Geospatial Alpha PS-88 Subway Ridership Analysis: The Neighborhood Impact of COVID-19, an Impetus for Innovative Testing Strategies

By Geospatial Alpha: Todd Simon, Jennifer Horowitz, Alexander Williamson

Abstract – In this paper, the Geospatial Alpha PS-88 study analyzes ridership composition based on home neighborhoods of a sample of riders for a select section of train lines in the Bronx, New York during the morning commute in one five-day period prior to the New York City COVID-19 shelter-in-place order, and replicates the analysis for one five-day period during the shelter-in-place order. The analysis shows correlation between neighborhood ridership data and median income data. The study asserts that lower income neighborhoods may be significantly more vulnerable, by their greater reliance on mass transit, to economic disruption and health destabilization posed by potential COVID-19 exposure.

I. Introduction

With the onset of COVID-19, the shelter-in-place restrictions on movement for non-essential workers and for non-essential services were intended to limit the virus spread. In densely populated cities with reliance on mass transit, there is heightened concern with potential for virus spread given the difficulty in maintaining social distancing practices on subway cars (1) and the CDC guidelines for prolonged exposure (2). This study considers the relative economic impact and health safety born by neighborhoods of different economic means. The study hopes to encourage further investigation of potential imbalance in this area, and encourage the evaluation of innovative mitigating solutions such as prioritized testing zones.

The underlying sample of riders was derived from mobile phone location data for signals ascribed to a polygon beginning and including the 167th Street Stations for the 4, B and D lines and southerly along the #4 Lexington Avenue Express Line to and including the 161st Street Stations for the 4, B and D lines ("Polygon"), on the 5-day period of January 13-17, 2020 from 4am to 9am eastern standard time.

The sample data was produced from detections during two five-day periods of January 13-17, 2020, prior to the New York City shelter-in-place order on March 30, 2020 (Pre-SIP), and of April 6-10, 2020 (In-SIP).

It may be noteworthy that New York City COVID-19 data for the week of March 30, publicly released immediately preceding the In-SIP detection period, acknowledged the highest weekly total for cases and hospitalizations in New York City occurred that week. Further, the week of April 6 registered the second highest weekly total for cases and hospitalizations and the highest for deaths in New York City, to that point.

This paper is organized as follows: In Section II the paper discusses the Bronx neighborhoods served by the subject train lines. In Section III the paper analyzes ridership data. In Section IV the conclusions are summarized.

II. Bronx Neighborhoods

The #4 Train Line in The Bronx begins at Woodlawn Station and makes 11 more stops including the last Bronx stop at 161st Street Station before continuing to Manhattan. The D Line begins at Norwood Station in The Bronx and makes 9 stops including the last Bronx stop at 161st Street Station. The B Subway Line begins at Bedford Park Boulevard Station and makes 8 stops including the last Bronx stop at 161st Street Station. There are 61 neighborhoods in the Bronx. Neighborhoods (10) substantially served by these train lines include: Woodlawn, Norwood, Bedford Park, Kingsbridge, Fordham, University Heights, Morris Heights, Tremont, East Tremont, and Highbridge.

The Polygon was constructed in place and time to capture a sample of Bronx train ridership traveling primarily in a southerly direction in morning commute to Bronx and Manhattan destinations, and for a period of five consecutive weekdays in 2020 to reflect normalcy in mobility and economy.

This study draws on data for median income which ranges from $24,443 (East Tremont) to $53,875 (Kingsbridge) and population which ranges from 10,669 (Kingsbridge) to 43,394 (Fordham). Data are presented in Table 1 (3).

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Table 1:

Neighborhoods	Population	Median Income
Highbridge	37,727	$27,041
University Heights	25,702	$29,651
Morris Heights	36,779	$24,850
Tremont	24,739	$26,290
E. Tremont	40,423	$24,443
Fordham	43,394	$33,932
Bedford Park	37,344	$43,850
Norwood	40,494	$37,465
Woodlawn	42,483	$52,510
Kingsbridge	10,669	$53,875

III. Ridership Analysis

The sample set of uniquely identified, neighborhood-mapped riders was normalized for the relatively short ridership dwell times to derive estimated ridership and ridership percent of populations (Tables 2 and 3) (4). The study compared each of estimated ridership and ridership percent of population with median income by neighborhood for the Pre-SIP period and for the In-SIP period. In the Pre-SIP period the study registered R-squared of 0.4852 and 0.3238, and found the average of ridership percentages for the bottom five median income neighborhoods of 11.8% far exceeded the top five median income neighborhoods of 5.4% by 118%. In the In-SIP period the study registered R-squared of 0.5084 and 0.3230, and found the average of ridership percentages for the bottom five median income neighborhoods of 8.54% far exceeded the top five median income neighborhoods of 3.56% by 140%.

Table 2:

Ridership Pre-SIP	Normalized Sample	Percent of Population
Highbridge	4,550	12.06%
University Heights	2,500	9.73%
Morris Heights	2,900	7.88%
Tremont	6,100	24.66%
E. Tremont	1,950	4.82%
Fordham	3,800	8.76%
Bedford Park	2,900	7.77%
Norwood	2,550	6.30%
Woodlawn	200	0.47%
Kingsbridge	400	3.75%

Table 3:

Ridership In-SIP	Nornalized Sample	Percent of Population
Highbridge	2,500	9.73%
University Heights	1,800	4.89%
Morris Heights	4,250	17.18%
Tremont	1,450	3.59%
E. Tremont	2,900	6.68%
Fordham	1,900	5.09%
Bedford Park	1,300	3.21%
Norwood	0	0.00%
Woodlawn	300	2.81%
Kingsbridge	0	0.00%

IV. Conclusion

In this paper, the Geospatial Alpha PS-88 Analysis mapped ridership composition by neighborhood with median income and population. The study asserts that lower income neighborhoods may be significantly more vulnerable, by their greater reliance on mass transit, to economic disruption and health destabilization posed by potential COVID-19 exposure.

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1. Returning to Work on the Subway? by Christina Goldbaum, New York Times, June 8, 2020.

2. CDC Guidelines, published June 4, 2020.

3. Wikipedia and Google Maps.

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