Demand for Public Transport in Germany and the USA: An Analysis of Rider Characteristics

by Ralph Buehler and John Pucher

Ralph Buehler ***(corresponding author)***
School of Public and International Affairs
Virginia Tech, Alexandria Center
1021 Prince Street, Suite 200
Alexandria, VA 22314
Tel: 703-706-8104
Fax: 703-518-8009
ralphbu@vt.edu; Ralph.Buehler@gmail.com

John Pucher
Bloustein School of Planning and Public Policy
Rutgers University
33 Livingston Avenue, Room 363
New Brunswick, New Jersey 08901
Tel: 848-932-2803
Fax: 732- 932-6564
pucher@rutgers.edu; JohnPucher@gmail.com

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Abstract

This paper presents a detailed analysis of public transport demand in Germany and the USA, using uniquely comparable national travel surveys from 2001/2002 and 2008/2009 for both countries. Public transport has been far more successful in Germany than in the USA, with much greater growth in overall passenger volumes and trips per capita. Even controlling for differences between the countries in demographics, socio-economics, and land-use, logistic regressions show that Germans are five times as likely as Americans to use public transport. Moreover, public transport in Germany attracts a much broader cross-section of society and for a greater diversity of trip purposes.

The success of German public transport is due to a coordinated package of mutually supportive policies that include: (1) more and better service, (2) attractive fares and convenient ticketing, (3) full multi-modal and regional integration, (4) high taxes and restrictions on car use, and (5) land-use policies that promote compact, mixed-use developments. It is the integrated package of complementary policies that explains why public transport in Germany can compete so well with the private car, even among affluent households. Conversely, it is the lack of complementary policies that explains the continuing struggle of public transport in the USA.

Introduction

For many decades, public transport has been struggling to compete with the automobile. Around the world, rates of car ownership have been increasing as incomes rise and cars become more affordable. The continuing decentralization of cities into suburban and exurban areas has generated land-use patterns and trips that are difficult for public transport systems to serve. Especially during the decades immediately following the Second World War, demand for public transport declined, first in North America but then in Western Europe as well [1-9].

Since the 1960s and 1970s, however, the number of annual public transport passengers in North America and Western Europe has generally been increasing. Although there is much variation among countries, the market share of public transport has stabilized in most countries. It is encouraging that public transport has succeeded in raising overall passenger levels and maintaining its market share in spite of rising incomes and car ownership and extensive, car-oriented suburban sprawl.

This paper focuses on a detailed analysis of public transport demand in Germany and the USA, using uniquely comparable national travel surveys from 2001/2002 and 2008/2009 for both countries. The questions of particular interest are:

1) Who rides public transport (disaggregated by gender, age, employment status, income, car ownership, city size, population density, and urban vs. rural location)?

2) What trip purposes does public transport serve (trips to work, school, shopping, recreation, visiting friends and family)?

3) How do rider characteristics and trip purposes differ between Germany and the USA, and how have they changed over time?

As this paper demonstrates, Germany has been much more successful than the USA at raising public transport use, both on a per-capita basis and as a market share of total urban travel. We conclude the paper with an examination of the public policies in Germany that have contributed to the impressive success of public transport and draw lessons that might be useful for other countries.

Long-Term Trends in Public Transport Demand in Germany and the USA

Public transport use plummeted in the USA after the Second World War from 16.4 billion trips in 1945 to only 4.7 billion in 1973 (see Figure 1). The loss of 13.7 billion passengers reduced overall demand by almost three-fourths. The initial decline was due to the ending of wartime fuel and tire rationing and the resumption of car production, which had been interrupted by the use of factories to construct military vehicles. Throughout the 1950s and 1960s, however, rapidly rising per-capita income and car ownership—as well as the resulting proliferation of car-oriented suburban sprawl—undermined public transport demand [9, 10]. The lack of public financing led to rising fares, deteriorating service, and widespread bankruptcies of public transport firms throughout the country. Streetcar services were almost completely terminated and only partially replaced by bus services. By 1970 most public transport services in the USA were poorly maintained, undependable, and uncoordinated [3, 9, 10].

During the 1970s, however, there was dramatic growth in federal government support for public transport, including both capital and operating subsidies. State and local government support also increased, with an almost complete transition to public ownership, management, and financing by the end of the 1970s [14]. There was a turn-around in public transport demand in the mid-1970s thanks to the considerable expansion and improvement of public transport services enabled by government funding. Although there have been many ups and downs, the general trend since 1973 has been upward. The biggest increase was from 1973 to 1980 (from 4.7 million to 6.0 million passengers) when the infusion of government funding was most dramatic. Since 1980, growth has been modest but steady, rising to 7.2 billion passengers by 2010 [11]. In general, short-term declines in passengers have been due to recessions while short-term spurts in demand have been due to economic booms or sharp rises in fuel prices.

Overall, it was a considerable accomplishment turning around the dramatic fall in public transport demand between 1945 and 1973. The total number of passengers rose by 57% between 1973 and 2010. Nevertheless, demand for public transport barely kept pace with overall population growth, with only a slight increase in trips per capita (from 22 in 1973 to 24 in 2010). Moreover, the revival of public transport in the USA required an enormous infusion of subsidy funds. Including all levels of government and both capital and operating subsidies, total financial assistance between 1975 and 2010 exceeded $830 billion in inflation-adjusted, constant 2010 dollars, averaging more than $23 billion per year [11, 15].

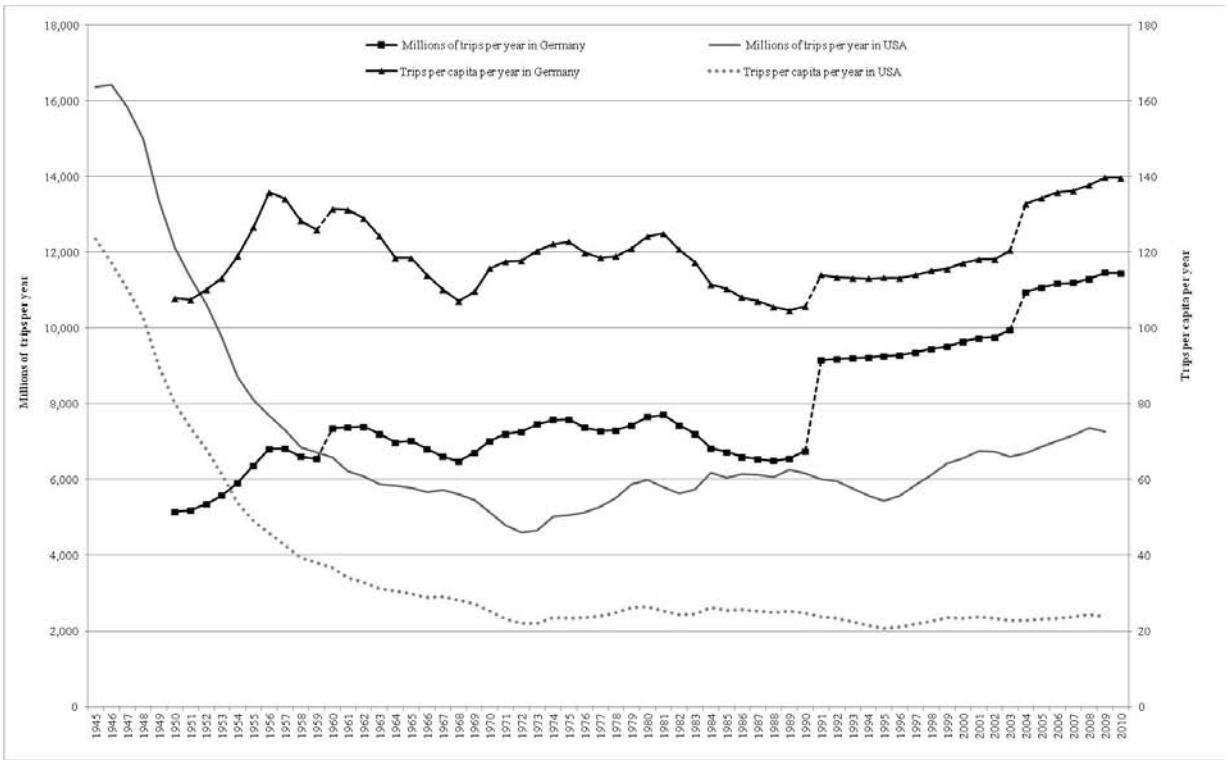

Figure 1. Trend in total public transport trips and trips per capita in Germany and the USA, 1945-2010 *Source: [11, 12]. Notes: Data from 1950 to 1990 are for West Germany only. West German data from 1950 to 1960 exclude West Berlin and the Saarland. German data from 1991 to 2010 are for the re-unified Germany, including the former East Germany. The strong increase in Germany between 2003 and 2004 is a statistical artifact due to a change in data collection methodology. Public transport trips as shown in this graphic are defined from origin to destination; thus, a trip involving transfers between public transport lines or modes is counted as one trip (technically designated as a linked trip). Since 1970 official data for the USA report unlinked trips, with transfers counted as additional trips. This study converted the unlinked trips to linked trips in order to ensure comparability with Germany, using a methodology explained in Polzin and Chu [13].*

There are no statistics available for Germany for the years immediately after the Second World War. From 1950 to 1956, however, public transport demand rose sharply (see Figure 1). Much of the public transport infrastructure had been destroyed during the war, but by the early 1950s most of the infrastructure was restored or at least repaired enough so that it was again usable. In the 1950s, the West German economy began its strong recovery, with increasing employment and more trips to work. Because car ownership was still low (80 cars per 1,000 population), most travel was by public transport, walking, and cycling [12]. Moreover, after the Second World War over 6 million ethnic Germans from Poland, Czechoslovakia, and other Soviet-occupied countries in Eastern Europe fled to West Germany [16]. Crowded urban areas, increasing employment, and low car ownership levels contributed to rising demand for public transport in West Germany in the 1950s [9].

Eventually, however, the economic recovery in West Germany led to steady increases in per-capita income, rising car ownership, and declining demand for public transport [3, 9, 16]. Overall, the total number of public transport passengers in West Germany fell by only 1% between 1956 and 1968, but trips per capita fell from 136 to 107, a 21% decline. During the same period motorization almost tripled, reaching 230 cars per 1,000 population in 1968 [12].

Moreover, in response to crowded housing in cities, the federal government subsidized the construction of single family houses at the urban fringe [9, 12, 16].

Public transport operators were not able to serve new low-density suburban locations. At the same time, the federal government subsidized reconstruction and expansion of the federal highway network, and most cities widened urban roads, built new arterial highways, and constructed parking garages in their city centers [17]. Faced with increasing competition from the automobile and decreasing demand for public transport, West German public transport systems reduced or cut services, replaced trolley services with buses, and raised fares [9, 16, 18].

Between 1968 and 1982, public transport demand increased from 6.4 to 7.7 billion passengers per year and from 107 to 125 annual trips per capita. That increase is partially explained by the two oil price shocks of the 1970s. Over the same period, public transport services were expanded and improved thanks to federal government subsidies for capital investments in local public transport.

As in the USA, during the 1980s governments in West Germany decreased their subsidies for public transport. By 1989, the year before German reunification, public transport demand had fallen by about 15% to 6.5 billion annual passengers or 105 trips per capita. Data in Figure 1 from 1991 onwards are for the re-unified Germany and show a steady increase from 9.2 billion passengers in 1991 to 11.5 billion in 2010. Per-capita ridership increased from 114 to 139 trips per person per year. The increase in ridership in the 1990s was concentrated in the former West Germany. Between 1990 and 2000, public transport demand in the cities of former East Germany fell from 24% to 12% of trips [19]. Moreover, motorization more than doubled in the former East Germany from 237 to 499 cars per 1,000 inhabitants [12]. In contrast, public transport demand in the former West Germany increased by 20% during the 1990s—offsetting the steep decline in the former East Germany. Since the early 2000s, public transport demand has been increasing throughout Germany.

Rising public transport demand in Germany since 1990 is partly explained by a doubling in the gasoline (petrol) tax from $0.41 per liter in 1990 to $0.88 per liter in 2010. Moreover, public transport systems have greatly improved their services through regional coordination of ticketing and timetables, new vehicles, real-time information at stations and on vehicles, and discounted monthly, semester, and annual tickets. Recent policies of German public transport agencies and governments are discussed in more detail later in this paper. The next sections focus on a detailed comparison of public transport demand in Germany and the USA in 2001/2002 and 2008/2009.

Similarity of German and American Travel Surveys in 2001/2002 and 2008/2009

International comparative studies of travel behavior typically are hampered by inconsistencies among country surveys in their timing, variable definitions, and survey methodology [20-22]. In contrast, the Mobility in Germany (MiD) surveys of 2002 and 2008 are almost entirely comparable with the 2001 and 2009 National Household Travel Surveys (NHTS) in the USA. They are similar in their design timing in almost every respect and thus offer a unique opportunity to compare public transport demand in two countries. Although the two countries' survey names differ by one year, their data collection periods are almost identical. Indeed, both surveys would be more accurately designated by their actual survey periods of 2001/2002 and 2008/2009.

The MiD and NHTS surveys are comparable along many dimensions [21]. For both years, each country's surveys used almost identical data collection methods and included

virtually the same variables. The surveys are so similar because German researchers used the 2001 NHTS survey as a model for their 2002 MiD survey. In fact, because of changes in methodology starting with the 2001 NHTS, and copied by the 2002 MiD, the NHTS and MiD surveys are more comparable to each other than to any earlier surveys within their respective countries. The data collection period was 14 months for all four surveys. After being contacted by phone and agreeing to participate, all U.S. households completed a computer-assisted telephone interview (CATI). Most German households also completed the survey using CATI; only 17% of households completed the survey online or on paper. All household members recorded their travel in a 1-day travel diary during a randomly assigned day. The diary helped respondents report their travel day activities in a subsequent phone interview. All surveys included adults and children as target population. Travel information for children aged <15 years was collected through proxy interviews with parents.

Recent Trends in Public Transport Demand in Germany and the USA

As discussed above, the two most recent national travel surveys in Germany and the USA are almost entirely comparable. Moreover, the two countries are similar in many ways that enable meaningful comparisons of public transport demand [23, 24]. Both Germany and the USA are affluent countries with market economies and federal systems of democratic government. Both countries have vast roadway systems, high rates of car ownership, and roughly the same proportion of licensed drivers [12, 25, 26]. Just as in the USA, most suburban development in Germany occurred after the Second World War during a period of rapid motorization [16, 27]. In spite of these similarities, there are significant differences between the two countries in public transport demand.

Differences between Bus and Rail

In 2008/2009, both bus and rail accounted for a higher share of trips in Germany than in the USA. The bus share of trips in Germany was 2.6 times greater (3.6% vs. 1.4%) and the rail share of trips was 8.2 times greater (4.9% vs. 0.6%). Buses accounted for the vast majority (70%) of public transport trips in the USA, compared to only 42% in Germany. During the last decade the percentage of trips by bus in Germany decreased from 3.9% to 3.6% of trips, while demand for rail travel (suburban rail, metro, light rail, and streetcars) increased from 4.1% to 4.9% of trips. Shifting demand from bus to rail in Germany may be partially explained by changes in public transport supply. Between 2000 and 2010, vehicle kilometers of bus service in Germany declined by 11%, while vehicle kilometers of rail service increased by 10% [28, 29].

From 2001/2002 to 2008/2009 the NHTS surveys indicate a slightly larger percentage point increase in mode share for bus than for rail in the USA (+0.3% vs. +0.1%). Adjusting for the higher initial mode share for bus, however, the percentage growth rate in mode share was roughly the same (+25%) for bus and rail. During the same time period, vehicle kilometers of service increased at similar rates for bus (+15%) and rail (+18%) [11].

Trip Purpose

During both survey periods, work and work-related trips accounted for a much higher share of public transport trips in the USA than in Germany (40.5% vs. 23.5% in 2001/2002 and 35.3% vs. 23.6% in 2008/2009). Compared to Germany, public transport use in the USA is more concentrated during the peak hours, dominated by commuter travel from the suburbs to central cities in the morning and from central cities back to the suburbs in the evening.

Nevertheless, the share of public transport trips for work declined in the USA between the two survey periods (from 40.5% to 35.3%), while the share of work trips in Germany remained stable (23.5% vs. 23.6%). Over the past three decades, both countries have experienced an overall decline in the relative importance of work trips for urban travel. In the USA the share of work trips (for all modes of transport combined) fell from 20% in 1983 to 16% in 2008/2009 [30]. In Germany, the work share of all trips fell from 21% in 1982 to 14% in 2008/2009 [31]. The continued decline in work trips over the last decade in the USA may be partly due to the economic recession in the USA during the survey period in 2008/2009. The worldwide recession affected Germany to a lesser degree than the USA, which may help explain Germany's stable share of work trips by public transport between 2001/2002 and 2008/2009.

In 2001/2002 and 2008/2009, education accounted for twice as high a share of public transport trips in Germany as in the USA: 26.6% vs. 11.9% in 2001/2002 and 24.7% vs. 11.6% in 2008/2009. In the USA most school systems provide their own fleets of school buses; indeed, for the country as a whole, there were five times more school buses than public buses in 2010. In a few large American cities, school children also ride public transport, but in most of the USA separate school bus systems are the norm, especially in the suburbs. In contrast, German children generally ride public transport (or walk or bike) for their trips to and from school. The lack of American school children's experience with public transport probably discourages their use of public transport later in life as well. By comparison, many German children learn how to use public transport on their daily trips to school, thus facilitating their use of public transport as adults.

Nevertheless, the share of public transport trips for education declined in Germany from 26.6% to 24.7%. That decline is probably due to the falling share of children in the rapidly aging German population [32]. The combined share of family/personal business and social/recreational trips rose in both countries, from 49.8% to 50.8% in Germany and from 47.6% to 52.6% in the USA.

Differences in Rider Age and Gender

In both Germany and the USA, women use public transport more than men (Figure 2). Between the two survey periods, however, there was a considerable increase in men's use of public transport in Germany (from 6.7% to 8.2% of trips), while the increase among women was much smaller (from 8.3% to 8.8%). The increase in public transport use in the USA was roughly the same for men and women, but for both genders, the share of trips by public transport was less than a fourth as high as in Germany.

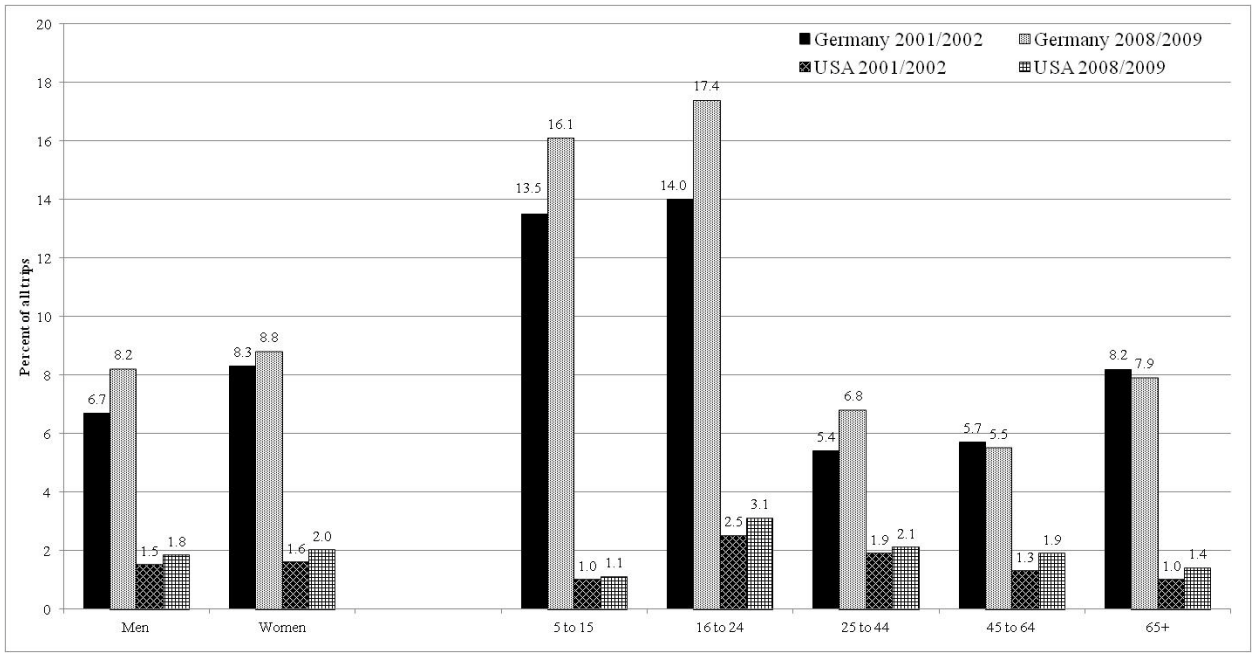

Figure 2. Percentage share of trips by public transport in Germany and the USA by gender and age group, 2001/2002 and 2008/2009
Source: Authors' calculations based on NHTS and MiD.

As shown in Figure 2, public transport use is much higher in Germany than in the USA for all age groups. The difference between countries ranges from a low of about 3-to-1 for the age category 25-46 years up to a high of 15-to-1 for the age category 5-15 years. The extremely large gap in public transport use between German and American children (5-15 years) is almost certainly due to the much greater use of public transport for the trip to school in Germany compared to the use of special school buses in the USA. At the other end of the age spectrum, it is notable that elderly Germans are far more likely to use public transport than elderly Americans (7.9% vs. 1.4% of trips). In 2008/2009 the share of licensed drivers among the elderly was almost identical in Germany (76%) and the USA (78%). The German elderly, however, have less access to a car: 0.5 cars per licensed driver in households with elderly members compared to 0.9 in the USA.

Car Ownership and Economic Status of Riders

Germans use public transport for a higher share of trips than Americans in all categories of car ownership, employment status, and income displayed in Figure 3. In 2008/2009, households without cars had the highest shares of trips by public transport in both countries (25.2% and 21.6%). Individuals in households without cars are often 'captive' public transport riders—at least for trips beyond distances that are easily covered by bicycle and foot. Having a car at all makes a dramatic difference in household travel behavior in both countries. Having additional cars per licensed driver makes less and less difference in rates of public transport use as the total number of cars per driver increases.

Whereas public transport use is similar for households without cars, public transport use in Germany is much higher than in the USA for households with cars. Compared to the USA, Germans in households with more cars than drivers made 20 times as high a share of their trips by public transport in 2008/2009 (5.7% vs. 0.3%). Between 2001/2002 and 2008/2009 the share

of trips by public transport in households with more cars than licensed drivers increased significantly in Germany, but remained stable in the USA. The increasing appeal of public transport in Germany for persons with easy access to a car may be explained by the rising cost of driving as well as improved public transport service—as discussed further below.

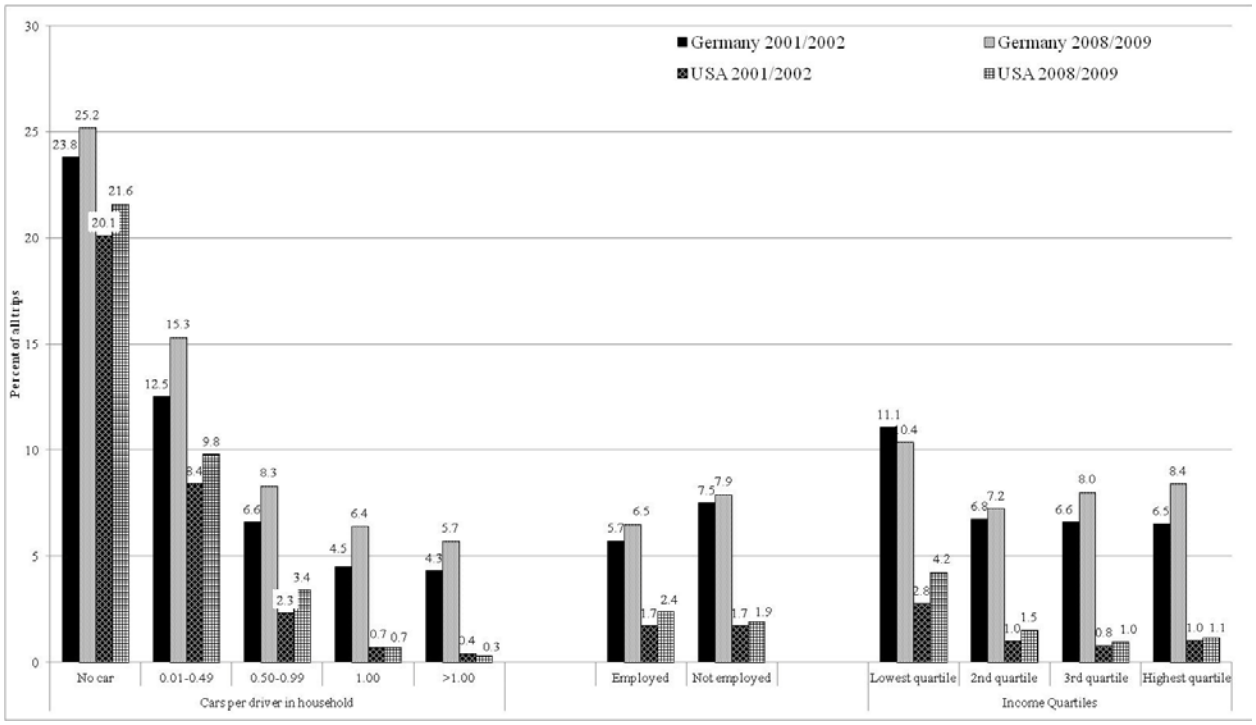

Figure 3. Percentage share of trips by public transport in Germany and the USA by car access, income quartile, and employment status, 2001/2002 and 2008/2009
Source: Authors' calculations based on NHTS and MiD.

In 2001/2002 Americans used public transport for 1.7% of trips regardless of their employment status (see Figure 3). By 2008/2009, however, Americans with jobs used public transport for 2.4% of their trips compared to 1.9% of persons without paid employment (including children, university students, housewives, retirees, and the unemployed). In contrast, public transport ridership in Germany was higher both in 2001/2002 and 2008/2009 for persons who were not employed.

In both Germany and the USA, the poorest income quartile used public transport much more than other income groups. Low-income persons are less likely to own a car and thus have fewer travel options. In 2001/2002, public transport use for the 2nd, 3rd, and highest income quartiles was almost identical within each country, but about six times greater in Germany than in the USA (about 1.0% in the USA vs. 6.5% in Germany).

Between the two survey periods, the share of public transport trips for the two highest income quartiles rose only slightly in the USA, but increased significantly in Germany (from 6.6% to 8.0% and from 6.5% to 8.4%). In 2008/2009, public transport's share of trips in the two highest income quartiles was eight times greater in Germany than the USA. Even more striking, Germans in the highest income quartile rode public transport at twice the rate of Americans in the lowest income quartile (8.4% vs. 4.2%).

In 2008/2009, bus and rail passengers in Germany had the same median income as each other and the national average ($52,000)—reflecting public transport's appeal to all income groups. In the USA, rail passengers had the highest incomes ($68,000) of any modal user group and considerably higher than average income in this sample ($61,000). In sharp contrast, bus passengers had incomes that were only a third of national average income ($21,000). Spatial segregation of poorer households in inner cities and wealthier households in the suburbs may help explain the discrepancy in incomes between rail and bus in the USA [33]. Commuter rail services typically run from high-income suburbs into downtown business districts with lucrative jobs. Poorer neighborhoods are usually served by slower, more crowded, and less attractive bus service. Moreover, buses in the USA are stigmatized as the travel option of last resort, used mainly by poor people and ethnic minorities [10, 33].

Given the much higher income of rail transit users in the USA, it is not surprising that the median incomes of transit riders overall are much higher in cities with extensive rail systems. For example, the U.S. Census Bureau [34] reports median household incomes of work commuters by mode of travel. Over the period 2006-2010 (5- year running average), the ratio of transit rider incomes to car driver incomes was highest for cities such as Boston (0.90), New York (0.83), Washington (0.93), Chicago (0.97), and San Francisco (0.88), all of which have extensive metro and suburban rail systems. By comparison the transit rider/car driver income ratio was much lower in cities without extensive rail systems, such as Dallas (0.60), Houston (0.62), Kansas City (0.56), and Phoenix (0.52).

Impacts of Urban vs. Rural Location, City Size, and Population Density

In both countries, public transport accounts for a higher share of trips in urbanized areas, large metropolitan regions, and high population densities (see Figure 4). Between the two survey periods, public transport use in Germany increased significantly in both urban and rural areas, in both small and large metropolitan regions, and for most of the population density categories displayed in Figure 4. In the USA, by comparison, rising trip shares for public transport were limited to urban areas, large metropolitan regions, and high population densities. Moreover, during both survey periods, public transport was more concentrated in urban areas, large metropolitan regions, and high densities in the USA than in Germany.

In 2008/2009 public transport use was 20 times higher in urban areas than in rural areas in the USA. Urban-rural differences were far smaller in Germany. For example, public transport's mode share was only 60% higher in urban areas than in rural areas in 2008/2009. Public transport's share of trips in rural areas was 30 times higher in Germany than in the USA (5.9% vs. 0.2%). Indeed, Germans living in rural areas rode public transport at twice the rate of Americans living in urbanized areas. In both countries, public transport use was higher in large metropolitan areas. The largest difference between the countries was for small metropolitan areas: Germans used public transport at 18 times the rate of Americans in 2008/2009 (7.3% vs. 0.4%). Even for large metropolitan areas, the discrepancy between the countries was large, five times higher in Germany than the USA (17.7% vs. 2.9%).

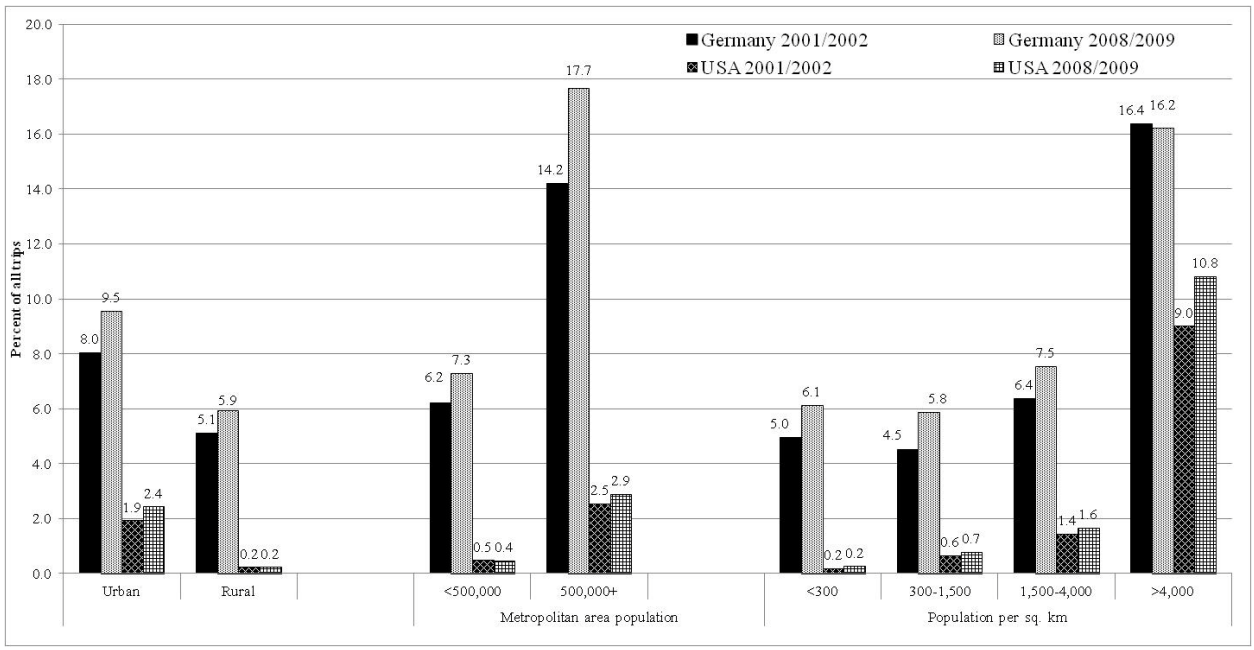

Figure 4. Percentage share of trips by public transport in Germany and the USA by metropolitan area size, population density, and urban vs. rural household location, 2001/2002 and 2008/2009
Source: Authors' calculations based on NHTS and MiD.

In both countries, public transport's share of trips increases as population density rises. The discrepancy in public transport mode shares between the countries declines with increasing population density from 30-to-1 in the lowest population density category to only 1.6-to-1 for the highest density category. Between the two survey periods public transport use stagnated in the highest density category in Germany but increased significantly in lower population density categories (+1.1%, +1.3%, and +1.1%). In the USA, the highest population density had the greatest percentage point increase in public transport mode share (from 9.0% to 10.8%). Increases at lower population densities in the USA were small (<0.2%).

Regional variation in public transport use is much greater in the USA than in Germany. For example, in 2008/2009 the transit share of all trips was 5.1% in the Northeast Census Region, 2.0% in the West, 1.2% in the Midwest, and only 1.0% in the South. Compared to that 5-to-1 difference among the four census regions of the USA, the transit share of trips among German states (excluding special city-states such as Berlin and Hamburg) ranged from 8.9% in Hessen to 6.3% in Lower Saxony, which is a ratio of only 1.4-to-1.

Logistic Regression Analysis of Public Transport Use

The bi-variate analysis above presents relationships between public transport use and individual explanatory variables, one at a time. Table 1 compares two logistic regression models—one for each country—estimating the likelihood of riding public transport, while controlling for other variables. Explanatory variables in the multiple regression analysis include almost all of the demographic, socio-economic, and land-use variables introduced in Figures 2, 3, and 4. Multi-collinearity prevented the inclusion of both automobile ownership and income in the same equation. Thus, the models in Table 1 include only automobile ownership because the most important impact of income on travel behavior is through car ownership [35, 36].

Within each country, adjusted odds ratios (AORs) represent the population subgroup's likelihood of riding public transport relative to a specific reference group assigned the base value 1.00. Controlling for other explanatory factors, AORs show that men in the USA are 1.07 times as likely as women to ride public transport. In Germany, by comparison, the likelihood of riding public transport is not significantly different between men and women. In both countries, the likelihood of riding public transport is highest for the 16-24 age group and declines with age.

In the USA, employed individuals are 1.41 times as likely to ride public transport as persons unemployed or not in the workforce, whereas there is no statistically significant difference for employment status in Germany. Differences between households with and without cars are much larger for the USA than for Germany. For example, American households without cars are 50 times more likely to use public transport than households with three or more cars; German households without cars are only ten times as likely to use public transport as those with three or more cars.

Similarly, density has a larger impact in the USA than in Germany. Americans living in areas with 4,000 or more persons per square kilometers are 13 times as likely to ride public transport as Americans living in areas with fewer than 300 persons per square kilometer. By comparison, Germans living at high densities are only twice as likely to ride public transport as Germans living at low population densities. Both Americans and Germans living in metropolitan areas with more than 500,000 inhabitants are roughly twice as likely to ride public transport as their fellow countrymen living outside of metropolitan areas (AORs 2.22 and 2.14). Finally, Americans as well as Germans are much less likely to ride public transport on weekends than on weekdays (AORs 0.42 and 0.52).

	Used Public Transport Adj. Odds Ratio[a,b]	
	United States	Germany
Gender		
Female	*1.00*	*1.00*
Male	1.07**	0.95
Age Group		
16-24	1.00	1.00
25-44	0.50**	0.19**
45-64	0.44**	0.18**
65+	0.19**	0.13**
Employment		
Not in Workforce/ or Unemployed	*1.00*	*1.00*
Employed	1.41**	0.99
Number of Cars in Household		
No Vehicles	*1.00*	*1.00*
One Car	0.10**	0.26**
Two Cars	0.03**	0.16**
Three or More Cars	0.02**	0.11**
Population per Square Kilometer		
<300	*1.00*	*1.00*
300<1,500	1.98**	0.95
1,500<4,000	3.66**	1.19**
4,000+	12.88**	1.89**
Metropolitan Area Population		
Outside of Metro	*1.00*	*1.00*
<500,000	1.05	1.20**
500,000+	2.27**	2.10**
Day of the Week		
Weekday	*1.00*	*1.00*
Weekend	0.44**	0.50**
Observations[b]	229,124	42,965

* P<0.05; ** P<0.01

[a] Relative likelihoods were calculated using logistic regressions, which control for the influence of other variables.

[b] Excludes persons younger than 16 years.

Table 1. Relative likelihood of riding public transport for population subgroups, 2008/2009
Source: Calculated by the authors based on NHTS 2008/2009 Version 2.0 and MiD 2008/2009.

Controlling for gender, age, employment, car ownership, population density, metropolitan area size, and day of the week, logistic regressions (not shown in Table 1) on a pooled USA-Germany dataset indicate that Germans, compared to Americans, are five times

more likely to ride public transport (AOR 5.12, 95% CI 4.81-5.46). As discussed in the following section, Germany has implemented a wide range of measures that help explain Germany's much greater and faster growing public transport use compared to the USA. We discuss some of the key policies that encourage public transport in Germany and suggest possible lessons for the USA.

Comparison of Public Transport Policies in Germany and the USA

As discussed in Buehler and Pucher [37], public transport agencies in Germany have been more successful at increasing productivity, reducing costs, and improving financial efficiency. In 2010, for example, the total operating and capital subsidy per passenger trip was less than half as much in Germany as in the USA ($1.82 vs. $5.09) [11, 29]. Passenger revenues in Germany covered 77% of public transport operating costs compared to only 33% in the USA [11, 29].

In contrast to the productivity and cost analysis of that earlier paper, we focus here on measures to increase public transport use. Of course, higher productivity and lower costs enable the provision of more services at lower fares, thus encouraging more riders. But there are many strategies specifically designed to increase demand. Such measures fall into the three general categories of 1) expanded and improved service; 2) attractive fares and convenient ticketing; and 3) regional and multi-modal coordination of services and fares. In addition, there are important complementary policies that can encourage public transport use, especially those restricting car use or increasing its price. Similarly, land-use policies can either promote or inhibit public transport demand. Table 2 provides a detailed comparison of policies in Germany and the USA. In the following discussion we focus on the successful German policies, which help explain the much higher and faster-growing levels of public transport use in Germany compared to the USA.

Expanded and Improved Service

There is about three times more public transport service in Germany than in the USA: 59 vs. 20 vehicle kilometers of service per year per inhabitant in 2009. Moreover, 88% of Germans live within 1km of a public transport stop, compared to only 43% of Americans [38]. Since the mid-1990s, most public transport systems in Germany have modernized their vehicles and improved the comfort, convenience, and reliability of their services. Schedules and routes are integrated across public transport operators and modes, providing quick and easy connections for passengers.

Real-time information about actual arrival and departure times is available at most suburban rail, metro, and light rail stations as well as on-board trains and buses. Express bus services and dedicated bus-only lanes improve the speed and reliability of bus services. In many cities, signal priority for light rail and buses triggers a green light when they approach intersections, making public transport service faster and more dependable. In Freiburg, for example, traffic signals give priority to light rail over cars at all but two intersections in the city [39]. Integrated multimodal websites allow searches across operators, public transport modes, and regions, providing up-to-date information on schedules, routes, and fares as well as walking, cycling, and driving access to public transport stops.

Integrated and Attractive Fares

Most regional public transport authorities in Germany offer integrated daily, weekly, monthly, semester, and annual tickets, which allow passengers to use one ticket for the entire trip,

regardless of the number of transfers and public transport modes used during the trip. Over the last two decades, German public transport agencies expanded their programs of deeply discounted tickets for school children, seniors, and university students. Most universities cooperate with public transport agencies to offer inexpensive semester tickets for students at a fraction of the cost of regular monthly tickets. Similarly, many firms negotiate directly with public transport systems to finance deeply discounted monthly tickets for their employees. For Germany on average, public transport systems offer regular monthly tickets that cost about 60% less per trip than single trip fares [29]. Annual tickets offer an additional discount ranging from 10% to 25%, often by charging for only ten months and offering the other two months of the year for free. Both monthly and annual tickets are especially useful for attracting and keeping long-term public transport users.

Customer-tailored fare policy in many German cities makes it economical and convenient to use public transport on a daily basis, increasing its competitiveness with the private car [28, 29]. During the last two decades German public transport has expanded the share of passengers using weekly, monthly, or annual tickets from 60% in 1992 to 76% in 2010. In cities such as Hannover and Freiburg, monthly and annual tickets also include other transport services, such as reduced rates for taxis, car-sharing services, rental cars, and discounts for long-distance rail travel. Moreover, virtually all German states now offer state-wide public transport tickets for groups of up to five travelers. Group tickets cost €30 ($39) per day and permit use of all regional and local public transport services in the entire state on weekends, holidays, and during off-peak periods [40]. Tickets for large events, such as professional soccer games and music concerts, often include free public transport access to such events.

In addition to conventional paper tickets, many public transport systems now offer smart cards with electronic chips that enable convenient re-charging and multiple uses. Moreover, in an increasing number of cities, fully electronic tickets can be purchased via mobile phone, eliminating the need to wait in line at ticket booths or vending machines. Passengers simply show the screen of their mobile phone when asked for their ticket, similar to the web-based ticketing on many airlines [41].

Regional and Intermodal Coordination

German public transport services are enhanced by the full coordination of routes, schedules, and fares within metropolitan regions [42]. Starting in the 1960s, German cities created regional public transport organizations that fully integrate all aspects of public transport operations and ticketing. Transfers between bus and rail are usually facilitated by coordinated schedules that minimize waiting time and by placement of bus stops within or directly adjacent to rail stations to minimize walking distance required for transfers. Between 1991 and 2010, metropolitan areas with public transport authorities, such as Berlin, Freiburg, Hamburg, Munich, Rhein-Main, and Stuttgart, reported increases of at least 20% in passenger volumes.

Extensive, safe and convenient walking and cycling networks in German cities facilitate public transport use. Most public transport riders in Germany reach public transport stops by foot or bicycle. Since the 1970s, most German cities have improved conditions for cycling and walking by traffic-calming nearly all neighborhood streets to 30km/h or less, establishing car-free zones in their centers, and expanding networks of separate bike paths and lanes [43]. For example, even large cities like Berlin and Munich have traffic calmed over 75% of their road networks. Most German cities provide safe and convenient sidewalks, crosswalks, bike lanes, and cycle tracks leading to bus and rail stops, whereas walking and cycling to public transport

stops in American cities is often difficult as well as dangerous due to poor design or the lack of facilities.

German public transport systems allow bikes on trains and provide extensive bike parking facilities at rail stations. In fact, there are more parking spaces at suburban rail and metro stations in the Munich region than in the entire USA (45,000 vs. 38,000) [44, 45]. American public transport systems, however, do a better job integrating buses with cycling. In the USA 75% of buses have bike racks, usually mounted on the front of the bus and accommodating two bikes. No German buses have bike racks.

Pricing and Restrictions of Car Ownership, Use, and Parking

Transport, taxation, and land-use policies at all levels of government make German public transport more competitive with the automobile. Federal taxation policies increase the cost of driving. For example, from 1999 to 2003 the federal government increased the gasoline (petrol) tax by €0.03 ($0.04) per liter each year to a total of €0.15 ($0.22) over five years [46]. In 2010 the share of taxes in the price of gasoline was four times higher in Germany than the USA (60% vs. 15%) [47]. Sales taxes on new vehicle purchases were four times higher in Germany than the USA. Moreover, the USA heavily subsidizes road transport. In the USA road user taxes and fees account for only 60% of roadway expenditures by all levels of government [48]. In sharp contrast, German road users pay taxes and fees that are 2.5 times higher than government roadway expenditures, yielding an important source of net tax revenues that can be used to finance other sectors.

There are many more restrictions on car use and parking in Germany than in the USA. Not only is the supply of roads per capita much less in German cities than in American cities, but motorways are mostly restricted to the outskirts of German cities and rarely penetrate city centers. By comparison, most American cities and suburbs are criss-crossed with extensive networks of high-speed motorways and wide arterials. Most German cities have reduced car parking supply and increased its cost, whereas most American cities continue to focus their redevelopment plans on increased provision of low-cost or free parking for cars.

Traffic calming of residential neighborhoods predominates in German cities, while it is rare in American cities and generally restricted to speed humps on a few isolated streets and not systematic. Almost all German cities feature extensive car-free pedestrian zones in their city centers. Only a few American cities have any car-free streets (usually pedestrian malls) and never an entire network of connecting streets that form a comprehensive car-free zone. In short, there are many more restrictions on car use in German cities, making it less convenient as well as more expensive than in American cities. That makes public transport far more attractive relative to the private car in Germany than in the USA.

Land-Use Policies

German land-use laws and regulations encourage dense and mixed-use settlements, which facilitate public transport use [49]. In the USA, local government land-use plans usually require single-use zoning and discourage mixed use. Higher population density and mixed land-uses in Germany facilitate short trip distances between public transport stops and trip origins and destinations. Many German cities specifically plan neighborhood town centers that enable easy walking and cycling access to shopping and other daily needs. German federal law mandates coordination of land-use planning among municipalities, regions, and states as well as among jurisdictions at the same level of government. German planning law also requires the integration

of land-use plans with transport, water, energy, and environmental plans. With the exception of some recent Transit Oriented Developments (TODs), land-use planning in the USA is generally fragmented, inconsistent, and conflicting across local jurisdictions and rarely integrated with transport plans.

Challenges for Public Transport in Germany

In spite of its relative success compared to the USA, German public transport faces several challenges. Over the coming decade, most urban rail systems that were built in the 1960s and 1970s will have to be renovated. There is still no dedicated funding source for this work because local, state, and federal governments have been quarreling about how much each should pay. Cost cutting by public transport systems over the past two decades has succeeded in reducing subsidy requirements but has taken a toll on labor by reducing wages and increasing work hours and the range of job responsibilities. As a consequence, the last five years have been marred by an increasing number of short-term labor strikes for higher salaries and benefits, which have disrupted service and irritated customers in many German cities. Moreover, because of a reduction of the labor force and cut-backs in maintenance expenditures, some German cities have experienced disruptions in service because vehicles broke down or were preemptively removed from service due to defects that were discovered. To make matters worse, crime has been increasing on public transport systems. In recent years, for example, there have been highly publicized assaults on passengers waiting at rail stations. Graffiti and vandalism of rail cars and buses has also become a problem.

Suburbanization also presents a challenge. Although most German cities are much more compact than American cities, there is a trend toward decentralization of businesses, big-box retailers at the urban fringe, and more suburban housing developments. This type of settlement pattern makes it increasingly difficult for German public transport to compete with the car in the suburbs. Demographic shifts also present a challenge: the aging of the German population will further reduce the number of children and young adults riding public transport.

German public transport will have to deal with all of these issues: funding shortages, maintenance problems, labor disputes, service disruptions, suburbanization, and an older population.

	USA	Germany
Public Transport Ownership and Finance		
Government subsidies	• Most firms privately owned and operated until 1960s; almost all firms publicly owned since 1970s • Sharp rise in federal subsidies during 1970s, but declining federal share of total government subsidies from 1980 (52%) to 2009 (25%) • Steady growth in state and local subsidies from 1970 to 2009, more than offsetting declining share of federal subsidies since 1980	• Public ownership and operation of firms since 1920s • In 1991 EU-mandated open competition for provision of all public transport services, including foreign operators • Federal subsidies for capital investments since mid 1960s • Cross-subsidies from municipal water and energy utilities • Devolution of suburban rail finance from federal to state level
Public Transport Service		
Quantity of service	• 20 vehicle kilometers of service per capita per year: regional rail & metro: 6km; bus & light rail: 14km	• 59 vehicle kilometers of service per capita per year: regional rail & metro: 28km; bus & light rail: 31km
Quality of service	• Many systems have modernized their vehicles and stations • Little coordination of services and ticketing across modes and operators	• All systems have modernized their vehicles and stations offering low floor boarding and comfortable seating • Full coordination of schedules and routes across modes and operators
Traffic priority	• Some cities have dedicated bus lanes or High Occupancy Vehicle (HOV) lanes that can be used by buses • Over 20 cities have Bus Rapid Transit (BRT), with varying degrees of separate right of way and traffic priority	•Many cities have special bus lanes and traffic signal priority for buses • Many cities operate express bus services that are similar to BRT in the USA
User information	• Fragmented, incomplete, and often undependable information • Real-time information rare even on trains, almost never on buses (except BRT) • Bus stops usually lack timetables, maps, and route information	• Convenient online information about regional, state-wide, and even national routes, timetables, and fares • Real-time information at most rail stops, some bus stops, and on-board most trains and buses • All bus stops provide schedules and route information
Fares and Ticketing		
Discounts	• Public transport commuter tax benefits • Slightly discounted monthly tickets for regular commuters • Discounts for off-peak travel provided by some systems	• Tax benefit based on daily commute distance • Discounts for children, university students, and seniors • Deeply discounted monthly tickets available to all groups • Entrance tickets for large events include free public transport
Region-wide fare integration	• Fares and ticketing are rarely integrated across operators and jurisdictions	• Urban areas have regional public transport authorities that fully integrate fares and ticketing across operators and jurisdictions •State-wide coordination of schedules, fares, and tickets

Table 2. Summary of policy differences between the USA and Germany

Note: continues on next page

Regional and Intermodal Coordination		
Regional integration	• Regional transport planning authorities in most cities, but with much less coordination and integration of services than in Germany	• Full coordination of operation and financing of public transport through regional public transport authorities since late 1960s
Multi-modal coordination	• Limited integration of bus and rail • Bike racks on 75% of buses; bike parking at many rail stations • Park and ride lots in suburbs at rail stations and key bus stops • Inconvenient walking and cycling access to bus and rail stops	• Convenient transfers between bus and rail • Extensive, high quality bicycle parking at rail stops • Park and ride facilities for cars at suburban rail stations • Bike and car rental programs run by public transport firms
Pricing and Restrictions of Car Ownership, Use, and Parking		
Sales tax for new car purchase	• State sales taxes for new car purchases range from 0% to 8.25%, with an average of 4.9%	•19% in all states
Driver licensing and cost	• Easy and cheap driver training and licensing, costing about $100 in most states	• Strict and expensive driver training and licensing, costing over $2,000 per license
Price of gasoline	• In 2011: $0.91 per liter (15% of price is tax)	• In 2011: $2.09 per liter (61% of price is tax)
Road revenues and expenditures	• Road user taxes and fees account for 60% of roadway expenditures by all levels of government	• Roadway user taxes and fees are 2.5 times higher than roadway expenditures by all levels of government
Traffic calming & speed limits in cities	• Few cities have any traffic-calmed neighborhoods • Speed limits on most city streets range from 35 to 45 mph (56 to 72 km/h)	• Most residential streets are traffic-calmed at 30km/h or less, with speeds reduced to 7 km/h on some residential streets • General speed limit of 50km/hr (33mph) in cities
Road supply and car restrictions	• High-speed motorways and arterials criss-cross cities and suburbs • A few cities have pedestrian malls, but not extensive zones	• High-speed motorways rarely penetrate into cities • Extensive car-free zones in centers of most cities
Parking supply and cost	• Municipal zoning codes require high levels of minimum parking • 95% of all car parking is free of charge • Free parking is provided by most firms for their employees and customers; cheap and convenient on-street parking in most cities	• Most cities have reduced car parking in downtowns and increased parking fees since the 1960s • German cities have only 39% as many parking spaces per job than U.S. cities
Land-Use Policies		
Coordination with public	• No coordination of public transport with land use, except for some Transit Oriented Developments (TOD) focused around rail stations	•Strict land-use controls limit low density sprawl and encourage compact development around public transport stops
Land-use planning process	• No federal land-use planning at all • Very limited state land-use planning • Metropolitan Planning Organizations (MPOs) can propose land-use plans, but have no power to enforce plans • Fragmented, uncoordinated, and often conflicting land-use planning by local jurisdictions	• Federal, state, regional, and local land-use plans backed by power of law • Coordination of land-use plans among levels of government and across jurisdictions • Integration of land-use, transport, and environmental planning at all levels of government

Table 2 continued.

Sources: [9, 10, 16, 28, 29, 38, 50-54]

Conclusion and Lessons for the USA

Over the past four decades, public transport has been far more successful in Germany than in the USA, with much greater growth in overall passenger volumes and in trips per capita. Even controlling for differences between the countries in demographics, socio-economics, and land-use, logistic regressions show that Germans are five times as likely as Americans to make a trip by public transport. In both countries, public transport use declines with increasing car ownership, rising incomes, and decreasing population densities. However, compared to the USA, public transport in Germany attracts a much broader cross-section of society and for a greater diversity of trip purposes. Most American public transport passengers are either work commuters in large, older cities or low-income captive riders without cars.

The success of German public transport is due to a coordinated package of mutually supportive policies that include: (1) more and better service, (2) attractive fares and convenient ticketing, (3) full multi-modal and regional integration, (4) high taxes and restrictions on car use, and (5) land-use policies that promote compact, mixed-use developments and densities high enough to support public transport. It is the integrated package of complementary policies that explains why public transport in Germany can compete so well with the private car, even among affluent households. Conversely, it is the lack of complementary policies that explains the continuing struggle of public transport in the USA.

Over the last two decades public transport agencies in both countries have improved the quality and quantity of public transport service. As shown in this paper, however, Germany is far ahead of the USA, offering more and better service, more attractive fares and ticketing, and superior multi-modal and regional coordination. The most important difference between the two countries, however, is that local, state, and federal governments in the USA have failed to restrict car use in cities, raise the cost of driving, and improve land-use policies. Indeed, all levels of government in the USA have subsidized roadways, car use, and parking. Due to political opposition from motorist groups, the U.S. federal government and many state governments have not increased the gasoline (petrol) tax for almost 20 years—in spite of large deficits in state and federal highway trust funds. Local government zoning ordinances usually require private developers and firms to supply large amounts of car parking, segregate residential from commercial land uses, and often ban high-density development of any kind. Free parking remains a tax-free fringe benefit for most employees and a tax-deductible expense for firms for both state and federal taxes.

Even $830 billion in government subsidies since 1975 have not succeeded in raising public transport's mode share in the USA, which remains at less than 2% of all trips. Without the necessary policies to restrict car use and make it more expensive, American public transport is doomed to remain a marginal means of transport, used mainly by those who have no other choice.

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