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Transport Policies, Automobile Use, and Sustainable Transport: A Comparison of Germany and the United States

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Abstract

The automobile contributes to costly trends like pollution, oil dependence, congestion, and obesity. This article investigates determinants of individual car travel through a comparison of Germany and the USA. Even controlling for socioeconomic variables and spatial development patterns, two comparable national travel surveys show that Germans are less car-dependent than Americans. Multivariate analysis reveals that car travel demand in the USA is more responsive to price than in Germany. Results suggest Americans may more easily reduce driving when faced with increasing gasoline prices. Low costs of driving in the USA may contribute to more discretionary driving, whereas higher costs of car travel in Germany may have already encouraged prudent car use.

Keywords

transport policies, sustainable transport, car use, international comparisons, automobile dependence

The automobile is linked to increasing environmental pollution, oil dependence, accident casualties, traffic congestion, and obesity. Governments around the globe, concerned with the costs of these trends, have begun to grapple with the complicated problem of how to mitigate the impacts of car travel effectively, efficiently, and in a manner that is politically tenable (Banister 2005). Scholars suggest the USA look to similarly wealthy and less car-dependent European countries for effective strategies to achieve more sustainable transport (Banister, Pucher, and Lee-Gosslin 2007). Studying comparably wealthy countries allows controlling for similarities, such as income or motorization, while accounting for differences, such as transport policies or spatial development patterns. Understanding why car use is different in similar countries may help inform policy decisions to make transport more sustainable. This article investigates the relationship of individual automobile use and transport policies in Germany and the USA, while controlling for spatial development patterns and socioeconomic and demographic factors.

Germany and the USA are both wealthy Western countries with two of the highest car ownership rates in the world and extensive limited access highway networks (International Monetary Fund [IMF] 2008; International Road Federation [IRF] 2007). Compared to Americans, Germans travel half as many kilometers per person per year in an automobile and are four times more likely to make a trip by transit, bicycle, and foot. Even for trips shorter than 1.6 kilometers (1 mile), Americans are more than twice as likely to use their car as Germans (68 vs. 28 percent of trips). Reliance on the automobile for most trips and more kilometers of car travel are connected to more energy consumption, environmental pollution, and higher private and public cost of transport in the USA (Banister 2005; Buehler, Pucher, and Kunert 2009).

Overall annual energy use and CO_2 emissions from ground passenger transport per person are three times higher in the USA (BMVBS 1991-2008; U.S. Department of Energy [DOE] 2007; Oak Ridge National Laboratory [ORNL] 2008; UBA 2005b). Moreover, American households spend $2,700 more on ground transport annually than Germans (U.S. Bureau of Labor Statistics [BLS] 2000-2003; DESTATIS 2003). Traffic fatalities per capita in the USA are more than two times higher than in Germany (International Traffic Safety Data and Analysis Group [IRTAD] 2008). The differences in traffic safety are especially striking for pedestrians and cyclists, with three times higher fatality rates per kilometer walked and cycled in the USA than in Germany.

The article first introduces a conceptual framework for analyzing international differences in car use—based on travel behavior theory and a review of comparative studies

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of travel behavior in Western Europe and North America. The subsequent section introduces similarities and differences between the countries and their transport policies. Next, based on two uniquely comparable national travel surveys, bivariate and multivariate analyses empirically investigate determinants of differences in car use between the two countries. The study finds that transport policies play a role in shaping differences in car use between the countries even after controlling for socioeconomic and demographic factors and spatial development patterns.

International Comparative Research on Automobile Use and Travel Behavior

Travel behavior theory provides a framework to analyze determinants of automobile use in international comparative perspective. This theory assumes that individuals maximize their utility and minimize the disutility of travel time and cost when participating in out-of-home activities, such as work, shopping, or leisure. The choice of number of car trips and automobile travel distance depend on the relative attractiveness of the car compared to other modes of transport for a specific trip, as well as socioeconomic and demographic characteristics and preferences of the individual. Transport policies and spatial development patterns shape out-of-pocket expenditures, opportunity cost of travel time, and convenience of travel—and thus help determine the relative attractiveness of the automobile and other modes (Chatman 2008; McCarthy 2001; Quinet and Vickermann 2004). Because of resource and time constraints, individuals minimize the cost of travel to access out-of-home activities by making trade-offs between modes of transport, number of trips, and travel distance (Ben-Akiva and Lerman 1985; McCarthy 2001).

Socioeconomic and Demographic Factors

Most international comparative studies identify socioeconomic and demographic characteristics as key explanatory factors for dissimilarities in car use—particularly for differences in travel between industrialized and developing countries (Axhausen et al. 2002; Dargay and Gately 1999; Giuliano and Dargay 2005; Ingram and Liu 1999; Schafer 1999; Timmermanns et al. 2003). Schafer (1999) and Schafer and Victor (2000) show that the daily amount of time spend on travel is similar worldwide but that higher incomes are related to more car use and longer car travel distances. With rising incomes, owning and operating a car becomes affordable, while the opportunity cost per minute of travel time increases. Faster travel speeds by automobile, compared to other modes, allow wealthier individuals to reach farther destinations by car in the same travel time as poorer individuals can access destinations close-by on foot or bicycle. Similarly, Dargay and Gately (1999), Giuliano and Dargay (2005), Ingram and Liu (1999), and Simma and Axhausen (2001, 2003) find strong positive correlations between income, car ownership, and amount of daily car travel. Causation might flow both ways. First, individuals in households that own more cars might choose to drive more. Second, households whose members wish to drive more might choose to own more automobiles—compared to fewer cars in households that either prefer transit, cycling, and walking or cannot afford an automobile.

While income and auto ownership have been seen as good predictors for mode choice and travel distance internationally, they might have lost some of their predictive power for differences between industrialized countries, where most households own one or multiple cars (Kunert and Lipps 2005). Thus other demographic indicators are also important explanatory factors (Axhausen et al. 2002; Giuliano and Narayan 2003; Timmermanns et al. 2003). For example, children, the elderly, and individuals not in the workforce are thought to make fewer and generally shorter car trips than employed individuals.

Spatial Development Patterns

Spatial development patterns and urban form offer opportunities and barriers that shape the time cost and convenience of different modes of transport (Boarnet and Crane 2001a, 2001b; Chatman 2008). First, in dense and mixed-use areas, trip distances are short, and more destinations can be reached by foot or bicycle. Second, population density, mix of land use, and other measures of urban form are correlated with more convenient, higher-quality, and better supply of infrastructure for nonautomobile modes (Boarnet and Crane 2001b; Chatman 2008; Handy 1996). Third, in densely populated areas, automobile parking supply is generally more limited, parking costs are higher, and road supply per capita is lower. Higher cost and slower car travel speeds increase the out-of-pocket and opportunity costs of car travel and reduce its convenience. Consequently, individuals might choose to walk and cycle more in dense and mixed-use areas and thus reduce daily car travel distance by forgoing car trips altogether. Moreover, if individuals chose to drive in densely built-up areas, car travel distance will likely be shorter, due to slower automobile travel speeds and higher opportunity cost of time.

Aggregate international comparative studies of countries and cities show that population and employment density, mix of land uses, and concentration of workplaces in central business districts do indeed moderate the relationship between socioeconomic factors and car use (Axhausen et al. 2002; Ingram and Liu 1999; Schwanen 2002; Stead and Marshall 2001). For example, Newman and Kenworthy (1996, 1999) and Newman, Kenworthy, and Laube (2001) find more car use in American and Australian cities with lower gross domestic product per capita than in wealthier European and Asian cities. Empirical evidence from individual level studies is mixed. Timmermans and colleagues (2003) show urban-suburban differences to be statistically insignificant, once their analysis controls for socioeconomic and demographic factors. Giuliano and Dargay (2005) and Giuliano and Narayan (2003, 2004) find that higher residential densities are associated with significantly shorter trip distances in the USA but not in Great Britain.

Individuals can influence the relative cost and availability of mode of transport by their choice of residential location. This is a long-term decision that influences daily travel choices, but households have been found to trade off lower housing costs against longer travel distances with higher time and out-of-pocket expenditures for transport (Giuliano and Dargay 2005; Meyer, Kain, and Wohl 1965). Recent research in the USA has found self-selection and residential sorting of individuals with preferences for nonautomobile travel in dense and mixed-use areas. Additionally, research shows that location choice and transit access influences employment participation rates in urban areas (Sanchez 1999).

Transport Policies

Transport policies are commonly cited as explanatory factors for international dissimilarities in car use, since they shape out-of-pocket expenditures, time cost, and convenience of different transport modes (Giuliano and Dargay 2005; Pucher 1988; Transportation Research Board [TRB] 2001). Transport and land use policies in Western European countries make car use more costly, slower, and less attractive than in the USA through higher taxes on gasoline and automobile ownership, higher cost and reduced supply of parking, fewer roads in urban areas, and lower car speed limits and traffic calming of neighborhoods (Pucher 1995a, 1995b; Pucher and Kurth 1995; Vuchic 1999). Policy analysts point to the important distinction between policies and policy outcomes. The process of policy implementation intervenes between the two and can determine the success or failure of a policy (Birkland 2001). Individuals make their travel choices based on policy outcomes rather than the formulated policy itself. For example, from an individual perspective, the outcomes of European transport policies increase time and out-of-pocket costs of car travel and thus reduce its attractiveness and relative utility compared to other modes. Transport policies also make alternative modes of transport less costly, faster, and more attractive in Europe—thus increasing their relative utility and attractiveness. For example, transit supply is generally greater and more convenient in Western Europe than in the USA, and networks of walking and cycling infrastructure provide direct and safe routes for pedestrians and cyclists (Pucher and Buehler 2008; Pucher, Dill, and Handy 2010). Greater supply of transit service and better infrastructure for walking and cycling make these modes safe, reliable, less time-consuming, and inexpensive for individuals, thus decreasing the relative cost compared to automobile use and potentially reducing car use and automobile travel distance. Individuals may choose transit and forgo an automobile trip if transit service is inexpensive, easily accessible, punctual, and follows an expedient route from origin to destination. However, car use will increase if the transit trip adds significant time and uncertainty and if car use is inexpensive and fast. Likewise, a walking trip to the corner store may be chosen over the car if the trip is safe, convenient, and more direct than the automobile traffic route; but it is less likely to be chosen if pedestrians must complete the same distance as a car or have to battle road traffic.

In many European countries, transport policies are integrated with stringent land use policies that keep settlements compact and trip distances between origins and destinations short—which make nonautomobile travel possible. Higher population and employment densities also make transit service more economically viable. Policy choices on local, state, or federal levels influence the relative competitiveness—in out-of-pocket cost, time, and convenience—of modes of transport and thus help determine car use and travel distance. Individuals use their cars less by either choosing alternative modes of transport for some trips or by driving shorter distances.

Culture and Attitudes

Cultural preferences, social norms, and individual attitudes may influence car use regardless of other factors (Flamm 2009; Gaerling, Gillholm, and Gaerling 1998). Even though difficult to quantify in international comparative studies, many authors emphasize the role of cultural differences in shaping spatial development, transport policy, and car use (Button 1998; Deakin 2001; Dunn 1981; Timmermanns et al. 2003).

Most recent empirical studies focus on the USA, however. In a study of travelers in Sacramento, California, Flamm (2009) finds that individuals with proenvironmental attitudes drive fewer kilometers per day—thus hinting at a connection of environmental attitudes and travel behavior. Moreover, in the USA, scholars have found evidence that individuals who prefer alternative modes of transport choose to live in dense mixed-use areas with transit access (Cao, Mokhtarian, and Handy 2006). After controlling for this self-selection, many studies still find a (smaller) net effect of spatial development patterns on travel behavior. In a study of Boston and Atlanta, Levine (2006) shows that this sorting effect might be related to a lack of supply of walkable and bikeable places with transit access—more widespread supply of alternative neighborhoods might reduce the need for spatial sorting. Self-selection might be less of a problem in countries with a higher supply of dense mixed-use transport modes and more ubiquitous transit access—although empirical evidence is more limited and not conclusive (Vance and Hedel 2008).

The interplay of socioeconomic and demographic factors, spatial development patterns, transport policies, and attitudes

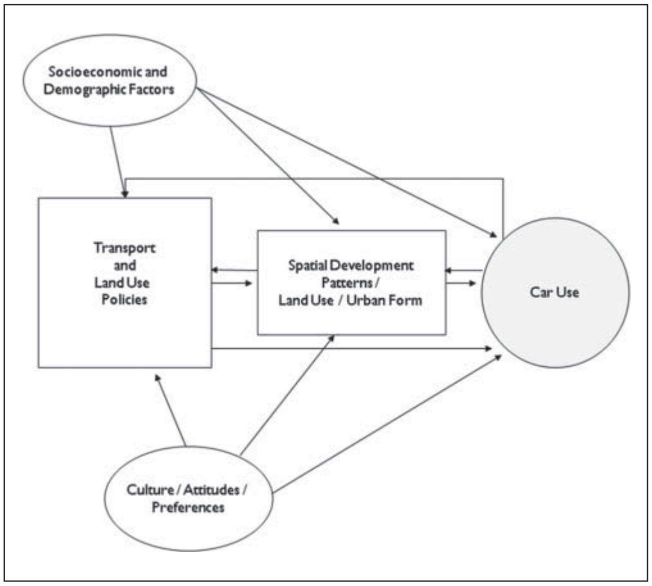

Figure 1. Expected relationships between explanatory factors and car use

might have a different impact on travel behavior in each country, contributing to unique transport patterns. These explanatory factors not only influence car use directly but also are interdependent of each other (Figure 1). Transport and land use policies shape the cost of car travel and, over time, also influence spatial development patterns and urban form. Spatial development patterns and car use are mutually interdependent. A definite causal relationship flowing from land use to transportation cannot be clearly determined as the automobile allows for low-density settlements, but at the same time these kinds of settlements then require the availability of a car for daily activities. The level of car use and suburban sprawl also shapes public support or opposition for different transport and land use policies. For example, policies that make car use more expensive are less likely to gain support among individuals in a car-oriented sprawled development. Socioeconomic and demographic factors influence car use directly, but also indirectly through the choice of residential location and support for or opposition to transport and land use policies by different groups of society. Individual preferences and cultural values might influence transport and land use policies, spatial development patterns, and car use. For example, individuals who prefer to cycle, walk, or use transit more often might move to denser and mixed-use neighborhoods.

Germany and USA: Many Similarities, but Dissimilar Transport Policies

Germany and the USA have many similarities in system of government, importance of the automobile industry for the national economy, motorization rates, economic strength, extent of limited access highway networks, and large parts of urban areas that were either built or rebuilt after WWII. This renders a comparison of determinants of travel behavior meaningful since these similarities can likely be ruled out as sources for differences in travel behavior.

First, Germany and the USA are Western countries with two of the highest car ownership rates in the world (IMF 2008; IRF 2007). Second, both countries are democracies with federal systems of government and a history of local self-government (Alterman 2001; Leipold 2000). Third, in Germany and the USA, the automobile and related industries constitute a considerable share of the national economy. Automobile manufacturing, dealerships, repair, gas stations, transport services, and road construction account for more than 10 percent of all jobs and GDP in both countries (Federal Highway Administration [FHWA] 1990-2008; VDA 2007). Fourth, both are among the wealthiest countries in the world with high standards of living. In 2008, the USA had a slightly higher per capita gross domestic product ($46,500) than Germany ($44,500) (IMF 2008). Fifth, in both countries the vast majority of households own at least one automobile, and 69 percent of the population in each country holds a driver's license (BMVBS 1991-2008; FHWA 2006). Sixth, the car is an important status symbol in both Germany and the USA, and policies that restrict car use are perceived as government limitation of personal liberty (Schmucki 2001; Wachs et al. 1992; Wolf 1986). Seventh, both countries were among the first in the world to experiment with limited access highways early in the twentieth century, and today they boast two of the most extensive road and highway networks worldwide (Dunn 1981; IRF 2007; Yago 1984). Eighth and last, in contrast to many other Western European countries, large parts of most German cities were destroyed during the Second World War. Thus—similar to newly constructed U.S. settlements—those areas could be adapted for automobile use while being rebuilt (Baron 1995; BMVBS 2000; Köhler 1995; Schmucki 2001).

Of course there are also many differences, which might help explain dissimilar levels of car use of Germans and Americans. This section briefly summarizes key differences in transport policy that make car use easier, cheaper, and more convenient in the USA. In each country, governments set the policy framework for individual travel behavior through targeted transport and other nontransport policies. These policies influence the cost, accessibility, and convenience of travel. Both the USA and Germany have long histories of government involvement in the urban passenger transport sector through regulation, taxation, and subsidies. It is beyond the scope of this article to give a full account of differences in transport policies and their history in the two countries—instead this article provides an overview so that the reader can get an understanding of the key differences between the countries (see Table 1).

First, compared to Germany, all levels of government in the USA have traditionally funded highways more generously.

Table 1. Key Differences in Transport Policies and Systems between Germany and the USA

	Germany	USA
Costs of automobile use and ownership[a]		
Taxes on gasoline (2006/2007)	$3.6 per gallon	$0.42 per gallon
Source of taxes on gasoline	Federal taxes only	Mix of federal, state, and local taxes
Gas tax revenue flow	Mostly into general fund	Majority earmarked for transport projects
Share of taxes in gas price (2006)	65%	15%
Fuel efficiency of car and light truck fleet (2005)	30 mpg	20 mpg
Regulation of fuel efficiency	Gas tax and vehicle registration fee	Regulation (CAFE-standards)
Parking supply	Restrictions on parking in most municipalities	Free parking at most destinations of trips
Average speed of car trip (2000/2001)	21 mph (33 km/h)	28 mph (41 km/h)
Tax on vehicle purchase	19% federal sales tax	Varies by state (avg. roughly 6%)
Urban roads per capita (2006)	3.8 miles	6.4 miles
Subsidies for roads	Road users pay 2.6 times more in taxes and fees than government spending on roads	Governments spend 20-30% more on roads than they collect from road users
Public transportation[b]		
Transit service per capita (2004)	36 vehicle miles per capita	15 vehicle miles per capita
Annual government subsidies (avg. since 2000)	$19 billion	$28 billion
Subsidy share of operating budget (2007)	30%	70%
Planning, ticketing, and coordination of service	Regional transit organizations integrate fare structures, timetables and services; steep discounts for monthly and annual tickets	Limited regional cooperation; monthly tickets provide small discounts; little integration of fares or timetables among transit providers
Walking and cycling[c]		
Government support	Widespread local government efforts since 1970s; increasing federal support since 1980s	Limited but increasing local government support; federal government support since 1991
Car-free pedestrian zones	Local efforts in most cities since 1960s/1970s	Only few cities have pedestrian-only streets
Traffic calming	Traffic calming of majority of residential areas of cities	Only few cities employ traffic calming areawide

CAFE = Corporate Average Fuel Economy.
[a]BMVBS (1991-2008); Bureau of Transportation Statistics (BTS; 2006); Buehler, Pucher, and Kunert (2009); Energy Information Agency (EIA; 2008); Federal Highway Administration (FHWA; 1990-2008, 2006); International Energy Agency (IEA; 2008); International Road Federation (IRF; 2007); Puentes (2003).
[b]American Public Transport Association (APTA; 2008); BMVBS (1991-2008); BTS (2006); Buehler, Pucher, and Kunert (2009); FHWA (2006); Rönnau 2004; VDV (2008); Yago 1984.
[c]Baron (1995); BMVBS (2000); Bratzel (1999); Buehler, Pucher, and Kunert (2009); Köhler (1995); Pucher (1995a, 1995b); Pucher and Buehler (2008).

Since 1970, expenditures from all levels of government for road transport have increased 6-fold in current dollars in the USA, compared to only a 1.5-fold increase in Germany (BMVBS 1991-2008; FHWA 1990-2008). Road user taxes and fees in the USA only account for roughly 75 percent of roadway expenditures by all levels of government (FHWA 1990-2008). In Germany, road users pay 2.6 times more taxes and fees than governments spend on roads (BMVBS 1991-2008; FHWA 1990-2008). Germany has a longer tradition of subsidies for countrywide transit supply (TRB 2001; Yago 1984). In 2001, almost 90 percent of Germans lived within one kilometer of a transit stop, compared to roughly 45 percent of Americans. Moreover, German transit systems provide two times more vehicle kilometers of transit service per inhabitant.

Second, car use is much cheaper in the USA. In 2007, the price of a gallon of regular unleaded gasoline was $6.4 in Germany, compared to $3.0 in the USA (adjusted for purchasing power parity) (International Energy Agency [IEA] 2008). Eight times higher gasoline taxes in Germany are the main cause for dissimilar prices at the pump. The percentage share of taxes in the gas price in Germany has increased from 60 to 65 percent between 1960 and 2007, compared to a decrease from 30 to 13 percent in the USA (BMVBS 1991-2008; FHWA 1990-2008). In contrast to the USA, in Germany gasoline taxes are not earmarked for a special highway trust fund but can be easily used for other government expenditures. One example is a recent targeted tax on energy consumption in Germany, which increased the gas tax by $0.15 per gallon each year between 1999 and 2003 to a total of $0.75 after five years—with revenues dedicated to fund social security (UBA 2005a). Higher gasoline taxes—with earmarked revenues or not—might influence travel behavior by increasing out-of-pocket costs of car use.

Third, car use is easier and more convenient in American cities. During the past forty-five years, a series of policy choices at the federal, state, and local levels in Germany have restricted automobile use in cities and simultaneously increased the attractiveness and quality of transit, walking, and cycling. In the USA, policies that limit car use are rarely implemented, and measures that make other modes of transport more attractive are generally more limited in scope than in Germany. In 2006, urbanized areas in the USA had about 70 percent more roads per capita than German settlements (6.4 vs. 3.8 kilometers of roads per thousand population) (BMVBS 1991-2008; FHWA 1990-2008). Subsidies for roads, more road supply in urban areas, and fewer local speed restrictions in the USA are likely connected to about 25 percent higher average car travel speeds here compared to Germany (41km/h vs. 33km/h) (BMVBS 2004; ORNL 2005).

These policy differences make car use generally cheaper, easier, more convenient, and faster in the USA than in Germany. The remainder of this article empirically investigates the role of determinants of car use in both countries based on two comparable national travel surveys. The analysis includes proxies for the policy differences described above and controls for spatial development patterns and socioeconomic and demographic factors.

Methods: Data Sources, Variables, and Analytical Technique

Of the fifty comparative studies reviewed for this article, forty-three are aggregate analysis of cities and countries and thirty-four are descriptive studies of differences of car travel. Descriptive aggregate level comparisons link trends in policies, socioeconomics, and land use to car travel (Bratzel 1999; Cervero 1998; Newman and Kenworthy 1999; Pucher and Lefevre 1996). The number of observations in these studies is too small for any sort of multivariate analysis; thus the authors rely on educated inferences about explanatory factors for dissimilar car use. Nine aggregate studies rely on countrywide or citywide averages for multivariate analysis (Dargay and Gately 1999; Ingram and Liu 1999; Kenworthy and Laube 2001; Schafer 1999; Schafer and Victor 2000). However, comparisons across averages fail to control for variations within different parts of countries and cities and cannot give insights into individual travel decisions. For example, income, car ownership, access to transit, land uses, pricing, and other policy measures can vary widely within countries and across individuals (Giuliano and Narayan 2004). Only seven—more recent—studies employ multivariate analysis based on individual-level travel survey data (Axhausen et al. 2002; Giuliano and Dargay 2005; Giuliano and Narayan 2003, 2004; Simma and Axhausen 2001, 2003; Timmermanns et al. 2003). International comparative studies—aggregate and disaggregate—are traditionally hampered by differences in data due to dissimilar data collection methods, timing of surveys, and variable measurement (Axhausen et al. 2002; Simma and Axhausen 2001, 2003; Timmermanns et al. 2003). While less similar surveys can still yield useful results, more comparable surveys will likely yield more robust results.

This analysis overcomes some of the shortcomings of traditional international comparative multivariate studies by relying on two uniquely comparable data sets: the National Household Travel Survey 2001 (NHTS) for the USA and the Mobility in Germany 2002 (MiD) (BMVBS 2004; ORNL 2005). Both surveys are based on similar data collection methods and contain comparable variables. Key similarities and differences of the two surveys are summarized in Table 2. A comparison with other existing travel surveys shows that NHTS and MiD are the most comparable national travel surveys that currently exist (Kunert, Kloas, and Kuhfeld 2002).

Analytical Technique

This analysis of international differences in determinants of car use consists of two parts. First, bivariate analysis compares the influence of individual variables on car use in Germany and the USA. Second, a multivariate analysis controls for the simultaneous influence of all independent variables. Equation (1) describes a general model for comparing international similarities and differences in determinants of car use based on the explanatory factors introduced in the conceptual framework above. The model assumes a pooled data set with German and American respondents. Country-specific interaction variables allow estimating differences in the impact of particular variables on car use in each country. A dummy variable flagging respondents in one country accounts for differences not captured by other variables in the model—including cultural preferences. A pooled sample is appropriate since this analysis (1) explores differences and similarities in car use within and between the countries, (2) captures differences in the connection of explanatory variables and travel behavior between the countries, and (3) evaluates the contribution of independent variables to explained variability.[1]

One might argue that car use can be divided into two distinct decisions: the choice to make a trip by car on a given day and—if the car is chosen—car travel distance. For example, living far away from transit, in a remote area, or in a household with easy access to a car may increase the likelihood of making a trip by car. Similarly, travel distance itself influences the choice of mode of transport—with longer trips more likely made by car than by foot or bicycle. In the two surveys, car travel distance is only observed for those respondents who use a car during the travel day. Thus, respondents

Table 2. Similarities and Differences of NHTS and MiD

	Range of national travel surveys[a]	Comparability of NHTS 2001 (USA) and MiD 2002 (Germany)
Field period of survey	10 weeks to 14 months	NHTS & MiD: 14 months
Travel period captured	1 to 7 days	NHTS & MiD: 1-day travel diary
Sample size	3,000 to 63,000 households	NHTS: 26,082 households with 60,228 individuals; MID: 25,848 households with 61,729 individuals
Survey method	Phone, person, mail	NHTS & MiD: Computer-assisted telephone interview (NHTS: 100%; MiD: 95%)
Target population	Civilian population	NHTS & MiD: Civilian population
Sampling technique	Random digit dialing to pop. register	NHTS: List-assisted random digit dialing; MiD: Stratified random sample
Response rates	Often below 40%	NHTS: 41% of households; MiD: 42% of households
Inclusion criteria	Vary widely	NHTS: households with at least 50% of household members over 18 years old responding; MiD: Households with at least 50% of household members responding
Weights	Vary widely	NHTS & MiD: Controlling for selection probability, nonresponse, household size, weekday, month, regional characteristics
Unit of analysis	Household, person, trip, or car	NHTS & MiD: Household, person, trip, car
Representation	Country, subsections	NHTS: USA, Census Regions and Divisions; MiD: Germany, states (Länder)

Adapted from Buehler (2009); Kunert, Kloas, and Kuhfeld (2002).
NHTS = National Household Travel Survey; MiD = Mobility in Germany.
[a]Based on nine national travel surveys.

who use a car constitute a nonrandom subsample of the population—namely, those who decided to travel by car. Just estimating daily car travel distance could lead to biased results, since it does not account for factors influencing the decision to make a trip by car or not. This could be particularly problematic when working with two different data sets for international comparisons. Indeed in this particular study, 80 percent of Americans, but less than 60 percent of Germans, choose to travel by car. The data show that in both countries individuals who live far from transit, in low-density areas, have a driver's license, with easy car access, and who are employed are more likely to make a car trip than the average. To control for potential bias, a two-stage Heckman selection model (HSM) is estimated modeling the decision to make a car trip in the first stage and the car distance traveled in the second stage (equation 2).

$$TB = f[TP(US), TP(G), SD(US), SD(G), SE(US), SE(G), CP] \quad (1)$$

$$\text{STAGE 1: Travel by Car } (1 = \text{Yes}/0 = \text{No}) = f(TP, SD, SE, CP)$$
$$\text{STAGE 2 (only if Stage 1 = Yes): Car Travel Distance} = f(TP, SD, SE, CP), \quad (2)$$

where TB = travel behavior, TP = transport policies, SD = spatial development patterns, SE = socioeconomics and demographics, CP = cultural preferences/country dummy variable, and US/G = country-specific interaction variables.[2]

Groups of independent variables are entered sequentially into the model to control for changes in total variance explained (adjusted R^2) and to identify omitted variable bias through changing signs and magnitudes of coefficients across the different models. For example, the first model contains all variables measuring transport policies; then variables capturing spatial development patterns are added. To gauge the unique contribution of each group of independent variables on changes in adjusted R^2, additional models are estimated by entering the groups of independent variables in all possible sequences and by estimating separate models each with just one group of independent variables.[3]

Variables and Measures

Some variables for the analysis are available for comparison in both data sets and only have to be transformed to be fully comparable. Several other variables are added from other sources, including population density, mix of work places and population, cost of driving per kilometer based on automobile type and gasoline price at the pump (including taxes), and household distance to transit. The enriched data allow a detailed investigation of the role of transport policies, spatial development patterns, and socioeconomic factors to explain similarities and differences of individual car use based on a pooled sample of 46,902 respondents from Germany and 50,979 from the USA. Tables 3 and 4 list definitions, measures, data sources, and descriptive statistics of variables included in this analysis. This discussion focuses on proxies for transport policy and spatial development patterns.

Car travel distance, the dependent variable, is measured as total kilometers of car travel per person per day—the sum of the distances of all individual car trips made on a given day. In Germany, 58 percent of respondents made a car trip during their travel day, compared to 80 percent in the USA. Daily car travel distance for those who travel by car ranges

Table 3. Variable Explanation and Data Sources

Variable	Explanation	Data sources
Car use (dependent variable)		
Daily car travel distance (km)	USA & G: Ranging from 0.1 to 200 kilometers	USA: NHTS; G: MiD
Choice of car trip	USA & G: Value of 1 if car was used on travel day	
Proxies for transport policies		
Household distance to a transit stop	USA & G: Two nominal variables indicating if a household is located within 400 meters 401-1,000 meters, or more than 1,000 meters from transit USA: Distance of household from rail station or bus corridor G: Distance of household from a bus stop or rail station	USA: ORNL; G: MiD
Automobile operating cost (U.S. cents per kilometer)	USA & G: Operating cost based on type and fuel economy of vehicle (assuming 55% urban) and average gasoline and diesel sales prices	USA: ORNL; G: ADAC
Spatial patterns/land use		
Population density (per sq km)	USA: Population per land area per census tract excluding bodies of water G: Population per settled land area per municipality excluding unsettled land	USA: NHTS; G: DESTATIS
Mix of land uses	USA & G: Index based on ratio of jobs and residents; ranging from 0 (no mix) to 1 (great mix); same geography as for population density	USA: Census Bureau; G: DESTATIS, BAA
Socioeconomic and demographic variables		
Car access	USA & G: Ratio of vehicles to licensed drivers in household	USA: NHTS; G: MiD
Gender	USA & G: Value of 1 for male respondents	
Employment status	USA & G: Value of 1 if respondent has a job (including part time)	
Driver's license	USA & G: Value of 1 indicates individual with driver's license	
Household income (U.S. $)	USA & G: Annual household income before taxes	
Retired	USA & G: Value of 1 for retired respondents	
Teenager/child	USA: Value of 1 for individuals younger than driving age (based on state driving ages) G: Value of 1 for individuals younger than driving age	
Country variable		
Germany-USA dummy	Value of 1 if respondent is from German sample	USA: NHTS; G: MiD

Source: ADAC (2007); BAA (2006); DESTATIS (2005, 2007); Oak Ridge National Laboratory (ORNL; 2003, 2005); U.S. Department of Commerce (USDOC; 2006).
NHTS = National Household Travel Survey; MiD = Mobility in Germany.

from 0.1 to 200 kilometers with a mean of 50.9 kilometers in the USA and 33.1 kilometers in Germany (see Table 4). The distribution of the variable is skewed to the right in each country and is transformed into the natural log for the analysis. Moreover, a log-log specification of the model allows an interpretation of the coefficients as constant elasticities, which is appropriate given diverging distributions of variables across countries.

Transport policy outcomes are difficult to capture in disaggregate analyses, since policy data are not readily available at the level of the individual. Neither NHTS nor MiD collect data on transport policies. Here, car operating cost per kilometer and household distance from bus and rail serve as proxies for transport policies that shape opportunities and cost of car travel. For both countries, automobile operating cost per kilometer is calculated based on gasoline mileage of the specific car the individual used on each trip and gasoline prices at the pump—including federal and state taxes—thus approximating individual out-of-pocket costs per kilometer of car travel.

Household distance from transit is provided by the FHWA for the USA and is already included in the German data set. Descriptive data show that more than half of all Germans live within four hundred meters of a transit stop, compared to less than one-third of Americans. Ideally, many other measures of transport policies such as transit vehicle kilometers, frequency and quality of service, and accessibility of destinations should be included in this analysis (Sanchez 1999; Sanchez, Shen, and Peng 2004). Unfortunately, these variables are not available at the level of the individual trip maker in both countries. Even if they were available, multicollinearity problems would likely have prohibited using them simultaneously. Moreover, ideally other variables determining the cost of car ownership and use could be included—but were not available for the analysis. Desirable variables include, among others, annual vehicle registration fees—potentially

Table 4. Descriptive Statistics of Variables

Variable	Overall mean	Standard deviation	Mean Germany	Mean USA	Correlation with car travel distance
Car use (dependent variable)					
Daily car travel distance (km)	44.1	41.3	33.1	50.9	N/A
Choice of car trip[a] (% using car)	69.6%	N/A	58.4%	79.7%	N/A
Proxies for transport policy					
Household distance to a transit stop[a]	42.8% (<400m)	N/A	54.1%	32.4%	–.12
	72.8% (<1,000m)	N/A	89.1%	43.5%	–.07
Automobile operating cost (U.S. cents per kilometer)	6.8	3.0	9.6	4.3	–.22
Spatial patterns/land use					
Population density (per sq km)	1,795	1,537	2,553	1,094	–.21
Mix of land uses (index 0-1)	0.33	0.20	0.34	0.31	–.09
Socioeconomic and demographic variables					
Car access (vehicles per driver)	0.89	0.51	0.67	1.08	.18
Gender[a] (% male)	46.60%	N/A	48.4%	46.9%	.06
Employment status[a] (% with job)	47.6%	N/A	44.2%	51.5%	.20
Driver's license[a] (% licensed)	70.2%	N/A	69.3%	71.0%	.20
Household income (U.S. $)	52,087	26,952	47,114	56,807	.11
Retired[a] (% retired)	20.50%	N/A	23.3%	18.7%	–.03
Teenager/child[a] (% teenagers or children)	22.2%	N/A	19.5%	24.8%	–.17
Country variable					
Germany-USA[a] (% German)	47.8%	N/A	N/A		–.21

All Pearson correlation coefficients are significant at the 99 percent level. Pooled sample from Mobility in Germany (MiD) and National Household Travel Survey (NHTS) with 97,881 respondents.
[a]Dummy variable.

influencing the decision to own an automobile—but also road and parking supply and local speed limits.

Variables measuring population density and mix of residences and jobs capture dissimilarities in *spatial development patterns* and are merged to the data sets. Land use data are available at the level of the municipality in Germany and the census tract in the USA. Moreover, population density is measured as population per settled land area in Germany and population per land area (excluding bodies of water) in the USA. The measure for the USA is geographically more precise than the German data but includes unsettled land within census tracts. The level of geographic scale can influence the statistical significance of variables measuring spatial development patterns (Boarnet and Crane 2001b). Even though both measures could ideally be more comparable (e.g., more geographic detail for Germany and excluding nonsettled land area for the USA), they are the best available data. In this data set, average population density in Germany is 2.3 times higher than in the USA—a ratio in line with other aggregate data sources comparing population density over settled land area (National Resource Inventory [NRI] 2006; Schulz and Dosch 2005). Research on U.S. metropolitan areas suggests that employment density might be a good proxy for predicting transit ridership for the commute (Brown and Thompson 2008). This study relies on population density, because transit in Germany is less focused on the work trip than in the USA (DIW 2004; Polzin and Chu 2003). Moreover, the dependent variable in this study is automobile use for all trip purposes—not just the work trip.

Mix of land uses is measured at the same geographic scale as the population density variable described above and is approximated by an index ranging from 0 to 1. A value of 1 indicates a balanced mix of residents and jobs in a given area, while a 0 stands for almost no mix of jobs and residents. The mean of both countries' distributions are relatively close together (.31 for USA vs. .34 for Germany). This is unexpected, as Germany is thought to have more mixed use than the USA (Hirt 2007). A closer look reveals that the German distribution is more homogeneous than the U.S. distribution. The U.S. median for mix of uses is 22 percent lower than the mean and 30 percent lower than the median for Germany.

Control variables for *socioeconomic and demographic factors* are annual household income, cars per licensed driver per household, possession of a driver's license, employment status, gender, and dummy variables capturing age (see Tables 3 and 4). Employment status and share of respondents with driver's license are similar in both countries. In line with national aggregate population distributions, the German sample contains more retired individuals, fewer teenagers and children, and fewer working individuals. Moreover, German respondents live in households with an average of 0.67 cars per licensed driver, compared to 1.08 in the USA. While average German households likely own one automobile, they are less likely to own a second or third car as households in the

Table 5. Results of Ordinary Least Squares (OLS) Regression for Daily Car Travel Distance (Ln Transformed)

	USA	Germany
Proxies for transport policy		
Transit access		
Household within 400m from transit	–0.098 (0.012)**	
Household within 401-1,000m from transit	–0.036 (0.024)	–0.088 (0.026)**
Automobile operating cost	–0.328 (0.029)**	–0.129 (0.046)**
Spatial patterns/land use		
Population density	–0.065 (0.003)**	
Mix of land use	–0.132 (0.016)**	–0.103 (0.009)**
Socioeconomic and demographic variables		
Car access	0.099 (0.020)**	0.222 (0.022)**
Gender	0.071 (0.010)**	0.145 (0.012)**
Employment status	0.197 (0.011)**	0.201 (0.016)**
Driver's license	0.218 (0.022)**	0.211 (0.036)**
Annual household income	0.003 (0.000)**	0.002 (0.000)**
Retired	–0.062 (0.020)**	
Younger than 16/18	–0.300 (0.023)**	–0.333 (0.043)**
Country dummy	—	–0.342 (0.148)*
Constant	3.833 (0.059)**	—
Model fit		
Observations = 67,352		
R-squared (adjusted) = .14		
F-statistic = .000**		

Robust standard errors in parentheses.
*Significant at 95 percent level. **Significant at 99 percent level.

USA. As discussed above, car access has been identified as an important variable for automobile use within the USA and internationally (Pucher and Renne 2003; Schafer and Victor 2000).

Results

The bivariate analysis confirms the expected relationship between individual explanatory variables and car travel distance—as outlined in the conceptual framework. However, all groups of population in America are more car-dependent than in Germany. In many cases the most car-dependent group in Germany uses the automobile less than the least car-oriented group in the USA. For example, Germans in the highest income quartile travel fewer kilometers by car per day than Americans in the lowest income quartile. In both countries, easy access to an automobile is connected to more kilometers of daily car travel. However, Americans in households with 0.5 or less cars per licensed driver are using their cars for more kilometers per day than Germans in households with 1 or more cars per driver (39 vs. 36 kilometers).

As expected, higher population density and a greater land use integration of workplaces and residences are related to less car use in both countries. However, at any population density category, Americans drive between 60 and 80 percent more kilometers per day. Even Americans who live in areas with more than five thousand people per square kilometer drive slightly more kilometers per day than Germans in areas with less than one thousand people per square kilometer (43 vs. 41 kilometers). Similarly, Americans living in areas with a high mix of residences and workplaces drive more kilometers per day than Germans in areas with less mix.

As outlined in the conceptual framework higher automobile operating cost and household proximity to transit are related to less daily car travel. However, Americans living within 400 meters of transit travel more kilometers by car per day than Germans living more than 1 kilometer away (41.5 vs. 36.3 kilometers). Individuals owning automobiles with similar operating costs do not display identical daily car travel distances. At any car operating cost per kilometer Americans travel more by car than Germans. Bivariate correlations confirm the expected relationships of individual explanatory factors and car travel distance (see Table 4) but cannot control for the impact of other factors. The multivariate regression analysis in the next section controls for other explanatory variables.

Regression Diagnostics

Tables 5 and 6 show the results of the multiple regressions—one for the linear ordinary least squares (OLS) regression and the other for the HSM. The adjusted R^2 (controlling for the degrees of freedom) for the OLS model suggests that the model explains 14 percent of the variation in car travel distance of the respondents (Table 5). This might seem low to some readers, but it is common for models with individual-level travel survey data (Giuliano and Dargay 2005; Giuliano and Narayan 2004). *F*-statistics indicate that the independent variables have joint statistical significance at the 99 percent level. Standard tests for multicollinearity (variance inflation factor, tolerance, and condition index) yield satisfactory results.[4] Robust coefficients and errors are estimated to control for potential spatial autocorrelation. Three statistics for evaluation of model fit indicate that the HSM is appropriate. A chi-square distributed overall likelihood ratio test (LR);

a significance test for the selection parameter Rho, and another chi-square distributed LR test—which is similar to a *t*-test for Rho—all confirm that the HSM is appropriate (Kennedy 2003; STATA Listserve 2003).

Discussion of Results

Interaction coefficients in pooled samples as presented in the results of the OLS in Table 5 are usually difficult to interpret. For the convenience of the reader, the interaction coefficients presented here can be read off the table directly (see Table 5).[5] One joint coefficient for both countries indicates no statistically significant difference between the countries. Two different coefficients—one for each country—indicate statistically significant differences between Germany and the USA. Results of the HSM are presented in Table 6. The columns labeled "Stage 1" display coefficients for a nonlinear probit model, estimating the probability of making an automobile trip during the travel day. The column named "Marginal Effect at the Mean" displays transformed probit coefficients, which can be interpreted more easily. Coefficients of the column named "Stage 2" can be interpreted like the linear regression results in Table 5. As in most multiple regression analysis, this study cannot claim proof of causality. However, the estimated equations and nearly all coefficients are consistent with the hypothesized impacts of the explanatory variables on car travel in each country.

Table 5 shows that in the USA, the impact of transit access on daily car travel distance is more limited to the immediate surroundings of a transit stop than in Germany: living within four hundred meters of a transit stop reduces daily car travel distances by 9.8 percent in both countries, but living between four hundred and one thousand meters from a transit stop reduces daily car travel distance by only 3.6 percent in the USA compared to 8.8 percent in Germany.[6] The mode choice portion of the HSM in Table 6 confirms that living close to transit is related to a lower probability of car use in both countries and that the effect is more pronounced in Germany than the USA. If all other variables are set at their mean, living within four hundred meters of a transit stop decreases the probability of using the car by 5.9 percent in Germany, but by only 0.9 percent in the USA (see Table 6). This might be related to higher levels of transit service, larger transit networks, and better quality of transit service in Germany, which make transit an attractive, fast, and convenient alternative to the car. Thus, people are willing to travel farther to access transit.

Higher automobile operating costs per kilometer are related to less daily car travel in both countries—as expected. However, according to both OLS and HSM models, a 10 percent increase in the operating cost per kilometer of car use leads to a roughly 3 percent reduction in daily car kilometers in the USA, compared to only about 1 percent in Germany (see Tables 5 and 6, respectively). The magnitude of the elasticities of travel demand is in line with values reported by other studies for European countries and the USA, which range from –.01 to –.57 (DeJong and Gunn 2001; Epsey 1998; Hanly, Dargay, and Goodwin 2002; Litman 2007). At a first glance, a larger elasticity for driving distance relative to cost in the USA than in Germany seems unexpected. Generally, Americans are thought to be more car-dependent than Germans and thus forced to drive, since walking, cycling, and transit are rarely considered viable options. However, it is possible that historically higher gasoline prices have lead to economizing of car travel in Germany. Further increases in the price of gasoline would thus result in smaller reductions in kilometers of travel there, since current car trips are difficult to substitute or forgo. In the USA, gasoline prices have traditionally been lower, and most trips are made as a single driver in a car. If gas prices increase, individuals can more easily forgo discretionary car trips, thus leading to a steeper reduction in car travel than in Germany. Gasoline price spikes in 2008 might serve as an illustration. Recent data for Germany suggest a smaller decline in vehicle miles traveled from 2007 to 2008 (–0.05 percent) as compared to the 3.6 percent decrease reported for the USA (DIW 2009; FHWA 2009).

As expected, higher population densities and a greater mix of land uses reduce daily car travel distance in both countries (see Tables 5 and 6). However, if all other variables are held at their mean, one thousand more people per square kilometer decrease the probability of car use by 2.8 percent in Germany and 0.5 percent in the USA (see Table 6). This might be related to more supply and better quality of bicycling and walking infrastructure and more car-restrictive policies in German cities—which make driving more costly and time-consuming and less convenient. Moreover, regional population densities and accessibility without a car are potentially lower in the USA—further increasing the need for car travel to access regional destinations even if individuals reside in dense or mixed-use areas.

Coefficients of socioeconomic variables point in the expected directions—but with distinct differences between the two countries. For example, one additional car per licensed driver in a household increases the probability of using the car by 36 percent in Germany and 4 percent in the USA (see Table 6). This is likely related to lower car ownership levels in Germany—where households are less likely to own a second or third car than in the USA. The dummy variable indicates that Germans drive 34 percent fewer kilometers per day than Americans.

As discussed earlier, groups of variables are entered into the model sequentially (not shown here). Results indicate that all groups of explanatory variables contribute to explaining the variability in car use. Depending on the model and the order of entering groups of variables, transport policies—the combined effect of the two policy variables—account for 1 to 6 percent and spatial development patterns explain between 1 and 5 percent of the variability in the data. Similarly,

Table 6. Overview: Results of Heckman Selection Model for Choice of Car Use and Daily Car Travel Distance

	Stage 1: Decision to use the car during travel day				Stage 2: Ln(car distance)	
	USA		Germany			
	Coefficient	Marginal effect at mean	Coefficient	Marginal effect at mean	USA	Germany
Proxies for transport policy						
Transit access						
Household within 400m of transit	−0.059 (0.023)*	−0.88%	−0.168 (0.026)**	−5.88%	—	—
Household within 401-1,000m of transit	0.041 (0.030)		−0.083 (0.027)**	−2.94%	—	—
Automobile operating cost	—		—		−0.284 (0.029)**	−0.118 (0.046)*
Spatial patterns/land use						
Population density	−0.034 (0.007)**	−0.49%	−0.081 (0.007)**	−2.84%	−0.065 (0.004)**	−0.016 (0.019)
Mix of land use	—		—		−0.091 (0.009)**	−0.125 (0.016)**
Socioeconomic and demographic variables						
Car access	0.259 (0.026)**	3.85%	1.035 (0.035)**	36.39%	—	—
Gender	0.07 (0.014)**	1.11%	0.014 (0.013)		0.098 (0.011)**	0.14 (0.013)**
Employment status	0.019 (−0.016)	2.76%	0.169 (0.015)**	5.90%	— (0.019)**	0.145 (0.016)**
Driver's license	0.472 (0.025)**	8.09%	0.672 (0.018)**	26.60%	—	—
Annual household income (U.S. $)	—		—		0.002 (0.001)**	0.002 (0.000)**
Retired	—		—		−0.157 (0.015)**	0.014 (0.017)
Younger than 16/18	—		—		−0.336 (0.018)**	−0.316 (0.031)**
Constant	0.846 (0.017)**	—	−0.437 (0.026)**	—	4.219 (0.038)**	3.479 (0.144)**
Model fit						
Observations = USA: 43,577; Germany: 40,517						
Likelihood ratio = USA: −68,702.68; Germany: −63,025.62						
LR test (chi-square[7]) = Prob > chi-square = .000 for both countries						
Rho (Athrho) = USA: −1.71 (0.039**); Germany: −0.83 (0.0285**)						

Robust standard errors in parentheses.
*Significant at 95 percent level. **Significant at 99 percent level.

socioeconomic and demographic variables explain between 7 and 9 percent of total variability in travel behavior. The country dummy variable captures between 1 and 4 percent of the variability between Germany and the USA.

Implications for Future Research and Planning in the USA

Automobile travel is at the center of many costly trends like environmental pollution, oil dependence, traffic congestion, road fatalities, and obesity. Based on two uniquely comparable national travel surveys from Germany and the USA, this article investigated the role of transport policies in shaping individual car travel, while controlling for spatial development patterns and socioeconomic and demographic factors.

Implications for Future International Comparative Research

In spite of the high comparability of the surveys, some recommendations for improvements of future travel surveys and international comparative analyses can be made. Most suggestions pertain to (1) better and more comparable data about individuals and the built environment and (2) more comparable time series data. First, this study relies on cross-sectional data, as no time series data are available to compare travel behavior over time. Cross-sectional data are useful in providing a glimpse into differences in travel in both countries at one point in time. However, a time series study, ideally a panel study, could show changes in independent variables and travel behavior over time. Second, endogeneity and self-selection bias are problems for analyses of travel behavior—and could not be addressed in this study due to stringent requirements for data, as well as comparability and availability of variables and measurements in both countries. For example, an instrumental variable approach was impossible, since there are no comparable variables available for both countries that could serve as an instrumental variable. Third, spatial development and policy variables have to rely on rough proxies or aggregate indicators. For example, neither survey includes information about the supply of transport infrastructure and service or local accessibility. Improvements in the measurement of spatial development patterns and policy variables will strengthen the accuracy of the models and might increase the portion of variability explained by these two groups of variables. Lastly, neither travel survey includes any information about respondents' attitudes or preferences, which might help to better understand differences in travel behavior within and between countries. Adding comparable variables for both countries could be beneficial to better understand the role of attitudes and travel preferences.

Implications for Planning in the USA

Keeping in mind these data limitations, the analysis still provides a number of insights about individual travel behavior that have implications for planning and practice in the USA. The analysis shows that socioeconomic factors and spatial development patterns—commonly cited factors for international differences in travel behavior—alone cannot fully account for dissimilarities in car use between Germany and the USA. As expected, in both countries individuals with higher incomes own more cars and travel more kilometers by car. Similarly, individuals living in denser and more mixed-use areas travel fewer kilometers by car. However, the analysis shows that these patterns do not fully hold true across the two countries. For example, Americans in the highest population density categories travel more kilometers by car than Germans in the lowest density category. Individuals in the highest income quartile in Germany travel less by car than the lowest income quartile in the USA. Transport policies play a role in explaining international differences in car use, even after controlling for spatial development patterns and sociodemographic factors. The multivariate analysis shows that proxies for transport policies accounted for a significant share of total variability explained.

All groups of American society and in all spatial settings travel more by car than Germans. If adopted, changes in spatial development patterns and transport policies geared at limiting car use in the USA would not likely reduce driving to German levels. Instead, Americans would likely still make a considerable share of their trips by car, but they might use their cars for fewer trips and travel shorter distances overall—and thus potentially save energy and reduce CO_2 emissions.

Planning projects that aim at reducing car use through increased population density and greater mix of land uses in the USA should be evaluated based on car travel distance *and* mode choice. This analysis indicates that in the USA changes in mode choice might be more limited initially, while adjustments in car travel distance are potentially more readily visible. Compared to Germans, Americans in dense and mixed-use areas make a high share of trips by car. However, dense and mixed-use areas in the USA display significantly fewer kilometers of car travel per capita than American low-density areas with less mix of land uses.

Similarly, compared to Germans, Americans living close to transit make a high share of trips by car. This is potentially connected to limited accessibility without a car outside of immediate surroundings of the transit stop and less transit supply in the USA. Metropolitan densities in America are lower, land uses are more spread out, and transit service is less frequent and reaches fewer destinations than in Germany. Thus, living close to transit in the USA encourages transit use and reduces car use, but for a more limited range of trips than in Germany. Improving transit networks, level and frequency of service, and accessibility by transit might encourage those who already live close to transit to ride more often. Thus, compared to Germany, American planners should initially expect a more limited effect of transit provision on travel behavior.

Increases in the price of gasoline might have the potential to reduce car travel in the USA. This analysis shows that car travel distance in America is more sensitive to the price of gasoline than in Germany. Thus, additionally increasing the cost of gasoline might reduce car travel more in the USA than Germany—where gasoline prices have been high and individuals already economize their driving to a greater degree. Facing increases in gasoline prices, Americans may more effectively cut back on driving, since current low gasoline prices encourage more discretionary car use (Handy, Weston, and Mokhtarian 2005). As a reaction to increasing gasoline prices, Americans may more easily forgo these optional car trips or switch to other modes. For example, gasoline price spikes in 2008 led to a 0.05 percent decline in vehicle miles traveled in Germany relative to 2007 levels but a 3.6 percent decrease in the USA (DIW 2009; FHWA 2009).

Transport policies in Germany make car use more costly and less convenient, while improving the quality, safety, and attractiveness of alternative modes of travel. The impact of each policy could not be directly measured in this analysis, but policies bundled together play an important role in explaining differences in travel. The combination of policy incentives for alternatives to the automobile and policy disincentives for car use in Germany tilts the balance of costs and benefits away from the car towards transit, bicycling, and walking. The USA has not applied the gamut of policies implemented in Germany since the 1960s, and car restrictive measures are particularly limited. The key to less car use in Germany might lie exactly in the concerted implementation of policies that push individuals out of cars and pull them into other modes. If the USA wants to achieve a more sustainable transport system, implementing car restrictive policies while increasing the attractiveness of transit, bicycling, and walking might be the key.

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Notes

1. Alternatively, two separate models—one for each country—could be estimated. *T*-tests could then identify if the coefficients are statistically different. The results of the pooled and separate approaches are very similar. However, the separate analysis cannot account for the country dummy variable.
2. The model specification allows correlation between variables and errors of stage one and stage two (Cao, Mokhtarian, and Handy 2006; Kennedy 2003). The two equations are estimated simultaneously, taking the correlation of variables and errors into account. In practice it has been common to use at least one variable that is the same in both stages of the model and at least one variable that was different in either stage (Cao, Mokhtarian, and Handy 2006; Kennedy 2003). This is appropriate for this analysis as similar variables help explain the choice to make a car trip and car travel distance. Heckman selection model (HSM) estimates the linear model in the second equation using a variable accounting for the nonselection probability from stage one. This is the so-called inverse Mills-ratio (IMR), which is—in the case of a probit regression in stage one—calculated as [*PDF*(Beta'*X*)/*CDF*(Beta'*X*)] of the assumed normal distribution (*PDF* = probability density function and *CDF* = cumulative distribution function of a normal distribution, which is assumed for probit models).
3. Endogeneity and self-selection bias have always been problems for analyses of travel behavior. Endogeneity bias can occur if (1) independent variables are also a function of the dependent variable or (2) independent variables are correlated with omitted variables (Cao, Mokhtarian, and Handy 2006). For example, the built environment influences travel behavior, but at the same time travel behavior also influences spatial development patterns over time. Furthermore, some researchers argue that the choice of household location and car ownership is associated with travel preferences and attitudes. Individuals who wish to travel less by car might own fewer cars and locate closer to transit stops or in areas with higher population density and a greater mix of land uses. In either case, not including specific variables about attitudes and travel preferences would lead to biased coefficients. Several solutions exist to overcome these problems, such as statistical control, instrumental variable models, sample selection models, joint models, and longitudinal designs (Cao, Mokhtarian, and Handy 2006). All of them come with stringent requirements of comparability of variables and measurements in both countries and are hard to implement with two cross-sectional surveys. For example, the instrumental variable approach cannot be used, since there are no comparable variables available in both data sets that were correlated with the endogenous variable and uncorrelated with the error term. If data were available the following three solutions seem to be the most promising:

1. A longitudinal study design could help overcome these problems by providing before and after data on changes in individuals, travel behavior, and spatial development patterns. Such an analysis might be possible once National Household Travel Survey (NHTS) and Mobility in Germany (MiD) 2008 data will become available.
2. Both MiD and NHTS could include questions asking for travel preferences of individuals. Explicitly including these attitudinal variables would overcome a potential correlation of location choice and car ownership with the error term.
3. Another possibility might lie in structural equation models (SEMs), which allow for causation to flow in multiple directions among independent and dependent variables. SEM should ideally also include variables about travel preferences and attitudes. Unfortunately, SEM is based on the analysis of bivariate correlations, which is problematic with the large number of nominal and categorical variables included in this analysis. In practice researchers often use SEM with nominal and categorical values. Ideally, SEM could be combined with a longitudinal design, capturing changes over time.

4. The overall VIF (variance inflation factor) was 2.46, well below the suggested the critical value of 5. The smallest tolerance value of a variable was 0.2, twice the suggested critical value of 0.1. Another test, the condition index, confirms these results.
5. *A more traditional presentation* would interpret the Germany coefficients as the *relative difference* in the coefficient (or slope) of a variable in Germany compared to the USA. For example, if a coefficient for the USA was α and the interaction effect for Germany showed a statistically significant coefficient of β, then the coefficient for this variable for Germany would be the sum of the USA coefficient plus the interaction coefficient ($\alpha + \beta$)—in this example a stronger effect in Germany compared to the USA. Opposite signs for α and β (e.g., plus for the USA vs. minus for Germany) would indicate a weaker relationship in Germany compared to the USA.
6. The coefficient for the USA is marginally insignificant at the 90 percent level.

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Bio

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