Buffalo MSA Accessibility Report (Assignment A05)

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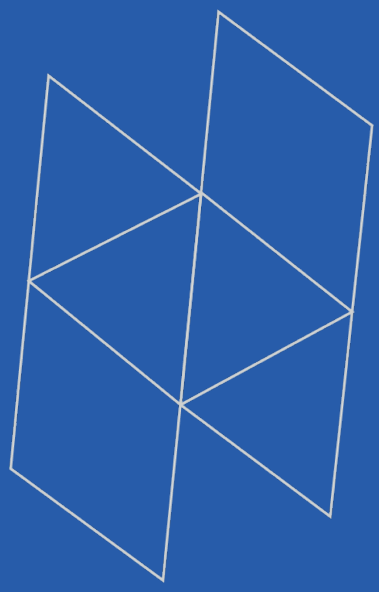

SES 5394: Travel Behavior and Forecasting
Professor Carole Voulgaris
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A05: Buffalo MSA Accessibility Report

Study Area Overview

The Buffalo-Cheektowaga-Niagara Falls, NY Metropolitan Statistical Area (aka the "Buffalo MSA") consists of Erie and Niagara Counties in western New York State; including the cities of Buffalo, Niagara Falls, Tonawanda, and Lackawanna. As of the 2020 census, the MSA had a population of 1,166,902 (the 49th most populous MSA in the United States), an area of 1,567 square miles, and a population density of 718 residents / square mile. The demographics of the MSA's population were 74.5% White, 13.0% Black or African American, 0.7% American Indian or Alaska Native, 4.2% Asian, <0.1% Pacific Islander, 2.1% Other, and 5.5% Two or More Races. 5.8% of the population identified as Hispanic or Latino.

Based on American Community Survey 2021 1-year data, 73% of residents drove alone to work, 6% carpooled, and 14% worked from home, while 3% of residents took public transit and 2% walked. 68% of units were owner-occupied, and the median home value of owner-occupied homes was $192,000. 65% of housing units were single units, 33% were in multi-unit buildings, and 2% were in mobile homes. 92.5% of residents had achieved a high school diploma or higher, while 36.9% of residents had attained a bachelor's degree or higher.

Zonal Statistics

We have defined the census tracts contained within the Buffalo MSA as our traffic analysis zones.

The median number of households in each traffic analysis zone is 1,471, having a median household income of $34,080. The median number of 1-person households was 517.5; 2-person households, 513.1; 3-person households, 212.7; and 4-person or larger households, 273.9. The median number of family households (married couples with or without children) in each zone was 555, while the median number of other family households (male/female households with or without children) was 218 and the median number of non-family households was 589.

On average, the majority of households in each zone of the Buffalo MSA have access to at least one vehicle. The median number of households per zone without any vehicle was 127, while the median number of households with one vehicle was 576.2 and the median number of households with two vehicles was 512. At the upper end of the spectrum, the median number of households with three vehicles was 155, and four or more vehicles was 61.13. A dot density map of vehicle ownership rates can be seen in Figure 1, and the percentage of households owning vehicles by zone is visualized in Figure 2.

Census tracts in the Buffalo-Niagara Falls MSA show a wide range of employment types. The median number of total employees per zone was 1036.5; with 148.5 of those being basic employees, 79 being retail employees, and 586 being service employees.

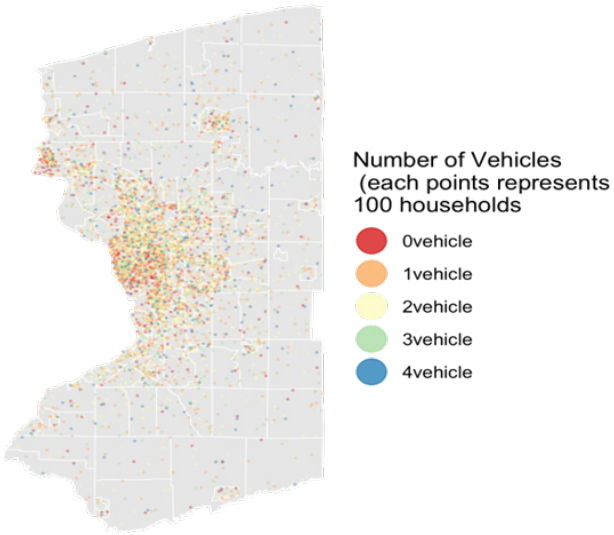

Figure 1 - Number of Vehicles Owned Per Household.

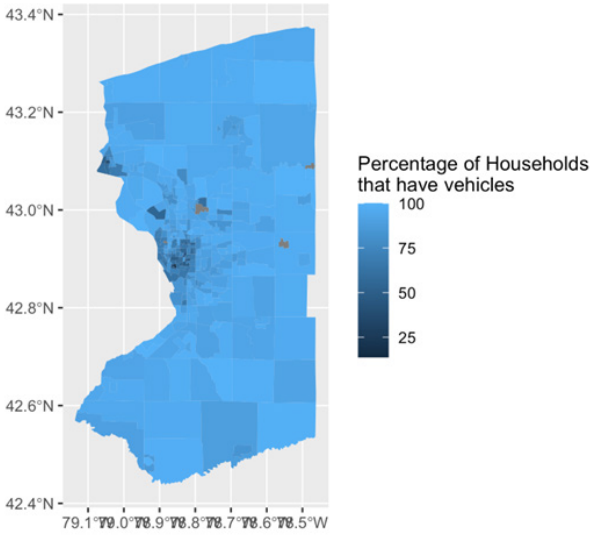

Figure 2 - Percentage of Households Owning Vehicles by Traffic Analysis Zone

Road Network Skim

Based on our skim of the road network, we calculated that the longest travel time between zones was 162.17 minutes, while the shortest travel time between zones was just 0.67 minutes. The average travel time between zones was 29.32 minutes, and travel times tended to increase with distance from the inner core.

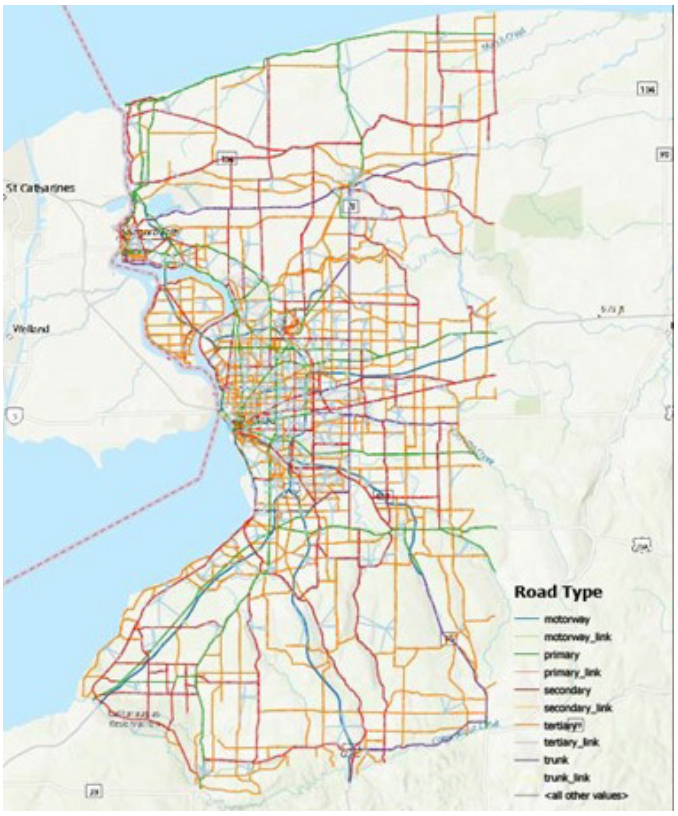

Figure 3 - Road Network Overview

Figure 3 provides an overview of the Buffalo MSA's road network by road type, while **Figure 4** illustrates the average vehicle travel time from each zone to the center of the MSA's principal business district in downtown Buffalo. We identified one census tract (indicated as black on the map) containing the highest rate of employment density as the employment center, and calculated the average travel time to this tract for the rest of the zones. In some zones, the average travel time to the employment center is higher than 100 minutes by car. **Figure 5** overlays a dot density map illustrating the number of households on top of the map from Figure 4. This map demonstraves that average travel times tend to be shorter in the denser zones near the core with the a higher number of households. **Figure 6** demonstrates the relationship between total population and the average travel time. Their relationship is not statistically significant. **Figure 7** demonstrates the relationship between median income and the average travel time. Their relationship is also not statistically significant.

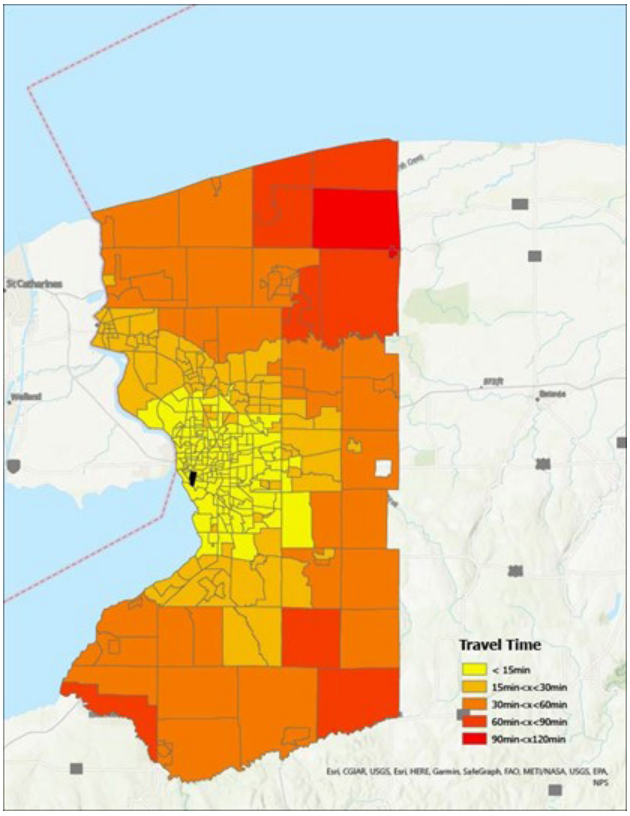

Figure 4 - Average Travel Time to Downtown Core by Zone

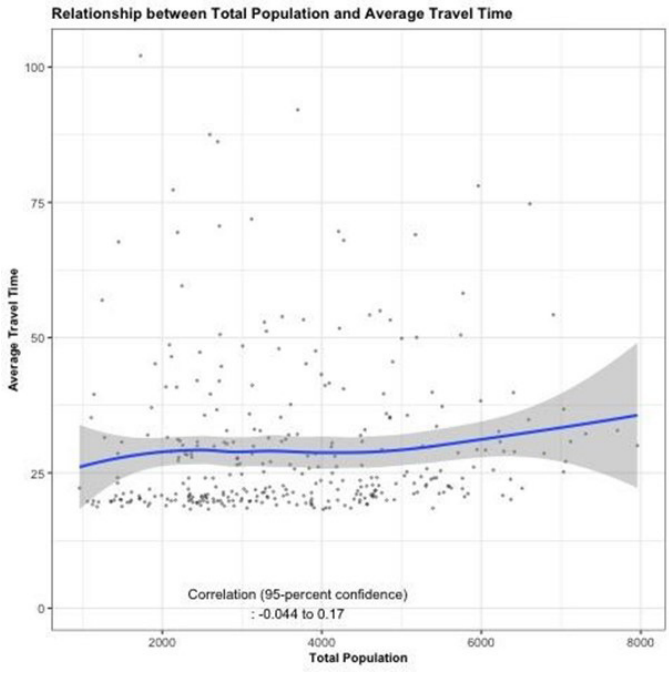

Figure 6 - Relationship between Total Population and Average Travel Time

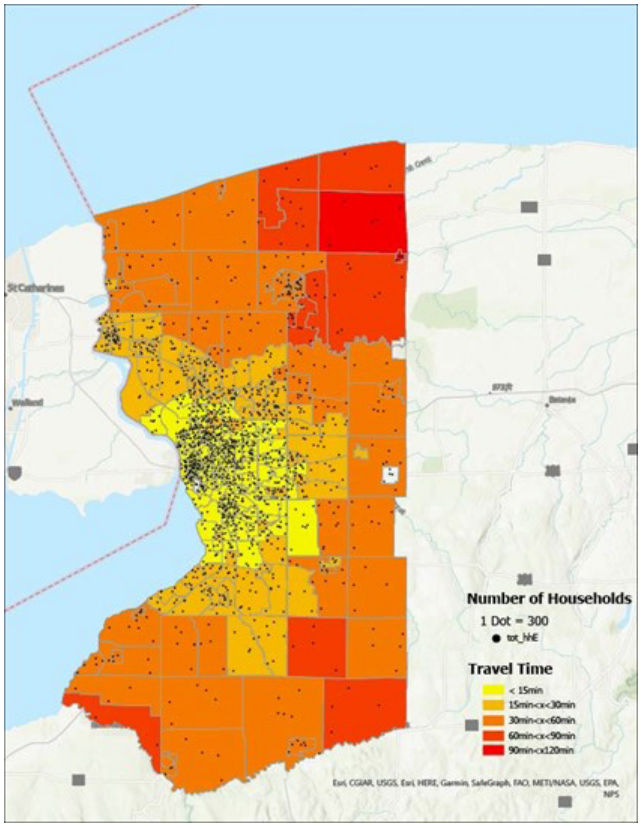

Figure 5 - Average Travel Time to Downtown Core by Zone and Number of Households

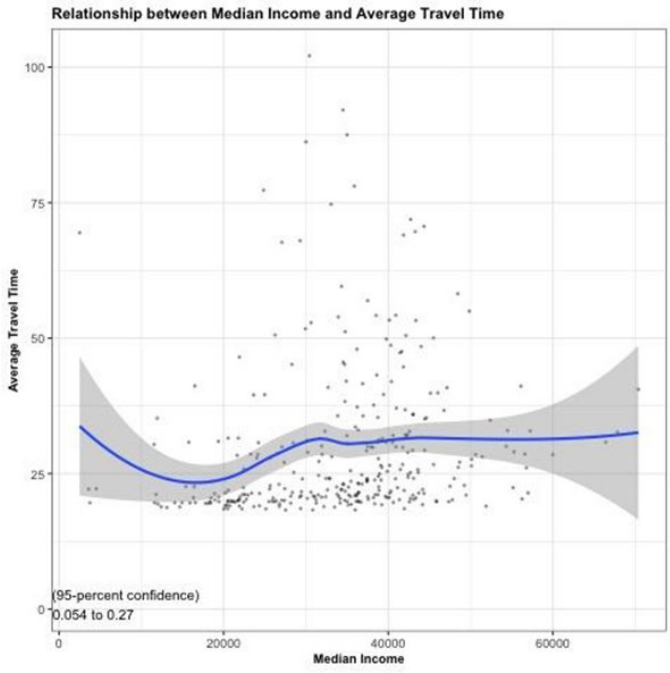

Figure 7 - Relationship between Median Income and Average Travel Time

Transit Network Skim

In order to analyze the Buffalo MSA's transit network, we designated one census tract in Buffalo's downtown area as the transit center. **Figure 8** maps total travel time by transit from the downtown transit center to transit-accessible zones. Although the maximum travel time from the transit center is more than six hours (377.67 minutes), the average total travel time is slightly over than an hour (67.59 minutes). 25% of transit-accessible zones are within 33 minutes of travel time from the transit center. **Figure 9** shows in-vehicle travel time (IVTT). The average IVTT among the census tracts within the transit network is 41.2 minutes, which isn't quite as long as we expected (demonstrating the relative density of inner Buffalo's transit network).

Figure 10 visualizes the median walk time to access transit stops and stations. Median walking time across the network is less than 10 minutes, and the maximum walking time to access transit is around 20 minutes. As can be seen in **Figure 11**, transfer wait time across the network is also relatively low in our model, averaging 4.19 minutes) The low amount of variation in walking access and transfer times between census tracts demonstrates a relatively equitable provision of service between zones which are transit-accessible, although it is clear that large areas of the Buffalo MSA are not accessible by transit.

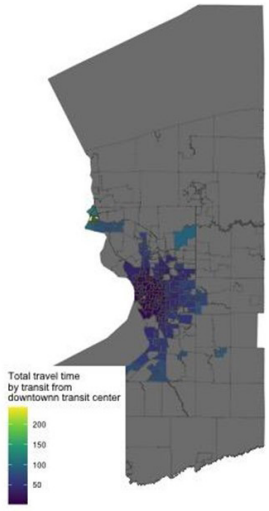

Figure 8 - Total travel time by transit from downtown transit center

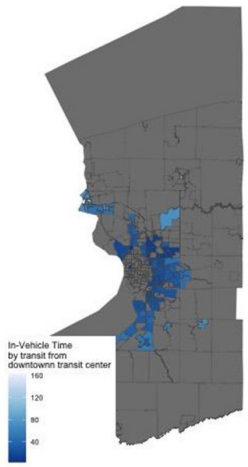

Figure 9 - In-Vehicle Travel Time (IVTT) by transit from downtown transit center

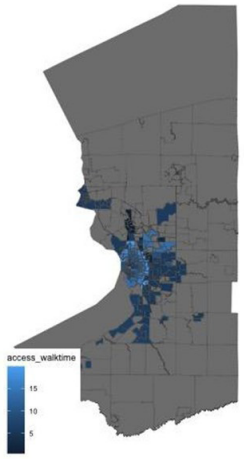

Figure 10 - Walk time to access to transit stops and stations

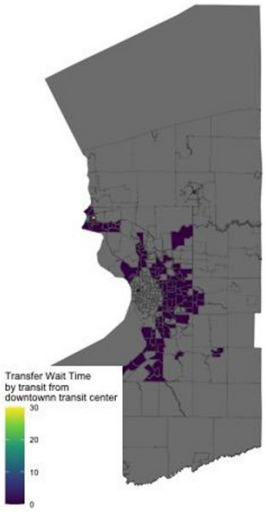

Figure 11 - Transfer wait time from downtown transit center

Accessibility Analysis

Overview

The measure of accessibility that we have chosen to explore in the Buffalo MSA is access to job opportunities. For the purposes of this analysis, we defined accessibility more narrowly as the number of jobs that one could access from each traffic analysis zone using one of the two modes in our model (automobiles and public transit).

Our data sources for this analysis included employment data and census tract shapefiles from the United States Census, road network data from OpenStreetMap, and GTFS data from the Niagara Frontier Transportation Authority (NFTA) website. This data was compiled and manipulated in order to build our road network and transit network models in TransCAD, followed by additional analysis and mapping via the use of several open-source libraries in RStudio.

Assumptions

For the purposes of this analysis, the transit network model is based on the peak service times of 4:00pm-7:00pm on weekdays. Transit service during other times of the day or weekends would likely be lower (thereby increasing travel times and reducing the ease of transit access to jobs), but we wished to explore transit access at peak service times in order to compare it favorably to road access.

Additionally, the road network in our model does not include roads smaller than those defined as "tertiary" by OpenStreetMap, which was a decision we made in order to streamline the size of our network file in TransCAD. This may have some impact on the accessibility of more rural zones in our analysis. Lastly, in order to create a functioning skim matrix, we had to delete some nodes, transit stops, and road segments in our TransCAD model, which may slightly reduce our model's accuracy compared to real world conditions.

In creating the accessibility index, we chose not to combine car and transit accessibility because we didn't feel that a combined indicator provided a meaningful insight for efforts to increase accessibility. By comparing car and transit accessibility separately, planners can have more intentional efforts to improve transit accessibility to an equivalent level of car accessibility.

Method of Analysis

Our approach to analyzing employment access was to calculate automobile and transit weights for jobs in each traffic analysis zone, then aggregate them by trip origin to compare the relative car and transit accessibility.

First, we imported our road and transit network skims from TransCAD in order to determine the average travel time for automobiles and the perceived travel time for transit. Because travel time for transit comprises two parts (in-vehicle travel time and out-of-vehicle travel time), we decided to combine them in order to create a total travel time. Because transit users tend to weigh out-of-vehicle travel time 2-3 times as badly as in-vehicle time, we decided to calculate a perceived time by weighting out-of-vehicle time 2.5 times higher than IVTT.

We then used decay functions to calculate a weight for the jobs at each zone for travel by automobile and by transit. Then, we multiplied the number of jobs by their weight to understand how many jobs people have access to via each mode and aggregated them by the trip origin. Lastly, we calculated relative accessibility by assigning a value of 100 to the maximum access by a given mode, and scaling all other values proportionally.

Results

After conducting our analysis, we conclude that jobs in the Buffalo MSA are fairly accessible by automobile, while transit only serves a relatively small percentage of

census tracts concentrated around the downtown Buffalo area. However, given the higher concentration of both households and jobs in this area, we would rank the Buffalo MSA as having a relatively high level of transit access to jobs for a mid-sized American city. This reflects Buffalo's status as a relatively dense older city with a well-defined street grid and clustered activity centers, both of which are beneficial to the operation of efficient transit service. If resources were spent bringing transit to low-density areas far from the urban core, then the utility of these services would be reduced, and precious operating funds would be spent on inefficient routes serving areas with high levels of car ownership.

Figure 12 maps the automobile accessibility of census tracts in the Buffalo MSA according to our chosen employment metric, while **Figure 13** maps the transit accessibility. The distribution of accessibility values in **Figure 14** shows the high rate of automobile accessibility in most census tracts. Conversely, we can see in **Figure 15** that the distribution of transit accessibility is almost inverse to automobile accessibility, which is further demonstrated by the scatter plot modeling the relationship between the two metrics in **Figure 16**. However, although the gross number of census tracts that are poorly served by transit is high, the most transit-accessible tracts in the Buffalo MSA also tend to contain the highest concentrations of jobs.

Figure 12 - Automobile Accessibility by Census Tract

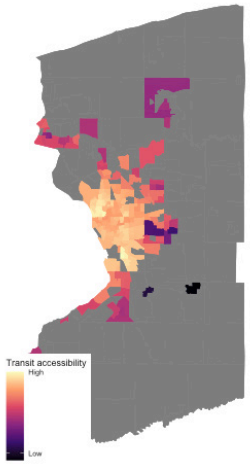

Figure 13 - Transit Accessibility by Census Tract

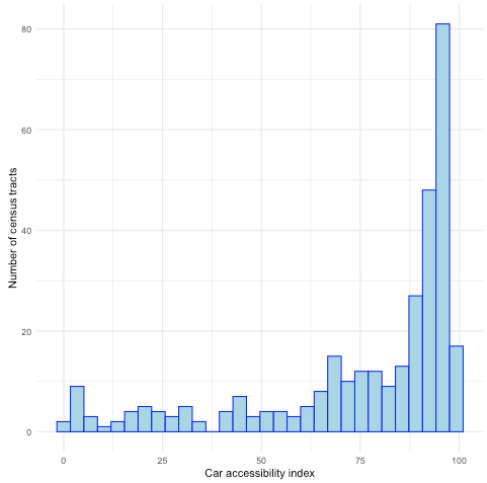

Figure 14 - Histogram of automobile accessibility index

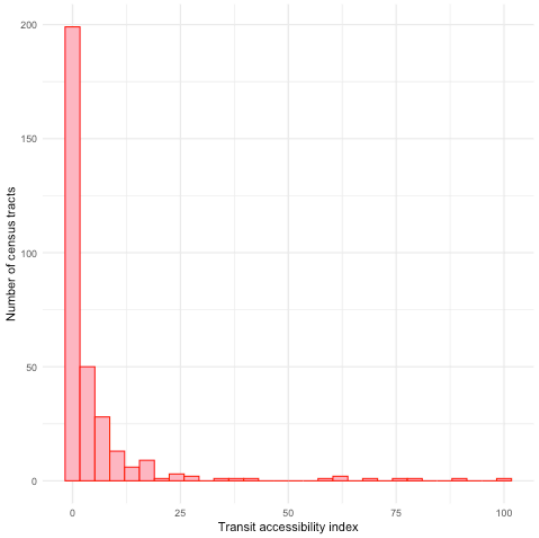

Figure 15 - Histogram of transit accessibility index

Discussion

Our model shows a high level of transit access to the principal employment centers at the core of the Buffalo MSA. Of course, not all jobs are located within this downtown area due to the effects of job sprawl and suburbanization. However, because the vast majority of jobs are located downtown, NFTA's transit network provides relatively good access to employment.

We could have explored other sectors besides employment if we defined accessibility as proximity to leisure destinations, parks, or other destinations which can be found in large cities like Buffalo due to the beneficial effects of urban agglomeration. However, these would have been much more difficult to model than access to jobs because of the granularity of our employment data.

A side effect of the high automobile accessibility in our study area is that increased traffic may reduce the accessibility and effectiveness of transit, and make it more unpleasant to travel via more sustainable modes like walking or biking. It is a limitation of our model that we weren't able to include these considerations in our analysis.

Overall, we conclude that the Buffalo MSA has a high level of transportation access to jobs as defined by our accessibility model. The majority of households live in traffic analysis zones which are less than 30 minutes from Buffalo's downtown by automobile, enabling easy access to employment opportunities for those who are able to drive. NFTA bus and rail routes serve a relatively small percentage of the MSA's total land area, but service is concentrated in the highest-density employment areas where transit is most effective and vehicle ownership rates are low.

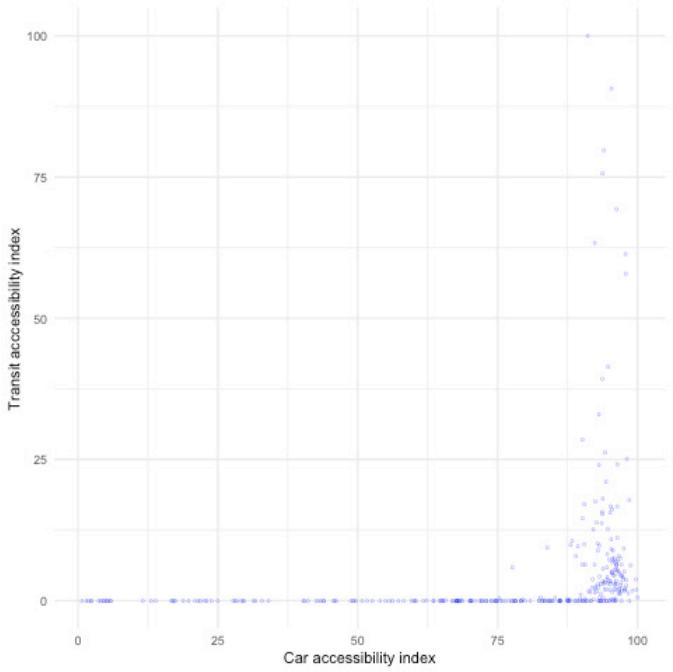

Figure 16 - Relationship between automobile accessibility index and transit accessibility index


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