SOCIAL IMPACT PROJECT

IMPACT OF SECOND AVENUE SUBWAY

Michelle Ho
Shay Lehmann
Francis Ko
Shalmali Kulkarni
Priyanshi Singh
Akshay Penmatcha

New York University
Center for Urban Science and Progress

Supervisor
Professor Lucius Riccio
NYU – CUSP

INTRODUCTION

The Second Avenue Subway is the Metropolitan Transportation Authority's (MTA) latest addition to the public transportation network, and is being built in three phases. The first phase comprises three new stations (96th Street, 86th Street and 72nd Street stations) in the Upper East Side neighborhood, and began operation on January 1, 2017. The line was originally proposed in 1920's as part of a massive expansion of what would become the Independent Subway System (IND). The MTA's vision for the completed first subway line phase has provided subway riders with substantially improved transit access including:

- Connecting the IND 63rd Street and BMT Broadway Lines (F and Q subway lines respectively)
- Easier access from the Upper East Side (UES) neighborhood to the rest of Manhattan and the city as a whole.
- Easy transfers to other subway lines—facilitating smoother, faster transportation between uptown and downtown, and the East Side and West Side—including to commuter rail lines.

The beginning of revenue service on the line has seen the following benefits:

- Reduced crowding on the IRT Lexington Avenue line (4, 5 and 6 train services), which previously carried 1.3 million riders daily.
- Better transit connections and reduced travel times for UES commuters traveling to various parts of Midtown and Downtown Manhattan.
- Reduce travel times for riders travelling from Upper East Side.

PROBLEM STATEMENT

The project aims to understand the short-term and long-term impacts of the new Q line extension.

Short-term impact questions:

- Are UES residents changing modes of transport?
- Is the Second Avenue subway relieving congestion on the Lexington Avenue line?
- Has there been an overall increase in subway ridership?

Long-term impact question:

- How has the opening of the subway extension affected real estate prices?
- How would this help in increasing public safety and reduction in crimes ?
- How would it help in the economic development of the the three neighbourhoods in Upper East Side and further the whole area along the complete proposed line?

DATASETS

The datasets explored for this study were Census Data, LODES(Longitudinal Employer-Household Dynamics), Citibike data, TLC trip data, MTA turnstile data, etc. The primary datasets in used were turnstile data from the MTA and home price/rental data from Zillow as the other datasets were not available for the year 2017.

MTA data was collected from January and February 2015-2017 for stations on the Upper East Side. These stations of interest were identified as the three newly-opened Q stations and the Upper East Side IRT Lexington Avenue line (68th, 77th, 86th and 96th St) stations. The MTA registers the cumulative entries for each turnstile once every four hours (or occasionally for special reasons). Interim entries were thus filtered out and the aggregate cumulative for each station of interest was found per four-hour period. From there, the marginal new entries per station were calculated for each four-hour period during January and February of 2015-2017 for the existing IRT stations and January and February of 2017 for the new Second Avenue Stations.

The Zillow data included median rent and median price per square foot of single family homes by neighborhood and zip codes in New York City for the months of January 2015 to January 2017. Zillow has its own proprietary definitions and geographies for neighborhoods and zip codes, which can be accessed from the Zillow data website. For this project, the neighborhoods of Upper East Side and Upper West Side and 85 zip codes in New York City were used for analysis.

ANALYSIS

Ridership Patterns

Since the start of the Second Avenue Subway, there has been a significant change in the ridership patterns when compared to the 2015 and 2016. (Appendix, Figure 1) shows that when compared to 2016, 2017 has seen a 29% increase from 3.01million to 3.88million in cumulative subway ridership volumes in the Upper East Side. From (Appendix, Figure 2) it is evident that Lexington Avenue has been relieved of the previously experienced overcrowding. There has been a 45% in the peak hours and a 24% decline in overall ridership.

Statistical Analysis of Riderships

The distribution of new entries per annum over the months of January and February was calculated for each station of interest and fitted with a kernel density estimation curve. A two-sample Kolmorogov-Smirnov test was then run for each station comparing 2015, 2016 and

2017 data on a pairwise basis with a null hypothesis indicating that the ridership distribution would be the same from year to year for each station on the Lexington line. Each of the stations on the Lexington line exhibited similar ridership patterns for the years 2015 and 2016, and we were unable to reject the null hypothesis with an ɑ = 0.01. However, ridership patterns in 2017 were found to be significantly different at the same significance level (Appendix, Figure 3). Data visualization shows that this difference is due to a leftward shift in ridership patterns, suggesting that the number of new entries at each station is now likely to be lower during any given four hour period, relieving congestion on the line (Appendix, Figure 4). Using 86th Street as an example, we can see that 2015 and 2016 had similar distributions with the average rush hour time period having approximately 10,000 new entries and an expected maximum of 20,000 new entries. In 2017, this average rush hour was reduced to 7,500 new entries with an expected maximum nearing only 12,500 (Appendix, Figure 5).

Moreover, our research found that combined 4/5/6 and Q 2017 subway ridership on the Upper East Side was greater than previous years' Lexington Avenue ridership. This suggests that additional riders are entering the system and that the subway is now serving additional customers as compared with previous years. Using 86th Street again as example, the aggregate swipes for 2017 over the Lexington and Second Avenue lines were found to be greater than previous 2015 and 2016 patterns (Appendix, Figure 6).

Time Series Prediction

The project also aimed to create a predictive analysis using the fourier transform analysis (Appendix, Figure 7). It can be observed that the ridership is high during January 2017 as compared to February 2017. This decrease can be due curious New Yorkers visiting the new subway line. The prediction model built on the just 59 day's data indicates a slight decrease in ridership by 0.01 % i.e about 500 ridership reduction in the month of March 2017. This extrapolation model does not take into consideration the weather and the seasonality of the ridership. Thus, the model has greater uncertainty and a higher risk of producing futile results as it is based on small training data, but still gives a fair idea about the prevailing trends.

Accessibility

Accessible area to a subway station is taken to be a comfortable 5 -min walking distance around the subway station. Using this it can be observed that there is an increased accessibility due to the extension to the Q- line around the three new station (Appendix, Figure 8) . Upper East side has about an 65% increase in accessible area to subway stations as compared to accessible area before these subway stations.

The long term impact considering the new line is planned till the 125th Street giving more transit options for the residents along the subway line and provides an opportunity to increase the subway ridership as a whole.

Travel Times

One of the objective of Second Ave subway line is to reduce the travel times for the riders of Upper East Side. MTA estimated a 10-min reduction in travel times. The project explored a platform developed by 'Sidewalk Labs' to confirm the travel time decrease. Using multiple origin and destination pairs it was seen that there is 6 - 8 minutes decrease in travel time for riders travelling from new stations on Q-line towards lower Manhattan during peak time of 8:00 - 9:00 a.m.
(https://transit.sidewalklabs.com/#{"origin":{"lat":40.703548367250455,"lng":-73.90546447045 898},"options":{"bus_multiplier":1},"center":{"lat":40.72382748514871,"lng":-73.97812135449 22},"zoomLevel":12})

Real Estate Impact Analysis

Connectivity with the transportation network can play an important role in housing decisions, increasing desirability and therefore property values and rents. The authors thus sought to identify the effects of the opening of the Second Avenue subway on home value and rental prices on the Upper East Side.

Median Rent Impact

The Upper West Side was chosen as a comparison neighborhood for home value and rental prices of the Upper East Side. Both neighborhoods show an uptick in median rent for a single family home for January 2017 as compared to December 2016. Rents on the Upper East Side increased by 18%, while rents in the Upper West Side increased by 10% (Appendix, Figure 9). Though this rise in median rent values may be due to many other factors but it clearly indicates the opening of subway as one of the major contributing factor.

Predictive Analysis of Impact of subway station in a neighbourhood

To evaluate the effect of the opening of a subway station on home values in the vicinity, the authors ran an ordinary least squares single variable regressions with the independent variable as the number of subway stations found in a zip code and the dependent variable as the median price per a square foot for single family homes. The observations used to fit the regression were

median prices per a square foot for 85 zip codes in New York City. The regression model returned a coefficient of $62.11 with an intercept of $638.24 (Appendix, Figure 10) . In other words, all else being equal, the presence of an additional subway station in a zip code area should increase the median listing price per square foot for all homes in that zip code by $62.11. This analysis fails to account for the uneven distribution of subway stations and homes across the city and other variables that impact home prices, but this simple analysis could serve as a baseline for determining the positive impact of opening new subway stations on home prices in the vicinity.

CONCLUSIONS

With the opening of the Second Avenue extension to the Q line, the Lexington Avenue line on the Upper East side has experienced a statistically-significant change in ridership patterns. Fewer riders enter the Lexington Avenue stations on the Upper East Side on the average weekday and, perhaps more importantly, riders are less likely to experience very congested periods. Moreover, this change comes even as overall subway ridership on the Upper East Side has increased. This implies that straphangers may be either shifting modes of transportation or that Upper East Side residents are now more likely to travel out of the neighborhood.

The addition of subway stations to the Upper East Side is expected to have positive impacts on home value and rental prices. Median rental prices in January 2017 for the Upper East Side already show a higher proportional increase when compared with the Upper West Side. A baseline model shows that every additional subway station to a zip code increases square foot values by approximately $65. The three subway stations that have opened are likely to have a large positive effect on the values of Upper East Side homes.

Further research is necessary to determine whether there has been a corresponding drop in other modes of transportation originating or terminating in the Upper East Side such as bus, taxi, other app-based ride hailing services, cycling, or walking. Finally, since this extension was only open for a two months at the time of this data analysis, it will also be necessary to continue monitoring trends and data.

In the long run, the Second Avenue subway could be a major economic driver providing more residential and work opportunities to the Upper East Side community. Further work quantifying these economic benefits will be necessary.
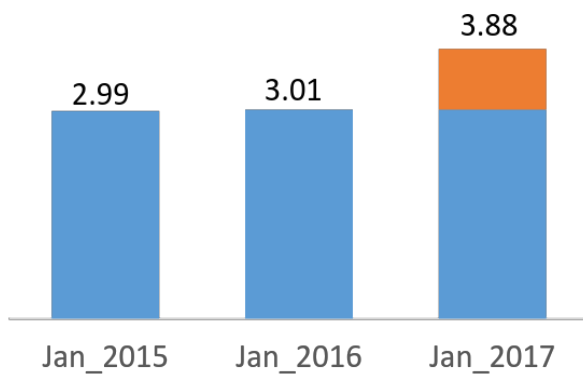
APPENDIX

Datasets:

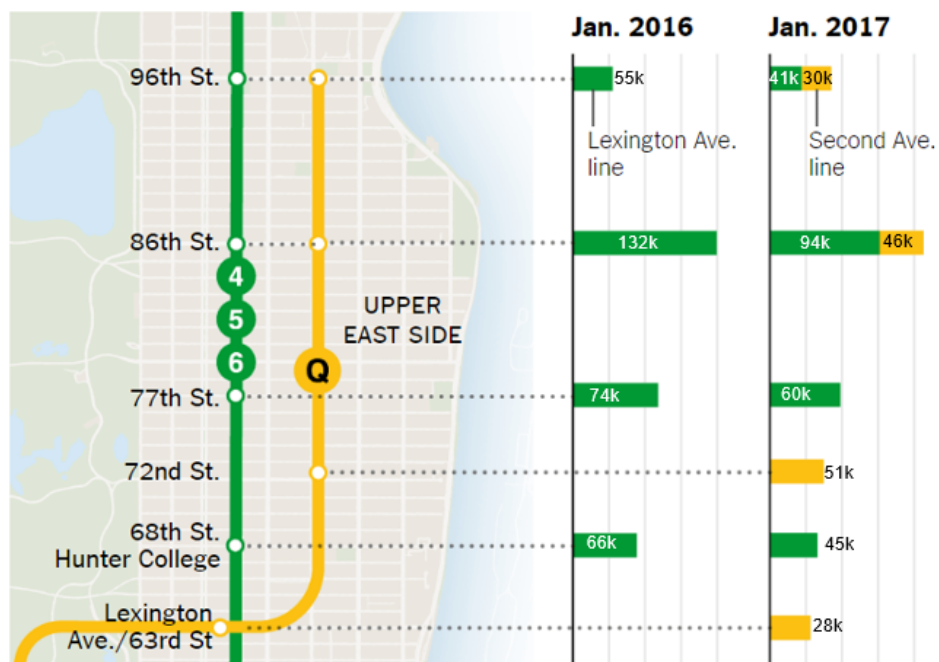[1] MTA Turnstile Data from Jan - Feb 2015-2017 http://web.mta.info/developers/turnstile.html

[2] Zillow Data for 2016 and Jan 2017 http://streeteasy.com/blog/download-data/

[3] Links to source code: https://github.com/shayle/Second_Ave_Subway

Figures:

Figure 1: January Ridership in the Upper East Side (millions)

**Figure 2:** Ridership comparison by Station : January 2016 vs 2017

		P values	Statistics
68ST-HUNTER CO	2015-2016	0.7886	0.0484
	2015-2017	0.0000	0.2486
	2016-2017	0.0000	0.2520
77 ST	2015-2016	0.4600	0.0633
	2015-2017	0.0000	0.2966
	2016-2017	0.0000	0.2554
86 ST	2015-2016	0.8914	0.0429
	2015-2017	0.0000	0.3843
	2016-2017	0.0000	0.3718
96 ST	2015-2016	0.8717	0.0442
	2015-2017	0.0000	0.3277
	2016-2017	0.0000	0.3246

Figure 3:

Results from the two-sample Kolmorogov-Smirnov test. At a significance of α = .01, we can reject the null hypothesis that ridership distribution for all Lexington Avenue stations on the Upper East Side were the same between the years 2015 and 2017, and 2016 and 2017. However, we fail to reject the null hypothesis that ridership distribution for all Lexington Avenue stations on the Upper East Side were the same between 2015 and 2016.

Distribution of Turnstile Swipes on the UES IRT
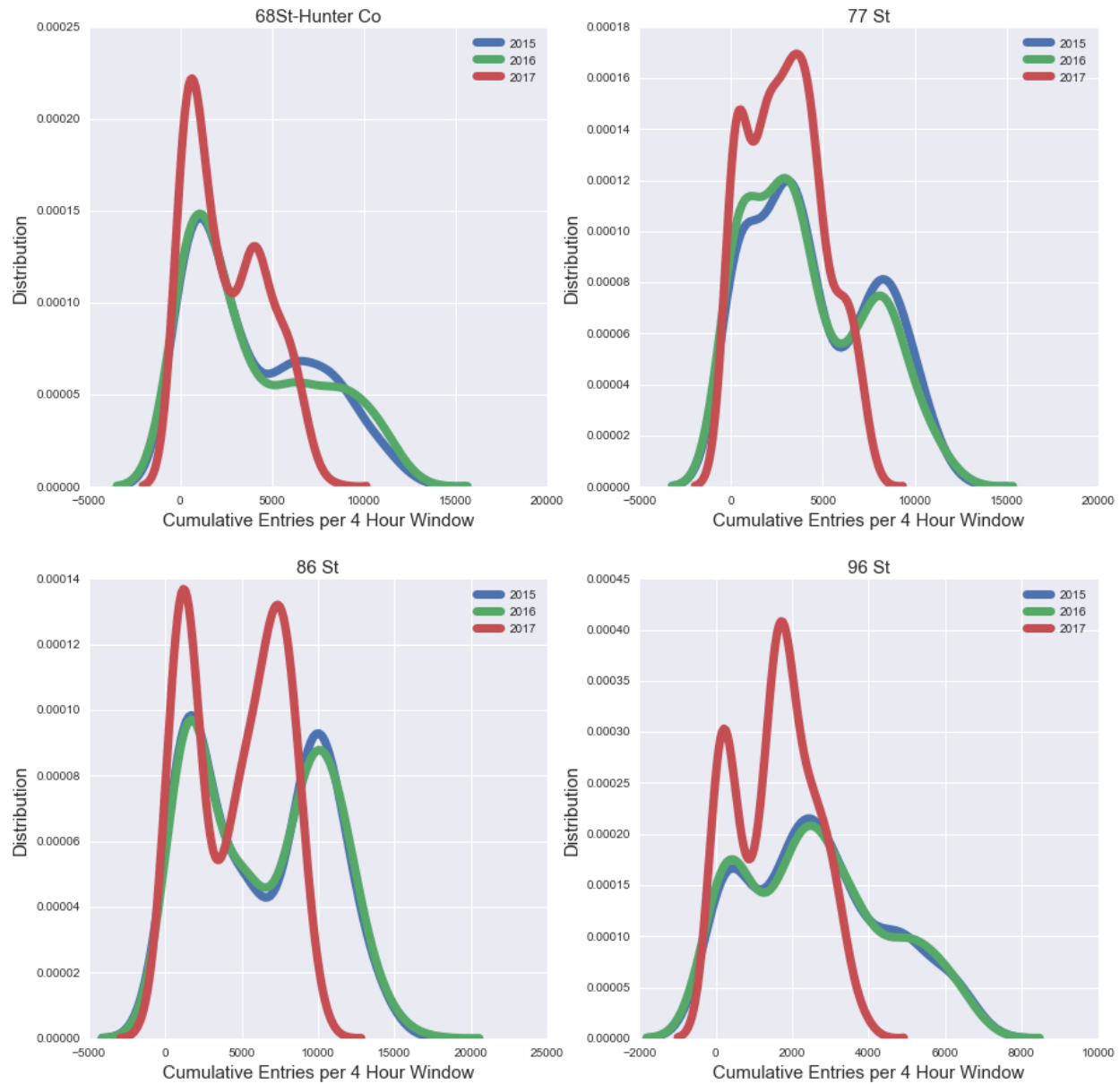
Figure 4:
Visualization of ridership patterns for each Lexington Avenue station on the Upper East Side. The X-axis represents new entries per four hour period while the Y-axis is a rough representation of frequency that each number of new entries might be observed. For each station, 2015 (blue) and 2016 (green) exhibited similar patterns while 2017 was clearly shifted leftward and was more condensed. These findings suggest both a decrease in ridership for any average time period and a relieving of the most congested periods in particular.

Distribution of New Entries at 86th Street 4/5/6
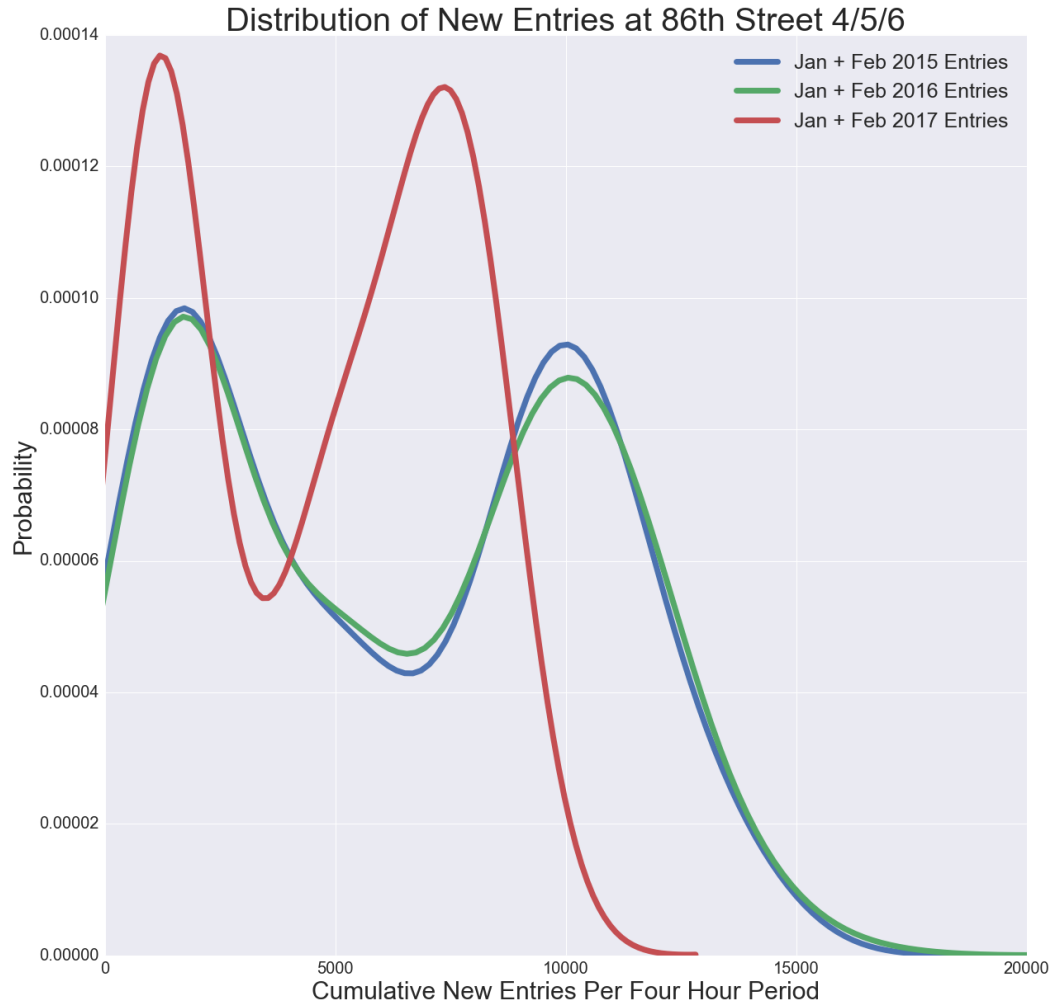
Figure 5:

Figure 3 represents a close up look at the 86th Street 4/5/6 station, our representative example. The change in distribution is quite pronounced with the distribution of new entries shifting leftwards, indicating that new entries decreased for the average 4-hour time frame.
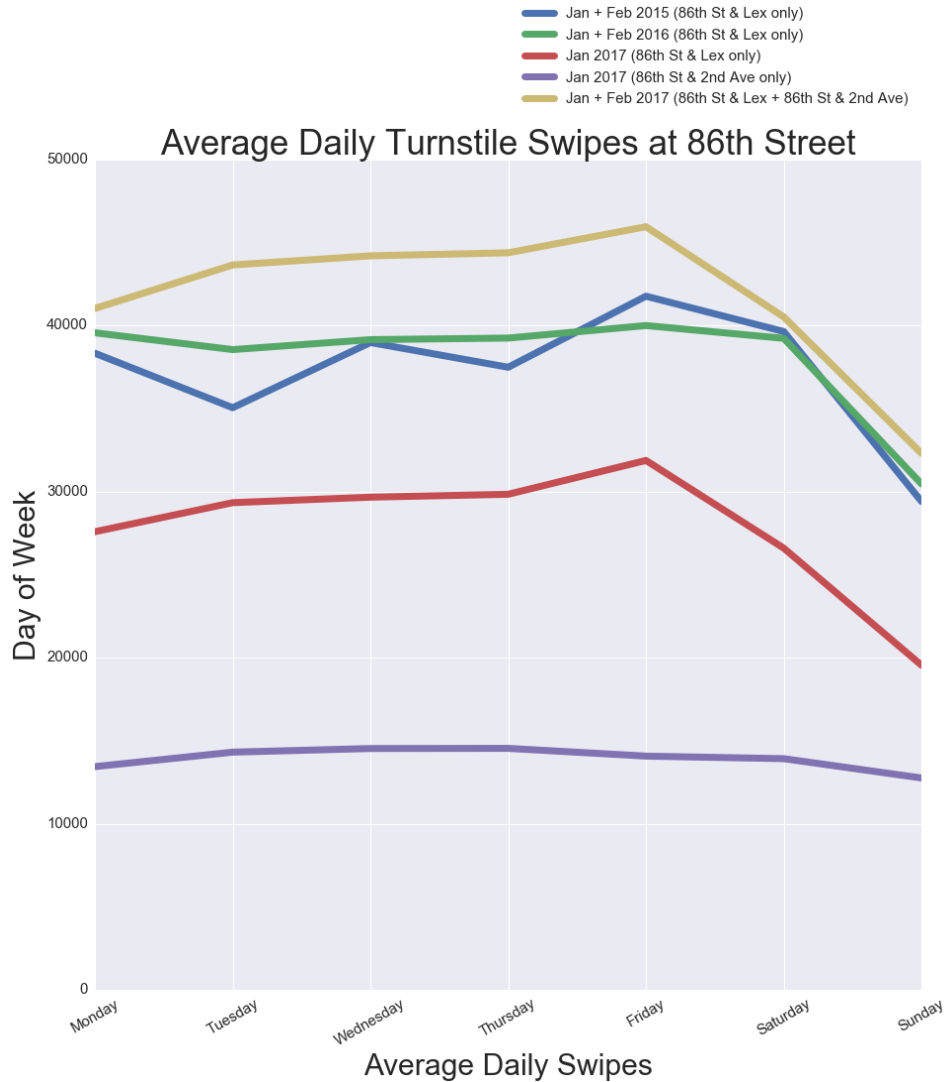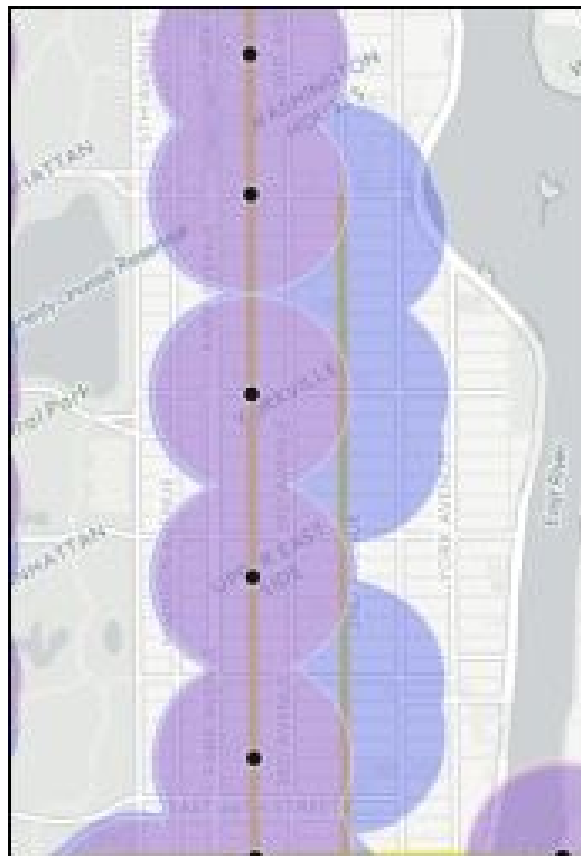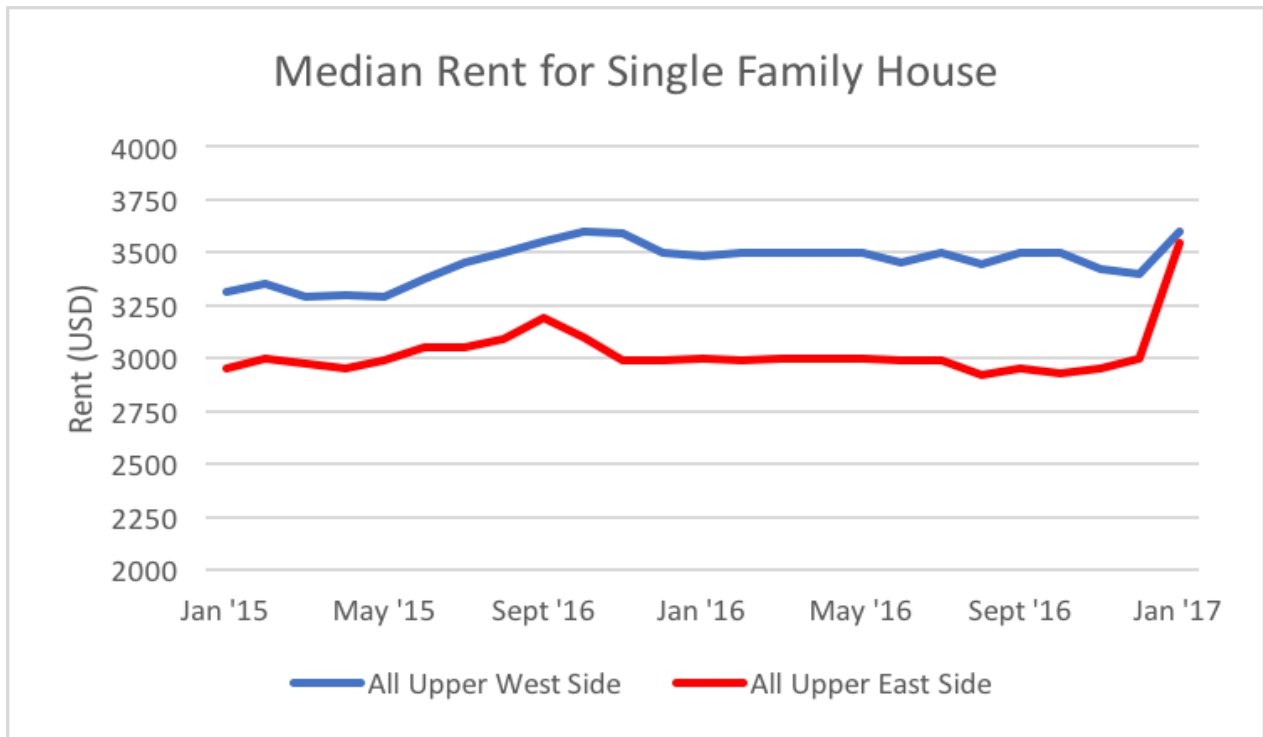
Figure 6:
Average daily swipes as aggregated by day of week. Once again, the blue and green lines represent data from 2015 and 2016 and are relatively similar. The red line represents data from 2017 on the Lexington Avenue line only, suggesting that approximately 10,000 fewer daily riders are entering the stations at those stops. The purple line represents the 86th Street Q line and hovers around 13,000. This number is more than the decrease on the Lexington Avenue line from previous years. Lastly, the gold line is the summation of the Lexington and Second Avenue Q lines, representing a clear increase in mean riders for each day of week.
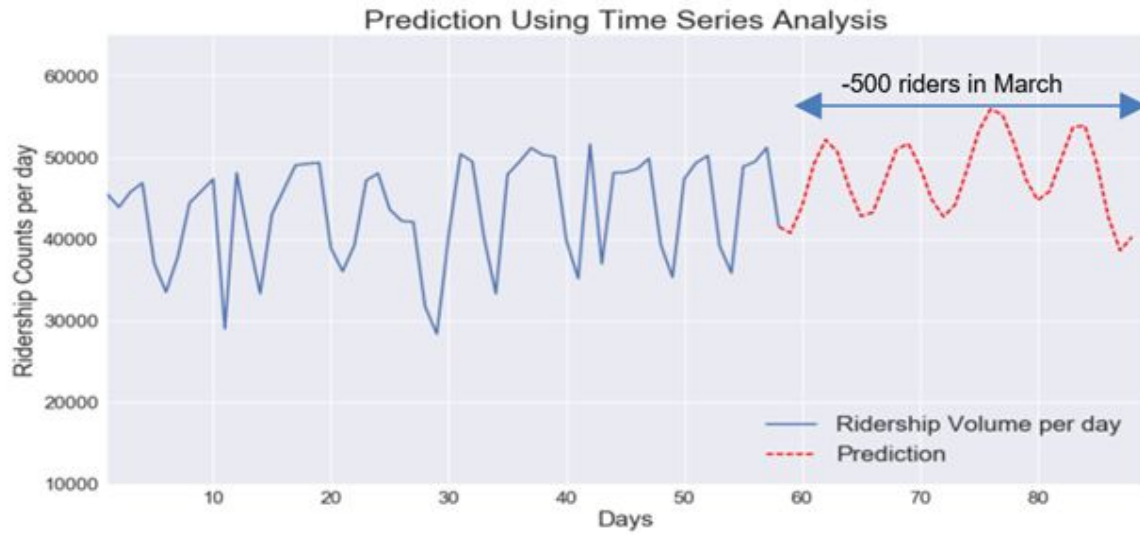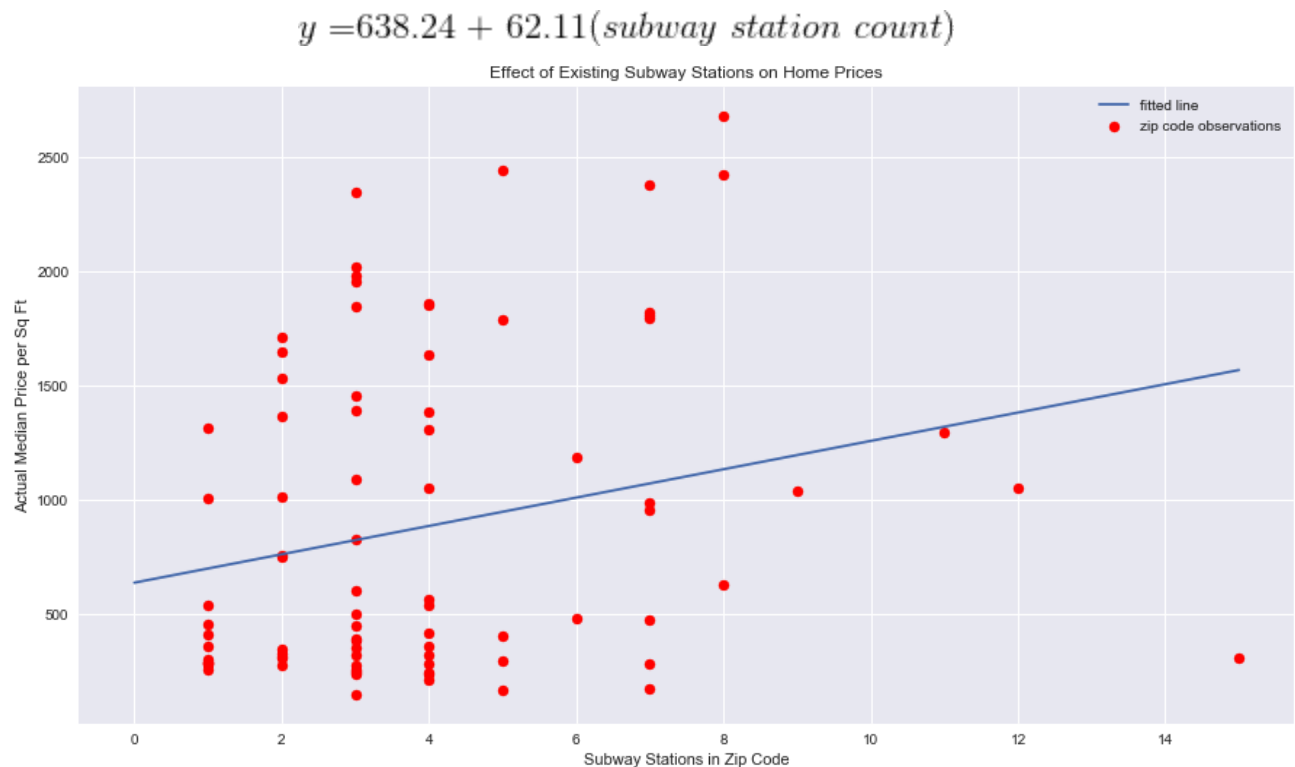
Figure 7: Time Series Analysis and Prediction for the month of March 2017

Figure 8: Accessibility increase : The blue colour circles indicates the additional accessible area in Upper East Side.

Figure 9: Comparing Median Rent for Single Family Homes on the Upper East Side and Upper West Side of Manhattan over time

$$y = 638.24 + 62.11(subway\ station\ count)$$

Figure 10: Ordinary Least Squares regression on a single variable