Determinants of CO_2 Emissions from Daily Travel: A Comparison of Germany and the United States

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Rationale and Research Goal

Transport accounts for roughly one quarter of global CO_2 emissions contributing to climate change. During the last two decades global CO_2 emissions from transport increased faster than for any other end-use sector.

In light of the recent 2015 United Nations Climate Change Conference, reduction of CO_2 emissions has gained renewed urgency. Reducing emissions from passenger transport is difficult, because it depends on technology and behavior. Improvements in technological efficiency of cars and fuels can be off-set by heavier vehicles, more powerful engines, and longer travel distances—the so-called 'rebound effect.'

Travel behavior depends on individual decisions about residential location, vehicle ownership, transport mode choice, number of trips, and travel distance. A better understanding of household and individual level determinants of travel behavior and CO_2 emissions can help inform policy development to help curb CO_2 emissions from transport. This research project uses two uniquely comparable individual-level datasets to identify determinants of daily travel behavior and related CO_2 emissions from ground passenger transport using the United States and Germany as case studies.

Similarities between Germany and the USA

- Federal systems of government, local self-government
- Strong economies, high standards of living
- Important automobile industry
- Highest levels of car ownership in the world
- Most adults have a driver's license
- Extensive road networks
- Much urban & suburban (re) development since WWII
- ~95% of the energy for transport comes from petroleum
- CO_2 accounts for about 95% of GHG emissions from transport

	1990	1995	2000	2005	2009/2010	% Change 1990-2000	%Change 1990-2005	% Change 1990-2010
Total CO_2 Equivalent (Tg)								
Germany	117	119	115	107	109	-2	-8	-15
USA	1,039	1,116	1,216	1,259	1,165	17	21	12
Ratio USA/Germany	*8.9*	*9.4*	*10.6*	*11.7*	*11.7*			
CO_2 Equivalent per Capita (Kg)								
Germany	1,470	1,455	1,399	1,303	1,327	-5	-11	-17
USA	4,166	4,246	4,309	4,255	3,753	3	2	-9
Ratio USA/Germany	*2.8*	*2.9*	*3.1*	*3.3*	*3.0*			
CO_2 Equivalent per Passenger km (G)								
Germany	134	121	119	113	107	-11	-16	-20
USA	214	228	217	214	208	1	0	-3
Ratio USA/Germany	*1.6*	*1.9*	*1.8*	*1.9*	*1.9*			
CO_2 Equivalent per Constant $1,000 GDP (using PPP) (Kg)								
Germany	57.0	52.4	46.2	41.8	36.4	-19	-27	-36
USA	129.4	122.7	108.4	99.7	89.0	-16	-23	-31
Ratio USA/Germany	*2.3*	*2.3*	*2.3*	*2.4*	*2.4*			

Figure 1. Levels CO_2 Emissions from Ground Passenger Transport *Note: CO_2 equivalent emissions are based on national fuel consumption estimates. The data do not capture 'gray imports' due to refueling abroad.*

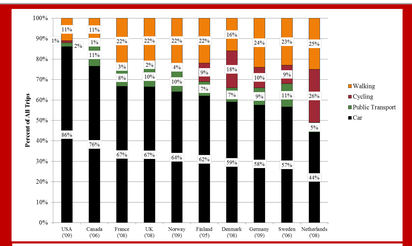


Figure 2. Percent of Trips by Means of Transport in the USA and Western Europe

	MiD 2002 and 2008 (Germany)	NHTS 2001 and 2009 (USA)
Collection Rhythm	Kontinuierliche Verkehrserhebung (KONTIV) '76, '82, '89 MID '02,'08	Nationwide Personal Transportation Survey (NPTS) '69, '77, '83, '90, '95 NHTS '01, '09
Survey Period	14 months 11/2001 - 12/2002 | 02/2008-04/2009	14 months 03/2001 - 04/2002 | 03/2008-04/2009
Sample Size Households	25,848 (2002) | 25,922 (2008)	69,817 (2001) | 150,147 (2009)
Sample Size individuals	61,729 (2002) | 60,713 (2008)	162,758 (2001) | 304,184 (2009)
Survey Method	Computer Assisted Telephone Interview (CATI) (95% in 2002 and 100% in 2008)	CATI (100% in 2001 and 2009)
Target Population	civilian population	
Eligibility of Household Members	adults and all children in 2002 and 2008	adults and all children in 2001 adults and children 5 and older in 2009
Sampling Technique	stratified random sample	
Data Collection Period per Respondent	1 day travel diary for randomly assigned travel day	
Response Rates (% of households)	42% (2002) | 21% (2008)	41% (2001) | 20% (2009)
Inclusion Criterion for Households	at least 50% of household members responding	at least 50% of household members over 18 years old responding
Weights	selection reciprocal, non-response, household size, weekday, month, regional characteristics; trimming of large weights	
Data Level Representative	for nation and individual states	for nation and individual Census regions
Definition of Trips	from one address to another	
Walk and Bike Access and Egress of Public Transport	number of access and egress trips by foot and bike	
Special Treatment of Active Transport	none	two trips; multiple prompts to report short walk and bike trips

Sources: *MiD and NHTS surveys*

Figure 3. MiD and NHTS Surveys

Methods: Using NHTS and MiD Surveys 2008/2009 to Compare CO_2 Emissions from Daily Travel per Person

- CO_2 emission estimates already in German dataset;
- Using comparable method to estimate CO_2 emissions for the USA based on NHTS:
  - Fuel efficiency of vehicle from vehicle file
    - Converting NHTS fuel efficiency from US testing cycle (CAFE) to European testing cycle (NEDC) using ICCT tool;
    - Distinguishing fuel type (diesel, gasoline);
  - Travel distance and transport mode from trip file;
    - Calculating CO_2 emissions based on trip distance;
    - Accounting for number of car passengers;
    - Using CO_2 averages per passenger mile for transit trips published by USDOT/FTA CO_2 emissions per km/mile of public transport mode (distinguishing bus, light rail, heavy rail);
    - Assuming no CO_2 emissions for walk and bicycle trips;
  - Aggregated to person file to calculate CO_2 emissions from travel per person per day.

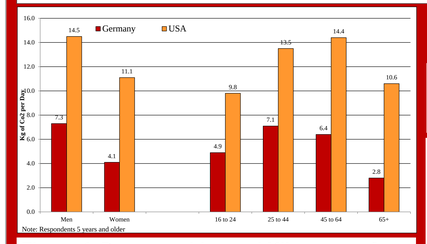
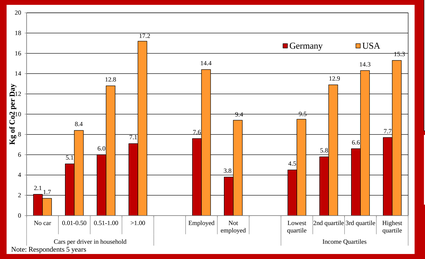


Figure 4. Demographics and Kilograms of CO_2 Emissions from Daily Travel in Germany and the USA, 2008/2009

Figure 5. Socio-Economics and Kilograms of CO_2 Emissions from Daily Travel in Germany and the USA, 2008/2009



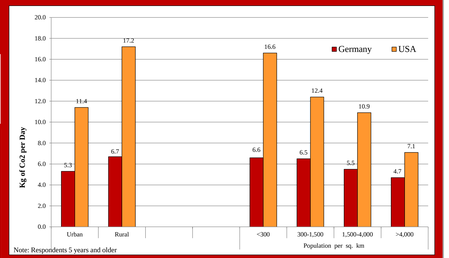
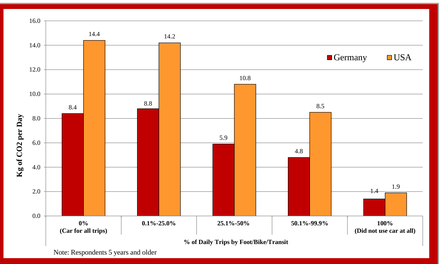


Figure 6. Land-Use and Kilograms of CO_2 from Daily Travel per Person in Germany and the USA, 2008/2009

Figure 7. Share of Daily Trips by Foot, Bicycle, and Public Transport and Kilograms of CO_2 Emissions from Daily Travel in Germany and the USA, 2008/2009



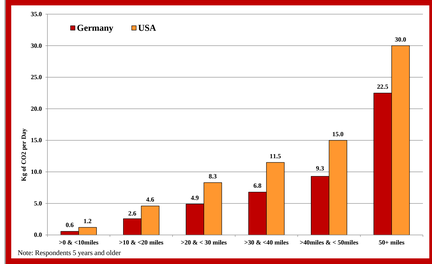


Figure 8. Daily Travel Distance and Kilograms of CO_2 from Daily Travel in Germany and the USA, 2008/2009

OLS and Logistic Regression Results

Determinants of daily CO_2 emissions are similar in both countries. The following groups are more likely among the top 20% emitters and have greater CO_2 emissions per day ($p<0.05$)

- Men
- Employed individuals (vs not employed)
- More cars per household driver
- Mid-age group (45-64)
- Lower population density
- Living in a rural area (vs. urbanized)
- During the week
- Individuals making more trips per day
- Individuals traveling longer daily distances
- A lower share of daily trips on foot, bike, transit

Limitations

Cross-sectional data; endogeneity; sample selection bias (survey response rates ~20%); surveys only representative for entire countries; only one travel day (vs. week); only personal travel (no freight UPS, FedEx…); measurement of variables (reported fuel efficiency; self-reported trip distances; transit CO_2 per passenger mile averages)