Final Project Proposal

DEMOGRAPHIC DETERMINANTS OF BICYCLE MODE SHARE IN MONTANA

BY:

Harry Potter

Hermione Granger

Ron Weasley

THE UNIVERSITY OF MONTANA

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INTRODUCTION

Many cities in the United States and around the world have experienced a resurgence in bicycle commuting. The rate of work commuters who choose bicycling as their transportation mode is not evenly distributed spatially, socio-economically, or demographically. Readily accessible census demographic data can be used to help explain variations in bicycle commuting.

The League of American Bicyclists reports that Montana has the 3rd highest share of bicycle commuters in the United States as of 2008, and the total share rose roughly 51% from 2000 (League of American Bicyclists, 2008). Montana is not only a haven for recreational bicycling, but also for urban commuting to work and other utilitarian bike trip purposes. Montana’s share of bicycle commuting as of 2008 is around 1.45%, but no GIS reports have been published displaying the geographic distributions of bicycle commuters by census tract in relation to other census demographics.

A great deal of work has been done to try to explain the factors which determine transportation mode choice and why people choose to bicycle (Buehler, 2011; Parkin et al., 2008; Pucher et al., 2010; Pucher and Beuhler, 2006). Research on the determinants of mode choice have covered a wide variety of factors at different scales, but none have attempted to spatially correlate different demographic variables with bicycle commuting in Montana by census tract. A census tract level GIS analysis of the demographic determinants of bicycle mode share for Montana will allow for a detailed spatial visualization of where the highest concentrations of bicycle commuters live within the state, and will determine which demographic variables most explain bicycle commuting.

This project will use Geographically Weighted Regression and Moran's I Spatial Autocorrelation in ArcGIS to determine which census demographic variables best explains bicycle mode share. The U.S. Census Bureau provides recent journey to work data and all of the other demographic data that will be needed for analysis. Geographic data (census tracts) can also be readily accessed from the U.S. Census Bureau.

PROBLEM STATEMENT

The purpose of this project is to explain which socio-economic and demographic variable most determines bicycle commuting as a transportation mode choice throughout Montana's census tracts. The demographic data can be tested using Geographic Weighted Regression techniques to see what correlations exist between Montana’s share of bicycle commuters and census tract demographic variables that may (or may not) explain people's mode choice.

The results will answer these two research questions:

1. Where are Montana's highest concentrations of bicycle commuters?
2. Which demographic variable (average commute time, average car ownership, average income, and percent educated) is the most correlated with bicycle mode share in Montana census tracts?

We will use census tracts of socio-economic and demographic data, and Geographically Weighted Regression analysis to explain the correlations that exist between share of bicycle commuting and four demographic (explanatory) variables (average commute time, average number of cars owned, average income, and percent educated), and to test which demographic variable explains higher bicycle mode share in census tracts throughout Montana.

CONCEPTUAL FRAMEWORK

Riding a bicycle as a primary mode of transportation is becoming more and more common in the U.S. Recent studies have shown, however, that Canadians and Germans are three to four times more likely to ride a bicycle as their primary method of transportation than in the US. Using Comparative national travel surveys, determinants of transport mode choice between Canada and Germany have been compared to the United States. John Pucher and Ralph Buehler describe the various reasons Canadians are more likely to use a bicycle as their main form of transportation in the paper “Why Canadians cycle more than Americans: A comparative Analysis of bicycling trends and policies." Ralph Buehler describes reasons Germans use alternate mode choices in the paper "Determinants of transport mode choice: a comparison of Germany and the USA."

In Canada, the majority of the population lives near the southern border. This conglomeration of population centers near the southern border has forced planners throughout Canadian history to build in a way that creates more densely compact cities than in the U.S. The many different and necessary uses of this portion of land along the southern border leaves only so much room for human settlement. Germany and the U.S. have much in common including wealth, high standards of living, high levels of car ownership, and dense cities. Germany is much less car dependent, however, than Americans and are more likely to choose an alternate mode choice over driving.

Statistically, cities that are denser have a higher percentage of people using a bicycle as a primary mode of transportation. Regression analysis reveals significant similarities between individuals who live close to destinations at higher population densities. Areas with a greater mix of residences and workspaces interspersed (i.e. mixed development land-use) results in increased bicycle transportation (Buehler, 2011). This is due to a variety of factors. The most obvious factor is that shorter distances are more easily biked on a regular basis. Canadians have a shorter ride time due to retail, businesses, and homes being located near one another (Buehler and Pucher 2006); this is contrary to the development of many U.S. urban environments where businesses and homes are separated. Other forms of travel, such as walking or using public transportation, are also easier in denser cities. The combination of all of these factors helps to promote regular use of the bicycle as a primary mode of transportation. Though these factors prove to be true for other countries, Americans living in dense mixed-use areas and close to public transport are more likely to drive than Germans living in lower density areas (Buehler, 2011).

Income and automobile ownership are primary determinants for explaining the difference in mode choice. Increased incomes make owning and maintaining a car more feasible and increases distances that can be traveled (Buehler, 2011). Car ownership in Canada and Germany is quite different from that in the U.S. Pucher and Buhler describe that the average household income of individuals and families in Canada is much lower, 23% less than in the U.S. This makes the cost of purchasing, maintaining, and regularly driving vehicles more difficult. Gasoline prices are much higher in Canada than U.S., because the Canadian government taxes petroleum at a higher rate than the U.S. Similarly, owning and operating a car is more expensive in Germany where tax on fuel is nine times higher and the cost of registration is 2.6 times higher (Buehler 2011). Parking in Canadian cities is very limited in comparison to the U.S. and, on average, costs much more. Canadians overall have 41% fewer cars and light trucks owned and operated than in the U.S. This implies that demographic values such as average income, household size, gender, and age have impacts on travel distance and frequency. Combined, these factors are likely to deter many people from choosing an automobile as their primary method of transportation.

Governments also play a role in transportation. Road infrastructure in cities contributes to faster, safer travel. A greater mix of land-uses and shorter trip distances make travel by bike and foot more feasible (Buehler 2011). Bike lanes make traveling by bicycle safer than sharing the road with cars. Limitations placed on drivers plays an important role on the mode of travel. Reduced speeds in urban areas makes traveling by bicycle safer and more practical then areas that have increased speeds.

Bicycling as a primary mode of transportation is slowly increasing. The Federal government now places a much higher emphasis on planning around the use of bicycling as a primary method of transportation and provides states with much more funding than they have in the past (Buehler and Pucher 2006). It remains the states' responsibility to choose how to spend this money. Not all states are actively planning around bike use, but many are.

The U.S. has much more space overall than Canada and has cities that have been designed more around the use of the automobile. The lack of bicycling infrastructure has a definite impact on overall bicycle use in the U.S. The lack of designated paths and bike parking clearly deters many people from biking regularly. This lack of infrastructure for bicycling creates a much more dangerous biking environment. Currently, the U.S. ranks the highest in total cycling fatalities with an average rate of 5.74 fatalities per 100 km cycled. In Canada, the average total is only 2.39 fatalities, and a number of European countries have even lower totals. Germany has a low of 2.43 fatalities per 100 km cycled, while France and Denmark follows closely with 2.04 and 2.0, respectively (Buehler and Pucher 2006).

Since 1999, a bicycling renaissance has been taking place in North America. Both the U.S. and Canada have experienced increases in utilitarian bike mode use and cycling infrastructure has been put into place to allow for the greater number of people choosing cycling as a form of transportation. In several large cities, cycling infrastructure has facilitated this cycling renaissance with the highest concentration of increase in bike mode transportation being found in the central portions of these cities. In particular, university districts and business districts are the focal points of cycling increases. Additionally, western cities tend to have much higher cycling rates while the South tends to have much lower rates (Pucher et al, 2011). This could be due to the fact that a majority of cycling is to and from work and humid environments are not suitable for biking to work.

Culture and attitudes influence travel behavior (Gleensen and Low, 2001). Cycling is becoming a mainstream mode of transportation in many cities due to the implementation of cyclist-friendly infrastructure and policies. Portland is a shining example of the proper implementation of policies and infrastructure. In 2008, Portland reported that roughly 18% of its residents utilized bike mode transportation as their primary or secondary form of travel to and from work (Pucher et al 2011).

Though there is certainly an increase in utilitarian bike mode transportation in many large North American cities, the majority of travel is dominated by cars. Dramatic progress has been made in these large cities but overall the U.S. has only seen cycling rise from 0.4% to 0.6% while Canada has had a rise from 1.1% to 1.3% (Pucher et al 2011). There can be no doubt, however, that proper infrastructure and policy implementation can facilitate large growths in bike mode transportation.

PROPOSED METHODS

In order to explain different ridership rates, we plan to use geographically weighted regression using up to three different variables. We will use census tract level data on share of bicycle commuters (those who work, commute by bicycle, and are 16 years or older), average travel time to work, percent educated, average income, vehicle ownership, population density, and other possible variables mentioned in Heinen et. al. (2010). We will gather our data from the U.S. Census Bureau and the League of American Bicyclists. We will perform Moran's I spatial autocorrelation on each variable combination. The results of each combination will be compared with each other to find the strongest combination. Nonsensical combinations (such as population and population density) will be ruled out.

Because we want to test all possible one, two, and three variable combinations, we will use python to automate the process. The script will take in the shapefile, perform a geographically weighted regression, perform a spatial autocorrelation, and write the results to a comma-separated values file. After completion, the .csv file can be open and sorted for easy comparison.

After we choose the strongest variable combination, we will visually analyze the resulting local R2 map to determine how dispersed or clumped the values are. A strong combination should appear neither dispersed nor clumped, indicating that our selected variables account for most of the spatial variation in ridership.

We will create a ridership map for the state of Montana, with additional maps for areas where census tracts are too small. We will also make local R2 maps for explanatory variables.

There are limitations to the study being proposed, as other factors besides census demographic variables play a role in people's choice to bicycle to work. For the intention of this project, the census demographic variables are the focus due to the ready availability of the demographic data on commute time to work, car ownership, percent educated, and average income. It should be noted that other factors contribute to people's choice to bicycle to work (i.e. infrastructure, mixed land-use, physical terrain or climate attributes, policies, social norms, and attitudes among others).

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