Bicycle Commuting and Facilities in Major U.S. Cities:
If You Build Them, Commuters Will Use Them – Another Look

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ABSTRACT

Some surveys indicate that providing bicycle lanes and paths may encourage more people to commute by bicycle. The presence of a striped lane or separated path can increase a cyclist's perception of safety. With growing concerns over traffic congestion and vehicle pollution, public policy makers are increasingly promoting bicycling as an alternative for commuting and other utilitarian trip purposes. States and local spending on bicycle facilities has increased significantly over the past decade. Previous studies have linked higher levels of bicycle commuting to various demographic and geographic variables. At least one analysis showed that cities with higher levels of bicycle infrastructure (lanes and paths) also saw higher levels of bicycle commuting. This research affirms that finding by analyzing data from 35 large cities across the U.S. This cross-sectional analysis improves on previous research by including a larger sample of cities, not including predominantly 'college towns,' and using consistent data from the Census 2000 Supplemental Survey. While the analysis has limitations, it does support the assertion that new bicycle lanes in large cities will be used by commuters.

INTRODUCTION

Increasing concern over vehicle congestion and pollution in urban areas has led to an interest in promoting bicycle use for non-recreation (utilitarian) purposes. This interest is evident at all levels of government. In the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, the U.S. Congress opened up new sources of funding for bicycle facilities. These new funding sources continued with the Transportation Equity Act for the 21st Century (TEA-21) of 1998 and have impacted spending nationwide. In 1991, states and MPOs spent $17.1 million in federal funds on stand-alone bicycle and pedestrian projects. This figure grew to $339.1 million in 2001 (1). In addition, federal planning requirements now include consideration of bicyclists in state and MPO long-range transportation plans. Bicycle projects must be considered in conjunction with all newly constructed and reconstructed facilities where bicycling is permitted (2). Promoting bicycle travel for utilitarian purposes is a federal objective. In 1994, the U.S. Department of Transportation released the National Bicycling and Walking Study (NBWS). One of the goals of the NBWS was to double the share of trips made by foot or bicycle (3).

With an increased public policy focus on bicycling, researchers and planners are trying to better comprehend what motivates people to use a bicycle instead of a motorized vehicle. The 1994 NBWS reviewed existing literature to understand why bicycling is not used more extensively (4). Reasons were categorized as either "1. Subjective factors which have less to do with measurable conditions than with personal perception and interpretation of one's needs" or "2. Objective, physical factors which exist for everyone, though they may not be weighed equally by everyone" (p. 6). Subjective factors include distance, traffic safety, convenience, cost, valuation of time, valuation of exercise, physical condition, family circumstances, habits, attitudes and values, and peer group acceptance. Objective factors include climate, topography, presence of bicycle facilities and traffic conditions, access and linkage, and transportation alternatives. Pucher et al identify eight factors that affect the level of cycling in North America: public attitude and cultural differences; public image; city size and density; cost of car use and public transport; income; climate; danger; and cycling infrastructure (5).

Public policy can influence most of these factors, to varying degrees. Current U.S. policy has focused largely on providing bicycle infrastructure, mainly through new funding made available through ISTEA and TEA-21 (5). Based on studies from the late 1970s and early 1980s, the NBWS concluded that bikeways (i.e., lanes and paths) "will significantly affect subjective perceptions of safety" (p. 11). The study also cited surveys conducted by a variety of sources. For example, 12 – 17 percent of the active bicyclists surveyed in Phoenix, AZ, Seattle, WA, and Portland, OR identified a 'lack of facilities' as a reason for not commuting to work by bicycle. Trip distance was the most frequently cited reason. A Harris Poll conducted in 1991 found that 49 percent of active bicycle riders who did not currently commute by bicycle said they would sometimes commute by bicycle if there were safe bike lanes. Similar surveys in Davis, CA and Seattle, WA found that 12 and 41 percent, respectively, of cyclists would commute by bicycle if there were safer routes. The results of these types of surveys, however, are influenced by the wording of the questions and they only reveal what people *might* do, rather than what they actually do.

EMPIRICAL RESEARCH

Of course, actual behavior does not always reflect stated preferences or desired choices. Using attitudinal surveys to predict shifts in travel due to bicycle improvements can overestimate demand for new facilities (6). While Pucher et al agreed that separate bike lanes and paths make cycling more attractive to non-cyclists, they did not find any "rigorous statistical studies" that demonstrated their impact on cycling. They also speculated that, to some extent, the provision of such facilities could be a response to the level of cycling in an area, rather than a cause.

Bicycling is predominantly a recreational activity in the U.S. Data from the Bureau of Transportation Statistics (BTS) Omnibus Survey for 2002 reveals that 14.3 percent of the adult respondents rode a bicycle in the previous month (7). Of those, 53.9 percent did so primarily for recreation and 31.2 percent did so primarily for exercise. Only 4.9 percent bicycled primarily for commuting to work or school and 7.5 percent for personal errands. The survey did not ask for secondary purposes. Also, those people bicycling primarily for exercise might be going to work. Of the bicycle commuters, 11.0 percent rode primarily on bike lanes, compared to 5.6 percent of the recreational cyclists. McDonald and Burns (8) found that regular bicycle commuters in Phoenix adjusted their routes to use bicycle facilities, lending support to the argument that providing facilities impacts behavior.

Nelson and Allen (9) used data from the NBWS to explain the relationship between bicycle commuting and bicycle pathways, controlling for extraneous variables. The data included 18 U.S. cities and used five explanatory variables: mean high temperature; number of days per year with more than one-tenth an inch of rain; terrain; miles of bikeways per 100,000 residents; and the percentage of college students as compared to the overall resident population. Their final linear regression model included bikeway mileage, rain days, and percent students as significant variables, with an adjusted R-squared of 0.825. They found that each additional mile of bikeway per 100,000 people is associated with a 0.069 percent increase in bicycle commuting, holding the other factors constant. The authors did not, however, interpret this as a cause-effect relationship.

Other researchers have explored the effect of additional variables on bicycle commuting. Baltes (10) used Census journey-to-work data from 284 metropolitan statistical areas (MSAs) to explore the relationship between bicycle commuting and various demographic and geographic factors. The analysis did not include data on bikeways, as this information is not included in the U.S. Census. A series of regression equations identified several significant variables, including the following: age (16-29 years); vehicle availability; race (Asian and non-white); household owner occupancy; unemployment; percent students; poverty; agricultural and manufacturing employment; and the share of workers and population living in the central city. Baltes found that several variables were not significant, including population density and median income, though some of the significant variables are likely to be highly correlated with these two variables. The analysis was conducted at the MSA level for each Census region and all the MSAs combined and found that the variables explained at least half of the variation in the level of bicycle commuting. The author did conclude that bicycle commuting was most prevalent in MSAs with unique communities, such as universities or colleges. Nankervis (11) found that short-term and long-term weather patterns impacted cycling levels, though not to the extent that he originally anticipated.

Overall, the empirical evidence explaining the link between bicycle facilities and commuting is limited. Nelson and Allen (9) made several recommendations on how to improve on their analysis, including a larger data set, time-series data, before-and-after studies, and including additional factors that influence mode choice. Moreover, the quality of the original data used for the analysis may be problematic. The NBWS noted that "innumerable difficulties were encountered when assembling the data" and that "the quality of the data varies so much" (p. 32, note 43). This was particularly true for the bicycle commuting data and bikeway mileage. Finally, of the 18 cities included in the Nelson and Allen study, the top four in terms of bicycle commuting are "college towns" – Boulder, CO, Eugene, OR, Gainesville, FL, and Madison, WI. Though the percentage of people who are students was included as a control variable, these cities may be driving the results and might not be considered useful as models for larger cities without a university-focus.

DATA AND METHODOLOGY

This analysis attempts to build upon the work of Nelson and Allen (9) by using new Census data, a larger sample of cities, and additional explanatory variables. Much of the data used in this study comes from the Census 2000 Supplemental Survey (C2SS). The C2SS is a demonstration program to evaluate the feasibility of collecting economic, demographic, and housing data outside of the decennial census. C2SS sampled 700,000 housing units in 1,203 counties, sampling approximately 58,000 addresses each month. The C2SS sampling rate for most geographic areas was five percent(12). While the sample size is much smaller than that used for the long form decennial census, the C2SS was thought to be more useful for this analysis as it samples households throughout the calendar year, rather than on April 1st, as the decennial census does. If bicycle commuting is influenced by weather, a random sample throughout the year may present a more accurate picture of regular behavior. In addition, at the time we conducted this research, the U.S. Census had not released bicycle commute data at the city level.

The C2SS includes data for 64 incorporated or Census designated places with a household population of 250,000 or higher. Three U.S. cities have a population greater than 250,000 but were not included in C2SS – Lexington, KY; Louisville, KY; and Corpus Christi, TX. Bicycle commuting rates in the top 55 cities ranged from 2.63 percent (Minneapolis, MN) to 0.04 percent (Dallas, TX) (13). Nine cities had estimates of zero percent of the workers commuting by bicycle. This is likely a result of the sample size. We contacted bicycle coordinators or other staff at the top 40 cities to obtain information on the number of miles of Class I and Class II bike facilities at the end of the year 2000. Class I facilities (also known as bike paths or shared use paths) are defined as a bikeway physically separated from motorized vehicular traffic. Shared use paths may also be used by pedestrians, skaters, wheelchair users, joggers and other non-motorized users. Class II facilities (also known as on-street bicycle lanes) are defined as a portion of a roadway which has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicyclists (14). Some cities also had bike routes, wide shoulders, bike boulevards, and other facilities. Although these other facilities may have some impact on bicycle commuting, we limited the analysis to Class I and II facilities to maintain consistency among cities, and focus the analysis on the highest level of facilities. We were able to obtain Class I and II facility data from 35 cities. We also asked whether or not the city had a designated bicycle coordinator on staff. This variable is an indicator of the level of policy support at the local level for bicycling, which may or may not be reflected in the level of facilities existing in 2000.

Based upon the previous research described above, we selected a number of other variables that could influence the level of bicycle commuting in a city. These are shown in Table 1.

FINDINGS

Data for the 35 cities appears in Table 2, sorted by the percentage of bicycle commuters. The rankings in the first column are from the original list of 64 cities from the C2SS. Looking at the data, there are few consistent trends. The top four cities have some of the highest numbers of bike lanes and paths per square mile, though cities further down the list (e.g., St. Paul, Long Beach, and San Jose) also have high numbers. The BTS data described above indicated that commuters are more likely than other cyclists to use bike lanes. Therefore, the number of Type 2 bike lanes per square mile is also included in the table. Three of the top six cities have over 100 days of rain per year, lending some doubt that rain is a significant deterrent to bicycle commuting. However, the bottom six cities all have over 100 days of rain. The maximum percentage of residents that are college students is 12.23 percent in Boston, significantly lower than that rates found in Boulder, Gainesville, and Madison in the Nelson and Allen data. Most cities have a relatively high rate of vehicle ownership – over one vehicle per household for all but three cities (Boston, Washington, DC and New York City).

Table 1: Variables and Data Sources

Variable	Source
Occupation/Employment	
Percentage of population that are college students	C2SS (15)
Percent of workers by industry category (Agriculture, construction, manufacturing, wholesale trade, retail trade, transportation/warehousing/ utilities, information, finance/insurance/real estate, professional/scientific, education, arts/entertainment/recreation, and public administration)	C2SS (16)
Percent of workers by occupation category (management/professional, service, sales/office, farm/forestry, construction, and production/transportation/manufacturing)	C2SS (16)
Availability/Attractiveness of Other Modes	
Mean number of vehicles per household	C2SS (17)
Percentage of households with zero vehicles	
Transit Availability -	National Transit Database 2000
Transit vehicle revenue miles per mile of service area	Transit Profiles
Gasoline price (state average, with taxes for 2000)	Energy Information Administration (18)
Land Use	
Percentage of housing units built before 1950 (a proxy for a grid-like street pattern)	C2SS (19)
Population density	2000 Census (20)
Socio-economic Characteristics	
Median and mean household income	C2SS (16)
Percent of persons over 18 in poverty	C2SS (16)
Weather	
Average annual number of days of rainfall (.01 inches or more)	National Climatic Data Center
Average annual precipitation (total inches)	(21), Western Regional Climate Center (22)
(Data for next closest city if city data not available)	
Public Support for Bicycling	
Average per capita annual state spending on bicycle and pedestrian improvements, 1990-1999 (federal funds)	Surface Transportation Policy Project (23)

The percentage of people commuting by bicycle is significantly correlated with the three bicycle infrastructure variables in Table 2, but not with any other variables listed in Table 1 or 2. The strongest and most significant correlation was with the number of Type 2 bike lanes per square mile (Pearson Correlation = 0.45, $p<0.01$). There was no significant correlation between state spending on bicycle and pedestrian projects and any of the three infrastructure variables. Several explanations are possible. First, the funding variable is for the state level and also includes pedestrian projects. Also, the funds could be spent on types of bicycle facilities and projects other than Type 1 or 2 paths and lanes, such as safety enhancements or intersection signals and detection equipment. The variable is included in this analysis as a possible indicator of states providing all types of bicycle facilities and overall public support for bicycling.

Table 2: Cities and Data Used in Analysis

Rank	City	% Commuting by bicycle	Lanes & Paths per sq. mi.	Lanes per sq. mi.	Lanes & Paths per 100,000 residents	Average State Spending per capita on ped/bike (1990-99)	Population Density (people/ sq mi land)	Days of Rain (historical average)	Percent College Students	Avg. Gas Price (state, with taxes)	Avg. # vehicles per household	Median Household Income
1	Minneapolis, MN	2.63%	1.44	0.47	20.65	$0.45	6,970	116	8.14%	1.52	1.34	$40,471
2	Sacramento, CA	2.59%	2.05	1.42	48.89	$0.09	4,189	58	9.83%	1.62	1.54	$37,216
3	Portland, OR	2.55%	1.44	1.05	36.48	$0.94	3,939	153	6.88%	1.63	1.53	$38,807
4	Tucson, AZ	2.22%	1.76	1.54	70.27	$0.26	2,500	53	10.27%	1.51	1.50	$30,248
5	Fresno, CA	1.96%	.13	0.00	3.23	$0.09	4,098	45	8.34%	1.62	1.43	$29,934
6	Tampa, FL	1.93%	.58	0.41	21.58	$0.58	2,708	106	5.73%	1.49	1.46	$34,194
7	San Francisco, CA	1.80%	.87	0.44	5.21	$0.09	16,634	68	9.81%	1.62	1.15	$57,417
8	Oakland, CA	1.77%	.20	0.09	2.75	$0.09	7,127	63	7.93%	1.62	1.41	$45,251
9	Mesa, AZ	1.64%	.37	0.36	11.61	$0.26	3,171	36	7.17%	1.51	1.65	$39,719
10	Anaheim, CA	1.59%	.45	0.29	6.78	$0.09	6,702	32	5.67%	1.62	1.92	$46,540
11	Boston, MA	1.48%	.28	0.01	2.29	$0.42	12,166	127	12.23%	1.57	.98	$42,117
12	Washington, DC	1.42%	.78	0.10	8.39		9,316	113	7.56%	1.50	.90	$41,162
13	Seattle, WA	1.23%	.58	0.25	8.70	$0.83	6,717	151	11.34%	1.60	1.43	$44,954
14	Albuquerque, NM	1.16%	.61	0.31	24.74	$1.29	2,483	61	8.33%	1.49	1.72	$37,235
15	New Orleans, LA	1.14%	.06	0.00	2.06	$0.29	2,684	114	7.17%	1.43	1.16	$27,496
16	Oklahoma City, OK	0.90%	.02	0.01	2.20	$0.45	833	83	5.55%	1.38	1.62	$34,660
17	Phoenix, AZ	0.87%	.48	0.38	17.41	$0.26	2,782	36	5.49%	1.51	1.60	$40,003
19	St. Paul, MN	0.69%	1.93	0.65	35.49	$0.45	5,442	116	7.41%	1.52	1.49	$45,944
20	Long Beach, CA	0.66%	1.27	0.00	13.87	$0.09	9,150	32	8.85%	1.62	1.42	$35,220
21	Santa Ana, CA	0.65%	.36	0.04	2.88	$0.09	12,452	32	5.19%	1.62	1.83	$38,258
22	Los Angeles, CA	0.63%	.34	0.25	4.36	$0.09	7,877	35	7.29%	1.62	1.50	$35,611
24	Honolulu, HI	0.61%	.46	0.25	10.49	$0.43	4,337	97	9.76%	1.75	1.43	$46,776
25	Denver, CO	0.53%	.62	0.07	17.13	$0.50	3,617	89	6.99%	1.54	1.57	$42,060
26	Chicago, IL	0.51%	.35	0.22	2.76	$0.24	12,750	125	7.01%	1.56	1.15	$38,295
27	Pittsburgh, PA	0.48%	.31	0.05	5.08	$0.21	6,019	152	7.91%	1.50	1.03	$30,352
28	San Diego, CA	0.48%	.92	0.77	24.52	$0.09	3,772	42	9.71%	1.62	1.66	$47,088
29	San Jose, CA	0.42%	1.02	0.74	19.89	$0.09	5,118	58	9.28%	1.62	2.07	$72,173
30	New York City, NY	0.42%	.64	0.40	2.44	$0.48	26,403	121	7.12%	1.57	.63	$39,686
35	Houston, TX	0.35%	.43	0.32	12.80	$0.17	3,372	105	5.28%	1.41	1.51	$36,073
36	Raleigh, NC	0.34%	.21	0.02	8.64	$0.35	2,409	113	11.08%	1.47	1.65	$46,763
37	Milwaukee, WI	0.27%	.26	0.08	4.19	$0.31	6,214	126	6.25%	1.55	1.31	$34,375
39	St. Louis, MO	0.26%	.45	0.06	8.08	$0.05	5,623	111	6.61%	1.42	1.22	$27,213
40	Cincinnati, OH	0.25%	.16	0.06	3.65	$0.47	4,249	137	8.49%	1.50	1.23	$28,116
41	Riverside, CA	0.23%	1.10	0.85	33.55	$0.09	3,267	32	8.13%	1.62	1.84	$41,555
42	Columbus, OH	0.22%	.13	0.01	3.94	$0.47	3,384	137	8.71%	1.50	1.52	$37,041
	Average	1.05%	0.66	0.34	14.49	$0.33	6,299	88	7.96%	1.55	1.44	$39,715

We estimated a series of regression models with various combinations of independent variables. The results from the best models, based upon model and variable significance, are shown in Table 3. The first two models include 34 of the 35 cities. State spending information was not available for Washington DC, so that city was excluded from the models with the spending variable. The results for Model 1 indicate that vehicle ownership and the number of days of rain are negatively related to bicycle commuting, as expected, but the coefficients are not statistically significant. Removing them from the model (Model 2) reduces the explanatory power of the model very little, as indicated by the adjusted R^2. The coefficient for the state spending variable is positive, as expected, but is also not significant. Removing this variable from the model however, does reduce the explanatory power of the model slightly (Model 3).

Table 3: Results of Regression Models

	Model 1	**Model 2**	**Model 3**	**Model 4 (NYC excluded)**
Constant	1.971 (0.058)	0.594 (0.008)	0.761 (0.000)	3.339 (0.005)
Type 2 lanes per square mile	0.892 (0.008)	0.888 (0.006)	0.861 (0.007)	0.998 (0.002)
State spending per capita on bike/pedestrian	0.771 (0.144)	0.427 (0.328)		1.021 (0.047)
Vehicles per household	-0.698 (0.208)			-1.520 (0.020)
Days of rain	-0.005 (0.206)			-0.008 (0.020)
Adj-R^2	0.192	0.190	0.178	0.304
F-statistic	2.964 (0.036)	4.868 (0.014)	8.383 (0.007)	4.495 (0.006)
n	34	34	35	33

Dependent Variable: Percentage of workers commuting by bicycle
Beta-coefficient is shown in each cell. Level of significance is shown in parentheses.

Model 4 includes all four independent variables, but excludes New York City. In this model, all variables are significant and explain about 30 percent of the variation in the dependent variable, higher than any other model estimated. New York City is often considered an "outlier" in transportation-related research due to its high amount of transit use and population density. New York City may also be unique in terms of bicycling. Pucher et al (5) suggest that New York could be a leading cycling city, with its flat terrain and close destinations. However, obstacles such as heavy traffic, poor pavement, poor links on bridges, vehicle exhaust, lack of secure bicycle parking and theft likely discourage high levels of bicycle commuting.

The results from Model 4 indicate that for more typical U.S. cities over 250,000 population, each additional mile of Type 2 bike lanes per square mile is associated with a roughly one percent increase in the share of workers commuting by bicycle. This level of increase in Type 2 bike lane mileage is significant – almost four times the current average of 0.34 miles per square mile. However, increasing the share of workers commuting by bicycle by one percentage point would double the average number of bicycle commuters for many of these cities. Of course, as noted by Nelson and Allen and Pucher et al, the strong association between the existence of bike lanes and levels of bicycle commuting does not certify a cause-effect relationship. It does, however, imply that commuters will use bicycle lanes if they are provided.

In a regression analysis that includes only 33 – 35 cities, one city can influence the results significantly, as shown with New York City in Model 4. Therefore, it is also worth looking at the data for other anomalies and possible explanations. For example, Fresno, CA is ranked fifth, with 1.96 percent of the workers commuting by bicycle, yet they have few bicycle lanes or paths. However, nearly six percent of the workers are employed in the farming, fishing, or forestry occupations, more than ten times the rate in any of the other cities. Baltes had found that the percent of the population employed in agriculture is positively related to bicycle commuting at the MSA level. Boston also has a high level of bicycle commuting (1.48 percent) and a low number of bicycle lanes and paths. The city also has the highest share of residents who are college students and a low rate of vehicle ownership – just less than one vehicle per household. The high density in Boston also indicates that destinations are closer than in many cities. These possible explanations do not apply to New Orleans, another city with a relatively high level of bicycle commuting and little infrastructure. One possible explanation is income; the median household income in New Orleans is over $10,000 less than the average for the 35 cities. However, income in general was not significantly correlated with bicycle commuting across all 35 cities and, when included in regression models, was not a significant variable. At the other end of the list, there are some cities with higher than average bicycle infrastructure, but lower than average bicycle commuting – San Diego, San Jose, and Riverside, CA, for example. All three cities have low rainfall, which should be conducive to cycling. However, they also have lower than average densities and higher than average auto ownership rates. This might imply that providing bicycle lanes and paths in more auto-oriented cities may not correlate well with increased bicycle commuting. However, Sacramento, CA and Portland, OR have similar population densities and higher than average vehicle ownership rates, yet much higher bicycle commuting and infrastructure.

CONCLUSIONS

The analysis performed here affirms the results of Nelson and Allen. Higher levels of bicycle infrastructure are positively and significantly correlated with higher rates of bicycle commuting. Achieving consistent results with a larger, more uniform (e.g., no small or college towns) set of cities lends strength to this finding. While additional variables were tested, such as income, gas prices, and transit availability, they were not significant in the regression models. However, there are still several limitations to this analysis. As already discussed, the analysis does not indicate the existence or direction of a cause-effect relationship. People may be commuting by bicycle more because there are more lanes and paths. Alternatively, because people are commuting by bicycle, the city is building more bike lanes and paths. Both relationships may be occurring to varying degrees in each city. But, as Nelson and Allen state, "This analysis confirms the hunches of public policy makers that at least some, but perhaps not an inconsequential number, of commuters will be responsive to the bicycling option if only it were made available" (p. 82). The range in rates of bicycle commuting among the 35 cities indicates that improvements can be made. However, bicycle lanes and paths *alone* are not likely to increase bicycle commuting. Bike lanes and paths need to connect popular origins and destinations, greater efforts should be taken to educate commuters about bicycling as an option, and commuters need adequate and safe parking at work (4, 5).

Additional research could overcome some of the limitations of this analysis. For example, our data was collected at the city level. A disaggregate analysis looking at individuals and their proximity to bike lanes and paths may shed more light on the relationship between proximity and propensity to bicycle. Socioeconomic variables, such as income and age, might be significant at the disaggregate level. This type of analysis is possible when the Census releases data at the micro level – the public use micro sample (PUMS). Although C2SS PUMS data is available, the sample does not list the city of the household or person. In addition, the sample includes only 727 bicycle commuters, compared to over 150,000 people commuting in personal vehicles. The data do include weighting factors to help reflect the data to the population as a whole. These weighted data do indicate that there are differences between cyclists and other commuters. For example, 82 percent of the bicycle commuters were men and 21 percent were students, compared to 54 percent and 11 percent of all commuters, respectively. Bicycle commuters had lower incomes than vehicle commuters. Only 31 percent of the bicycle commuters had children of their own at home, compared to 42 percent of all commuters. This may indicate that commuting parents are less likely to use bicycles because they also need to transport children. It may also indicate that cyclists are more likely to be students. Thirty-five percent of bicycle commuters lived in homes built before 1950, compared to 21 percent of all commuters. This may indicate that people living in older neighborhoods, which are more likely to have a grid street pattern, are more likely to bicycle. However, additional statistical analysis to control for other variables, such as density and income, is necessary before drawing clear conclusions.

Two limitations of the data involve the dependent variable – the percent of workers that commute by bicycle. First, commuting is only one of many trip purposes. The BTS data described above indicates that more people bicycle to run errands. Personal travel surveys, such as the Nationwide Personal Transportation Survey (NPTS, now called the Nationwide Household Travel Survey) and regional surveys, would provide data on bicycling for all trip purposes. However, the NPTS does not include a large enough sample to analyze individual cities. Regional travel surveys could be used, but they are conducted at different times (ranging from every 5 to over 10 years) and employ different methods. One advantage of the Census and C2SS is the consistency in data collection methods and that the data is all for the same year.

The second limitation with regards to the dependent variable is that the Census asks how the person usually got to work the previous week. Therefore, only regular bicycle commuters are captured in the data. Someone who rides a bike one or two days a week will not be listed as a bicycle commuter. For this reason, some bicycle advocates feel that the Census systematically undercounts cyclists. Again, a regional or citywide travel survey could overcome this limitation. Such surveys usually involve a one- or two-day travel diary. With a large enough sample, occasional cyclists will be included in the data.

Additional research could more clearly explain the relationship between cycling and infrastructure by including additional variables. For example, bicycle commuting may be correlated to the distance of travel, which is not collected by the U.S Census Bureau. In addition, changing the level of analysis (aggregate versus disaggregate) would allow for the use of variables such as sex, that don't vary by city significantly. Before-and-after studies and time-series data may help explain the direction and significance of causality.

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