BIKE SHARING: A RANDOMIZED STUDY EVALUATING THE UNIVERSITY OF OREGON BIKE LOAN PROGRAM

by

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Around the world, active transportation is looked at as one solution to problems presented by climate change, epidemic obesity, rising fuel prices, and crippling traffic congestion. In 2008, the University of Oregon launched the Bike Loan Program as an effort to address these issues. Because those interested in participating in the Bike Loan Program were randomly selected based on bicycle size availability, those who were not chosen acted as a perfect control group. This study evaluates the impacts of the Bike Loan Program on participants vis-à-vis non-participants, and seeks to determine if those participating do ride bikes more often than non-participants. This study will also show what modes of transportation are being replaced by bike trips when a person participates in the Bike Loan Program. Finally, this study also shows if there are changes in attitudes or perceptions about transportation resulting from participation in the program.

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CHAPTER I

INTRODUCTION

Today, America lags behind other western countries in the quality and consistency of its bike and pedestrian amenities. Thanks in large part to their powerful policy initiatives to promote active transportation and reduce personal vehicle use, other countries such as Denmark, the Netherlands, and Germany boast bike commute rates between 14% and 37% for trips under one mile (Pucher & Buehler 2008). Meanwhile, Americans make only 2% of such trips by bike (*Ibid.*). After decades of auto-oriented development in the U.S., however, active transportation is gaining increased attention in American transportation policy. As America grapples with an obesity epidemic, climate change, foreign oil dependence, and traffic congestion, policymakers are beginning to look more closely at biking and walking as simple solutions to these problems (LaHood 2010). With federal, state, and local support, there are a host of programs being implemented across America to lure people out of cars and onto bikes. Some of these programs include Safe Routes to School, the Non-motorized Transportation Pilot Project, Complete Streets policies, and bike festivals or other cultural events.

Of many arguments in favor of increasing investments in bike infrastructure, three main justifications are most commonly used. These are the benefits to public health, the relief of traffic congestion, and reduced environmental impacts. Below, each reason will be more fully explored.

Policy Context

Health

For the first time in American history, today's generation of children may have shorter lifespans than their parents (Olshansky et al. 2005). This is attributable largely to the surge in childhood and adult obesity, which directly costs America an estimated $75 billion in additional health spending (TRB 2005). This represents a serious drain not only on the nation's economic vitality, but also a measurable reduction in American quality of life.

In contrast to America's public health crisis is the relatively good health of European counterparts such as Denmark, France, and Germany (Bassett et al. 2008). One common denominator between these countries is the level of physical activity engaged in simply traveling to and from destinations by biking and walking (*Ibid.*). Researchers and policymakers alike have begun serious study on how America can reduce the obese population, and these countries can act as case studies for just that.

Recently, attention has been paid to the relationship between the built environment and levels of physical activity, particularly among children. For example, simultaneous to the rise in obesity has been a decline in the number trips children made by walking, from a high of 87% in 1969 to 39% in 2001 (Watson & Dannenberg 2008). The Federal Highway Administration reported that during the same time period children walking or biking to school declined from roughly 50% to fewer than 15% (SRTS 2010). It is in the face of numbers such as this that the Safe Routes to School Program was established to encourage children to walk or bike to school.

Nonetheless, the link between the built environment and public health is still being debated (TRB 2005). Other factors, such as the availability of low-priced, high-calorie food, certainly also play a role in obesity rates. However, the evidence shows that improvements in infrastructure, such as bike lanes, sidewalks, and path connectivity, can increase the number of people choosing not to drive (*Ibid.*). Whether this increase in walking and biking leads to better health outcomes, however, is still being established (*Ibid.*).

Traffic Congestion

A second major reason for promoting bicycling, and more generally non-automobile modes of transportation, is the massive economic drain caused by congestion. Every year, the Texas Transportation Institute releases a report on the cost of congestion. In 2005, the authors estimated a total national cost of $65 billion from time and fuel spent while idling in traffic (Schrank and Lomax 2005). Cervero (1998) estimated that congestion costs the economy roughly 2-3% GDP annually in productivity.

The growing consensus is that we are no longer able to "build our way out" of this problem. One of the reasons for this is the erosion of the purchasing power of gas tax revenues, which have lost approximately 33% of the purchasing power they had in 1993 (NTIFC 2009). This means that we are struggling to pay for just maintenance of existing roads and highways, let alone expanding the capacity to accommodate increased traffic (*Ibid.*).

The allure of increasing the number of people walking and biking, then, is powerful in the face of seemingly intractable obstacles to fixing our car-oriented system. While the cost of a road expansion to reduce congestion can be in the millions of dollars, adding paint to existing roadway to create a bike lane might only cost thousands. By accommodating for bicyclists and automobiles, more capacity is added to existing roadways, allowing for greater efficiency of use and allowing car trips to be replaced with bicycle trips.

There is, of course, the possibility of induced travel demand – that is, by reducing traffic congestion drivers may make more trips to take advantage of the reduced time cost of driving, negating any gains (Cervero 2003). However, the same problem exists for adding lane capacity to accommodate for more cars. A key difference, as mentioned above, is that adding lane capacity is several orders of magnitude more expensive than striping a bike lane.

Environmental Impacts

Environmental concerns are the final reason that bicycling is promoted as an alternative to automobility. Globally, transportation accounts for roughly one-third of greenhouse gas (GHG) emissions by sector, second to electricity generation (EPA 2010). Because of the amount of hydro-electric dams in the Northwest, the proportion of GHG emissions from transportation is even higher at roughly 38% (GAGGW 2004). As policymakers and the public at large become more aware of the grave risks associated with climate change, the need for more sustainable forms of transportation becomes highlighted.

Degraded air quality is also a serious concern, particularly in large urban areas like Los Angeles. The most comprehensive survey to date of the impact of vehicle emissions on public health by the Health Effects Institute (2010) found that the literature generally supported the hypothesis that living in close proximity to major roadways exacerbates, if not causes, asthma in children. Given that asthma costs Americans over $20 billion annually (NIH 2010), reducing emissions to alleviate this health burden could benefit the country as a whole.

Active transportation, again, offers a promising possibility to reduce tailpipe emissions without reducing levels of mobility. A travel survey from the San Francisco Bay area showed that over 60% of trips under one mile are made with a car (Cervero & Duncan 2003); these are the kinds of trips likely to be replaced by walking or biking. If levels of bike commuting reached Copenhagen rates (roughly 40%), then it can be presumed that GHG and other air pollution emissions from mobile sources would decline.

It is unclear what the magnitude of reductions from bicycling can be expected. According to the National Household Travel Survey, 25% of trips are two miles or less (2004), and so could conceivably be replaced by bicycling trips. However, it is not certain what proportion of total GHG emissions they comprise, and thus what a realistic expectation of bicycling's role in GHG reduction would be.

Bike Sharing Programs

One method used to increase bicycling is Bike Sharing. As the name indicates, bike sharing can be any system wherein a fleet of bicycles is rented or loaned to multiple users. These systems typically exist in a limited geographic area, such as within a central business district or on a college campus (SmartBike, in Washington, DC for example covers approximately four square miles), and can be publically or privately owned. The logic is plain to see – these areas are high-value destinations with office buildings or dense commercial areas where congestion may be severe and parking scarce. By limiting the geographic scope, it is easier to keep track of the communal bikes, and since bicyclists do not typically want to ride very long distances, a limited scope is unlikely to be a burden to the user.

One such program, the Bike Loan Program (BLP), started in the summer of 2008 after the Associated Students of the University of Oregon (ASUO) dedicated $18,000 in start-up funds to the Outdoor Program. The program was designed to take impounded bikes that had been abandoned on campus and add a certain amount of accessories and branding (baskets, fenders, stickers, etc). The program operates on an "ownership" model, where the student keeps the bike for one to three academic terms and is responsible for maintenance.

The Bike Loan Program states as its mission:

> . . . to increase access to affordable, reliable, and sustainable transportation. Through the integration of long-term bicycle loans, education, and recreation, the BLP will enhance the physical and cultural development of students. As a resource for alternative transportation, we will minimize our campus and community environmental impact." (UO Outdoor Program 2010).

While this mission statement is broad, it covers many key issues described above. Most obvious is the goal of minimizing environmental impact through promoting sustainable transportation. They also seek to increase access to affordable transportation options, and thus increase student mobility and transportation equity. Lastly, enhancing physical and cultural development can be interpreted as improving student health and strengthening community cohesion.

What is more interesting than the stated goals of the BLP is the manner in which the program was incorporated into the political platforms for ASUO presidential hopefuls in the Spring of 2009. Two main candidates, Nick Schultz and Emma Kalloway, both promoted creating a permanent source of funding, or institutionalizing, the Bike Loan Program (Emerald Editorial Board, 4/18/2009). They cited two primary reasons for institutionalizing the BLP: 1) reducing the environmental impact of the University of Oregon and 2) easing the parking burden on campus (*Ibid.*). Implicit in both cited reasons was that the Bike Loan Program will entice people to bike instead of drive.

This study seeks to evaluate the impacts of the BLP on the program participants, looking specifically at any changes in transportation mode use and in attitudes regarding bicycling. By determining these impacts, conclusions can be drawn on the progress made toward its goals, both stated by the program administrators and by political proponents.

The following report is broken down into four sections. The first is the literature review on bike sharing programs. The next section describes the data and methods. The third section details the findings of the study, followed by a discussion and recommendations based on the findings.

CHAPTER II

LITERATURE REVIEW

The number of bike sharing programs on university campuses and city centers today is growing. Unfortunately, the literature on impacts of bike sharing systems is thin, but is gaining more attention as cities like Paris, Minneapolis and New York devote their resources to such programs. Below, existing literature dealing with bike sharing programs will be reviewed.

Bike sharing is described by Shaheen et al. (2010) as being a solution to what is called the "last mile problem." This is where a commuter is trying to decide between driving or taking transit/carpooling, and decides on driving because there is no connection between the drop-off point and the destination (*Ibid.*). By putting in shared bicycles around high-value destinations like urban cores, college campuses or corporate campuses, these systems can provide the last vital link in a non-automobile commute.

Bike sharing started in the late 1960's in the Netherlands and the UK as free, communal bikes that could be picked up, ridden to any destination, and then dropped for the next user (Shaheen et al., 2010). Due to theft and vandalism, these programs changed first into coin operated and then electronic stall systems so that the fleet could be better tracked and maintained (*Ibid.*). These programs spread to North America in the early 1990's, starting with Portland, Oregon's Yellow Bike Program. This program eventually ran into the same problems of theft and vandalism as the early programs in Europe (*Ibid.*).

The most prominent case study today for urban bike sharing systems is Paris, France. The Velib program in Paris started with 13,000 subscribers, growing to 100,000 only three months later, and gaining international accolades for its environmental responsibility in the process (NYCDCP 2009). Velib is an example of a "Smart System", complete with docking stations and digital rental technology, which one study put the international total at 78 cities with a combined fleet of almost 70,000 bicycles in 2008 (Midgley 2009). A separate report put the number at 90 (MetroBike 2009). These systems are not cheap; Velib in Paris had start-up costs of $114 million, with annual operating costs of $45.8 million for a fleet of 24,000 bicycles (NYCDCP 2009).

Across North America, there are roughly 65 college campuses with bike sharing programs, with another 10 planned by the end of 2010 (Shaheen et al., 2010). In the U.S. only Smart Bike in Washington DC has automated kiosks like in Europe (NYCDCP 2009). However, Minneapolis is slated to begin a bike sharing program "Nice Ride" in June of 2010, and Philadelphia and New York City are both in the planning stages for bike sharing programs of their own (*Ibid.*). Other programs have a variety of funding levels and organizational structure; indeed, some have no apparent funding source and operate based on donated labor, space, tools, and bikes

Despite the time, effort and funding devoted to these programs, there have to date been few systematic studies evaluating the effectiveness of them in cities, and no pre- and post-test evaluations done on college campus bike sharing programs. As Pucher et al.

(2010) points out, "The impacts of these programs are hard to assess, as they are often accompanied by the expansion of the bicycle network in anticipation of the increased bicycling." There are suggestive findings, such as a more than doubling of the bicycle mode share in Barcelona and Paris after the implementation of their programs (*Ibid.*) These statistics are confounded however by concurrent improvements in bicycle infrastructure.

Determining the mode shift impacts of these urban bike sharing programs can be challenging. A 2007 study of the bike sharing programs in Paris, Lyon and Barcelona showed that when asked how trips would have been made if not by a shared bicycle, the majority of respondents indicated public transit (see Table 1) (JZTI & Bonnette Consulting 2010). However, it is noted that the survey results do not make it clear if the trip on a shared bike replaces only part of a transit trip (i.e. a circulator bus trip to a subway line) or the entire transit trip. Depending on interpretation, these results may overstate or understate the shift from transit.

In the case of bike sharing programs on campus, the evidence base is even shallower. Probably because of the low cost, grassroots nature of campus bicycle sharing programs initiated by students, there is very limited data on the potential impact they might have. Two studies have been conducted by students to determine campus interest in potential bike sharing programs, though none could be found which evaluate the actual impacts of existing programs (Brougham et al. 2009; ECOHusky 2004).

Despite the paucity of literature dealing expressly with evaluating the efficacy of bike sharing programs, there are studies indicating their potential for influencing mode share. Cervero et al. (2009) found that the single strongest predictor for bicycle use is the availability of a bike. Furthermore, Dill and Voros (2006) found that 45% of non-cyclists wish they bicycled more, indicating that there is latent demand present prevented by some factor that may include not having access to a bicycle. However, the reasons most cited preventing increased bicycling were traffic volumes and lack of infrastructure—bicycle access was not addressed in the article.

As a last note, there is some evidence that programs providing incentive to increase bicycling impact primarily what Ogilvie (2005) termed the "motivated subgroups." Two studies found a shift of 1% to 5% of all trips from car to bicycle following campaigns to increase bicycling (*Ibid.*). However, this increase in bicycling was seen primarily from those who already bicycle regularly increasing the number of trips taken by bike (*Ibid.*). In the context of bike sharing programs, this may mean that a person who normally takes a circulator bus to get from the downtown transit station to work, instead uses a shared bike to travel in the urban core. While this may reduce crowding on circulator buses, it may not impact the single occupancy vehicle users, who are the targets of such programs.

The present study will help fill this significant gap in the literature analyzing bike sharing programs' impacts on travel behavior, and specifically on college campuses. By using the method described below, any changes in travel behavior relative to a control group will shed key insights on the role bike sharing could play.

CHAPTER III

DATA AND METHODS

This study used a pre-test (Time 1), post-test (Time 2) model to evaluate the impacts of the Bike Loan Program. Described in further detail below, this study used Bike Loan Program (BLP) bike recipients as the experimental group, and prospective program participants who were not able to receive a bike as the control group. Online surveys were sent out via email to gather self-reported travel behavior and attitudinal data. The data was then analyzed using three different methods to look for statistically significant differences between the test and control groups.

Bike Loan Program Rental System and Subject Selection

The rental system for the Bike Loan Program worked through a somewhat informal application and allocation process, shown in Table 2. First, prospective participants in the Bike Loan Program were advertised to through various methods during the 2008-2009 academic year. One of these methods was through "IntroDUCKtion," the new student orientation that occurred in May 2009 for incoming students in October 2009. The second method was coordinating with the International Studies Office to distribute information to incoming international students before they arrived in Eugene. The third method was through word of mouth, press coverage in the school newspaper, and the branded bicycles that sit on campus throughout the year.

A prospective program participant contacted the Bike Loan Program staff one of two ways: she either sent an email to the BLP coordinator asking for more information, or physically came to the BLP Office to inquire further. Once interest was expressed, students were directed to sign up for one of two check-out sessions, which occurred on Saturday, September 19th and Sunday, September 20th. On both days, there were three one-hour time slots for prospective participants to sign up for (six time slots total). In order to register for one of the six time slots, prospective participants signed up on posted sheets in the BLP Office. Each time slot had ten spaces, meaning that potentially 60 students could fill the six time slots.

In addition to the 10 spaces per slot, each one-hour time slot had space for additional students to sign up as "alternates" in the case that one of the ten was not able to rent a bike. In total, an additional 32 students signed up to be alternates. See Table 13 for a complete listing of the distribution of control group and experimental group subjects across the six time slots. Finally, there were also 25 students who emailed the BLP office to request information about how to receive a BLP bike, but never signed up on the sheet posted.

Once a student signed up in one of the 60 spaces, or as an alternate, she was expected to come to the bike rental facility to be matched to a bike. Those who were unable to receive a BLP bike due to sizing problems or availability were placed on a waitlist. During the course of the year, more bicycles would be rented out to waitlisted individuals in smaller numbers (approximately five every other week).

Because the bicycle facility for the Bike Loan Program was undergoing a renovation immediately following the two September rental sessions, the ordinary system of releasing new bikes to waitlisted students was put on a reduced schedule until the renovation was complete. Only two waitlisted survey respondents were given bikes during a release on October 15th, shifting them out of the control group and into the experimental group.

Ultimately, only 40 bicycles were properly functioning and fully equipped for the two check-out sessions. BLP staff chose 20 bikes for the September 19th session, making sure to include a wide array of sizes, since that is the primary consideration when matching a student to a bicycle. This meant that at least 10 prospective participants who showed up to the first check-out session were necessarily not going to receive a bicycle, since there were 30 prospective participants and only 20 bicycles; the same situation was true for the September 20th session

Those prospective participants who signed up for one-hour time slots later in the day were less likely to receive a bicycle than those who signed up for time slots earlier in the day. This opens the possibility that those who were more motivated to receive a BLP bike would have taken the initiative to sign up for an earlier slot in order to maximize their chances of receiving a bicycle, potentially undermining the randomness of the bike allocation.

A second non-random element of bicycle assignment was that smaller bikes ran out earlier in the day than larger bikes. In general, taller prospective participants were able to rent bikes at all three of the slots, while shorter prospective participants were put on the waitlist if they had signed up for a later slot in the day. It is not known what impact height might play in travel behavior, and height information was not collected in the survey.

Finally, the academic year did not begin until Tuesday, September 29th, and so the two rental sessions were nine or ten days prior to this date. Most students arrived the weekend of the September 26th through 28th, meaning that only students who arrived early or lived in the city of Eugene would have been able to sign up for a slot on one of the two rental days. This was a primary reason that the International Studies Program was targeted for students – those coming from abroad arrived in Eugene on the 15th of September for orientation. This introduces a third element of possible non-randomness to the study – only those in Eugene prior to the beginning of the academic year could participate in the first round of BLP bike rentals. Because of the above three elements of potential non-random bicycle assignments, the demographic information and travel preferences of the control group and experimental group were compared to see if there were any statistically significant differences.

Surveys were electronically distributed to prospective participants based on the information given when signing up on the posted list or when emailing BLP staff to express interest in the program. Using this information, emails containing arbitrary ID numbers and URLs to the online surveys were sent out on September 15th by BLP staff, and reminders were sent daily until September 20th. The arbitrary ID numbers helped to ensure the anonymity of the subjects' responses when analyzing the data and reporting results.

For those who signed up for the 60 one-hour slots, every effort was made to collect their information before the rental sessions on the 19th and 20th of September. For the 32 who signed up to be on the waitlist and the 25 who only emailed, but did not sign up on the list, the period to respond to the survey closed on October 13th. Table 12 shows the number of subjects who responded before the bike rental session.

The Time 2 survey was distributed in the same manner to those who answered the Time 1 survey. On Wednesday, November 25th the URL to the Time 2 survey was emailed to the 68 study participants of the Time 1 survey. Reminders were sent every few days until Tuesday, January 6th, at which time the window to respond closed.

Variables

The survey was designed to answer the following key questions:

1. What travel behavior can be established?
2. What expectations exist regarding transportation modes in the absence of program participation?
3. What are their attitudes and perceptions regarding various modes of transportation?

The dependent variables used to answer these questions can be seen in Tables 3 to 5. Table 3 shows the Time 1 and Time 2 variables having to do with travel behavior. The Time 1 questions asked what the expected mode of travel in the absence of a BLP bike would be, and the Time 2 questions asked what the travel behaviors in fact were. The Time 2 variables were then subtracted from the Time 1 variables to perform the

Difference-in-Difference (DiD) analysis. In both cases, subjects were able to choose multiple modes.

Table 4 shows the Time 1 and Time 2 variables dealing with attitudinal questions. These questions were identical at both survey times, making the analysis of the change simpler. As with Table 3, the Time 2 responses were subtracted from the Time 1 responses for the DiD analysis.

Table 5 shows the variables asking about frequency of travel mode use during the Fall term, and utilizes only Time 2 data. This is because many of the students had just arrived on campus at Time 1, and so no baseline travel behavior could be established.

Independent variable data were collected in the Time 1 survey and can be seen in Table 6. Demographic information, questions regarding distance of living space from campus, and automobile accessibility was included in these questions. A question establishing whether the student received a bicycle was asked in the Time 2 survey (that is to say, whether the student was in the control group or experimental group). This is because the Time 1 survey was taken before the loan sessions, thus before the study participant knew of which group she would be a part. Contact was made with BLP staff to ensure that those who received a bicycle in the middle of the academic term were shifted into the experimental group.

Some demographic questions were repeated on the Time 2 survey intentionally. This was to reduce the likelihood of a study participant accidentally giving the incorrect ID number when taking the Time 2 survey. This demographic information was used to verify the accuracy of the given ID number.

Some potentially confounding variables were not accounted for, however. As discussed in the Chapter 2, concurrent efforts to improve bicycling can confound results from studies looking at one particular program in a whole portfolio of treatments. There were two main confounding factors in the Fall academic term of 2009. The first was the city-wide effort to increase bicycling, including a more robust effort to keep bike lanes clear of leaves and the on-going improvements in bicycling infrastructure. A new bike bridge connecting a residential neighborhood across a previously inaccessible highway to the Gateway Mall is one example of these infrastructure improvements.

The second confounding factor was the Bike Loan Program itself. The BLP not only provided bikes, but also a free, fully staffed workspace for any student to maintain his or her bicycle. On top of that, the Bike Loan Program sponsored communal bike rides and other cultural events to support cycling on campus, which could have also had an impact on people's use of bicycles.

Because the control groups and experimental groups were equally exposed to these confounding factors, any changes found in travel behavior between the two groups can be assumed not to be a result of these factors. Rather, it must be assumed that the changes are the result of some variable one group was exposed to and the other was not, such as participation in the Bike Loan Program.

Data Analysis

The first step in analyzing the data was to recode the responses from frequency statements (see Table 5 for the frequency response choices) into trips per week. The recoding assignments are shown in Table 8. It should be noted that the recoded values could undercount trips, since "daily" use of a particular mode could indicate multiple trips per day, and not only one (or seven per week). However, since the number of trips undoubtedly varied between study participants, a conservative approach was used.

The same variables were also recoded to calculate weekly usage rates. In this case, any responses of "weekly" or more frequently were coded as "1" and responses of "A Few Times per Month" and less frequently were coded as "0."

The initial analysis looked at the demographic information of the experimental and control groups, then the aggregated demographic information of both groups. Lastly, this information was compared against the university population as a whole. T-tests were performed to see if there were any statistically significant differences between the experimental and control groups.

The dependent variable data from Tables 3 – 5 were analyzed in three different ways. The first used only Time 2 data from Table 5. T-tests were used to compare the mean number of trips per week using each mode across the control and experimental groups. As can be seen in Table 5, there were two Time 2 variables for biking – frequency of BLP bike use, and frequency of non-BLP bike use. These two were aggregated into one "Fall Bike Use" variable, and in general those in the experimental group did not use non-BLP bikes and those in the control group did not use BLP bikes. See Table 9 for the disaggregated use rates.

The second analysis compared the change between Time 1 and Time 2 questions regarding attitudinal shifts, shown in Table 4, also known as a difference-in-difference

(DiD) analysis. The DiD analysis is a method of controlling for unseen static independent variables that might create a response bias. A second DiD analysis was performed on the travel behavior change variables in Table 3.

The third level of analysis was a regression to control for independent variables shown in Table 6 that might influence travel behavior. The regression looked at both Time 2 mode shifts (Table 5) and Time 1 and 2 attitudinal change data (Table 3). The regression analysis helps to control for any imbalances between the control and experimental groups, removing potentially confounding impacts of other independent variables.

Sensitivity Tests

Because some of the experimental group might have been influenced on their decision to fill out a survey once the bicycles were issued, a sensitivity test was performed on the above-described data analyses. As seen in Table 12, those subjects who responded to the Time 1 survey after the bike rental sessions were excluded from the analysis. This helps to mitigate potential response bias, particularly among the experimental group.

Anonymity and Incentives

The University of Oregon's Internal Review Board gave approval in August 2009 for this project, and as described in the application all survey responses were anonymous. To provide an incentive for the students to complete the entrance survey, study participants could enter a drawing for a $20 gift certificate to the University of Oregon's Book Store if they provided contact information. The drawing took place, and a student was awarded the prize. Since completion of the exit survey was also paramount in obtaining useful data, $5 in cash was offered to those who completed both the entrance and exit surveys. Twenty out of the 59 Time 1 and 2 survey respondents collected their $5 compensation.

CHAPTER IV

FINDINGS

Described below, the data analysis consistently yielded statistically significant findings with regard to mode shift. Attitudinal change was less consistent in statistical significance. The results must be taken as suggestive, however, and not conclusive, due to the likelihood of response bias. Despite the effort to randomize the population, the response rate shows a much higher percentage of experimental group respondents than control group, indicating a non-random element in the bike allocation process.

Response Rate

The response rate for the Time 1 survey was 57.3% (See Table 10). Of the 117 prospective participants, 11 provided illegible or incorrect email addresses. None of those 11 prospective participants ever received a bicycle, and so came out of the control group. This resulted in 106 successfully contacted for participation in the study. Of these, 61 responded online to the survey. An additional six filled out paper surveys, as opposed to online surveys, on the day they were signed up to receive a bicycle. The paper surveys were administered while the prospective participants waited for their time slot to begin. It is unlikely that paper surveys would affect the answers given, since the students were aware of the fact that there was more demand than supply of BLP bicycles. Thus, the argument can be made that the six who filled out the paper survey were equally as unsure of whether they were going to receive a bike as those who filled out an online survey. Nonetheless, they were removed from the sample during the sensitivity testing.

As Table 11 shows, the response rate among the control group went down between Time 1 and Time 2. The reason for some of those in the control group choosing not to participate in the second round of surveys is possibly because they did not feel as "invested" in the Bike Loan Program as the experimental group. It should also be noted that two of the subjects in the control group were assigned bicycles midway through the term, and thus were shifted into the experimental group. This is why the experimental group actually increases in size between Time 1 and Time 2. Ultimately, the Time 2 response rate was 50.4% out of the original 117 prospective program participants.

Tables 10 – 12 indicate that there was probably response bias, despite the intended randomness of bicycle allocation. In all three tables, the experimental group has well over three times the response rate of the control group. Assuming that the bike allocation was random, those in the experimental group should have been equally as likely to fill out a survey as those in the control group. While it is unclear from where this bias comes, it may be a result of the fact that those who sign up for an earlier slot in the bike rental sessions are more likely to get a BLP bike. Furthermore, it may be that those who are "pro-bike" enough to sign up early for a BLP bike are also more likely to fill out a survey for a study. Table 13 corroborates this intuition, showing that the experimental group came from those who signed up earlier in the day as opposed to those who signed up for later slots.

Demographic Information

As can be seen in Table 14, there are few demographic similarities to the university as a whole. Women, international students, and graduate students in particular were overrepresented in the study participants. For other measures, such as car ownership, campus commute distance, and income, no information for the university as a whole could be found. The differences suggest that the results of this study cannot be extended to the University-wide population.

The demographics between the control and test groups showed more similarities to each other than to the campus as a whole. As seen in Table 15, there was an absence of statistically significant demographic differences which confirms the two groups' similarities. In both groups, there were high proportions of international students, graduate students, and women, although the control group graduate students were less disproportionately represented. Other areas, such as income, distance from campus, and car ownership/access were similar between groups. However, it should be noted that age and status a graduate or undergraduate student were almost different at 5% significance.

A second test of this homogeneity was a comparison of mean scores in the variables included in the category "Mode of Travel without a BLP Bike" described in Table 3. Had statistically significant differences been found, such a result would show that the groups were not homogenous in their travel preferences, which might have indicated a non-random element in the participant selection process. However, as can be seen in Table 16, there was no statistically significant difference between test and control groups. This suggests that the travel mode preferences or expectations were not different between groups, meaning that neither group was predisposed to using one mode of transportation over another, and indicating homogeneity between the two groups.

The above tests would indicate a randomly chosen allocation into the control and experimental groups. However, this finding is contradicted by the response bias discussed above. While the statistical tests did not yield any significant findings, the response bias does suggest a non-random bike allocation process.

Cross-Sectional Analysis

Using t-tests on the Time 2 travel behavior data described in Table 5, a cross-sectional look at the two groups showed significant results. As seen in Table 17, there is a statistically significant difference between the number of trips taken per week on bike versus public transit between the control group and experimental group. The control group reported 3.74 fewer bike trips per week as compared to the experimental group. At the same time, the experimental group reported just over 2.26 fewer public transit trips per week versus the control group. No statistically significant results were found in car use or walking between the control and experimental groups.

Statistically significant findings were also produced when the weekly usage rate was compared. As seen in Table 19, there was a significantly higher percentage of study participants in the experimental group who biked at least once per week as compared to the control group. Similarly, those in the control group used public transit and walked more than those in the experimental group. Again, no statistically significant differences were found in the use of cars to travel to any destination.

Difference-in-Difference Analysis

The DiD analysis looked at both travel expectations versus actual mode choice, and attitudes; the former showed stronger statistically significant findings. The question was worded so that potential participants should imagine what their travel behavior would have been in the absence of a BLP bike; thus, if the control group was totally accurate, there would have been no change between their prediction and actual mode choice.

Table 21 shows that the statistically strongest difference was between expected and actual bike use. The control group overestimated the amount that they would bicycle, with an overall 60% decrease in biking activity over expectations. The experimental group showed an increase of bicycling activity versus a no BLP bike scenario, with bicycling 10% above expectations.

Table 21 also shows a statistically significant decrease in public transit usage over expectations among the experimental group, with a 41% reduction below expected use rates. In the control group, public transit expectations were met, with the difference between expected and actual use being zero.

Table 23 shows the change in attitudes between the Time 1 and Time 2 surveys. The only statistically significant findings were in the perception of physical health. On a 5-point scale, the control group rated themselves as .4 points worse in the Time 2 survey, whereas the experimental group rated themselves .1 points better. There were no other statistically significant findings.

Multivariate Regression

The multivariate regression did not maintain all of the findings from the t-tests after controlling for several independent variables. Table 25 shows that after controlling for age, gender, student status, car ownership and access, income and distance from campus, the experimental group is still more likely to take an increased number of bike trips per week as compared to the control group. However, the statistical significance with regard to walking and public transit trips does not hold in the regression.

Two other independent variables were significant predictors of mode choice. The first is proximity to campus. Perhaps unsurprisingly, those who live within half a mile of campus ("walking distance") are more likely to walk. A second statistically significant factor was whether one was an international student, with international students taking 2.03 more bike trips per week more than undergraduates.

Attitude differences, as shown in Table 28, showed some statistically significant findings when controlling for other variables. Those in the experimental group were more likely to have a positive feeling about personal health. The regression also showed that international students are more likely to have an improvement in their confidence in mechanical knowledge and skills with bikes, and to have a positive feeling about their health.

Sensitivity Analysis

The sensitivity analysis showed that the most statistically significant finding, that the Bike Loan Program increases the use of bicycling, to still be significant after removing the questionable data. Table 18 maintains the findings in the original analysis shown in Table 17. The sensitivity test in Table 20 shows that the modes used at least one time per week has the statistically significant findings reduced. The Difference-in-Difference analyses were largely unchanged in sensitivity testing (Table 22 and 24), however the finding regarding improved sense of personal health was no longer significant.

The sensitivity analysis for the regressions (Table 27 and 30) showed similar results to the full analysis, with biking being the only mode significantly impacted by participation in the Bike Loan Program. However, the health impacts are still significantly impacted in the sensitivity analysis.

CHAPTER V

DISCUSSION

This data analysis has important implications for the design of the Bike Loan Program, depending on the desired outcomes. As was seen in the findings section, the statistically strongest results were that the experimental group did, in fact, bicycle more often than the control group. However, this appears to have been at the expense of public transit and walking trips, with no impact on car use.

However, because of the response bias, these findings must be taken as suggestive and not conclusive. Since the prospective participants who filled out the entrance survey were disproportionately those who also received a bicycle, it can be presumed that whatever variable predisposed them to respond to the survey may have also facilitated participation in the Bike Loan Program. One likely scenario is that those who were already "pro-bike" were able to sign up for an early slot on one of the two rental days, thus ensuring their participation in the BLP. This same enthusiasm for the BLP was what motivated them to fill out the survey for this study. Thus, their responses would be biased with "pro-bike" feelings, meaning that it is uncertain what impact the BLP actually had on their actions. While other statistical demographic comparisons between the groups did not yield any significant differences, this key aspect of the study compromises the conclusiveness of the findings.

Prospective Participant Pool

As described above, the demographic information showed some interesting contrasts between the population targeted by the Bike Loan Program and the University of Oregon population at large. While only 6.5% of UO students are international students, there are almost ten times as many represented in the overall sample for this study. However, this proportion of international students is unsurprising given a partnership between the BLP and the International Studies Office.

The targeting of international students may be counterproductive to the goal of reducing the environmental impact of the campus. Since international students studying for one year or less at the university are unlikely to invest in a car, these students are unlikely to have a car to forgo, which is key to reducing GHG emissions or alleviate parking pressures. This is corroborated by the fact that only six study participants reported owning a car, constituting just 10.5% of the sample.

Health

The evidence indicates that experimental group members do, in fact, consider themselves healthier as compared to the control group. The t-tests and regressions all show that this dependent variable is significantly impacted by participation in the BLP. Logically, this conclusion makes sense; the most consistently significant mode shift is from public transit to bicycles for those in the experimental group. This means that students are shifting from a passive to an active mode of transportation, and this physical activity could contribute to a stronger feeling of health.

Further study is needed to determine if the experimental group actually is healthier than the control group. For one thing, a feeling of health does not necessarily equate actual health. Furthermore, there is no evidence that a leisurely bike ride is better for one's health than a brisk walk, for example.

Mobility and Equity

There is some evidence of increased mobility resulting from the Bike Loan Program through self-reported trip rates. The number of walking and transit trips is exceeded by the number of biking trips replacing them (see Table 25). This could indicate a number of things: it could mean that bicycles provide increased mobility, and so the experimental group no longer chained trips together that might accompany a slower walking trip, or a more complex transit trip. It could also mean that the bike trip itself was an end, with more recreational outings.

Furthermore, there is a logical increase in accessibility of goods and services when walking trips are replaced by biking trips. Walking is typically very slow (2 – 3 mph), whereas even slow biking is five times faster. This means that the same destinations can be accessed in one-fifth the time, or destinations five times further away can be accessed in the same amount of time, versus walking. Thus, it can be inferred that the Bike Loan Program has successfully increased mobility for the experimental group.

The data also demonstrate that low-income individuals were by and large the typical recipients of BLP bikes. Based on the section of the mission statement hoping to increase the accessibility of affordable transportation options, the Bike Loan Program appears to have been a success.

Environmental Impact

The environmental goal of the program was stated as "reducing the environmental impact of campus." The environmental impacts of this program can be estimated based on the number of trips generated or reduced as a result of bicycle allocation. Since the evidence shows the control and experimental groups to be statistically similar, we can assume that all 117 students in the original prospective participant pool would have exhibited the same mode shifts had they participated in the program. If this is the case, we can estimate conservatively an increase of 3.69 bike trips and a decrease of 1.59 public transit trips per week per student (see Table 25). Across 117 students, that is a reduction of 204 transit trips per week or 2,046 trips per academic term. However, that also means there is an increase of bicycling trips by 431 per week, or 4,749 trips per academic term.

Even though we can estimate the transit trip reduction resulting from the program, it is difficult to assess the environmental impacts. Because of the limited number of students in the program (42 out of 22,386), it is unrealistic to assume that bus frequency would be reduced based on this mode shift. The other finding, that experimental group members replaced walking trips with biking trips, means that a zero-emissions mode is being replaced with a zero-emissions mode. Thus, it can be assumed that emissions remained essentially unaltered in the short term.

Longer term findings might reveal something more substantial. As mentioned in Chapter Three, the Bike Loan Program services included a free bike maintenance workspace, cultural events, and short-term bike rentals. Upon consideration, it is quite surprising that a significant mode shift was found over a relatively short amount of time (six weeks between the end of the Time 1 data collection period and the beginning of Time 2 data collection). It is unknown whether these students continued biking at an elevated rate after their participation in the BLP ended, or what impact these other bike-encouraging activities might have. It is conceivable that this program could act as a catalyst to spur longer-term bicycle use among a broader array of students. As those who have rented and returned long-term bike loans increase in number over the years, the impacts could be broader.

Future Studies

Future studies should try to ascertain the applicability of the BLP impacts to the wider campus population. If, for example, the BLP bike fleet were increased by a factor of ten, would the mode shift from public transit to biking also increase by a comparable amount? This question could be answered by analyzing the existing data and weighting the cases based on demographic information.

Another research direction based on this study would be determining the longer-term impacts of the BLP on the experimental and control group. This would require a follow-up survey at a Time 3 sometime after those in the experimental group had left the program. A third survey would allow lingering impacts of the program, such as continued use of bikes instead of transit, to become apparent.

Finally, a geo-spatial analysis of the existing dataset could reveal interesting findings. As was shown in Table 25, those who live within 0.5 miles of the university are more likely make walking trips, controlling for other factors. It could be interesting to determine if there is a catchment area around the university wherein bicycling is maximized – perhaps those who live within 0.5 miles walk more and use transit and bikes less, those within 0.5 to 2 miles of the university are likely to bike or use transit, and those more than 2 miles from the university are most likely to drive. Determining this catchment area could also help the BLP to better target potential participants.

Conclusion

The Bike Loan Program appears to have been successful in many respects. The number of students using bicycles is probably greater than in the absence of such a program. There is evidence that the health of the students is at least perceived to have been improved, and increased use of active transportation would logically verify that finding. And it would appear that mobility may have improved based on an increased number of bike trips as compared to the walking and transit trips replaced.

In order to reduce the environmental impact of the campus through tailpipe emissions abatement, and potentially alleviate parking pressures, it is recommended that the Bike Loan Program consider changing its targeted student participants. In some ways, international students comprise the ideal target group for the program (at the university for a limited duration, early arrivers in Eugene, etc.). And, furthermore, there may be value in accommodating international students to provide incentive for expanded international student presence at the University. Nonetheless, rather than focusing on international students, it might be more effective to form a partnership with UO Parking Services to target those students who have applied for parking permits in order to reach the program's environmental goals. One model could be providing materials for the Bike Loan Program along with the application for a parking permit, and a cost comparison to make a bicycle rental competitive with a permit. Since the opportunity cost of simply providing targeted advertising materials is relatively low, it is recommended that the BLP pursue this course of action.

There is also the question of whether or not the Bike Loan Program is the most effective use of $18,000 in the pursuit of the stated environmental, health, and equity goals. For example, another model might have been to provide a low- or no-interest loan to students to buy a bike of their own, if it is discovered that the initial investment is a barrier to increased bike use. While this study is not a benefit-cost analysis of the Bike Loan Program, a future study could build off of these findings to attempt to quantify the benefits provided by the BLP.

In all, the findings of this study are consistent with the existing literature showing that the bulk of mode shift with such programs is from transit to bicycles. On a larger scale, this could result in reduced bus frequency or eliminated routes, but that is unlikely to happen in the near term. To address GHG emissions and parking pressures, deliberate targeting of choice student populations who are likely to own and use cars should be undertaken. In this way, the program may be able to achieve its environmental goal in the shorter-term.

APPENDIX A

TABLES

Table 1. Self-Reported Mode Replaced by Shared Bike

City/Program	Public Transit	Walk	Car	Other
Lyon/Velo'v	50.6%	36.7%	6.7%	6.0%
Barcelona/Bicing	51.0%	26.0%	10.0%	13.0%
Paris/Velib	65.0%	20.0%	8.0%	7.0%

Table 2. Chronology of Events

Date	Event	Notes
Before September 12th	Prospective participants are directed to sign up for the Bike Loan Program	25 prospective participants inquire about the program, but never sign up on the posted sheet
September 12th	92 students sign up for the bike loan program	A sign-up sheet is posted in the BLP administrative office
September 15th	Surveys sent to 117 program applicants	11 email addresses were invalid. Those emailed included 25 prospective participants who did not sign up on the posted sheets.
September 19	41 students complete Time 1 surveys prior to bike assignments	6 program applicants completed paper copies of the survey prior to bike assignments on Sept 19, 20.
September 19 & 20	40 students receive bikes (experimental) 77 students placed on waiting list (control)	
September 19 - October 13	20 students complete online surveys	
November 25	Time 2 survey emailed to 67 students who completed Time 1 Survey	2 Control Group Subjects received a BLP bike on October 15.
January 6	Time 2 data collection ends	59 subjects submit survey responses.

Table 3. Dependent Variables for Travel; Times 1, 2, and Change

Time	**Variable**	**Variable Name**	**Potential Answers**	**Notes**
Time 1	Mode of travel without a BLP bike.	NoBLPPubTrans	Public Transit	
		NoBLPWalk	Walk	
		NoBLPDrive	Drive a car (Alone)	
		NoBLPCarpool	Carpool	
		NoBLPBike	Bike Anyway	
Time 2	Primary Mode of Travel in Fall 2009.	FallPubTrans	Public Transit	
		FallWalk	Walk	
		FallCarpool	Carpool	
		FallBike	Bike	Aggregate trips taken on both BLP and non-BLP bikes.
		FallDrive	Drive a Car (Alone)	
Time 2 - Time 1	Change between expectations and actual actions.	PubTransDif	--	FallPubTrans - NoBLPPT
		WalkDif	--	FallWalk - NoBLPWalk
		DriveDif	--	FallDrive - NoBLPDrive
		CarpoolDif	--	FallCarpool - NoBLPCarpool
		BikeDif	--	FallBike - NoBLPBike

Table 4. Dependent Variables for Attitudes; Times 1, 2, and Change

Time	Variable	Variable Name	Notes
Time 1, 2	Enjoy Bikes	EnjoyBike1, EnjoyBike2	Attitude Questions on a Scale of 1 - 5, from Strongly Disagree to Strongly Agree
	Confident Cyclist	ConfCyc1, ConfCyc2	
	No Mechanical Skills	NoMech1, NoMech2	
	Healthy Person	Health1, Health2	
	Bike facilities are Important	BikeImp1, BikeImp2	
	Transit is Important	TransImp1, TransImp2	
	Car facilities are Important	DriveImp1, DriveImp2	
Time 2 - Time 1	Change Between Time 1 and Time 2	EnjoyBikeDif	EnjoyBike2 - EnjoyBike1
		ConfCycDif	ConfCyc2 - ConfCyc1
		NoMechDif	NoMech2 - NoMech1
		HealthDif	Health2 - Health1
		BikeImpDif	BikeImp2 - BikeImp1
		TransImpDif	TransImp2 - TransImp1
		DriveImpDif	DriveImp2 - DriveImp1

Table 5. Dependent Variables for Travel; Time 2

Time	Variable	Name	Notes
Time 2	Frequency of BLP Bike Use.	BLPFreq	Response options were: Daily; Several Times per Week; Once a Week; A Few Times per Month; A Few Times per Year; Never
	Frequency of Non-BLP Bike Use.	NBLPFreq	NBLPFreq and BLPFreq were aggregated into BikeFreq
	Frequency of Transit Use.	PubTransFreq	
	Frequency of Car Use (Driving Alone).	DriveFreq	
	Frequency of Walking.	WalkFreq	

Table 6. Independent Variables; Times 1 and 2

Time	Variable	Name	Notes
Time 2	Program Participant	Prgprt	Time 1 preceded BLP Rental Sessions
Time 1	Year in School	Stustat	
	International Student	StuIntl	
	Age	Age	
	Gender	Gender	
	Annual Income	Income	Possible Answers: Under $10,000; $10,001 - $15,000; $15,001 - $20,000; $20,001 - $30,000; Over $30,001
	Live within Walking Distance of Campus	Walkdist	
	Own a Car	Carown	
	Have Access to a Car	Caracc	

Table 7. Minima, Maxima, and Standard Deviations for Variables

	Min.	Max.	STD
Prgprt	0.0	1.0	0.477
Gender	0.0	1.0	0.471
Age	18.0	44.0	4.513
StuIntl	0.0	1.0	0.497
Income	0.0	1.0	0.131
WalkDist	0.0	1.0	0.504
StuStat	0.0	1.0	0.504
CarOwn	0.0	1.0	0.305
CarAcc	0.0	1.0	0.479
PubTransFreq	0.0	7.0	2.440
WalkFreq	0.0	7.0	2.730
DriveFreq	0.0	7.0	0.800
BikeFreq	0.0	7.0	2.920

Table 8. Travel Mode Frequency Response Values

Response	Value
Daily	7.00
Several Times per Week	3.50
Weekly	1.00
A few Times per Month	0.50
A few Times per Year	0.25
Never	0.00

Table 9. BLP Bike versus Non-BLP Bike, Number of Times per Week

	Control	Experimental
N	**19**	**40**
BLP Bike	0.05	5.00
Non-BLP Bike	1.19	0.30

Table 10. Time 1 Response Rate

	Experimental	Control	Total
Responses	38	29	67
Total	40	77	117
Response Rate	95.0%	37.7%	**57.3%**

Table 11. Time 2 Response Rate

	Experimental	Control	Total
Responses	40	19	59
Total	42	75	117
Response Rate	95.2%	25.3%	**50.4%**

Table 12. Time 1 Responses Received before the Rental Sessions*

	Experimental	Control	Total
Responses	31	10	41
Total	40	77	117
Response Rate	77.5%	13.0%	**35.0%**

*Does not include responses from paper surveys.

Table 13. Responses by Time Slot

	September 19th			September 20th		
	Experimental	Control	Total	Experimental	Control	Total
Slot 1	9	3	13	9	3	18
Slot 2	6	1	13	4	6	19
Slot 3	5	1	12	5	8	17
Total	20	5	38	18	17	54

*Total = Survey Reponses + Non-Responders
**Seven Control Group Subjects did not sign up on posted sheets

Table 14. Demographic Comparison to University

Demographics	All	University of Oregon*
N	**57**	**22,386**
Age (Mean)	23.6	23.2
Male	32.2%	49.0%
Female	67.8%	51.9%
International Student	58.6%	6.5%
Income < $20K	96.6%	--
Live w/in 0.5 mi	52.5%	--
Freshman	8.5%	22.3%
Sophomore	13.6%	18.8%
Junior	11.9%	17.5%
Senior	15.3%	21.3%
Graduate Student	47.5%	15.5%
Have Car Access	36.7%	--
Own a Car	10.0%	--

*From 2009 OUS Factbook

Table 15. Demographic Comparison between Groups

Demographics	All	Control	Experimental	P-Value
N	**59**	**19**	**40**	
Age (Mean)	23.6	22.1	24.5	0.056
Male	32.2%	25.0%	36.0%	0.405
Female	67.8%	75.0%	64.0%	--
International Student	58.6%	65.0%	54.0%	0.483
Income < $20K	96.6%	100.0%	93.0%	0.166
Live w/in 0.5 mi	52.5%	45.0%	66.0%	0.415
Undergraduate	52.5%	70.0%	43.6%	0.053
Graduate Student	47.5%	30.0%	56.4%	--
Have Car Access	34.0%	27.0%	38.0%	0.476
Own a Car	10.0%	10.0%	10.0%	0.976

*p < .05; ** p < .01; *** p < .001

Table 16. Travel Expectations in Absence of Bike Loan Program

	Control	Experimental	P-Value
N	**19**	**40**	
NoBLPBike	80%	67%	0.270
NoBLPWalk	80%	62%	0.134
NoBLPDrive	5%	10%	0.457
NoBLPCarpool	5%	5%	0.983
NoBLPPubTrans	80%	74%	0.637

*p < .05; ** p < .01; *** p < .001

Table 17. Trips per Week for Various Modes Used to Travel to any Destination

	All Responses		Control		Experimental		
	Mean	STD	Mean	STD	Mean	STD	P value
N	**59**		**19**		**40**		
FallBike	3.75	2.92	1.24 ***	1.92	5.05	2.47	0.000
FallPubTrans	2.38	2.44	3.90 ***	2.60	1.60	1.96	0.000
FallDrive	0.37	0.80	0.50	1.07	0.30	0.62	0.371
FallWalk	2.87	2.73	3.70	3.00	2.45	2.51	0.095

*p < .05; ** p < .01; *** p < .001

Table 18. Sensitivity Test of Times per Week Used Excluding Late Time 1 Responses

	All Responses		Control		Experimental		
	Mean	STD	Mean	STD	Mean	STD	P value
N	**41**		**10**		**31**		
FallBike	4.27	2.87	1.45 ***	2.42	5.19	2.38	0.000
FallPubTrans	2.37	2.43	4.08 **	2.76	1.82	2.08	0.009
FallDrive	0.31	0.62	0.25	0.41	0.32	0.68	0.751
FallWalk	2.64	2.70	3.25	3.39	2.44	2.43	0.499

*p < .05; ** p < .01; *** p < .001

Table 19. Percentage of Responses Indicating Mode Used at Least Once per Week.

	All Responses		Control		Experimental		
	Mean	STD	Mean	STD	Mean	STD	P value
N	**59**		**19**		**40**		
FallBike	70%	0.46	35% ***	0.49	87%	0.34	0.000
FallPubTrans	64%	0.48	90% **	0.31	51%	0.51	0.001
FallDrive	15%	0.36	20%	0.41	13%	0.34	0.476
FallWalk	63%	0.49	80% *	0.41	54%	0.51	0.038

p < .05; ** p < .01; *** p < .001

Table 20. Sensitivity Test of Use Weekly Use Rates Excluding Late Time 1 Responses

	All Responses		Control		Experimental		
	Mean	STD	Mean	STD	Mean	STD	P value
N	**41**		**10**		**31**		
FallBike	76%	0.44	30% **	0.48	90%	0.30	0.003
FallPubTrans	66%	0.48	90%	0.32	58%	0.50	0.026
FallDrive	15%	0.36	20%	0.42	13%	0.34	0.592
FallWalk	59%	0.50	60%	0.52	58%	0.50	0.917

p < .05; ** p < .01; *** p < .001

Table 21. Travel Expectations versus Mode Used (Time 2 – Time 1)

	All Responses		Control		Experimental		
	Mean	STD	Mean	STD	Mean	STD	P-Value
N	**59**		**19**		**40**		
PubTransDiff	-27%	0.52	0% **	0.46	-41%	0.50	0.003
WalkDiff	-36%	0.58	-35%	0.67	-36%	0.54	0.959
DriveDiff	-8%	0.28	-5%	0.22	-10%	0.31	0.501
CarpoolDiff	-3%	0.26	-5%	0.22	-3%	0.28	0.737
BikeDiff	-14%	0.66	-60% ***	0.60	10%	0.55	0.000

p < .05; ** p < .01; *** p < .001

Table 22. Sensitivity Test of Expected Mode versus Actual Excluding Late Time 1 Responses

	All Reponses		Control		Experimental		
Variable	Mean	STD	Mean	STD	Mean	STD	P-Value
N	**41**		**10**		**31**		
PubTransDiff	-27%	0.55	20% *	0.42	-42%	0.50	0.001
WalkDiff	-39%	0.59	-40%	0.70	-39%	0.56	0.950
DriveDiff	-5%	0.22	0%	0.00	-6%	0.25	0.420
CarpoolDiff	-2%	0.27	-10%	0.32	0%	0.05	0.319
BikeDiff	-12%	0.60	-70% ***	0.48	6%	0.51	0.000

p < .05; ** p < .01; *** p < .001

Table 23. Change in Attitudes and Perceptions (Time 2 – Time 1)

	All Responses		Control		Experimental		
	Mean	STD	Mean	STD	Mean	STD	P-Value
N	**59**		**19**		**40**		
EnjoyBikeDif	0.08	0.73	-0.05	0.76	0.15	0.71	0.311
ConfCyclDif	0.12	1.00	-0.10	1.02	0.23	0.99	0.233
NoMechDif	-0.08	1.10	0.00	1.12	-0.13	1.11	0.676
HealthDif	-0.07	0.74	-0.40 *	0.82	0.10	0.64	0.023
BikeImpDif	-0.17	0.89	-0.30	0.87	-0.10	0.91	0.426
TransImpDif	0.02	0.90	-0.30	0.80	0.18	0.91	0.052
CarImpDif	-0.05	1.22	-0.30	1.46	0.08	1.09	0.315

Table 24. Sensitivity Test of DiD Attitudes Excluding Late Time 1 Responses

	All Responses		Control		Experimental		
Statement	Mean	STD	Mean	STD	Mean	STD	P-Value
N	**41**		**10**		**31**		
EnjoyBikeDif	0.07	0.61	0.00	0.82	0.10	0.54	0.670
ConfCyclDif	0.02	0.96	-0.20	1.10	0.10	0.91	0.400
NoMechDif	-0.07	1.17	-0.20	1.40	-0.03	1.11	0.700
HealthDif	0.00	0.67	-0.30	0.82	0.10	0.60	0.100
BikeImpDif	-0.20	0.68	-0.30	1.06	-0.16	0.52	0.580
TransImpDif	-0.05	0.63	-0.40 *	0.70	0.06	0.57	0.040
CarImpDif	-0.02	1.37	-0.40	1.84	0.10	1.19	0.440

p < .05; ** p < .01; *** p < .001

Table 25. Time 2 Travel Behavior Multivariate Regression

	PubTransFreq	WalkFreq	DriveFreq	BikeFreq
R-Square	0.36	0.84	0.17	0.53
Program Participant	-1.59	-1.32	-0.39	3.69 ***
Female	-0.20	0.04	0.37	-0.09
Age	0.04	-0.05	0.04	-0.12
International Student	0.15	-0.30	0.30	2.03 *
Income < $20K	--	--	--	--
Income > $20K	-0.84	-0.97	-0.01	3.49
Live w/in 0.5 mi	-0.55	2.50 **	-0.30	-0.66
Undergraduate	--	--	--	--
Graduate Student	-1.34	0.54	0.17	0.98
Own a Car	3.89	1.47	-0.34	1.05
Have access to a car	1.84 *	-1.58	0.00	0.56

p < .05; ** p < .01; *** p < .001

Table 26. P-Values and T-Statistics

	PubTransFreq		WalkFre		DriveFreq		BikeFreq	
	P	T	P	T	P	T	P	T
Constant	0.150	-1.47	0.126	1.57	0.298	-1.06	0.008	2.81
Program Participant	0.056	1.98	0.129	1.55	0.244	1.18	0.000	-4.51
Female	0.785	-0.28	0.960	0.05	0.229	1.23	0.905	-0.12
Age	0.743	0.33	0.704	-0.38	0.455	0.76	0.334	-0.98
International Studen	0.857	0.18	0.730	0.35	0.383	-0.88	0.022	-2.41
Income < $20K	--	--	--	--	--	--	--	--
Income > $20K	0.731	-0.35	0.707	-0.38	0.996	-0.01	0.166	1.42
Live w/in 0.5 mi	0.467	0.74	0.003	-3.18	0.332	0.99	0.391	0.87
Undergraduate	--	--	--	--	--	--	--	--
Graduate Student	0.189	-1.34	0.613	0.51	0.685	-0.41	0.343	0.96
Own a Car	0.053	2.01	0.481	-0.71	0.676	0.42	0.599	-0.53
Have access to a ca	0.03	-2.31	0.068	-1.88	0.991	-0.01	0.497	0.69

Table 27. Sensitivity Test of Mode Use Regression Excluding Late Time 1 Responses

	PubTransFreq	WalkFreq	DriveFreq	BikeFreq
R-Square	0.28	0.25	0.06	0.48
Constant	-5.95	-7.03	1.51	16.89
Program Participant	-1.90	-1.16	0.02	3.86 ***
Female	-0.22	0.25	0.14	0.10
Age	0.02	0.10	0.00	-0.20
International Student	-0.86	-0.55	0.10	1.28
Income < $20K	--	--	--	--
Income > $20K	-0.94	-0.60	-0.26	2.07
Live w/in 0.5 mi	-0.93	1.97	-0.08	-0.51
Undergraduate	--	--	--	--
Graduate Student	0.22	0.13	0.02	0.95
Own a Car	-1.86	-3.13	0.61	1.83
Have access to a car	-0.04	-0.15	0.03	0.07

p < .05; ** p < .01; *** p < .001

Table 28. Change in Attitudes and Perceptions Multivariate Regression

	EnjoyBikeDif	ConfCyclDif	NoMechDif	HealthDif	BikeImpDif	TransImpDif	CarImpDif
R-Square	0.21	0.19	0.30	0.26	0.05	0.19	0.16
Constant	-0.63	0.82	5.06	2.80	-1.27	-0.10	1.34
Program Participant	0.14	0.68	0.16	0.59 *	0.18	0.32	0.30
Female	0.01	0.32	-0.38	-0.15	0.34	0.21	-0.54
Age	0.04	0.06	-0.06	-0.03	0.03	-0.03	0.02
International Student	0.28	-0.21	1.06 **	0.54 *	0.09	0.21	0.22
Income < $20K	--	--	--	--	--	--	--
Income > $20K	-0.07	-0.36	1.85	1.27	0.13	-0.24	1.55
Live w/in 0.5 mi	0.45	0.29	-0.10	0.13	0.16	-0.16	-0.62
Undergraduate	--	--	--	--	--	--	--
Graduate Student	-0.50	-0.28	0.43	-0.10	-0.22	0.01	0.25
Own a Car	-0.69	0.38	-0.83	0.09	-0.22	-0.60	0.73
Have access to a car	-0.02	0.23	0.34	-0.05	-0.15	-0.52	0.09

p < .05; ** p < .01; *** p < .001

Table 29. P-Values and T-Statistics

	EnjoyBikeDif		ConfCycDif		NoMechDif		HealthDif		BikeImpDif		TransImpDif		CarImpDif	
	P	T	P	T	P	T	P	T	P	T	P	T	P	T
Constant	0.710	-0.38	0.715	0.37	0.028	2.29	0.101	1.69	0.603	-0.52	0.957	-0.06	0.653	0.45
Program Participant	0.591	-0.54	0.055	-1.98	0.650	-0.46	0.027	-2.31	0.630	-0.49	0.287	-1.08	0.514	-0.66
Female	0.980	0.03	0.316	1.02	0.241	0.24	0.521	-0.65	0.331	0.99	0.444	0.77	0.215	-1.26
Age	0.317	1.02	0.300	1.05	0.265	-1.11	0.484	-0.71	0.584	0.55	0.511	-0.66	0.764	0.30
International Student	0.306	-1.04	0.554	-0.60	0.005	-3.00	0.049	-2.04	0.823	-0.23	0.487	-0.70	0.650	0.46
Income < $20K	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Income > $20K	0.931	-0.09	0.732	-0.35	0.083	1.79	0.112	1.63	0.908	0.12	0.790	-0.27	0.272	1.12
Live w/in 0.5 mi	0.073	-1.85	0.381	-0.89	0.763	0.30	0.591	-0.54	0.646	-0.46	0.558	0.59	0.157	1.45
Undergraduate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Graduate Student	0.133	-1.54	0.522	-0.65	0.558	0.59	0.748	-0.32	0.641	-0.47	0.984	-0.02	0.664	0.44
Own a Car	0.284	1.09	0.654	-0.45	0.284	-1.09	0.886	0.15	0.811	0.24	0.398	0.86	0.518	-0.65
Have access to a car	0.955	0.06	0.500	-0.68	0.725	0.36	0.854	-0.19	0.684	-0.41	0.083	-1.79	0.847	0.20

Table 30. Sensitivity Test of DiD Attitudes Excluding Late Time 1 Responses

	EnjoyBikeDif	ConfCyclDif	NoMechDif	HealthDif	BikeImpDif	TransImpDif	CarImpDif
R-Square	0.17	0.13	0.15	0.19	0.19	0.16	0.17
Constant	-1.84	1.91	0.42	0.99	-0.23	0.14	-3.14
Program Participant	0.13	0.38	-0.22	0.57 *	0.38	0.49 *	0.50
Female	0.01	0.19	-0.24	-0.02	0.17	-0.08	0.62
Age	0.00	-0.03	-0.07	-0.02	0.00	0.01	-0.03
International Student	-0.44	-0.15	-0.66	-0.06	-0.33	0.03	-0.50
Income < $20K							
Income > $20K	-0.59	-0.50	0.41	0.97	0.14	-0.22	0.10
Live w/in 0.5 mi	0.20	0.30	0.19	0.00	0.12	0.25	0.01
Undergraduate							
Graduate Student	-0.10	0.16	0.73	-0.17	-0.23	0.01	0.54
Own a Car	-0.92 *	0.40	-0.12	-0.18	0.02	-0.32	-1.10
Have access to a car	-0.01	-0.02	-0.01	0.02	-0.04	-0.04	-0.07

p < .05; ** p < .01; *** p < .001

APPENDIX B

TIME 1 SURVEY

ID# ___________

Bike Loan Program Entrance Survey

The following is an entrance survey for Bike Loan Program (BLP) participants, and for students who have expressed interest in participating in the program for the Fall 2009-10 term. Please fill out the below questions. The data will be reported anonymously and cannot be used to link your identity to your response. If "other" is chosen, please write in a brief explanation or description.

If you do not feel comfortable answering a question, feel free to skip to the next one.

At the end of the survey, you will be asked to provide your contact information. Again, this will not compromise anonymity when data is reported.

1) Are you interested in participating in the Bike Loan Program? (If not, please do not continue)

   A. Yes   B. No

2) Please indicate your academic status at the start of the Fall 2009 term.

   A. Freshman
   B. Sophomore
   C. Junior
   D. Senior
   E. Other ______________________________

3) Are you an international student studying at U of O for one year or less?

   A. Yes   B. No

4) How old are you? _____

5) What is your sex?

   A. Male   B. Female

6) What state or country were you a resident of before enrolling at U of O?

7) What is your annual income (not including student loans)?

   ☐ Under $10,000
   ☐ $10,000 - $15,000
   ☐ $15,001 - $20,000
   ☐ $20,001 - $30,000
   ☐ $30,001 - $40,000
   ☐ Over $40,000

8) Do you live within walking distance (about 0.5 mi/1 km) from campus?

   A. Yes   B. No

9) What is the nearest street intersection to your residence?

10) Is this your first school term attending the U of O? (If yes, skip to 12)

   A. Yes   B. No

1) How did you primarily travel in previous terms while attending U of O?

- ☐ Public transit (Bus, EmX)
- ☐ Walk
- ☐ Drive a car
- ☐ Carpool
- ☐ Bike
- ☐ Other ______________________________

2) How often did you use the following to travel to any destination in previous terms while attending U of O:

Bike

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ____________________________

Public Transportation

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ____________________________

Car

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ____________________________

Carpool

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ____________________________

Walking (Not including from a parking spot/bus/bike rack)

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ____________________________

3) How Often did you park on campus in previous school terms?

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ____________________________

14) Do you currently own a car?

A. Yes

B) No

15) If you own a car, how often do you expect to park on campus?

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ___________________________

16) If you do not own a car, do you have access to a car if necessary?

A. Yes

B) No

17) In the event that you were not to have a Bike Loan Program bike, how would you plan to travel this year? (Please check all that apply)

- ☐ Public transit (Bus, EmX)
- ☐ Walk
- ☐ Drive a car
- ☐ Carpool
- ☐ Buy a bike
- ☐ Other ___________________________

18) What problem(s) do you generally encounter with bicycling? (Please Check all that apply)

- ☐ Dangerous traffic conditions
- ☐ Lack of bike facilities (e.g., racks, lanes, etc.)
- ☐ Bad weather
- ☐ Other
- ☐ Lack of mechanics knowledge
- ☐ Poor biking skills or training
- ☐ Poor physical health
- ☐ Hilly terrain

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Circle the number that corresponds best to your attitude, where 1 indicates that you strongly disagree and 5 indicates that you strongly agree. **Leave blank if the question does not apply to you.**

	Strongly Disagree		Neutral		Strongly Agree
1) I generally enjoy riding bikes	**1**	**2**	**3**	**4**	**5**
2) I am a confident bicyclist and don't mind riding in traffic.	**1**	**2**	**3**	**4**	**5**
3) I do not understand how to fix or adjust problems with a bike.	**1**	**2**	**3**	**4**	**5**
4) I am a generally healthy person.	**1**	**2**	**3**	**4**	**5**
5) Having a bike-friendly community (bike lanes, slow traffic, bike parking) is important to me.	**1**	**2**	**3**	**4**	**5**
6) Public transportation with low cost and frequent service is important to me.	**1**	**2**	**3**	**4**	**5**
7) Having a car-friendly community (many lanes, few crosswalks, free parking) is important to me.	**1**	**2**	**3**	**4**	**5**

Please enter your name and contact information below to be entered into a drawing for a $20 gift certificate to the Duck Store, and to be eligible for a $5 payment for completion of the exit survey at the end of the Fall term.

APPENDIX C

TIME 2 SURVEY

ID# ___________

Bike Loan Program Exit Survey

The following is an entrance survey for Bike Loan Program (BLP) participants, and for students who have expressed interest in participating in the program for the Fall 2009-10 term. Please fill out the below questions. The data will be reported anonymously and cannot be used to link your identity to your response. If "other" is chosen, please write in a brief explanation or description.

If you do not feel comfortable answering a question, feel free to skip to the next one.

At the end of the survey, you will be asked to provide your contact information. Again, this will not compromise anonymity when data is reported.

1) Did you receive a bike from the Bike Loan Program during Fall term of 2009?

   A. Yes
   B. No

2) Did you complete an entrance survey for this study?

   A. Yes
   B. No

3) Please indicate your academic status at the start of the Fall 2009 term.

   A. Freshman
   B. Sophomore
   C. Junior
   D. Senior
   E. Other ______________________

4) Are you an international student studying at U of O for one year or less?

   A. Yes
   B. No

5) How old are you? _____

6) What is your sex?

   A. Male
   B. Female

7) What state or country were you a resident of before enrolling at U of O?

8) Do you still live within walking distance (about 0.5 mi/1 km) from campus?

   A. Yes
   B. No

9) What is the nearest street intersection to your residence?

10) How did you primarily travel in during Fall term of 2009 at U of O? (Check all that apply)

   ☐ Public transit (Bus, EmX)
   ☐ Walk
   ☐ Drive a car
   ☐ Carpool
   ☐ Bike
   ☐ Other ______________________

11) How often did you use the following to travel to any destination during Fall term 2009 at U of O:

Bike

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ______________________

Public Transportation

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ______________________

Car

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ______________________

Carpool

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ______________________

Walking (Not including from a parking spot/bus/bike rack)

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ______________________

12) Do you currently own a car?

A. Yes
B) No

13) If you own a car, how often did you park on campus during Fall term at U of O?

A. Daily
B. Several times per week
C. Once a week
D. A few times per month
E. A few times per year
F. Never
G. Other ______________________

14) If you do not own a car, do you have access to a car if necessary?

A. Yes

B) No

15) What problem(s) do you generally encounter with bicycling? (Please Check all that apply)

- ☐ Dangerous traffic conditions
- ☐ Lack of bike facilities (e.g., racks, lanes, etc.)
- ☐ Bad weather
- ☐ Other
- ☐ Lack of mechanics knowledge
- ☐ Poor biking skills or training
- ☐ Poor physical health
- ☐ Hilly terrain

____

____

Circle the number that corresponds best to your attitude, where 1 indicates that you strongly disagree and 5 indicates that you strongly agree. **Leave blank if the question does not apply to you.**

	Strongly Disagree		Neutral		Strongly Agree
1) I generally enjoy riding bikes	**1**	**2**	**3**	**4**	**5**
2) I am a confident bicyclist and don't mind riding in traffic.	**1**	**2**	**3**	**4**	**5**
3) I do not understand how to fix or adjust problems with a bike.	**1**	**2**	**3**	**4**	**5**
4) I am a generally healthy person.	**1**	**2**	**3**	**4**	**5**
5) Having a bike-friendly community (bike lanes, slow traffic, bike parking) is important to me.	**1**	**2**	**3**	**4**	**5**
6) Public transportation with low cost and frequent service is important to me.	**1**	**2**	**3**	**4**	**5**
7) Having a car-friendly community (many lanes, few crosswalks, free parking) is important to me.	**1**	**2**	**3**	**4**	**5**

Please enter your name and contact information below to be eligible for a $5 payment for completion of the exit survey at the end of the Fall term.

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