0.000*	−76.7	*0.004*
Urban ∗ year	3.7	*0.338*	4.8	*0.255*
Work	74.0	*0.001*	38.9	*0.122*
Work ∗ year	1.8	*0.612*	3.5	*0.377*
Observations	*2058*		*2057*	
Explained variation[a]	*0.18*		*0.10*	

[a] Explained variation is measured by how much variance on the interpersonal level has diminished between an unconditional means model with one fixed effect and the conditional model presented above. For details see (Singer, 1998).

intrapersonal correlation has to be considered in the multiple regression analysis. We used a multilevel regression with an additional error term for the person level to account for the nested nature of the data (Bliese, 2009; Singer, 1998).

Our models are not designed to explain kilometers of travel in their entirety. Instead the models intend to test time trends for different important covariates identified in the literature and during our descriptive analysis above. In Table 1 the variables 'male' ("1" if male, "0" if female), 'urban' ("1" if population of town of residence >100.000, "0" if otherwise) and 'work' ("1" if person is employed; "0" if otherwise) serve to establish differences in travel behavior for the reference year 1998. The count variable 'year' (1998 = 0, 1999 = 1, 2000 = 2, etc.) identifies the general time trend against this reference case. The interaction variables (male ∗ year, urban ∗ year, work ∗ year) identify potentially diverging time trends by gender, land-use, and employment status.

Results suggest that men travel more per week than women – by car and in total. Similarly, compared to individuals living outside of large cities urbanites appear to drive and travel less in total. Employed young adults seem to drive significantly more per week, but there appears to be no difference in overall travel for employed and unemployed individuals. Through the inclusion of these variables our model takes account of changes in the socio-economic set-up of the young adult population with regard to employment and residential location during the analyzed decade. These changes are discussed in more detail below.

After factoring in these socio-economic changes hardly any of the analyzed time trends are significant at the 10% level: The only significant interaction variable is "male ∗ year". This suggests that significant changes in travel behavior can only be identified for men, but not for women. Men seem to have reduced their driving and overall travel. Results suggest that there is no significant time trend for employment status and type of residential area. The latter is rather unexpected and might by due to the limited possibilities to differentiate land use types in the MOP data.

Considering the limitations of our surveys discussed in the data section above, conclusions have to be drawn cautiously. Nevertheless, there is indication that the reduction of automobile travel is limited to young males. This adds to our findings from the descriptive analysis above, which showed that gender differences in license holding, car ownership and automobile travel have largely disappeared among young adults.

6. Further research: explaining changes in travel trends

In the following we briefly outline some possible explanations for the observed changes of mobility patterns by young Germans. The purpose of this section is not to quantify the explanatory contribution of potentially influential factors. We rather intend to frame the discussion and provide a basis for further research. We differentiate two domains of relevant influential factors: (a) socio-economic shifts in the population and (b) possible causes for behavioral changes holding other factors constant.

6.1. Socio-economic shifts in the population

Germany is undergoing structural changes that likely affect aggregate travel behavior of young adults. The most important trend is probably the increasing share of young people attending universities and colleges. The number of enrolled students per 1000 persons in the age group 15–34 has increased from 80 to 100 between 1997 and 2007 (Destatis, 2010d). Correspondingly, there is decreasing workforce participation among young adults (The World Bank, 2010). As universities and colleges in Germany are often located in cities, increasing enrollments also contribute to an increasing share of urban population among young adults: While in 1998, 24% of Germans aged 20–34 lived in cities with a population of over 100,000, this share had reached 27% by 2008 (Destatis, 2010b). Changes in educational and professional careers probably also contribute to an increasing age for starting a family. The average age of a German mother when having the first baby was 28 in 1998. This had increased to 30 by 2008 (Destatis, 2010c). All of these trends contribute to a larger share of young people being in a life situation in which they are less likely to use or own an automobile.

A delayed start of the professional career also has implications for incomes of young people. The average inflation adjusted real income of households with a household head younger than 35 was 2300 Euros per month in 1998 and had declined to 2150 Euros in 2008 (Destatis, 2010a). This was not only caused by decreasing labor force participation of young adults, but also by young professionals suffering real income losses during this decade. The strong correlation of income and car ownership (Ingram and Liu, 1999; Quinet and Vickerman, 2004) suggests that falling incomes contributed to the decreasing car ownership among young adults.

6.2. Possible causes for changes in travel behavior

There is also a wide range of factors that may explain why young Germans today drive less than their counterparts in the late 1990s even when life circumstances are similar. First, the costs of driving increased considerably in the 1990s: Between the 1970s

and 1990s car ownership and use had become less expensive relative to income – making the car affordable for larger parts of the population (Buehler and Kunert, 2010). However, between 1991 and 2007, the price for gasoline paid at the pump in Germany almost doubled due to increasing world market crude-oil prices and German taxation policies (MWV, 2007; The World Bank, 2010). As discussed above, during the same time real incomes increased slowly or even decreased. Thus, the average work time needed to pay for a liter of gasoline increased from slightly under four minutes in 1990 to almost six minutes in 2007 (ESSO, 2008). Besides the strong increase in out-of-pocket costs for car use (+81% cost increase for fuel), there were also increases in the fixed costs of car ownership (+12% cost increase for vehicle purchase) between 1998 and 2008 (Destatis, 2009).

Overall, public transport prices increased only by 42% during this time—possibly making public transport a more attractive transport alternative even for car owners (Destatis, 2009). Moreover, students in many university cities in Germany benefitted from the introduction of "Semestertickets", special public transport season tickets for students with minimal costs (Peistrup and Stingel, 2007; Buehler and Pucher, 2010). Correspondingly, according to the MOP the share of Germans aged 20–29 with a monthly or annual public transport ticket more than doubled from 25% in 1996 to 52% in 2008 (BMVBS, 2010a,b).

Changes in the transport system were not only price related. Driving in urban areas has been discouraged by parking policies, traffic calming, pedestrianized downtowns and other measures. Public transport on the other hand has improved its service in many urban areas—e.g. through the introduction of integrated ticketing, real time information at stops, or online information and ticket purchase (Buehler and Pucher, 2011). Moreover, many German municipalities have implemented policies and measures that promote walking and cycling, e.g. by traffic-calming virtually all neighborhood streets to 30 km/h or less, and expanding networks of separate bike paths and lanes (Pucher and Buehler, 2008).

Moreover, the use of information and communication technology (ICT) has increased during the last decade. The impact of ICT on travel behavior remains an open question (ifmo, 2003; Mokhtarian et al., 2006). Possibly, this issue should be revisited with a focus on those young adults who grew up with ICT and developed their mobility habits in the presence of such technology–the generation under focus in this paper.

Finally, psychological factors represent an important aspect to consider. They may range from environmental awareness to more pragmatism in everyday mobility choices. The non-psychological factors outlined above mostly affect men and women alike. However, the changes in travel trends are more pronounced among young men. Hence, it seems specifically worthwhile to investigate psychological factors against the background of the diverging trends for men and women.

7. Conclusions and outlook

This paper adds a new aspect to the discussion of stagnating travel demand by focusing on travel trends among young adults aged 18–29 years. Based on a wide range of secondary data sources and analysis of primary data we find that young adults in Germany reduced their use of automobiles. Within this age group we identified two main reasons for less car use: (1) increasing multimodality, specifically among car owners; and (2) decreases in car ownership and use among young men. In fact, young men reduced their driving so much that there is no longer a gender gap in car use between young men and women. Together these trends have contributed to a decrease of automobile travel by young adults. This decrease represents a trend reversal compared to strong increases in automobile travel prior to the 1990s.

The results of our study have implications for future research. First, this paper contributes to explaining why overall travel demand has been stagnating in Germany since the turn of the millennium – a development that occurred unexpectedly in a time during which an increasingly auto-oriented and mobile generation of seniors emerged. Our study suggests that increases of car ownership and use among the elderly were partly offset by decreases in car use among the young. Studies of young adults in other countries could help shed more light on stagnation of aggregate travel demand.

Second, our findings raise the question about causes for changes in travel behavior of young adults. In the past, changes in fuel prices, urban density, or ICT seemed to influence aggregate demand for automobile travel only minimally. This led many to believe that increasing travel demand was almost invariant to external conditions. Our study indicates that young adults whose mobility patterns are not yet as ingrained but more malleable than later in life may show stronger behavioral reactions than older travelers.

So far, however, we do not know whether this new generation of travelers will maintain their less car-oriented and more multimodal mobility patterns in the future—or if they will adopt the same mobility behavior as past generations at a later stage in their life. In any case, the mobility patterns of young adults deserve to stay under observation and high on the research agenda in the coming years.

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