Impact of the High Population Events on Urban Mobility: Who is Affected the Most?

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Abstract

This project explores mobility in Washington, D.C. in normal conditions and during highly populated events that create a shock to the transportation system. Washington is significant as the nation's capital and therefore a host of major events. Washington is also a considerably segregated city. Because of the frequent events and segregation, it is important to model mobility throughout the city and the metropolitan area. Specifically, this paper models normal traffic conditions in Washington and conditions during the 2017 inauguration and subsequent Women's March by using Spatial Autoregressive Models.

Introduction

Examining Washington D.C. during the 2017 women's march and presidential inauguration, this paper looks to examine the effect that large scale public events have on urban mobility. On January 20, 2017, Donald Trump was inaugurated in Washington. The following day, January 21, hundreds of thousands of people protested Trump's inauguration through the Women's March. The women's march in Washington has been called the largest protest in the United States with an estimated 470,000 people in attendance. Crowd scientists estimate that the crowd at the Trump inauguration was about around 160,000 people, a third of the size of the protest (Wallace and Parlapiano 2017). A population increase of this size over the course of just one weekend creates a huge shock to the transportation system. This can occur through the influx of people coming into the city as well as road blocks impeding traffic. This study looks at changes in the mean travel time to the center of D.C., with the center point defined as the Washington Monument. Before modeling this impact, however, we first modeled the impact of demographic census data on travel time during normal January conditions. We then were able to observe how demographics impact mobility and how those factors are exacerbated during major shocks to the system. We found that the number of roads, distance to the Washington Monument, and the number of black residents are consistently the most significant predictors of travel time to each polygon from the Washington Monument. Further, we found that ____________ ADD FINDINGS ABOUT SIGNIFICANCE DURING SHOCK!!!

It is important to examine urban mobility in two ways. First, city attributes such as road or transit access make certain areas more accessible. Unfortunately, accessibility or mobility often falls along racial or class lines. Washington is highly segregated and the cause of which is likely in part be due to urban planning that partitions the city into separate demographics.

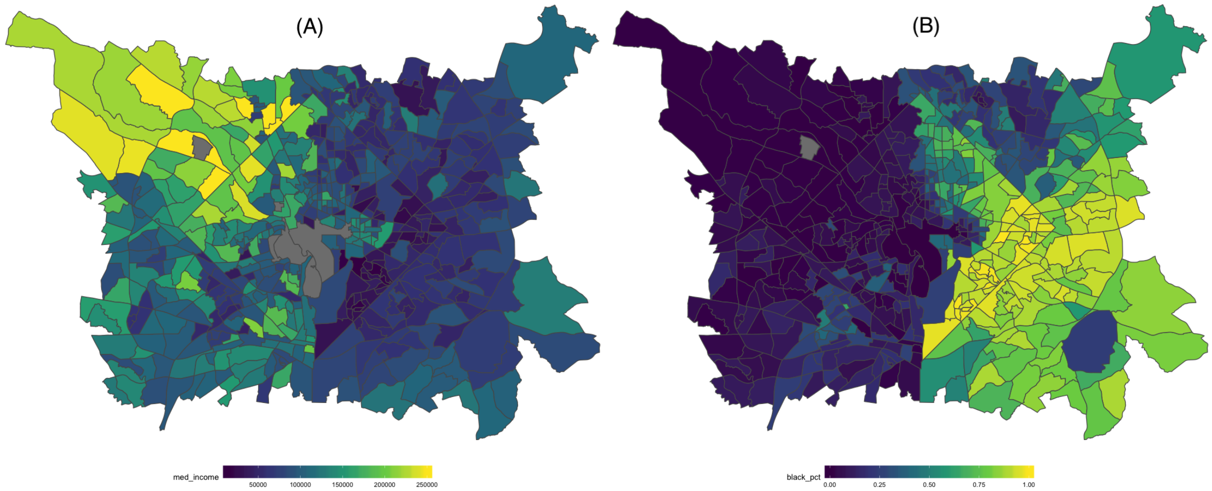

Figure 1: Graph 1

As shown in figure 1 and 2, it is clear that there are sharp both economic and racial divides as shown by census demographics. Whether the partitions assigned to each demographic group affect their ability to access the center or downtown area of D.C. is a key question to answer if transportation policy is focused on helping different demographics. By using a simultaneous autoregressive model on travel time to the Washington Monument during normal times, we are able to see the impact of race on D.C. area mobility. We observed that the population of black residents in a census tract is one of the few significant variables in predicting travel time to the Washington Monument. Second, major increases in population during special events can shock the city's infrastructure. For this reason, we looked at Washington because it is a city that is especially significant during major national events such as the inauguration and therefore attracts huge numbers of additional visitors. We used a similar simultaneous autoregressive model for the week of the inauguration and Women's March and then modeled the differences between the normal weeks and the inauguration and march to observe the shock on the system. Through modeling both before and during the major events, we were able to observe both demographic significance of travel time and the impact of major population changes on the system.

In order to examine the shock from these massive events, we used areal Uber data which includes travel times between various census tract locations in the DC metropolitan area. To model travel times before and during the event periods, we isolated a location and looked only at the travel time between each census tract in the Washington metropolitan area and the Washington Monument. We chose the Washington Monument as the origin because it is in the middle of the National Mall, where many significant events, including the inauguration and Women's March, took place. Because the spatial features being analyzed are census tracts, we were able to include census information for each polygon through the `tidycensus` package (Walker 2018). This data allowed us to address the impact of demographics on travel time.

Literature Review

Many scholars have studied both mobility and shocks to the system in a variety of contexts. It is important to closely study every city's transportation system which is why many studies have been conducted. Noulas et. al use a network called Foursquare which records peoples locations to track and model mobility in a number of different cities (Noulas et al. 2012). Studies about mobility and accessibility have been conducted in many cities including New York City (Litman 2017) where concepts such as accessibility can be quantified and modeled to demonstrate lapses in the system. Shocks to transportation systems have also been modeled by a number of scholars. Donovan and Work's 2017 study uses taxi data to model the impacts of major events such as hurricane Sandy on New York city (Donovan and Work 2017). Wang also modeled the impact of Hurricane Sandy on New York city by looking at images of people throughout the city (Wang and Taylor 2014). Other major events modeled by scholars include the Olympics (Friedman et al. 2001) and the World

Cup (Menezes and Souza 2014). Transportation scholars have used a variety of data sources to observe the mobility of people including taxi data, satellite imagery, and cell phone data (Calabrese et al. 2010). Uber data is accessible and also provides an indication of mobility since so many people travel in cars. Because of this accessibility, we decided to model the effects of the inauguration and Women's March in Washington, D.C. that happened during the third weekend of January 2017.

Methods

Our goal in modeling the travel times of different census tracts to the Washington monument is twofold. First, we want to see what factors in general influence travel times; and second, we want to see if these factors determine whether a census tract is heavily affected by a signficant event such as the inauguration and Women's March. The census track features we consider during this analysis are the distance to Washington monument, median income, asian, white, and black percentage demographics, percent of people who use cars as their primary mode of transportation versus public transit, number of primary-secondary roads (see ACS Technical Documentation, Page 3-42), and number of transit lines. The purpose of using several features that may distinguish census tracts and specific methods is to find non-confounded estimates and accurately infer what affects travel times.

We first consider whether or not our data is spatially autocorrelated. For example, neighboring census tracts likely have very similar travel times and demographics simply by virtue of being physically near each other. If this correlation was not present, we would see that the travel times between neighboring census tracts have no relation at all. Under spatially autocorrelated conditions, the standard errors of regression become inflated and thus a correlation structure based on neighboring polygons is necessary. Understandably, another equally important choice involved in this analysis is how to define neighbors.

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