Impacts of Bicycling Strategies on Passenger Vehicle Use and Greenhouse Gas Emissions

Technical Background Document

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Study Selection

Drawing on the extensive review by Pucher, et al. (2010) and a search for more recent studies, this review focused on studies from North America over the last 20 years that measure the impact of strategies on bicycling levels while controlling for socio-demographic characteristics. The search identified a small number of studies after excluding those that do not provide a quantitative measure of bicycle use and that do not differentiate between utilitarian trips (i.e. as a mode of travel) and recreational trips. The review considered both cross-sectional studies that compare bicycling in areas with different levels of infrastructure and before-and-after studies that measure changes in bicycling resulting from strategy implementation (i.e., infrastructure investment, promotional program, or other policy). Studies that focus on the use of a new facility without accounting for potential shifts from other facilities were excluded. Only studies that provided enough information to enable the calculation of an effect size were included. No studies provided evidence of the effect of bicycle strategies on VMT, though Marshall and Garrick (2010) and Noland and Kunreuther (1995) give insights into the effect on driving. Given the limited number of U.S. studies, two peer-reviewed before-and-after studies from the U.K. were included in the review; approximately 2 percent of daily trips are by bicycle in the U.K., compared to 0.5 percent in the U.S. (Buehler and Pucher, 2012).

Effect Size, Methodology and Applicability Issues

Effect sizes were calculated from the information presented in the papers as outlined in Tables 1 and 2. Each study uses a different methodology and different measures of bicycling, so that it is not possible to compare results. While controlling for socio-demographic characteristics, most studies do not account for weather, topography, and other factors that might moderate the effect of the strategy. They also do not control for self-selection, that is, the possibility that bicycling-inclined individuals choose residential locations with better bicycle infrastructure, or for the possibility that programs are more likely to be adopted in areas with greater potential for increased bicycling.

Other evidence suggests upper bounds for the total effect that could be expected from bicycle strategies. Pucher, et al. (2010) examined trends in cities world-wide that have adopted comprehensive programs involving infrastructure improvements and promotional programs, and reported increases in bicycling share, as shown in Table 3.

Note that the recent report published by the California Air Pollution Control Officers Association (CAPCOA), “Quantifying Greenhouse Gas Mitigation Measures,” assessed similar literature and, on the whole, found similar effects. The report does identify an effect size as large as 830 percent, but this is for an increase in bicycle lanes from 0.34 miles per square mile to 8.0 miles per square mile, nearly a 24-fold increase. This effect is thus equivalent to the effect reported here of a 0.3 percent increase in share of bicycle commuters for a 1 percent increase in bicycle lanes per square mile (derived from Dill and Carr (2003) in the “Moving Cooler” report (Cambridge Systematics, 2009)).

Table 1: Calculation of Effect Sizes for Studies of Infrastructure Projects

Study	**Infrastructure measure**	**Bicycling measure**	**Results**		
			Elasticities	*Calculation of effect size*	*Notes*
Buehler (2012)	Adding one mile of bike lanes/ paths per 1000 population	Bicycle commuting or not	n/a	Odds ratio of 1.11 (odds of bicycle commuting are 1.11 times the odds of not bicycle commuting)	Based on 2007/2008 household travel survey in Washington, DC region
	Workplace provides bike parking		n/a	Odds ratio of 1.78	
	Workplace provides bike parking, lockers, and showers		n/a	Odds ratio of 4.86	
Marshall and Garrick (2010)	Percent of citywide street length with bike lanes	% commuting by bicycle	0.3490 to 0.3621 for impact of percent of citywide street length with bike lanes on percent commuting by bicycle -0.0036 to -0.0104 for impact of percent of citywide street length with bike lanes on percent commuting by driving	Elasticity calculated based on expected changes in mode shares for increase from 50 to 100% of street length with bike lanes as shown in Table 3 in cited paper. Calculated for three network types. e.g. elasticity biking for tributary tree network = [(2.59 - 1.92)/1.92] / [(100 - 50)/50] (see reference for diagram of “tributary tree network”)	Based on census block-group data for 24 medium-sized California cities

Study	Infrastructure measure	Bicycling measure	Results		
			Elasticities	*Calculation of effect size*	*Notes*
Dill and Carr (2003)	1. Miles of bike lanes per sq. mile 2. Average state spending of federal funds per capita on bicycle and pedestrian facilities (1990-99); not adjusted for inflation	% commuting by bicycle	0.323 for impact of miles of bike lanes per sq. mile on percent commuting by bicycle 0.321 for impact of average state spending of federal funds per capita on bicycle and pedestrian facilities on percent commuting by bicycle; elasticity should be adjusted for inflation to reflect value of current dollar relative to 1990-99 dollars.	Elasticity calculated based on regression coefficients (β) in Model 4 (see Table 3 in cited paper), average measure of infrastructure (x_o) and average % commuting by bicycle (y_o): $\beta * x_o / y_o$ 1. β=0.998, x_o=0.34, y_o=0.01055, elasticity = 0.323 2. β=1.021, x_o=\$0.33 y_o=0.0105, elasticity = 0.321	Based on aggregate data for 33 of the largest U.S. cities, excluding New York City

Study	Infrastructure measure	Bicycling measure	Results		
			Elasticities	*Calculation of effect size*	*Notes*
Noland and Kunreuther (1995)	1. Perceived bicycle parking available	Probability of bicycling; probability of driving	0.83 for impact of perceived bicycle parking on probability of bicycling -0.01 for impact of perceived bicycle parking on probability of using automobile	Effects on probability of bicycling are taken from direct short-run elasticities reported in Table 6 of cited paper. Effects on probability of using automobile are taken from short-term cross-elasticities reported in Table 7 of cited paper. Aggregate effects on mode share, as summarized in the brief, are reported in Table 8 of cited paper.	Short-run elasticities reflect the actual availability of different modes at the time of the study. Effect of bicycle comfort on probability of auto use is insignificant.
	2. Perceived bicycle convenience		3.16 for impact of perceived bicycle convenience on probability of bicycling -0.02 for impact of perceived bicycle convenience on probability of using automobile		
	3. Perceived bicycle comfort		0.97 for impact of perceived bicycle comfort on probability of bicycling		

Table 2: Calculation of Effect Sizes for Studies of Promotional Programs

Study	Promotional program	Bicycling measures	Calculation of effect size	Notes
Johnson and Margolis (2013)	Adult Training Program	Average number of days cycled to work in the last week for participants	Mean number of days cycled to work for participants increased from 0.66 days prior to training to 1.33 days three months after the first training session	Study did not include control group

Study	Promotional program	Bicycling measures	Calculation of effect size	Notes
League of American Bicyclists (2008)	Bike to Work Day promotion	Bicycle counts at central street intersection	Counts at Market Street and Van Ness from 8-9 am: One week before: 406 bikes Bike to Work Day: 813 bikes Four weeks later: 509 bikes	Counts may reflect seasonal effect
Cooper (2007)	Promotion of transit and non-motorized modes to individuals who commit to reduce driving for 10 weeks	Bicycle trips that replace drive-alone trips	263 bicycling trips replaced driving trips (see Table 5 in cited paper), for 667 households that pledged to participate (see Table 4 in cited paper)	
Staunton et al. (2003)	Safe Routes to School program	Number of children bicycling to school	As reported in paper, 114% increase in number of children bicycling from before to after implementation of program	Study did not include control schools

Table 3: Long-Term Increases in Bicycling Share for Comprehensive Programs

City	Bicycling Share at Start of Program	Number of Years After Start of Program	Increase in Bicycling Share
Barcelona	0.7%	2	135%
Paris	1.0%	6	150%
Bogota	0.8%	8	300%
Portland	1.1%	18	445%
Boulder	3.8%	26	132%

Source: Pucher, et al. 2010

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