Bicycle Commuting, Transportation Efficiency and Safety: A US Cities Perspective

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This study investigates the relationship among the volume of bicycle commuters and the occurrence of traffic fatalities, per capita, in 30 U.S. cities. The analysis controls for automobile commuters, those who work from home, average annual rainfall, average temperature, and hours lost to traffic congestion. Through multivariate regression techniques, it is found that, per 150,000 workers aged 16 and older, there is a reduction of 4.0365 traffic fatalities for every one percentage point increase in bicycle commuters across these 30 U.S. cities. This output is statistically significant at the 0.05 confidence level.

1. INTRODUCTION

Since the late 19th century, bicycles have provided Americans and Europeans with a form of transportation and leisure.[1] As roads became more established and bicycle technology more modernized, the bicycle transitioned from a luxury item among the wealthy class, to a common mode of leisure, exercise, and transport that grew steadily throughout the 20th century, making way for the bike boom of the 1970s.[2] Although the number of bicyclists across the United States has grown rapidly since then, 89 percent of workers commute via car, truck, or van, and only half a percent of workers commute by bicycle. Globally, the United States falls well behind other developed nations by the percentage of commuters using bicycles as a mode of transportation at least once per month. See Figure 1 below.

Proponents of bicycle commuting cite the transportation method's cost, health, and environmental benefits. Opponents of bicycle commuting cite safety concerns and the potential for aggravated traffic congestion due to the addition of bike lanes. The goal of this analysis is to assess whether there is any association between i.) the share of workers who commute by bicycle, ii.) the rate of traffic congestion, and iii.) the occurrence of traffic fatalities in the top 30 US cities by worker population.

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[1] In an article in Vox *"Roads were not built for cars": how cyclists, not drivers, first fought to pave US roads*, Joseph Stromberg discusses the effort of cyclists in the 1890s and early 1900s to advocate for paved streets and new roads. (Stromberg, 2015)

[2] Sisson, P. (2017, June 28). *'Bike Boom': Lessons from the '70s cycling craze that swept the U.S.* Retrieved from Curbed: https://archive.curbed.com/2017/6/28/15886810/bike-transportation-cycling-urban-design-bike-boom

Figure 1 Bike commuting in the U.S. vs other nations

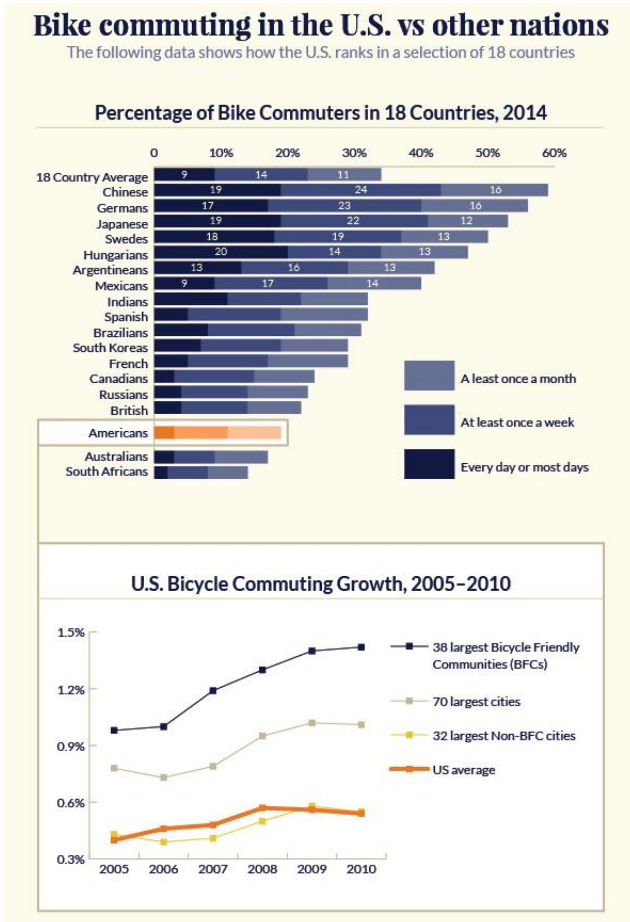

Chart from [Triple Pundit]

2. DATA

Commuter variables are collected from the United State Census Bureau and derived from 1-Year Estimates in the American Community Survey from 2019 (United States Census Bureau, 2021). Traffic safety variables are collected from United States Department of Transportation's Annual Report Tables, measuring fatality rates in cities with populations of 150,000 or greater from 2019 (United States Department of Transportation, 2021). Precipitation and temperature variables are collected from the National Oceanic and Atmospheric Administration's 30-Year U.S. Climate Normals, using averages from 1991-2020 (National Centers for Environmental Information, 2021). Traffic congestion variables are collected from the 2021 INRIX Global Traffic Scorecard, with "Hours Lost in Congestion" defined as the total number of hours lost in congestion during peak commute periods compared to free-flow conditions (Inrix, 2021).

U.S. cities are collected and arranged by total number of workers 16 and older, and the top 30 cities by worker population are selected for analysis. See Table 1 City Data below.[3]

[3] Dallas, TX was omitted from this analysis due to a lack of commuter data.

Table 1 City Data

City	Workers 16 years and over	Commute by Car, truck, or van (%)	Commute by Bicycle (%)	Work from Home (%)	Traffic Fatalities (per capita)
New York	9490268	55.2	0.7	0.1	2.57
Los Angeles	6525348	84	0.7	0.2	6.71
Chicago	4730881	76.8	0.6	0.2	5.23
Washington D.C.	3374979	74.7	0.8	0.2	3.26
Houston	3371952	90.1	0.2	0.3	11.03
Miami	3036115	86.1	0.5	0.3	12.39
Philadelphia	3013833	79.4	0.6	0.2	5.68
Atlanta	2978627	85.2	0.2	0.4	16.97
Boston	2649813	72.9	1.1	0.3	2.89
San Francisco	2438609	65.1	1.8	0.3	4.42
Phoenix	2341707	86.1	0.7	0.4	12.2
Seattle	2100080	76.7	1.1	0.3	3.18
Detroit	2043078	91.5	0.2	0.2	17.16
Riverside	2000758	90	0.2	0.4	10.26
Minneapolis	1963547	85	0.8	0.3	2.79
San Diego	1671791	84.3	0.6	0.4	6.18
Denver	1620439	82.2	0.9	0.4	8.39
Tampa	1488779	86.2	0.5	0.4	15.76
Baltimore	1412890	84.6	0.3	0.3	7.41
St. Louis	1394219	90.3	0.2	0.3	19.96
Charlotte	1329275	87.5	0.1	0.4	8.24
Orlando	1290880	88.2	0.4	0.5	13.22
Portland	1270095	78.4	1.9	0.4	7.48
San Antonio	1216469	89.8	0.2	0.4	9.76
Austin	1204161	83.7	0.6	0.6	9.3
Pittsburgh	1142265	83.3	0.3	0.3	7.99
Sacramento	1108303	85.7	1.4	0.5	9.73
Cincinnati	1107809	90.1	0.1	0.4	6.91
Kansas City	1098306	90.8	0.2	0.4	15.95
Columbus	1085889	0.8	0.3	0.4	8.24

Annual precipitation and average temperature variables are included to control for the effects of climate on bicycle commuting in each city. Share of workers using automobiles and share of workers who work from home are included to control for the variability of worker behavior. See Table 2 Summary of Variables below.

Table 2 Summary of Variables

Variable	Mean	Std. dev.	Min	Max
Workers 16 and Older	2383372	1811276	1085889	9490268
Auto Commuters	1857204	1207770	81.6	5481292
Auto Commuters (%)	80.15667	16.99137	0.8	91.5
Bicycle Commuters	15155.48	15506.16	1107.809	66431.88
Bicycle Commuters (%)	0.6066667	0.4704608	0.1	1.9
Work from home	83868.61	18623.2	55884.18	133360
Work from home (%)	6.603333	1.466284	4.4	10.5
Population by U.S. City	1211522	1577098	287442	8336817
Traffic Fatalities Per 150k	9.042	4.719176	2.57	19.96
Avg Annual Precipitation (in)	36.87333	14.77572	7.2	67.4
Avg Annual Temperature (F)	60.65	8.61149	46.5	77.5
Hours Lost in Congestion	38.13333	26.10685	17	104

3. EMPIRICAL STRATEGY AND ESTIMATION APPROACH

There are two central issues in estimating the relationship between bicycle commuting, transportation efficiency, and transportation safety. First, the effects of exogenous factors such as climate, including precipitation patterns and average temperature, should be considered as this may introduce interactions that weaken the accuracy of our model. Second, socioeconomic, and demographic factors should be considered to control for any variability in our model that may affect the relationship. While variables such as age, income, education status, should be analyzed to provide a more robust regression model, for the purposes of this project, the analysis was limited to the six independent variables in the table above.

Our hypothesis can be tested through interaction terms between the rate of traffic fatalities per capita, the percentage of workers who commute by bicycle, and the hours lost due to traffic congestion in each U.S. city. Table 3 represents a multivariate regression model that is developed to estimate the relationship between the proportion of total traffic fatalities per capita, the proportion of workers who commute by bicycle, and hours lost to traffic congestion in each city.

Table 3

Dependent Variable	Obs	Parms	RMSE	R-sq	F
Traffic Fatalities Per Capita	30	7	3.942732	0.4464	3.091106

Traffic Fatalities Per Capita	Coefficient	Std. err.	t	P>t	[95% conf. interval]	
Bicycle Commuters (%)	-4.0365	1.8013	-2.24	0.035	-7.7629	-0.3102

Auto Commuters (%)	0.0484	0.0460	1.05	0.304	-0.0468	0.1436
WFH (%)	0.3491	0.5969	0.58	0.564	-0.8855	1.5839
Avg Annual Precip (in)	0.0496	0.0542	0.92	0.369	-0.0625	0.1618
Avg Annual Temp (F)	0.1081	0.0962	1.12	0.273	-0.0909	0.3073
Hours Lost Traffic Congestion	-0.0511	0.0303	-1.69	0.105	-0.1138	0.0115
_cons	-1.1371	6.7846	-0.17	0.868	-15.1722	12.8979

Analyzing the multivariate regression above, two associations appear interesting. The association between Bicycle Commuters and Traffic Fatalities is statistically significantly with a P-value of 0.035. The association between Hours Lost to Traffic Congestion and Traffic Fatalities falls just short of achieving statistical significance with a P-value of 0.105. Table 4 represents a second regression to measure the fit of these two models.

Table 4

Dependent Variable	Obs	Parms	RMSE	R-sq	F
Traffic Fatalities Per Capita	30	3	4.039219	0.3179	6.292725

Traffic Fatalities Per Capita	Coefficient	Std. err.	t	P>t	[95% conf. interval]	
Bicycle Commuters (%)	-4.7343	1.5945	-2.97	0.006	-8.0058	-1.4627
Hours Lost Traffic Congestion	-0.0546	0.0287	-1.9	0.068	-0.1136	0.0043
_cons	13.9976	1.6284	8.6	0	10.6564	17.3388

4. RESULTS AND CONCLUSIONS

The output from the two regression models above suggests strong correlation between bicycle commuters as a share of the worker population and traffic fatalities per capita. At the $P \leq 0.05$ level, we achieve statistical significance and can reject the null hypothesis that there is no association between bicycle commuting as a mode of transportation and traffic fatalities. A negative effect of -4.734 is realized between the proportion of bicycle commuters and rate of traffic fatalities in the 30 cities analyzed. This suggests that for every 1 percent increase in bicycle commuters, there is a decrease of -4.7 traffic fatalities per capita across the 30 U.S. cities analyzed.

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