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Exploring Mobility Inequality and Its Trend in New York State

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Background

Humans generally do not live alone, isolated from each other. Instead, individuals tend to live in communities with other people related by ethnicity, nationality, religion, or some other cultural element. A human society is a group of people who share a common lifestyle and organization. Within the human society, certain communal services are furnished by communal authority to exercise governance over the organization entity. Some researcher recognized the immense importance of public services for moral reasons. Their universal provision should be guaranteed. They may be related with fundamental human rights (such as the right to water). Access to certain all-inclusive social services can be thought as access to fundamental human rights. Certain community services should be available to all populations, regardless of income, physical ability or mental acuity.

Social equity is an important characteristic of public transportation infrastructure investment. Any sound transportation policy must support and improve the standard of living (economic and financial sustainability); it must improve the general quality of life (environmental and ecological sustainability); and its benefits must be shared equitably by all sections of the community (social sustainability). A key role for elected transportation official is to set an agenda for mobility based on the concepts of equity.

Objective

This study showcases the mobility inequality and its impacts on households and local economy, using the 2017 NHTS public use data. It considers various factors related to mobility inequality, such as region, access to transit, age, gender, household income, car ownership, etc. In addition to data from 2017 NHTS, this study also utilizes American Community Survey (ACS), and other public data sources.

National Household Travel Survey (NHTS)[1]

Since 1969, the Federal Highway Administration (FHWA) has been collecting travel information through a probability-based random sampling survey[2]. The 2017 National Household Travel Survey (NHTS) is the eighth and most recent survey in this series. The survey collected passenger travel information and the results are used to inform transportation policy and planning efforts at the Federal, state, and local levels.

The 2017 NHTS collected travel information from 129,969 households, from April 2016 to April 2017. Daily travel details provide comprehensions into work and school commutes, non-emergency medical trips, shopping trips, and even how travel differs in the summer and on weekends as compared to typical weekday travels when school is in session. The survey result represents all Americans demographically and is appropriate for analysis at the national and census region levels.

Transportation Mobility[3]

Transportation analyst cannot evaluate the inequality in transportation resource allocation without a clearly defined inequality measurement matrix. With well-defined inequality matrices, transportation analysts can decide what is measured, how it is measured, and how data are presented often affect how problems are defined and solutions selected.

One must define transportation measuring matrices to showcases the mobility inequality. This paper defines "transportation mobility" means person- or ton-miles, "trip" means person- or freight-vehicle trip. This study presumes that any increase in travel mileage benefits the society. This study concentrated on the use of cumulative proportion of person miles traveled (PMT) from lowest to highest and cumulative proportion of household income from lowest to highest. This information founded in NHTS data[4].

Methodology

A commonly used narrative to describe the disparity in allocating disproportionate fossil fuel resources to limited countries is listed below.

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[1] https://nhts.ornl.gov/assets/2017_NHTS_Technical_Release_Notes_030518.pdf
2017 NHTS Technical Release Notes (Version 1, 3/8/18)

[2] The 2017 weights were developed at a higher aggregate geography than prior surveys, and when combined with changes in survey methods, there are some specific areas users should be aware of as they begin to use the data and conduct trend analyses.

[3] http://www.vtpi.org/tdm/tdm55.htm#_Toc218835147
Measuring Transport - Traffic, Mobility and Accessibility

[4] https://nhts.ornl.gov/assets/codebook_v1.1.pdf
2017 NHTS Household File - Public Use Codebook

"*The United States, with less than 5 % of the global population, uses about a quarter of the world's fossil fuel resources*[5]."

Such statement easily informs laymen that there is an economic disparity and the magnitude of unfairness in a society**.** Following the similar train of thought, this study assesses mobility inequality by revealing the discrepancy of proportions between allocated resources and the size of the interest group entitled the resources.

This study explored the use of the Lorenz curve[6] and 2017 National Household Travel Survey (NHTS) data, in examining the disparities on the transportation mobility service distribution for New York State (NYS). Specifically, this research aims to identify and quantify mobility inequalities between, for examples, elderly and non-elderly, as well as white and non-white groups among populations**.** The Lorenz curve is an easy to understand graphical representation of the apportionment of allocated resources. The concept is useful in describing inequality, where the cumulative proportion of population is plotted against the cumulative proportion of attribute.

To help illustrate the utility of this methodology, presume the bottom x% of population, is percentage (y%) of the attribute they have. The Lorenz curve represents by plotting the curve cumulative percentage of population on the x-axis, and, the cumulative percentage of attribute on the y-axis.

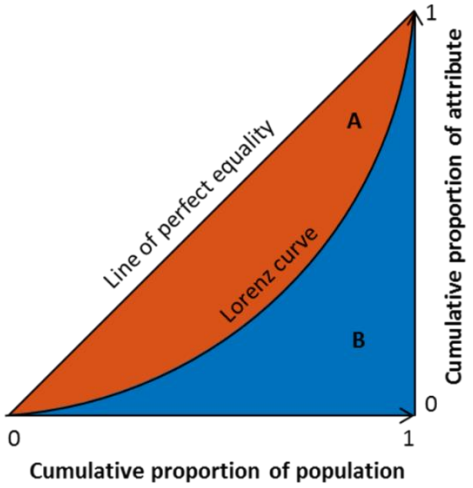


Figure 1: Lorenz Curve

While Lorenz curves can reveal recourses allocation inequality imbedded in a society easily and quickly, they cannot quantify the identified inequality. Additional analysis, calculating Gini coefficient, is required. The Gini coefficient is the ratio of the area between the line of perfect equality and the observed Lorenz curve to the area between the line of perfect equality and the

[5] http://www.worldwatch.org/node/810
[6] https://en.wikipedia.org/wiki/Lorenz_curve

line of perfect inequality. The higher the coefficient, the more unequal the distribution is. In the diagram above, this is given by the ratio A/(A+B), where A and B are the areas of regions as marked in the diagram.

Along with 2017 NHTS data, prior years' NHTS data (i.e., for 2009 and 2001) were also used in this study to investigate trends in travel patterns, and to evaluate changes in mobility inequalities over time. The mobility inequality measure explored under this study was the Lorenz curve with its associated Gini Coefficient (expressed as a normalized Gini index), which is a well-known and intuitive economic inequality measure. Specifically, this study quantifies the inequality distribution numerically through the Gini Index.

Transportation Inequality Analysis

Figure 2 shows an example to help illustrate how Lorenz curves and Gini index can help a layman to visualize the inequality and the degree of the mobility inequality. As mentioned before, this study assesses mobility inequality by revealing the discrepancy of proportions between allocated resources and the size of the interest group entitled the resources. In other word, this study concentrates on use of cumulative proportion of PMT from lowest to highest and cumulative proportion of household income from lowest to highest.

The example hypothesizes three different degrees of uneven resource allocations, 10% of households has taken 25%, 50%, and 90% of the PMT, respectively. Resulting Lorenz curves and Gini index are presented in Figure 2.

The Lorenz curve is accompanied by the straight diagonal line with a slope of 1, which represents perfect equality in mile-of-travel vs. household distribution; the Lorenz curve lies beneath it, showing the actual distribution[7]. The area between the straight line and the curved line, expressed as a ratio of the area under the straight line, is the Gini Coefficient, a measurement of inequality. The farther away the curve is from the baseline the higher the level of inequality.

The Gini coefficient is used to express the extent of inequality in a single figure. It can range from 0 (or 0%) to 1 (or 100%). Complete equality, in which every household contribute the exact same PMT, corresponds to a coefficient of 0. Plotted as a Lorenz curve, complete equality would be a straight diagonal line with a slope of 1 (the area between this curve and itself is 0, so the Gini coefficient is 0). A coefficient of 1 means that one household contributed to all PMT.

[7] https://www.investopedia.com/terms/l/lorenz-curve.asp
BREAKING DOWN 'Lorenz Curve'

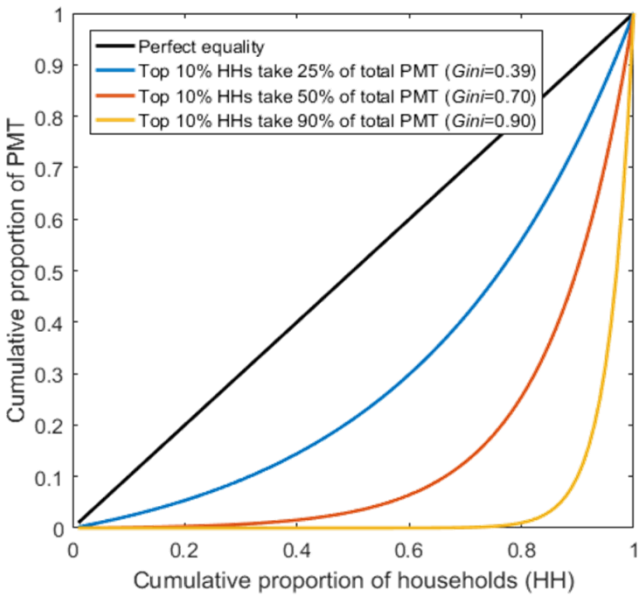


Figure 2: Hypothetical Lorenz curves and Gini coefficient

Preliminary Results

Figure 3 illustrates the result of mobility inequality comparison for the households of NYS between 2017, 2009, and 2001 using the NHTS datasets. Comparing to the example in Figure 2, the Lorenz curves in Figure 3 and Figure 4 are not smooth concave curves. This is because the Lorenz curves in this study have drawn by using every 10^{th} percentile of the households sorted by household income. Since the household income variable in NHTS is not continuous, but categorical, consecutive percentile points can refer to the same income level. In addition, the relationships between PMT and household income in the datasets are not completely positive linear.

Apparently, the inequality is highest for 2017 (i.e., Gini coefficient of 0.39 for 2017, compared to 0.25 for 2009 and 2001). This is mainly due to the significant disparity for the top 30 percent of the highest income households. The slope of the Lorenz curve of 2017 between 70 and 90 percentiles is lower than those of the previous years, whereas the slope for the top ten percent of highest income households is steeper in 2017 than in the other years.

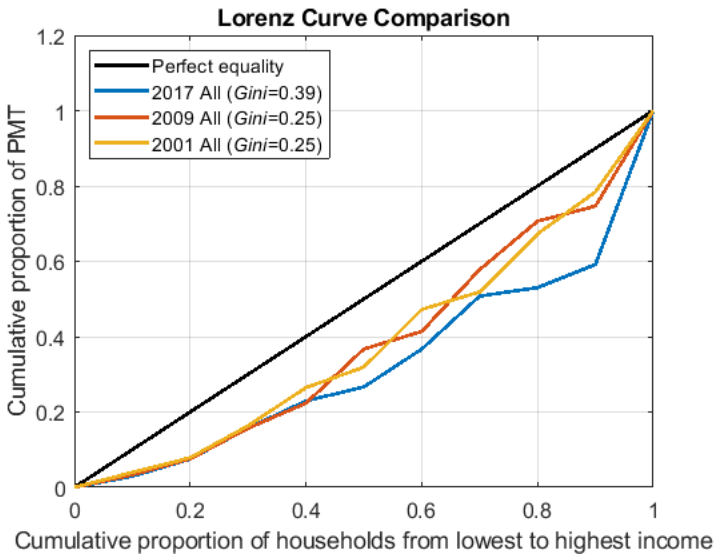


Figure 3: Mobility inequality trend for NYS

The higher mobility inequality in 2017 is attributed to the mixed impact of the following three factors: (1) increase in income inequality; (2) change in the survey methodology; and (3) inflation of the purchasing value of money.

The first factor is most relevant to the focus of this study, i.e., to identify the trend of mobility inequality with consideration of household income. The underlying research hypothesis is that there is a positive relationship between mobility and income. The income inequality of NYS represented by Gini index has increased for the last decade (see Figure 4).

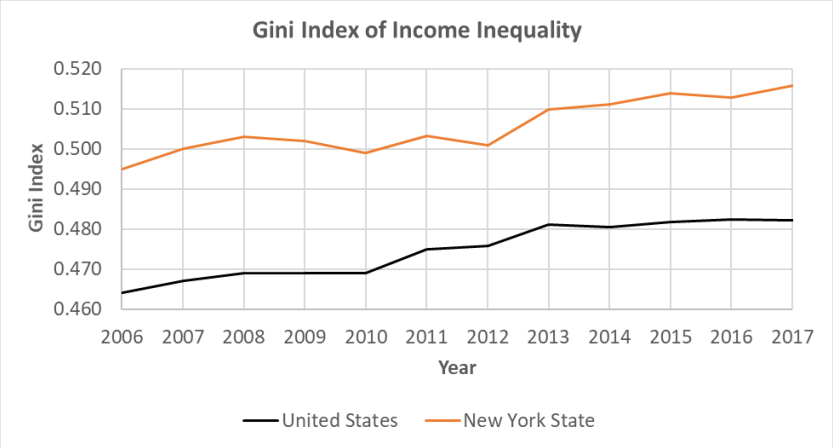


Figure 4: Income inequality trend[8]

[8] American Community Survey, U.S. Census, https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

In contrast, the other factors can also affect the mobility inequality quantities. The survey methodology changed from a phone interview type for 2001 and 2009 NHTS to a self-reporting web-based survey for 2017 NHTS. In addition, the highest income level segment (i.e., $100,000 or more) in the previous year surveys was further subdivided into four categories in 2017 NHTS as shown in Table 1. Therefore, it is more likely to obtain higher response rates from the highest income range households about the income question during the survey (see Figure 5). Inflation of purchasing power of money also contributed to the significant difference in the percentage of the highest income segment between 2017 and the others in Figure 5. The median income for each category considered in this study are nominal values, i.e., the inflation between years was not reflected. If converting the nominal income to constant value, some of the households fell into the second highest income range (i.e., $75,000 to $99,999) for 2009 and 2001 become the highest income segment (i.e., $100,000 or more).

Table 1: Difference in household income level definition

2001 & 2009 NHTS		2017 NHTS		This Study	
Label	Income Range	Label	Income Range	Label	Income Range
1	Less than $5,000	1	Less than $10,000	1	Less than $10,000
2	$5,000 - $9,999	2	$10,000 to $14,999	2	$10,000 to $14,999
3	$10,000 - $14,999	3	$15,000 to $24,999	3	$15,000 to $24,999
4	$15,000 - $19,999	4	$25,000 to $34,999	4	$25,000 to $34,999
5	$20,000 - $24,999	5	$35,000 to $49,999	5	$35,000 to $49,999
6	$25,000 - $29,999	6	$50,000 to $74,999	6	$50,000 to $74,999
7	$30,000 - $34,999	7	$75,000 to $99,999	7	$75,000 to $99,999
8	$35,000 - $39,999	8	$100,000 to $124,999	8	$100,000 or more
9	$40,000 - $44,999	9	$125,000 to $149,999		
10	$45,000 - $49,999	10	$150,000 to $199,999		
11	$50,000 - $54,999	11	$200,000 or more		
12	$55,000 - $59,999				
13	$60,000 - $64,999				
14	$65,000 - $69,999				
15	$70,000 - $74,999				
16	$75,000 - $79,999				
17	$80,000 - $99,999				
18	$100,000 or more				

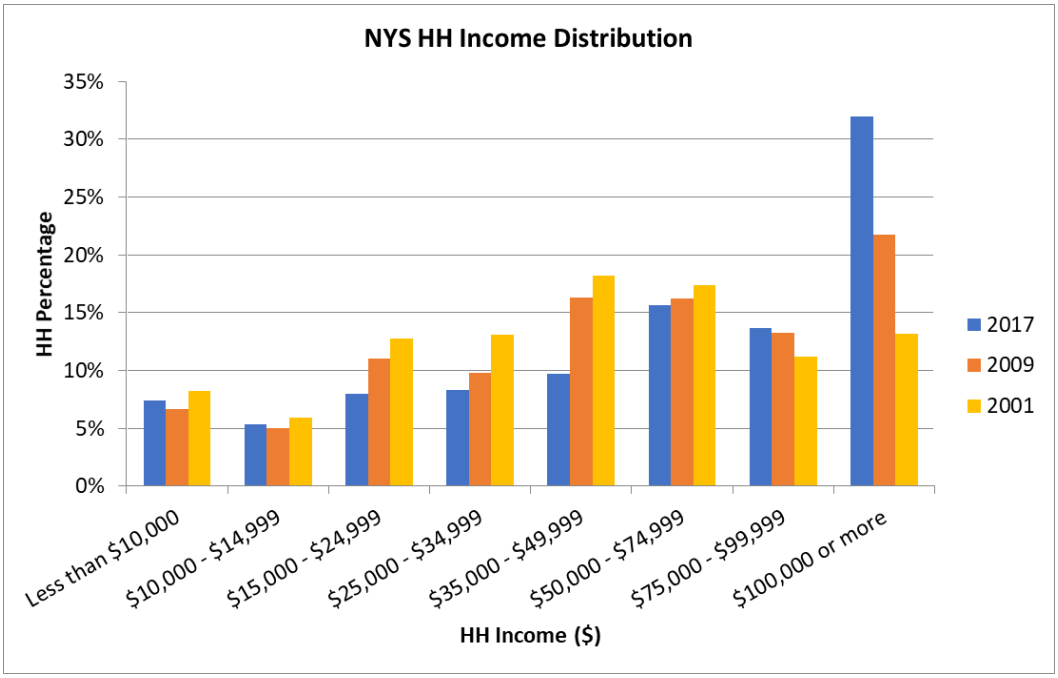
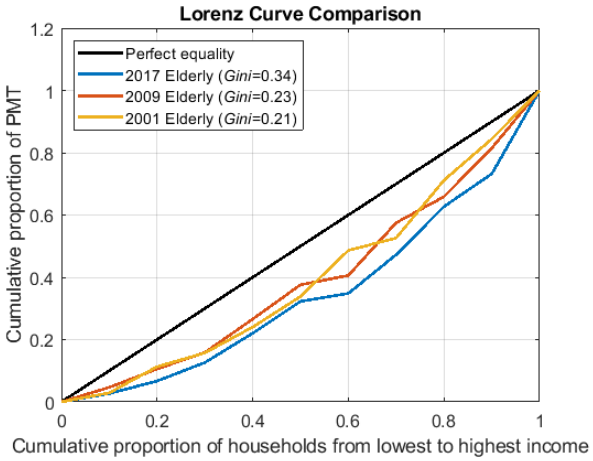
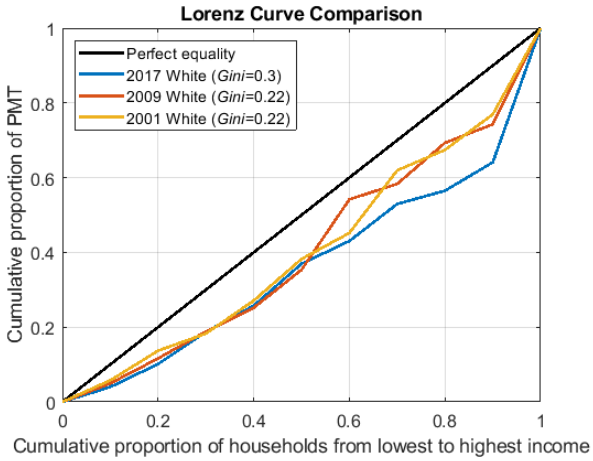


Figure 5: NYS Household income distribution in NHTS

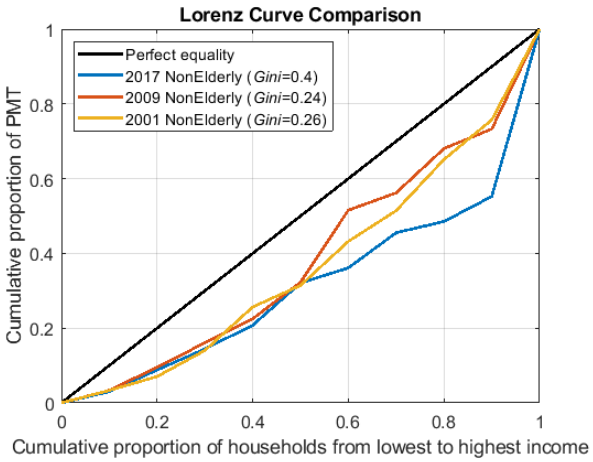
Elderly (age 65+)



White



Non Elderly (age under 65)



Non White

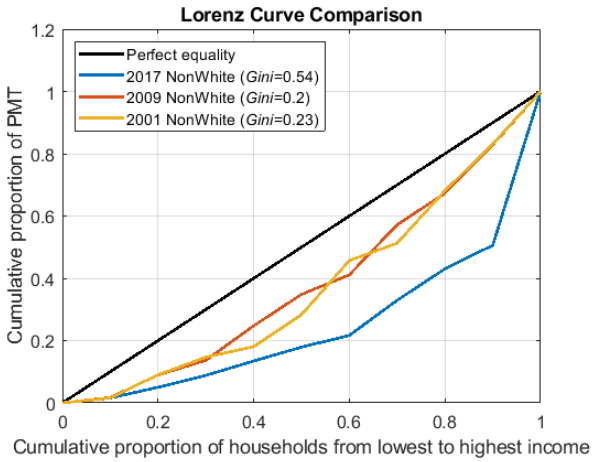


Figure 6: Mobility inequality trend for NYS

Preliminary Observation

To further investigate the mobility inequality for NYS, comparisons were also made between subpopulations using age and ethnicity (see Figure 6). The brief observations of the additional mobility inequality comparisons are described as follows.

- The mobility inequality, measured by PMT, for NYS residents showed a significant increase, on average, from 2009 to 2017.
- Among NYS's elderly households, mobility inequality increased from 2001 through 2017, mainly due to the increasing PMT for the highest income households; while the mobility inequality declined for their non-elderly neighbors between 2001 and 2009, then increased through 2017.
- The mobility inequality within NYS's White households did not changed between 2001 and 2009, then increased in 2017, due to the increase in PMT among the top-ten-percentile-income white households. The inequality of non-White households experienced a slight decrease from 2001 to 2009, but it significantly increased from 2009 to 2017.
- Based on Gini coefficient, there is no noticeable differences in mobility inequality between 2001 and 2009, but significant increase in 2017.

The result of this study reveals that the mobility inequality in NYS increased between 2009 and 2017. The increase in the income inequality in NYS justifies this pattern. As future work, a further study is required to identify the separate impacts of three factors (i.e., income inequality; survey methodology; and inflation of the purchasing value of money) on the inequality increases in 2017.

Epilog

This research finding can assist Federal, state and local government agencies in making informed decisions and developing equitable transportation policies that all citizens can benefit from, and, consequently, benefits the community and the local economy.