VI. The Investigation of the Determinants of Bicycling in Colorado

Using the data described earlier in this report, statistical analyses are performed to identify the factors that influence the propensity to use bicycles for work, school and utility trips. The statistical framework can be summarized as follows.

The decision to bicycle (to work, to school, or for utility trips) is a binary one. That is, individuals decide on whether or not to bicycle for a particular purpose, and as a result, two outcomes of this decision are observed. B = 1 if the person bicycles, and B = 0 if he/she does not. A number of explanatory variables, such as age, race, gender, education and work history can impact the observed binary decision. These variables are potentially important determinants of the bicycling decision as they capture the tastes of the individual as well as individual-specific circumstances that may influence the bicycling decision. In addition, the environment in which the transportation decision is made is important. The condition of the roads, the availability of bicycle storage facilities, and traffic safety concerns are examples of variables that are characteristics of the bicycling environment. Within this framework, the decision to bicycle can be described as follows.

(1) $I_i = X_i \forall + Y_i \exists + ,_{1i}$,

where I_i stands for the latent variable, which captures the propensity to bicycle for the *i*th individual. X_i represents individual characteristics (such as age, education, gender), Y_i stands for bicycling conditions which can be altered. Examples include the availability of off-street bike paths, the availability of shoulders and the presence of route hazards, such as gravel and potholes. " and $ are the coefficients, and $,_{1i}$ is a white noise error term that captures unobservable individual-specific factors that have an impact on the propensity to bicycle.

Without loss of generality, a dichotomous variable B_i is defined as $B_i = 1$ (the person is bicycling) if $I_i > 0$.

This indicates that the probability of bicycling, $\text{Prob}(B_i = 1)$, can be written as

(2) $\text{Prob}(B_i = 1) = M(Z_i\,()$,

where M stands for standard normal distribution, Z is the vector of variables, including X and Y, and (is the vector of coefficients.

The details of these binary choice models can be found in Greene (1997)[1], and Maddala

[1] Greene, William H., 1997, Econometric Analysis, New Jersey: Prentice Hall.

(1983)[2]. Examples of recent applications include Mocan and Rees (1999)[3]; Mocan, Tekin and Zax (2000)[4]; Manning, Blumberg and Moulton (1995)[5].

For individuals who bicycle (those with $B_i = 1$), the frequency of bicycling, F, can be explained by a set of explanatory variables K, such as

(3) $F_i = K*+,_{2i}$.

Workers

The analysis of the determinants of using a bicycle for commuting to work is conducted based on the data presented in Appendix I using a sample of individuals who work outside their homes (workers). A dichotomous dependent variable is created which takes the value of one if the worker uses a bicycle as a primary or secondary means of transportation to work, and zero otherwise.

Using Equation (2) described above, a probit model is estimated, where the probability of using a bicycle for a work commute is explained by the age, gender, race, marital status, education, occupation, salary of the individual, as well as the household income. Household income is measured by a set of four dichotomous variables. HHINC1 is equal to 1 if the household income is less than or equal to $20,000, and zero otherwise. HHINC2 is a dichotomous variable, equal to 1 if household income is between $20,001 and $40,000; and zero otherwise. HHINC3 is equal to 1 if household income is between $40,001 and $60,000, and zero otherwise. Similarly, HHINC4 takes the value one if the household income is between $60,001 and $100,000; and zero otherwise. Inclusion of these four household income variables in the regression models indicates that the left-out category is the one where household income is greater than $100,000.

An important set of explanatory variables is the one which pertains to the bicycling environment, depicted by Y in Equation (1) above. The respondents to this survey were asked to evaluate various variables in this group on a scale from zero to three to measure the degree to which these variables create obstacles for bicycling. In this group are PUBLIC TRANSP, which stands for inability to take

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[2] Maddala, G. S., 1983, Limited Dependent and Qualitative Variables in Econometrics, New York: Cambridge University Press.

[3] Mocan, H. Naci, and Daniel I. Rees, 1999, "Economic Conditions, Deterrence and Juvenile Crime: Evidence from Micro Data," NBER Working Paper 7405.

[4] Mocan, H. Naci, Erdal Tekin, and Jeffrey S. Zax, 2000, "The Demand for Medical Care in Urban China," NBER Working Paper 7673.

[5] Manning, Willard G., Linda Blumberg, and Lawrence H. Moulton, 1995, "The Demand for Alcohol: The Differential Response to Price," Journal of Health Economics, 14: 123-148.

the bicycle on public transportation, BIKE STORAGE, which stands for lack of secure bike storage at the destination, SHOWER , which stands for lack of shower or dressing facilities at the destination, ROAD HAZARD, which stands for hazardous road conditions, such as gravel and potholes; TRAFFIC SAFETY, which stands for traffic safety concerns; CRIME, which stands for lack of personal security (crime); BIKE PATHS, which stands for off-street bike paths; SHOULDERS, which is lack of shoulders to ride on; TRANSIT, which stands for lack of transit connections; CONGESTED ROUTE, which stands for having no alternative to congested routes. The range of these variables is 0 to 3; 0 indicating not a factor, 1 stands for minor factor, 2 is major factor, and 3 prevents the individual from bicycling.

Table VI.1 presents the descriptive statistics of the sample of workers used in the analysis. We identified the individuals who have a high distaste for bicycling, and dropped them from the estimating sample. Question 23 of the survey asks for various factors that may impact the propensity to bicycle to work. If a respondent to the survey indicated that none of these items was a factor in his/her decision to bicycle, and if he/she did not bicycle, this suggests a distaste for bicycling (a high negative value for , in Equation 1). Thus, individuals who indicated that none of the listed items in Question 23 was a factor in their bicycling decision and who nevertheless did not bicycle, were not used in estimation. The proportion of this group, however, is helpful information in making the simulations described below.

The results of the probit model of bicycling to work are reported in Table VI.2. The coefficients reported are the marginal effects; that is they demonstrate the impact on the probability of bicycling to work of a one unit change in the corresponding variable. The estimated standard errors are also reported. Marginal effects which are statistically significantly different from zero at the 5 percent level or less are denoted by a star.

All else the same females are almost seven percent less likely to bicycle to work than males. Married and divorced or widowed individuals are seven and eight percent less likely, respectively, to bicycle to work in comparison to singles.

Individuals are categorized into the following racial and ethnic groups: Hispanic, Black-non-Hispanic, Native American, Asian and White. Because there were no Asians, or black-non-Hispanics in the sample who bicycled to work, they could not be included in the analysis. Thus, we included three race categories: HISPANIC, NATIVE AMERICAN, and OTHERRACE. The omitted category is White, Asian, and Black-non-Hispanic. According to the results of Table VI.2, there is no statistically significant difference between Hispanic, Native Americans and Whites (as well as Asians and Blacks). However, individuals who identified themselves as belonging to some “other race” are 24 percent more likely to bicycle to work.

Individuals who have an associate degree are eight percent less likely to bicycle to work in comparison to those who are high school graduates (the left-out category). Individuals with a Ph.D. are 18 percent more likely to commute to work on their bicycles.

Occupation and industry affiliation have no impact on the propensity to bicycle to work. On the other hand, household income is a significant determinant. For example, the coefficient of HHINC1 is 0.18, and it is statistically significantly different from zero. This indicates that individuals from households with household incomes of less than or equal to $20,000 are18 percent more likely to bicycle to work in comparison to persons with the same characteristics, but household income in excess of $100,000. This may reflect the cost savings of bicycling. Similar results are obtained for other household income categories (see Table VI.2).

The bottom of Table VI.2 contains the variables that represent bicycling environment, which can be altered by policy. Three variables in this group are statistically significant. They are SHOWER, TRAFFIC SAFETY and BIKE PATHS. For example, the coefficient of BIKE PATHS indicates that if the rating of satisfaction with shower and dressing facilities at work improves by one point (e.g., if it goes down from being from minor factor to not a factor), this would increase the probability of bicycling to work by 5 percentage points.

The results reported in Table VI.2 are based on a sample of workers, some of whom are students. To investigate the behavior of the non-student workers, individuals who identified themselves as working students are dropped from the sample, and the model is re-estimated. The results are reported in Table VI.3 are virtually the same as the one reported in Table VI.2

Using the estimated parameters of Table VI.3 simulations can be performed to determine the increase in the number of individuals who bicycle to work as a reaction to an improvement in the bicycling environment. The 1998 population estimates from the State Demographer’s Office indicates that there are 2.26 million workers in Colorado between the ages 16 and 55. Using the information obtained from our survey, 9.08 percent of these individuals attend school, implying that there are approximately 2,053,000 non-student workers between the ages of 16 and 55. In our data set, it was found that 58% of the individuals in this group have a dislike for bicycling. Thus, the remaining 42 percent (862,000 individuals) constitute the group which is prone to bicycling. Eighteen percent of this group bicycles to work, indicating that 155,000 non-student workers bicycle to work in Colorado.

The average value of the TRAFFIC SAFETY question for non-student workers is 1.52, where 1 stands for traffic safety being a minor factor, and 2 indicates that traffic safety is a major factor. Thus, a policy that would reduce the average rating of traffic safety to a minor factor (a 0.52

point decline from 1.52 to 1.00) increases the propensity to bicycle to work by 2.2 percentage points. This increases the number of people who bicycle to work by 18,800.

BIKE PATHS is another statistically significant factor that determines the propensity to bicycle to work. The mean value of this particular question is 1.30. Thus, an improvement in the availability of bike paths to the extent that on average its rating goes down to a being a minor factor translates into a 0.30 point decline. Using the estimated parameter of BIKE PATHS in Table VI.3, this improvement generates a 1.4 percentage point increase in the probability of bicycling to work, which translates into an increase of 12,000 workers who bicycle to work.

The coefficient of SHOWER is statistically significant in the regression. However, the mean value of the rating of this variable is 1.01 indicating that on average people rate this aspect of the bicycling environment as a minor factor.

Our data indicate that given that the individual decides to bicycle to work the probability of doing so for less than once a month is 41 percent. The probability of bicycling to work once a month is 7.8 percent. The probabilities for bicycling to work 2-3 times a month, once per week and more than once per week are 13.9, 10.9, and 26.4 percent, respectively.

The average distance traveled in a month can be found by multiplying the distance between home and work and the frequency of the bicycle trips in a month. If the individual bicycles to work less than once a month, he/she is assumed to travel 0.5 times a month. If he/she travels more than once per week, it is assumed that he/she bicycles twice a week (8 times per month). Using this algorithm, we found that the average distance bicycled between work and home is 8 miles for those who bike to work for less than once per month, 12 miles for those who bicycle once per month, 36 miles for those who bicycle 2-3 times per month, 44 miles for those who bicycle once per week, and 84 miles per month for those who bicycle more than once per week.

Using the frequency distribution of the bicycle trips to work, and assuming that that distribution will be relevant for those who start bicycling following a change in bicycling environment the following inference can be made. Of the 19,000 people who will start bicycling to work following an improvement in traffic safety concerns (enough to reduce the average rating to 1), 41 percent (7,800 individuals) will bicycle less than once per month, 1,482 (7.8 percent) will bicycle once a month, 2,641 will bicycle 2-3 times per month, 2,062 will bicycle once per week, and 5,024 will bicycle more than once per week. Using the twice the one-way travel miles between home and work reported above, this indicates that 680,000 miles will be bicycled by the new participants per month.

The frequency distribution of bicycling to work and the associated work-home distance indicates that 12,000 individuals who would bicycle to work if the availability of bike paths improved to such a level that it became a "minor factor," this would have generated 434,000 additional miles traveled by workers each month.

For those individuals who already bicycle to work, the determinants of the frequency of bicycling can be investigated using the model depicted by Equation (3). For this analysis, the frequency of the trips in the sample of workers who bicycle to work is analyzed using question 24 of the survey (see Appendix II for the survey instrument). The responses are categorized as: less than once per month, once per month, 2-3 times per month, once a week, and more than once per week. An ordered-probit model is estimated which examines the probabilities of moving to different frequency categories as a function of personal characteristics and the degree of satisfaction with various bicycling environment conditions as revealed by bicyclists. These variables are captured by question 88 of the survey. For consistency between work, school and utility trips, the mean value of the satisfaction with bicycle parking at work, school and other places (PARKING) is used in the regressions. The scale of these variables is from 1 to 5, a five indicating being very satisfied. The vector of explanatory variables Z and K in equations (2) and (3) are not identical, which facilitates identification of the parameters.[6]

The policy variables included as explanatory variables, in addition to satisfaction with parking, are the degree of satisfaction with the following aspects of the bicycling environment: courtesy of the motorists; courtesy of other cyclists; courtesy of runners, walkers and skaters; crossing at road intersections; debris on roads and paths; speed bumps and drainage grates on roads; road surface conditions; bike path surface conditions; road shoulder surface conditions; road shoulder widths; and signs and travel markers. The results, which are presented in Table VI.4, demonstrate that the satisfaction with parking conditions is the only policy variable that significantly influences the frequency of bicycling to work. The average value of satisfaction with bicycle parking is 3.08 on a scale from 1 to 5, where 5 stands for very satisfied. The calculation of the probabilities of each bicycling frequency reveals that a one unit increase in the parking satisfaction (from 3.08 to 4.08) reduces the probability of bicycling to work less than once per month by 7 percent. It reduces the probability of making the work trip by a bicycle once a month by 0.3 percent. The probability of bicycling to work 2-3 times a month increases by 0.5 percent; the probability of bicycling to work

[6] For a non-technical discussion of identification see: Corman, Hope, and H. Naci Mocan, 1998, "An Economic Analysis of Drug Use and Crime," Journal of Drug Issues, 28(3): 613-629.

once a week increases 1.4 percent, and the probability of bicycling more than once a week increases by 5.3 percent.

Using this information, and noting that the number of workers who bicycle to work is 155,000, it is straightforward to calculate that a one unit improvement in the average parking satisfaction (from the current average of 3.08 to 4.00) generates an additional 663,000 miles bicycled for work travel.

Students

The analysis of the probability of bicycling to school is presented in Table VI.5. It should be noted that this analysis includes all students, regardless of their work status. The data set does not contain a large enough number of students to perform the analysis separately for working students and non-working students. Along the same lines, the analysis of the determinants of the frequency of school trips cannot be done for students because of the small sample size regarding students who bicycle to school.

According to the data obtained from the Colorado Department of Education and from the Colorado Commission on Higher Education, there are 350,000 students who are 16 years of age and older in Colorado. Using the information obtained from our data, 70 percent of the student sample is not prone to bicycling. Of the remaining 30 percent, 39.6 percent use bicycles as a primary or secondary mean of transportation to school, implying that there are 41,500 students who bicycle to school at some frequency. This figure is consistent with the raw 12 percent we reported in Section 1B. That is, 12 percent of 350,000 students generates 42,000 students who bicycle.

Table VI.5 shows that the only variable that is significant is TRAFFIC SAFETY. The mean value of this variable is 1.22, which indicates that to reduce the traffic issues to a "minor concern" would involve a reduction of 0.22 units. Using the estimated coefficient of TRAFFIC SAFETY, this implies a 7.4 percentage point increase in the probability of bicycling to school, which translates into 7,700 additional students.

The analysis of the frequency of student travel reveals that 24.2 percent of the students bicycle to school for less than once a month; 8.1 percent do so once a month; 9.7 percent bicycle 2-3 times a month; 4.2 percent bicycle once a week; and 50 percent bicycle to school more than once a week. Converting the "less than once per month" to 0.5 trips per month, and "more than one trip per week" to two trips a week, and using the reported home-school distances, it is found that those who bicycle to school less than once a month have an average trip length of 4 miles per month. Those who bicycle once a month travel an average of 10 miles between home and school. Students who bicycle to school 2-3 times per month, travel an average of 46 miles per month; and students who travel once per week, travel 72 miles per month. Those who use their bicycles for school travel for more than once per week travel an average of 46 miles per month between home and school. This implies that an additional 7,700 students would travel if average traffic safety concerns were to go down to a “minor concern,” and this would generate an additional 270,000 miles per month traveled by these students.

Utility Trips

Of the 2.4 million people who are ages 16 to 55 in Colorado, 63.3 percent have no propensity to use a bicycle for utility trips. Of the remaining 36.7 percent, 27.4 percent use a bicycle a primary or secondary method for utility trips, implying 241,000 individuals bicycle for utility trips. As Table VI.6 demonstrates, road hazards and the availability of bike paths are two statistically significant determinants of bicycling for utility trips. The mean value of route hazards is 0.93, indicating that on average, individuals think road hazards as a minor factor that impact bicycling for utility trips. On the other hand, the mean value of the rating for lack of off-street bike paths is 1.11. Thus improving the availability of off-street bike paths such that it becomes a minor concern (a reduction of 0.11) would generate a 0.8 percentage point increase in the number of utility bicyclists, which implies an additional 7,170 individuals.

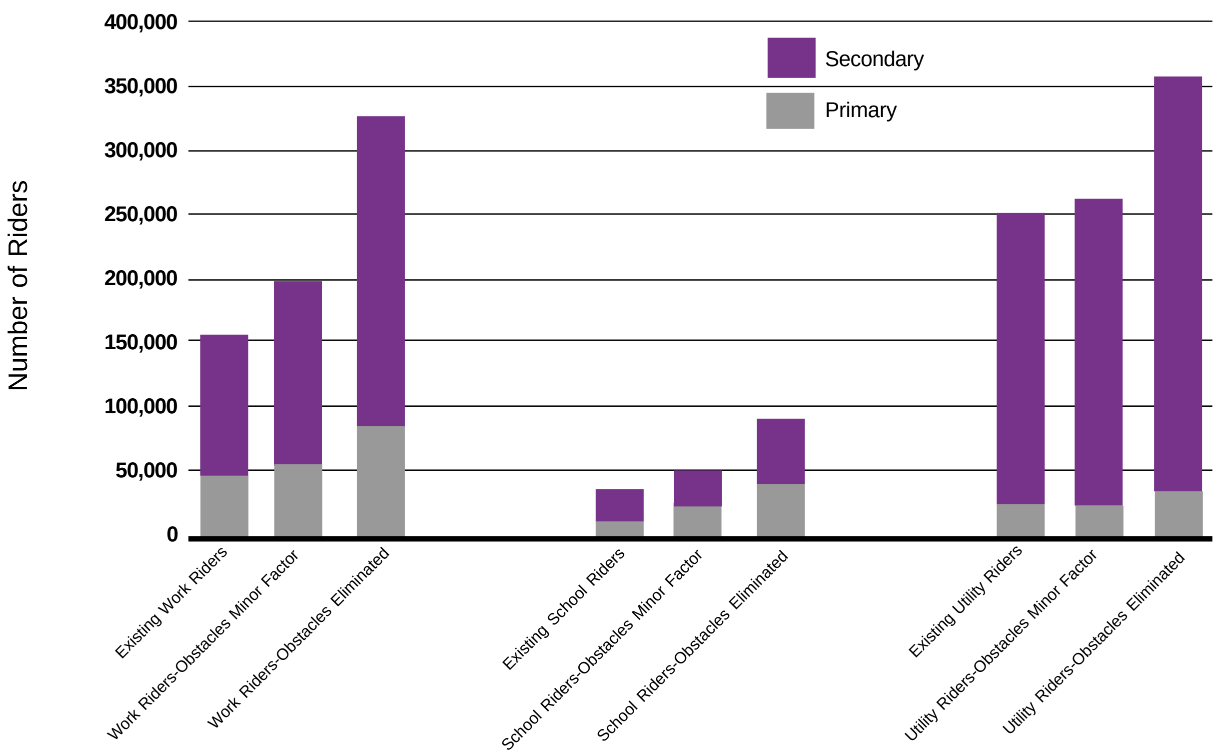
Our data reveal that of the individuals who bicycle for utility trips 39.6 percent do so less than once a month, 15.5 percent do so once a month. 19.2 percent use a bicycle for a utility trip 2-3 times a month, 13.9 percent does so once per week, and 11.8 percent does so more than once a month. The average monthly miles for those use bicycle less than once per month for a utility trip is 6. It is 10 for those who bicycle once a month, 26 for those who do so 2-3 times a month, 28 for those who bicycle once a week, and 68 for those who bicycle more than once a week. Using the same algorithm as described above, this implies that an additional 159,000 miles would be bicycled per month for utility trips following the improvement in off-street bike paths as described above.

The ordered probit model presented in Table VI.7 indicates that for those who are bicycling for utility trips, satisfaction with the courtesy of the cyclists, bike path surface conditions and signs and travel markers are statistically significant determinants. The average rating of the satisfaction with the courtesy of other cyclists is 3.5 (out of 5), the rating of bike path surface conditions is 3.6, and the average rating of the satisfaction with signs and travel markers is 3.1. A one unit increase in the average satisfaction with the courtesy of other bicyclists would decrease the probability of bicycling less than once a month by 13.8 percent, and the probability of bicycling once a month by

0.6 percent. It would increase the probability of bicycling 2-3 times a month by 4.7 percent, the probability of bicycling once a week by 4.1 percent, and the probability of bicycling more than once a week by 5.6 percent. The corresponding probabilities are –11 percent, -0.5 percent, 4 percent, 3.3 percent, and 4.4 percent, respectively, for bike path surface conditions, and –17 percent, -0.8 percent, 5.9 percent, 5 percent and 6.9 percent for signs and travel markers (see Table VI.7). This indicates that if the satisfaction level with cyclist courtesy would go up to 4.0 (from the current average of 3.5), this would generate an additional 684,000 bicycle miles per month for utility trips. Similarly, an improvement in bike surface conditions so that the average rating of the bicyclists would go up to 4.0 would generate an additional 435,000 bicycle miles per month for utility trips. An increase to 4.0 in the satisfaction with signs and markers would increase utility bicycle miles by 1,520,000 per month.

The information regarding the increase in the number of bicyclists and the miles bicycled for different trips are summarized in Figures VI.1 to VI.4. Figure VI.1 displays the number of individuals who currently bicycle to work, to school and for utility trips (existing riders). The figure also displays

Figure VI.1 Number of New Riders



the number of bicyclists one would observe if the factors that matter in bicycling decisions were reduced to being a "minor factor" in each commute category (work, school and utility trips). These include traffic safety concerns, the availability of bike paths and shower facilities for work trips; traffic safety concerns for school trips; and road hazards and bike paths for utility trips. Also presented is the number of individuals who would bicycle for work, school and utility trips when the obstacles mentioned above were eliminated entirely. This corresponds to a reduction in the average obstacle rating to zero, or obstacles being "not a factor." This represents a scenario which produces the upper-bound of the number of riders. The figure also displays the number of individuals who use bicycles as their primary and secondary means of transportation within each category. For example, in Figure VI.1, the number of existing riders is 155,000 for work trips, and around 28 percent do so as their primary means of transportation to work. A decrease in the obstacles such that they constitute only a "minor concern" would increase the number of individuals who bicycle to work by 36,000 to 191,000.

Figures VI.2 and VI.3 display the miles bicycled per month for different trips. In addition, they present the number of miles bicycled per month if the satisfaction of the current riders increased to 4.0 on a scale from 0 to 5 for various conditions. More specifically, availability of parking is the only factor that impacts the frequency of bicycling for individuals who currently bicycle to work. Thus, the middle bar in the "work" category demonstrates the number of bicycle miles per month that would result in reaction to an increase in satisfaction with parking to 4.0 from the current average of 3.08. The third bar under work travel demonstrates the monthly number of miles traveled due to an increase in travel frequency of the existing riders plus the number of new riders who decide to bicycle due to an improvement in various obstacles. These obstacles are denoted in the legend of the figure.

Figure VI.2 Monthly Miles Commuted by Current and New Bicyclists Due to Factors Becoming “Minor Factors” and Satisfaction Raised to 4 on Five Point Scale

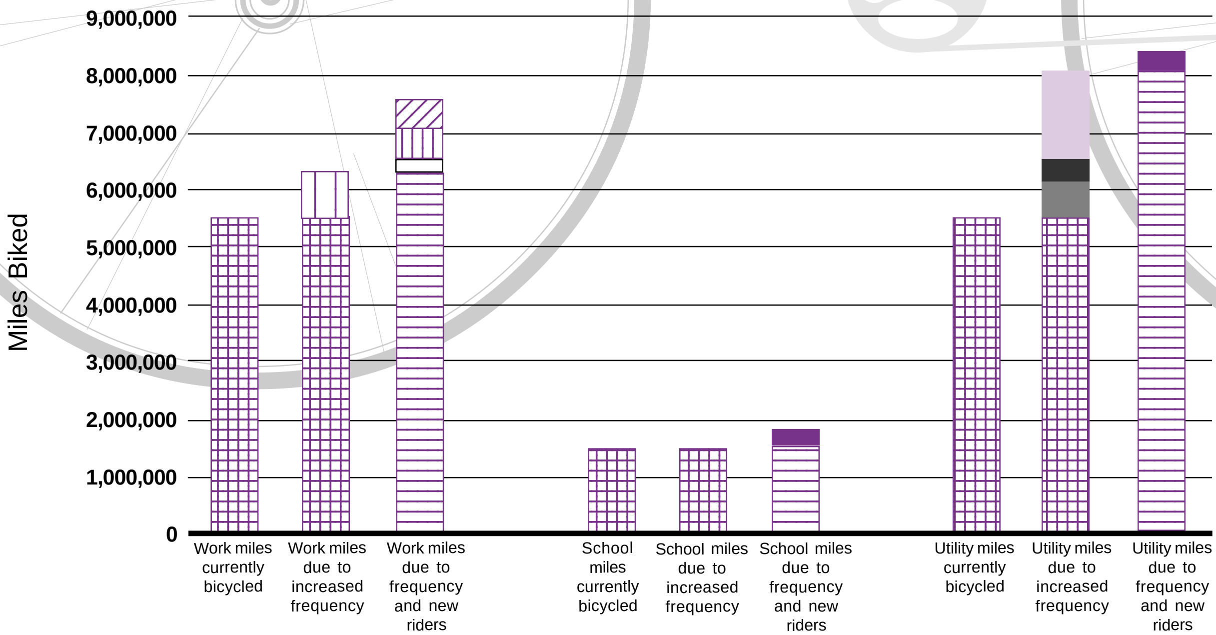
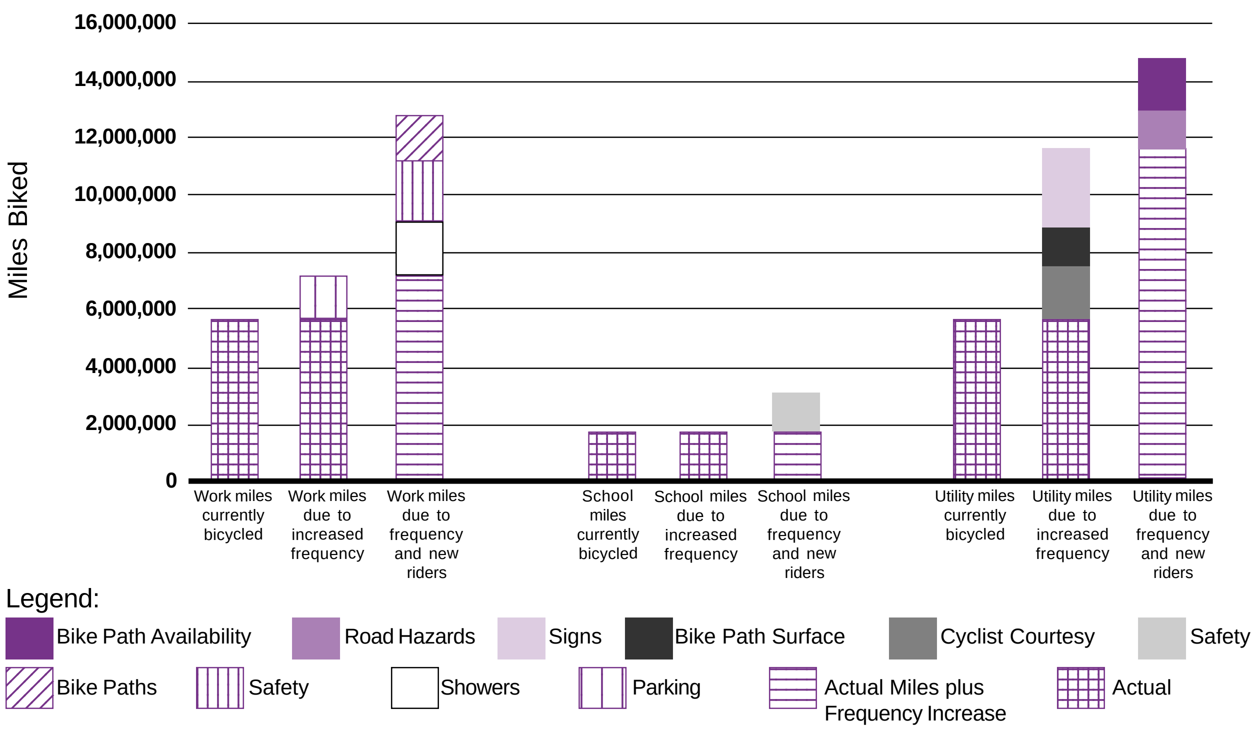


Figure VI.3 Monthly Miles Commuted by Current and New Bicyclists Due to Factors Becoming “Not a Factor” and Satisfaction Raised to 4 on Five Point Scale



It should be noted that the analysis of the determinants of the frequency of school rides could not be performed because of the small sample size of the students who bicycle. Therefore, the middle and left-hand bars in the school category are the same height.

Figure VI.3 is similar to Figure VI.2, with the exception that it represents the upper-bound scenario in which the obstacles are eliminated entirely. Finally, Figure VI.4 displays the total number of miles bicycled per month for work, school and utility trips. Along with the actual miles bicycled currently (the bar on the left), the number of miles that would be observed if the obstacles were reduced to a "minor concern" and if satisfaction with various bicycling conditions were increased to 4.0 are presented by the middle bar. Finally, the bar on the right represents the number of miles that would be traveled per month under the scenario of the elimination of all obstacles that matter, and the increase in the satisfaction to the maximum (to 5.0). Specifically, if all obstacles to bicycling were eliminated, as shown in the third bar, the maximum number of miles bicycled monthly for all types of trip would be 30.5 million miles.

Figure VI.4 Total Monthly Miles Bicycled Under Various Conditions

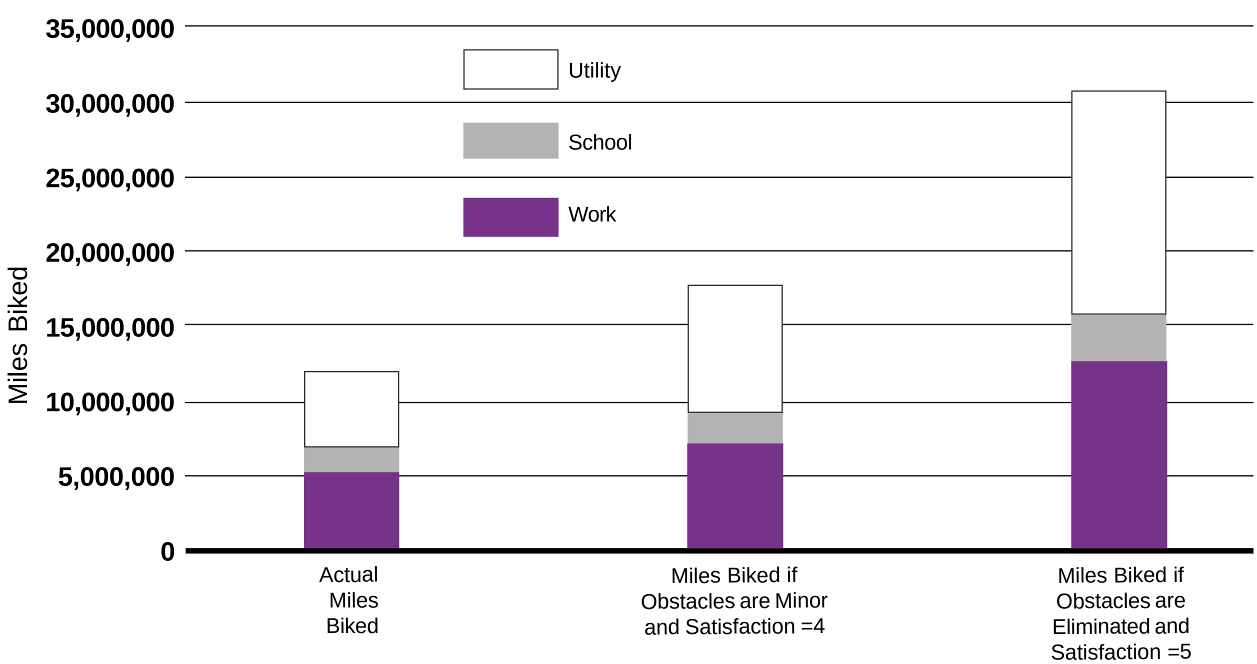


Table VI.1 Summary Statistics

Variable	N	Mean	Std. Error
PRIMARY BIKE	986	0.035497	0.185126
SECONDARY BIKE	978	0.156442	0.36346
BIKE AT ALL	988	0.189271	0.391922
HOW OFTEN BIKE	966	0.856108	1.589147
BIKE	966	0.303313	0.459927
BIKE IN COLO	981	0.902141	0.297276
AGE	988	34.75405	6.92449
FEMALE	985	0.484264	0.500006
MARRIED	988	0.614373	0.48699
DIVORCED/WIDOWED	988	0.069838	0.255003
HISPANIC	988	0.040486	0.197196
BLACK	988	0.010122	0.100146
ASIAN	988	0.010122	0.100146
NATIVE AMERICAN	988	0.009109	0.095055
OTHER RACE	988	0.018219	0.133809
NONSMOKER	985	0.91066	0.285379
NO HIGH SCHOOL	988	0.016194	0.126286
ASSOCIATES DEGREE	988	0.12753	0.333735
BACHELORS DEGREE	988	0.3917	0.488378
MASTERS DEGREE	988	0.198381	0.398982
PHD	988	0.064777	0.246257
MINING	988	0.004049	0.063532
CONSTRUCTION	988	0.051619	0.22137
MANUFACTURING	988	0.075911	0.26499
TRANSPORTATION	988	0.086032	0.280554
WHOLESALE	988	0.022267	0.147626
RETAIL	988	0.07085	0.256704
FINANCE	988	0.088057	0.283521
SERVICE IND	988	0.470648	0.499391
PUBLIC ADMINISTRATION	988	0.015182	0.122339
GOVERNMENT	988	0.08502	0.279053

Table VI.1 Summary Statistics (continued)

Variable	N	Mean	Std. Error
PROFESSIONAL	988	0.408907	0.491881
TECHNICAL	988	0.089069	0.284987
SALES	988	0.062753	0.242641
ADMINISTRATION	988	0.060729	0.238953
PROTECTIVE SERVICES	988	0.011134	0.10498
SERVICE	988	0.061741	0.240806
MECHANICAL	988	0.012146	0.109592
OTHER OCCUPATION	988	0.112348	0.315954
SALARY	901	37630.14	37036.96
HHINC	927	5.239482	2.191392
PUBLIC TRANSP	988	0.212551	0.610084
BIKE STORAGE	988	0.473684	0.811715
SHOWER	988	1.011134	1.105791
ROAD HAZARD	988	1.038462	1.078734
TRAFFIC SAFETY	988	1.465587	1.045001
CRIME	988	0.45749	0.77526
BIKE PATHS	987	1.29382	1.084088
SHOULDERS	988	1.304656	1.075328
TRANSIT	988	0.336032	0.760231
CONGESTED ROUTE	988	0.800607	1.070806
HHINC1	988	0.048583	0.215104
HHINC2	988	0.176113	0.38111
HHINC3	988	0.244939	0.430269
HHINC4	988	0.308705	0.462193

Table VI.2 Decision to Bicycle for All Workers

Variable	Marginal Effects	Std. Error
AGE	0.016	(0.016)
AGESQ	0	(0)
FEMALE	-0.067**	(0.024)
MARRIED	-0.066*	(0.028)
DIVORCED/WIDOWED	-0.08*	(0.026)
HISPANIC	-0.055	(0.041)
NATIVE AMERICAN	0.192	(0.177)
OTHER RACE	0.24*	(0.131)
NONSMOKER	0.007	(0.042)
NO HIGH SCHOOL	-0.02	(0.093)
ASSOCIATES DEGREE	-0.077*	(0.027)
BACHELORS DEGREE	-0.021	(0.031)
MASTERS DEGREE	-0.014	(0.036)
PHD	0.18**	(0.084)
CONSTRUCTION	0.054	(0.095)
MANUFACTURING	0.062	(0.089)
TRANSPORTATION	-0.069	(0.046)
WHOLESALE	0.02	(0.106)
RETAIL	0.015	(0.078)
FINANCE	-0.033	(0.059)
SERVICE IND	-0.021	(0.061)
PUBLIC ADMINISTRATION	0.01	(0.115)
GOVERNMENT	-0.028	(0.061)
PROFESSIONAL	0.041	(0.034)
TECHNICAL	-0.02	(0.042)
SALES	0.023	(0.058)
ADMINISTRATION	0.004	(0.058)
PROTECTIVE SERVICES	-0.049	(0.069)
SERVICE	0.043	(0.062)
OTHER OCCUPATION	-0.03	(0.04)
HHINC1	0.184*	(0.1)

Table VI.2 Decision to Bicycle for All Workers (continued)

Variable	Marginal Effects	Std. Error
HHINC2	0.133**	(0.055)
HHINC3	0.088*	(0.043)
HHINC4	0.114**	(0.039)
PUBLIC TRANSP	0.001	(0.024)
BIKE STORAGE	-0.003	(0.017)
SHOWER	-0.072**	(0.012)
ROAD HAZARD	-0.012	(0.014)
TRAFFIC SAFETY	-0.049**	(0.015)
CRIME	0.001	(0.021)
BIKE PATHS	-0.048**	(0.015)
SHOULDERS	-0.009	(0.016)
TRANSIT	-0.043	(0.025)
CONGESTED ROUTE	-0.005	(0.015)
N = 948		
Log Likelihood = -355.15393		

* indicates statistical significance at the 5% level

**indicates statistical significance at the 1% level or better

Table VI.3 Decision to Bicycle for Non-Student Workers

Variable	Marginal Effects	Std. Error
AGE	0.027	(0.023)
AGESQ	0	(0)
FEMALE	-0.082**	(0.025)
MARRIED	-0.056*	(0.03)
DIVORCED/WIDOWED	-0.089*	(0.025)
HISPANIC	-0.029	(0.053)
NATIVE AMERICAN	0.144	(0.2)
OTHER RACE	0.235	(0.163)
NONSMOKER	-0.025	(0.054)
NO HIGH SCHOOL	0.128	(0.228)
ASSOCIATES DEGREE	-0.073*	(0.029)
BACHELORS DEGREE	-0.032	(0.034)
MASTERS DEGREE	-0.024	(0.037)
PHD	0.18*	(0.089)
CONSTRUCTION	0.038	(0.095)
MANUFACTURING	0.063	(0.095)
TRANSPORTATION	-0.069	(0.047)
WHOLESALE	0.031	(0.114)
RETAIL	0.039	(0.096)
FINANCE	-0.022	(0.067)
SERVICE IND	-0.041	(0.065)
PUBLIC ADMINISTRATION	-0.087	(0.052)
GOVERNMENT	-0.019	(0.068)
PROFESSIONAL	0.039	(0.035)
TECHNICAL	-0.01	(0.047)
SALES	0.008	(0.057)
ADMINISTRATION	0.007	(0.064)
PROTECTIVE SERVICES	-0.026	(0.087)
SERVICE	-0.02	(0.054)
OTHER OCCUPATION	-0.008	(0.048)
HHINC1	0.252*	(0.138)

Table VI.3 Decision to Bicycle for Non-Student Workers (continued)

Variable	Marginal Effects	Std. Error
HHINC2	0.137**	(0.062)
HHINC3	0.111**	(0.048)
HHINC4	0.123**	(0.042)
PUBLIC TRANSP	-0.015	(0.025)
BIKE STORAGE	0.01	(0.018)
SHOWER	-0.066**	(0.012)
ROAD HAZARD	-0.015	(0.015)
TRAFFIC SAFETY	-0.042**	(0.016)
CRIME	0.013	(0.023)
BIKE PATHS	-0.046**	(0.016)
SHOULDERS	-0.013	(0.017)
TRANSIT	-0.047	(0.027)
CONGESTED ROUTE	-0.009	(0.016)
N = 816		
Log Likelihood = -300.66578		

* indicates statistical significance at the 5% level

**indicates statistical significance at the 1% level or better

Table VI.4 Decision of Bicycling Frequency for Non-Student Workers

Variable	Coeff.	Std. Error
AGE	-0.396	(0.206)
AGESQ	0.005	(0.003)
FEMALE	-0.151	(0.2)
MARRIED	-0.176	(0.206)
DIVORCED/WIDOWED	0.296	(0.451)
HISPANIC	0.64	(0.586)
BLACK	8.175	(3527252)
NATIVE AMERICAN	0.87	(0.965)
OTHER RACE	-0.131	(0.587)
NONSMOKER	-0.166	(0.451)
NO HIGH SCHOOL	8.301	(3527252)
ASSOCIATES DEGREE	0.577	(0.396)
BACHELORS DEGREE	-0.219	(0.279)
MASTERS DEGREE	-0.224	(0.325)
PHD	-0.177	(0.388)
CONSTRUCTION	-1.162	(0.627)
MANUFACTURING	-0.761	(0.595)
TRANSPORTATION	-0.756	(0.64)
WHOLESALE	-2.331*	(0.99)
RETAIL	0.102	(0.649)
FINANCE	-0.696	(0.614)
SERVICE IND	-0.919	(0.539)
PUBLIC ADMINISTRATION	-0.831	(0.895)
GOVERNMENT	-1.251*	(0.606)
PROFESSIONAL	0.068	(0.263)
TECHNICAL	0.382	(0.386)
SALES	0.201	(0.47)
ADMINISTRATION	-0.693	(0.488)
PROTECTIVE SERVICES	-0.018	(0.771)
SERVICE	0.278	(0.518)
MECHANICAL	-10.687	(2681226)

Table VI.4 Decision of Bicycling Frequency for Non-Student Workers (continued)

Variable	Coeff.	Std. Error
OTHER OCCUPATION	0.501	(0.401)
HHINC1	0.515	(0.518)
HHINC2	0.377	(0.358)
HHINC3	0.579	(0.296)
HHINC4	0.23	(0.244)
PARK	0.179*	(0.083)
MOTORIST COURTESY	-0.202	(0.122)
CYCLIST COURTESY	0.05	(0.116)
PEDESTRIAN COURTESY	-0.06	(0.126)
ROAD CROSSINGS	-0.077	(0.119)
ROAD/PATH DEBRIS	0.044	(0.116)
GRATES/SPEED BUMPS	-0.064	(0.128)
ROAD SURFACE	0.166	(0.135)
BIKE PATH SURFACE	-0.103	(0.114)
SHOULDER SURFACE	0.061	(0.134)
SHOULDER WIDTH	-0.1	(0.132)
SIGNS	-0.029	(0.108)
N = 209		
Log Likelihood = -263.94475		

* indicates statistical significance at the 5% level

**indicates statistical significance at the 1% level or better

Table VI.4b Marginal Effects for Decision of Bicycling Frequency for Non-Student Workers

Variable	Less than once a month	Once per month	2-3 times per month	Once per week	More than once per week
AGE	0.1506	0.0074	-0.0099	-0.0318	-0.1164
AGESQ	-0.002	-0.0001	0.0001	0.0004	0.0016
FEMALE	0.0575	0.0028	-0.0038	-0.0121	-0.0444
MARRIED	0.0671	0.0033	-0.0044	-0.0142	-0.0518
DIVORCED/WIDOWED	-0.1126	-0.0055	0.0074	0.0238	0.087
HISPANIC	-0.2435	-0.012	0.0159	0.0515	0.1881
BLACK	-3.1379	-0.1544	0.2054	0.663	2.4238
NATIVE AMERICAN	-0.3307	-0.0163	0.0217	0.0699	0.2554
OTHER RACE	0.0498	0.0025	-0.0033	-0.0105	-0.0385
NONSMOKER	0.0631	0.0031	-0.0041	-0.0133	-0.0487
NO HIGH SCHOOL	-3.7991	-0.1869	0.2487	0.8027	2.9345
ASSOCIATES DEGREE	-0.2195	-0.0108	0.0144	0.0464	0.1695
BACHELORS DEGREE	0.0835	0.0041	-0.0055	-0.0176	-0.0645
MASTERS DEGREE	0.085	0.0042	-0.0056	-0.018	-0.0657
PHD	0.0674	0.0033	-0.0044	-0.0142	-0.0521
CONSTRUCTION	0.4419	0.0217	-0.0289	-0.0934	-0.3414
MANUFACTURING	0.2892	0.0142	-0.0189	-0.0611	-0.2234
TRANSPORTATION	0.2874	0.0141	-0.0188	-0.0607	-0.222
WHOLESALE	0.8864	0.0436	-0.058	-0.1873	-0.6847
RETAIL	-0.0388	-0.0019	0.0025	0.0082	0.03
FINANCE	0.2646	0.013	-0.0173	-0.0559	-0.2044
SERVICE IND	0.3495	0.0172	-0.0229	-0.0738	-0.27
PUBLIC ADMINISTRATION	0.316	0.0156	-0.0207	-0.0668	-0.2441
GOVERNMENT	0.4758	0.0234	-0.0312	-0.1005	-0.3675
PROFESSIONAL	-0.0259	-0.0013	0.0017	0.0055	0.02
TECHNICAL	-0.1454	-0.0072	0.0095	0.0307	0.1123
SALES	-0.0762	-0.0038	0.005	0.0161	0.0589
ADMINISTRATION	0.2634	0.013	-0.0172	-0.0557	-0.2035
PROTECTIVE SERVICES	0.0069	0.0003	-0.0005	-0.0015	-0.0053

Table VI.4b Marginal Effects for Decision of Bicycling Frequency for Non-Student Workers (continued)

Variable	Less than once a month	Once per month	2-3 times per month	Once per week	More than once per week
SERVICE	-0.1058	-0.0052	0.0069	0.0224	0.0817
MECHANICAL	3.7577	0.1849	-0.246	-0.794	-2.9026
OTHER OCCUPATION	-0.1906	-0.0094	0.0125	0.0403	0.1472
HHINC1	-0.1959	-0.0096	0.0128	0.0414	0.1513
HHINC2	-0.1435	-0.0071	0.0094	0.0303	0.1109
HHINC3	-0.2201	-0.0108	0.0144	0.0465	0.17
HHINC4	-0.0876	-0.0043	0.0057	0.0185	0.0676
PARK	-0.068	-0.0033	0.0045	0.0144	0.0525
MOTORIST COURTESY	0.077	0.0038	-0.005	-0.0163	-0.0594
CYCLIST COURTESY	-0.0192	-0.0009	0.0013	0.0041	0.0148
PEDESTRIAN COURTESY	0.0229	0.0011	-0.0015	-0.0048	-0.0177
ROAD CROSSINGS	0.0294	0.0014	-0.0019	-0.0062	-0.0227
ROAD/PATH DEBRIS	-0.0166	-0.0008	0.0011	0.0035	0.0129
GRATES/SPEED BUMPS	0.0244	0.0012	-0.0016	-0.0052	-0.0188
ROAD SURFACE	-0.063	-0.0031	0.0041	0.0133	0.0486
BIKE PATH SURFACE	0.0392	0.0019	-0.0026	-0.0083	-0.0303
SHOULDER SURFACE	-0.0233	-0.0011	0.0015	0.0049	0.018
SHOULDER WIDTH	0.0381	0.0019	-0.0025	-0.0081	-0.0294
SIGNS	0.0111	0.0005	-0.0007	-0.0023	-0.0086

Table VI.5 Decision to Bicycle for Students

Variable	Marginal Effect	Std. Error
AGE	0.066	(0.099)
AGESQ	-0.001	(0.002)
FEMALE	-0.182	(0.169)
NONSMOKER	-0.393	(0.405)
NO HIGH SCHOOL	0.597	(0.533)
ASSOCIATES DEGREE	0.96*	(0.071)
BACHELORS DEGREE	0.284	(0.283)
MASTERS DEGREE	-0.082	(0.168)
RETAIL	0.981	(0.029)
FINANCE	0.477	(0.714)
SERVICE IND	0.11	(0.25)
PUBLIC ADMINISTRATION	-0.091	(0.184)
GOVERNMENT	-0.044	(0.258)
PROFESSIONAL	0.025	(0.238)
TECHNICAL	0.869*	(0.153)
SALES	-0.309**	(0.226)
ADMINISTRATION	0.089	(0.403)
SERVICE	-0.169	(0.134)
OTHER OCCUPATION	-0.099	(0.139)
HHINC1	0.894	(0.199)
HHINC2	0.369	(0.399)
HHINC3	0.093	(0.32)
HHINC4	0.482	(0.368)
PUBLIC TRANSP	-0.369	(0.268)
BIKE STORAGE	-0.096	(0.097)
SHOWER	0.042	(0.069)
ROAD HAZARD	-0.168	(0.117)
TRAFFIC SAFETY	-0.335**	(0.247)
CRIME	-0.072	(0.096)
BIKE PATHS	0.099	(0.159)
SHOULDERS	-0.229	(0.151)

Table VI.5 Decision to Bicycle for Students (continued)

Variable	Marginal Effect	Std. Error
TRANSIT	0.048	(0.186)
NEED CAR	0.038	(0.092)
CONGESTED ROUTE	0.059	(0.082)
N = 107		
Log Likelihood = -24.687939		

* indicates statistical significance at the 5% level

**indicates statistical significance at the 1% level or better

Table VI.6 Decision to Bicycle on Utility Trip

Variable	Marginal Effects	Std. Error
AGE	0.004	(0.003)
FEMALE	-0.141**	(0.033)
MARRIED	-0.126**	(0.038)
DIVORCED/WIDOWED	-0.059	(0.062)
HISPANIC	-0.047	(0.082)
NATIVE AMERICAN	-0.047	(0.158)
OTHER RACE	0.23*	(0.111)
NONSMOKER	0.149**	(0.044)
NO HIGH SCHOOL	0.165	(0.128)
ASSOCIATES DEGREE	-0.03	(0.057)
BACHELORS DEGREE	-0.022	(0.046)
MASTERS DEGREE	0.022	(0.058)
PHD	0.064	(0.082)
CONSTRUCTION	0.106	(0.089)
MANUFACTURING	0.109	(0.086)
TRANSPORTATION	-0.138	(0.063)
WHOLESALE	0.205	(0.13)
RETAIL	0.168	(0.097)
FINANCE	0.043	(0.082)
SERVICE IND	0.028	(0.058)
PUBLIC ADMINISTRATION	-0.078	(0.162)
GOVERNMENT	-0.112	(0.065)
PROFESSIONAL	0.031	(0.046)
TECHNICAL	-0.019	(0.065)
SALES	-0.03	(0.071)
ADMINISTRATION	0.026	(0.084)
PROTECTIVE SERVICES	0.155	(0.199)
SERVICE	0.059	(0.082)
MECHANICAL	0.112	(0.182)
OTHER OCCUPATION	0.043	(0.06)
HHINC1	0.143	(0.092)

Table VI.6 Decision to Bicycle on Utility Trip (continued)

Variable	Marginal Effects	Std. Error
HHINC2	0.136*	(0.059)
HHINC3	0.084	(0.051)
HHINC4	0.045	(0.045)
PUBLIC TRANSPORT	0.025	(0.029)
BIKE STORAGE	-0.036	(0.019)
SHOWER	-0.034	(0.024)
ROAD HAZARD	-0.047*	(0.021)
TRAFFIC SAFETY	-0.027	(0.022)
CRIME	0.005	(0.026)
BIKE PATHS	-0.074**	(0.024)
SHOULDERS	0.047	(0.025)
TRANSIT	0.02	(0.028)
CONGESTED ROUTE	0.009	(0.021)
N = 922		
Log Likelihood = -491.19851		

* indicates statistical significance at the 5% level

**indicates statistical significance at the 1% level or better

Table VI.7 Decision of Bicycling Frequency for Utility Trips

Variable	Coeff.	Std. Error
AGE	-0.033	(0.168)
AGESQ	0.001	(0.002)
FEMALE	0.204	(0.264)
MARRIED	-0.611	(0.321)
DIVORCED/WIDOWED	0.278	(0.577)
HISPANIC	0.907	(0.781)
BLACK	-11.515	(6109157)
NATIVE AMERICAN	0.645	(0.971)
OTHER RACE	-1.302**	(0.497)
NONSMOKER	-0.976*	(0.426)
NO HIGH SCHOOL	-0.442	(1.055)
ASSOCIATES DEGREE	0.942	(0.484)
BACHELORS DEGREE	1.105**	(0.372)
MASTERS DEGREE	0.822	(0.474)
PHD	0.911	(0.579)
CONSTRUCTION	1.692*	(0.782)
MANUFACTURING	0.145	(0.606)
TRANSPORTATION	1.158	(0.722)
WHOLESALE	3.714**	(1.387)
RETAIL	0.995	(0.723)
FINANCE	-0.098	(0.683)
SERVICE IND	0.909	(0.543)
PUBLIC ADMINISTRATION	2.586**	(1.001)
GOVERNMENT	0.177	(0.726)
PROFESSIONAL	-1.134**	(0.409)
TECHNICAL	0.229	(0.468)
SALES	-1.029	(0.642)
ADMINISTRATION	-1.652*	(0.809)
PROTECTIVE SERVICES	1.941	(1.34)
SERVICE	-0.995	(0.624)
MECHANICAL	1.596	(1.278)

Table VI.7 Decision of Bicycling Frequency for Utility Trips (continued)

Variable	Coeff.	Std. Error
OTHER OCCUPATION	-0.084	(0.458)
HHINC1	0.838	(0.536)
HHINC2	0.49	(0.428)
HHINC3	0.106	(0.427)
HHINC4	0.718	(0.38)
PARK	-0.095	(0.123)
MOTORIST COURTESY	-0.067	(0.153)
CYCLIST COURTESY	0.378*	(0.164)
PEDESTRIAN COURTESY	-0.229	(0.155)
ROAD CROSSINGS	-0.014	(0.155)
ROAD/PATH DEBRIS	0.229	(0.132)
GRATES/SPEED BUMPS	-0.194	(0.157)
ROAD SURFACE	0.11	(0.181)
BIKE PATH SURFACE	0.301*	(0.147)
SHOULDER SURFACE	0.096	(0.196)
SHOULDER WIDTH	-0.235	(0.188)
SIGNS	0.467**	(0.144)
N = 134		
Log Likelihood = -169.09839		

* indicates statistical significance at the 5% level

**indicates statistical significance at the 1% level or better

Table VI.7b Marginal Effects Decision of Bicycling Frequency for Utility Trips

Variable	Less than once a month	Once per month	2-3 times per month	Once per week	More than once per week
AGE	0.0119	0.0006	-0.0041	-0.0035	-0.0048
AGESQ	-0.0003	0	0.0001	0.0001	0.0001
FEMALE	-0.0742	-0.0035	0.0256	0.0221	0.03
MARRIED	0.222	0.0105	-0.0766	-0.0661	-0.0897
DIVORCED/WIDOWED	-0.101	-0.0048	0.0349	0.0301	0.0408
HISPANIC	-0.3297	-0.0156	0.1138	0.0981	0.1333
BLACK	3.785	0.1786	-1.3068	-1.1264	-1.5304
NATIVE AMERICAN	-0.2346	-0.0111	0.081	0.0698	0.0948
OTHER RACE	0.4733	0.0223	-0.1634	-0.1409	-0.1914
NONSMOKER	0.3549	0.0167	-0.1225	-0.1056	-0.1435
NO HIGH SCHOOL	0.1606	0.0076	-0.0555	-0.0478	-0.0649
ASSOCIATES DEGREE	-0.3426	-0.0162	0.1183	0.102	0.1385
BACHELORS DEGREE	-0.4019	-0.019	0.1388	0.1196	0.1625
MASTERS DEGREE	-0.2987	-0.0141	0.1031	0.0889	0.1208
PHD	-0.3312	-0.0156	0.1143	0.0985	0.1339
CONSTRUCTION	-0.6153	-0.029	0.2124	0.1831	0.2488
MANUFACTURING	-0.0527	-0.0025	0.0182	0.0157	0.0213
TRANSPORTATION	-0.4209	-0.0199	0.1453	0.1252	0.1702
WHOLESALE	-1.3502	-0.0637	0.4662	0.4018	0.5459
RETAIL	-0.362	-0.0171	0.125	0.1077	0.1463
FINANCE	0.0358	0.0017	-0.0123	-0.0106	-0.0145
SERVICE IND	-0.3305	-0.0156	0.1141	0.0984	0.1336
PUBLIC ADMINISTRATION	-0.9403	-0.0444	0.3247	0.2798	0.3802
GOVERNMENT	-0.0644	-0.003	0.0222	0.0192	0.026
PROFESSIONAL	0.4124	0.0195	-0.1424	-0.1227	-0.1667
TECHNICAL	-0.0832	-0.0039	0.0287	0.0248	0.0337
SALES	0.3741	0.0177	-0.1292	-0.1113	-0.1513
ADMINISTRATION	0.6007	0.0283	-0.2074	-0.1787	-0.2429
PROTECTIVE SERVICES	-0.7058	-0.0333	0.2437	0.21	0.2854

Table VI.7b Marginal Effects Decision of Bicycling Frequency for Utility Trips (continued)

Variable	Less than once a month	Once per month	2-3 times per month	Once per week	More than once per week
SERVICE	0.3619	0.0171	-0.1249	-0.1077	-0.1463
MECHANICAL	-0.5803	-0.0274	0.2003	0.1727	0.2346
OTHER OCCUPATION	0.0307	0.0014	-0.0106	-0.0091	-0.0124
HHINC1	-0.3048	-0.0144	0.1053	0.0907	0.1233
HHINC2	-0.1783	-0.0084	0.0616	0.0531	0.0721
HHINC3	-0.0385	-0.0018	0.0133	0.0114	0.0155
HHINC4	-0.2612	-0.0123	0.0902	0.0777	0.1056
PARK	0.0346	0.0016	-0.0119	-0.0103	-0.014
MOTORIST COURTESY	0.0245	0.0012	-0.0084	-0.0073	-0.0099
CYCLIST COURTESY	-0.1375	-0.0065	0.0475	0.0409	0.0556
PEDESTRIAN COURTESY	0.0831	0.0039	-0.0287	-0.0247	-0.0336
ROAD CROSSINGS	0.0051	0.0002	-0.0018	-0.0015	-0.0021
ROAD/PATH DEBRIS	-0.0834	-0.0039	0.0288	0.0248	0.0337
GRATES/SPEED BUMPS	0.0704	0.0033	-0.0243	-0.021	-0.0285
ROAD SURFACE	-0.0399	-0.0019	0.0138	0.0119	0.0161
BIKE PATH SURFACE	-0.1093	-0.0052	0.0377	0.0325	0.0442
SHOULDER SURFACE	-0.035	-0.0017	0.0121	0.0104	0.0142
SHOULDER WIDTH	0.0855	0.004	-0.0295	-0.0254	-0.0346
SIGNS	-0.1697	-0.008	0.0586	0.0505	0.0686