

The background of the cover is a photograph of a suspension bridge, likely the Manhattan Bridge, with people walking and a cyclist. A green rectangular box with a white border is centered in the upper half, containing the title and subtitle in white text.

# **Bridging the Boroughs**

**How Well Does New York's  
Bike Sharing System Serve  
New Yorkers?**

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# Executive Summary

This report examines the Citi Bike network from an economic and racial equity perspective, using spatial analysis to investigate the extent to which bike sharing helps to improve mobility options for New Yorkers most in need of such options. Specifically, we ask the following questions:

1. Who has access to Citi Bike, and who doesn't?
2. How have the populations with access to Citi Bike changed since 2013?
3. Which neighborhoods use Citi Bike, and which don't?
4. How should bike sharing expand in the future to address existing inequities and gaps in the transit system?

Our analysis finds that the Citi Bike network mainly serves a privileged population that already has strong transit options. Future expansions of bike sharing in NYC, either through the existing Citi Bike system or through the introduction of new competitors, should expand the effective size of the population who can access the subway in neighborhoods of high social need.

## KEY FINDINGS

- **Citi Bike serves the wealthiest, most privileged part of New York City.** More than three quarters (76.8%) of New Yorkers do not have access to bike sharing, and the remaining 23.2% who do are wealthier, whiter and better educated than the rest of the city.
- **People with access to Citi Bike are wealthier than those without access,** with a median household income of \$90,400 in service areas versus \$54,700 outside service areas.
- **The poorest parts of New York mostly lack bike sharing access, while the wealthiest parts of New York City are all located within Citi Bike's service area.** More than 7 in 10 of the neighborhoods with median household income under \$20,000 lack bike sharing, while every neighborhood with a median household income higher than \$200,000 has access.
- **Citi Bike serves disproportionately few New Yorkers in poverty.** While 20.3% of New Yorkers without bike sharing access live in poverty, this figure drops to 15.9% for New Yorkers with access. Meanwhile, three-quarters of neighborhoods in extreme poverty (where at least 45% of the population falls under the poverty threshold) are located outside the Citi Bike service area.
- **Citi Bike serves disproportionately few New Yorkers of color; its service area is twice as white as the rest of the city.** Just under a third (32.1%) of New Yorkers are non-Hispanic white, but more than half of people

within Citi Bike's service area are. Only 16.5% of people of color in New York City have access to bike sharing services, while 37.5% of white New Yorkers do.

- **People with access to Citi Bike are more educated than those without.** 47.5% of the population with access to Citi Bike hold a bachelor's degree or higher. Only 19.0% of the population without bike sharing access have a bachelor's degree.
- **Citi Bike overwhelmingly serves people who already have subway access.** 2.5 million New Yorkers live further than half a mile from the subway, and only 94,000 of them (3.8%) have Citi Bike stations. But 95.3% of those with Citi Bike access also live close to the subway.
- **22.1% of the city's population has access to both Citi Bike and the subway; 27.8% has access to neither.** Those who have access to both are wealthier (median household income of \$92,100 vs. \$66,500), and whiter (52.7% vs. 31.2%), and have higher rates of educational attainment (48.4% have a bachelor's degree or higher vs. 20.6%).
- **1.2 million New York residents have gained access to Citi Bike since 2013, but only 48,700 of them are underprivileged people lacking subway access.** The remaining 1.1 million are only slightly more diverse and less

affluent than the original population with bike sharing, with a median household income of \$84,900 (compared to \$54,700 in the portion of the city without bike sharing access) and a poverty rate of 16.6% (compared with 20.2% in the area without bike service), half are white (49.9% compared with 26.2% elsewhere), and 44.9% have at least a bachelor's degree (compared to 19.0% elsewhere).

- **Citi Bike ridership increases the wealthier, whiter and better educated the surrounding area is,** but the effect is small, and largely driven by the fact that ridership is highest near Broadway in Manhattan.
- **760,000 disproportionately poor and non-white New Yorkers without good subway access would benefit from an equity-focused bike sharing network expansion.** The most equitable way to expand bike sharing would be to prioritize areas just out of reach of subway access and have high social need. We have identified twelve such neighborhoods across four boroughs. Building new bike sharing facilities to connect people to the subway would greatly improve accessibility for 760,000 people who are 85.9% non-white with a median household income of \$50,800. In total, under the most aggressive expansion scenario, up to 3.7 million New Yorkers could gain bike sharing access.



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# 1. Introduction

In 2013, the Citi Bike docked bike sharing service opened in New York City. Its initial 332 stations served 827,000 New Yorkers, and those numbers have since grown to 746 stations serving two million people across much of Manhattan and parts of Brooklyn, Queens, and Jersey City. Among all US cities, New York is the most dependent on non-car forms of transportation—in fact, only 27 percent of New Yorkers commute to work with a car (NYCEDC 2018). This means that the creation of a major new transportation service such as bike sharing could be an important mechanism for improving New Yorkers' mobility options. Moreover, because Citi Bike operates as a municipally-granted private monopoly (the service is currently owned and operated by Lyft, which is better known for its ride-hailing business), it is in the public interest to closely examine whether the network is adequately serving the needs of New Yorkers. This report extends such scrutiny by applying an economic and racial equity lens to the operation of the Citi Bike network, asking the following questions:

- 1. Who has access to Citi Bike, and who doesn't?** From a demographic perspective, what do neighborhoods with good bike share access look like compared to ones without good access to Citi Bike?
- 2. How have the populations with access to Citi Bike changed since 2013?** Since the Citi Bike system was opened in 2013, who has benefited from its expansion, and who hasn't?
- 3. How should New York City's bike sharing expand in the future to address existing inequities and gaps in the transit system?** If the city were to prioritize improving mobility

options for New Yorkers in the most social need, where would it be best to target new bike sharing investments?

The premise of this report is that bike sharing can be an effective means of expanding mobility options, and that this is particularly important for people with greater social need and fewer existing mobility opportunities. Accordingly, one important role for a bike sharing service would be to serve underprivileged neighborhoods. However, our analysis finds that the Citi Bike network mainly serves a highly privileged population. Another important role for a bike sharing service would be to help expand the effective size of the population that can access the subway (i.e. people who live relatively near the subway, but not near enough to conveniently walk to a station). However, our analysis finds that the Citi Bike network mainly serves people who already have excellent subway access.

Our conclusion is that future expansions of bike sharing in NYC, either through the existing Citi Bike system or through the introduction of new competitors, should help expand the number of people that can access the subway in neighborhoods of high social need, by radiating out from subway stations in socially vulnerable areas. The firm—or firms—operating bike sharing services in New York will principally be motivated by the desire to earn the most profit, and this motivation may lead to investments in neighborhoods which are already affluent and highly accessible. But, as a matter of public policy, New York City should treat the bike sharing network as a powerful tool for addressing disparities in transit access, and by this metric the existing network falls significantly short.

## DATA AND METHODOLOGY

The findings in this report are based on a spatial analysis of Citi Bike stations and subway stations in relation to the demographics of New York City. The study relies on three public data sources. The first is data on Citi Bike ridership and bike stations, available through Citi Bike's data portal ([citibikenyc.com/system-data](http://citibikenyc.com/system-data)), which includes sample ride details (start and end times and stations, and rider age and gender), and aggregated ridership and membership figures. The second is 2018 New York City subway data from the Newman Library at Baruch College CUNY. The third is the US Census Bureau's American Community Survey (ACS), the main source of demographic data concerning American communities. We used the standard five-year ACS tables from 2017 (the most recent year), at the scale of census tracts—small, relatively stable areas of approximately 4,000 residents.

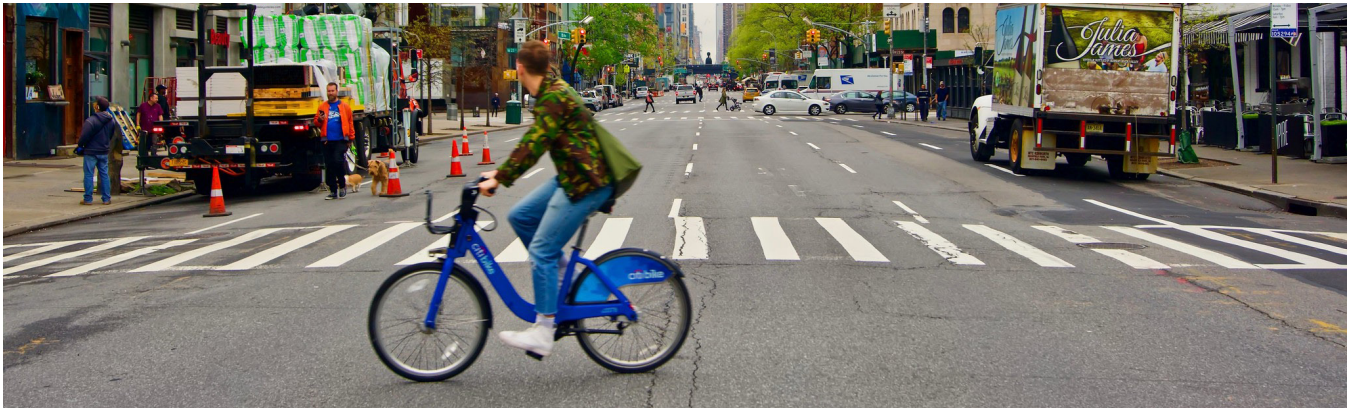
The study's three key research tasks are 1) to compare the demographics of areas of New York City with bike sharing access to the demographics of areas without such access, 2) to identify demographic differences in actual bike share ridership, and 3) to identify areas of the city which would be plausible candidates for bike sharing, if questions of social equity were prioritized in the development of future bike sharing services.

For the first task, the core methodology is to define service areas for bike sharing stations and then aggregate census data within these service areas. We define bike sharing service areas as 0.2-mile (300-meter) radial buffers around stations, which approximates the scenario where people are willing to walk four or five minutes, or roughly a fifth of a mile, to reach a station. (Walking distances are farther than straight distances as the crow flies.) By combining 0.2-mile buffers around all the bike sharing stations in the city, we define a service area for the entire network. We then aggregate a series of demographic variables from the ACS to this combined service area, using uniform areal

interpolation. (We assume the population is spread evenly throughout each census tract, so that if half a tract's area falls in the bike sharing service area, half its population does as well.) The variables are: median household income, percentage of the population living in poverty (according to a measure of household pre-tax income falling below a nationally defined threshold), the percentage of the population which is non-hispanic white, and the percentage of the population with a bachelor's degree. We perform similar aggregating operations for other relevant geographies, such as the subway service area. This is defined through 0.5-mile (800-m) radial buffers, because people are generally willing further to reach high-frequency transit than to reach a bike sharing station. Most of the comparative spatial analysis is conducted using the boundaries of the current bike sharing system, but occasionally we analyze the system at different points in its expansion. For the purposes of this historical analysis, the study period is June 2013 (the first full month of Citi Bike's operation) to December 2018. We construct the effective network each year in this period as follows: each Citi Bike station in service at any point during the month of June or December is assumed to have been active that year. We thus present an expansive definition of the Citi Bike service area for each year, since in practice stations are frequently taken out of service for repairs or other issues, and so the effective service area at any point in time will likely be smaller than our estimates.

For the second research task, in order to analyze the spatial and demographic distribution of Citi Bike rides, we aggregate Citi Bike sample ridership data from June and December of 2013 and 2018 to find the total number of rides that originated from each bike sharing station during these months. (June is a summer month where high levels of both casual resident and tourist rides would be expected, while December is the opposite.) To account for bike sharing stations which were repaired or shifted





throughout the year, all stations within 100 feet (30 m) of each other are merged. We estimate station-specific service areas using Voronoi polygons (all the places which are closer to a given station than to any other station.) We then aggregate census variables to each of the station service areas using the methodology described on the previous page, and run correlation and linear regression analyses to identify systematic relationships between demographic variables and the number of rides taken at a station.

For the third research task (identifying plausible areas for bike sharing service expansion), we synthesize two potential priorities: areas with high social need, according to a set of demographic indicators, and areas with poor but not non-existent access to the subway. Areas with high social need are identified using a “vulnerability index” combining variants of the same four variables from the ACS used for the comparative analysis (median household income, percentage of the population living in poverty, the percentage of the population which are people of color, and the percentage of the population without a bachelor’s degree). Following a procedure similar to Smith, Oh, and Lei (2015), we standardize the variables as Z-scores (a unitless measure with a mean of 0 and a standard deviation of 1), transform the values to have their minimum and maximum range at 0 and 1, and then add them together to construct a single index with range 0-4. Areas with an index score of 2.75 or higher are considered to have met the vulnerability criterion. One third of census

tracts have a score this high. Areas with poor but not non-existent subway access are identified by drawing 1.2-mile (2000-m) radial buffers around subway stations, and then subtracting half-mile (800-m) buffers. The remaining areas lie between a 10- and 25-minute walk from the nearest subway—a distance exceeding what most people will be willing to undertake in their daily commute, but which would become much more feasible with bike sharing access.

All the 1.2-mile subway station buffers with vulnerability index scores of 2.75 or greater were considered candidates for bike sharing service expansion. The disparate buffers were aggregated into neighborhoods (using the boundaries of public-use microdata areas from the census, which approximate New York’s community districts) and their more detailed demographics were subsequently examined.

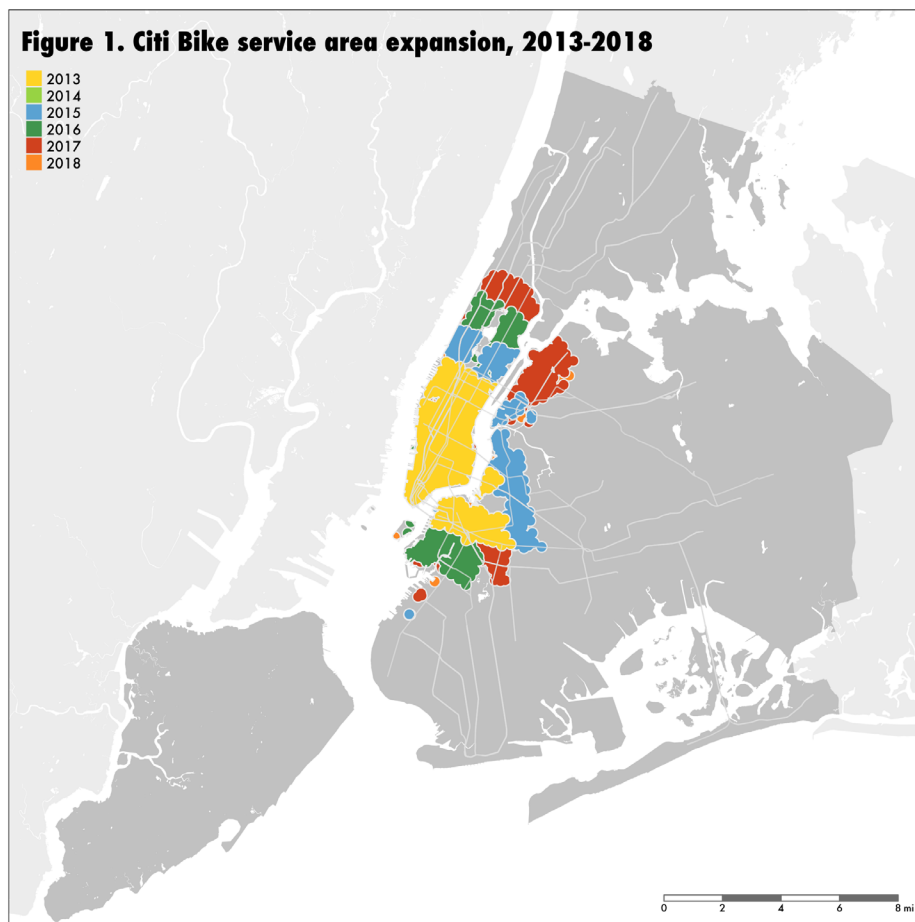
Maps are displayed using the UTM 18N projection and the WGS 84 datum. All steps of the research process, including data collection, cleaning and analysis, were conducted in the R programming language, using the following software packages: dplyr, extrafont, purrr, readr, sf, smoothr, stargazer, tibble, tidycensus, tidyr, tigris, tmap, tmaptools, units. The analysis in this report is reproducible; the code and data necessary to generate the statistics, tables and maps in the report are publicly available at [github.com/UPGo-McGill/nyc-bikeshare](https://github.com/UPGo-McGill/nyc-bikeshare), and are licensed for downstream use and modification under the MIT License.

## 2. Equity and bike sharing in New York City

Citi Bike is New York City's docked bike share system, initially announced by the New York City Department of Transportation in 2011. In 2012, Citibank was announced as the title sponsor, with Mastercard as the preferred payment partner. It launched in 2013 with a fleet of 6,000 bikes at 332 stations, located primarily in Manhattan and western Brooklyn, and was at the time the largest bike sharing network in the United States. The initial fleet serviced 827,000 people. Since then, it has seen multiple expansions (Figure 1), increasing both the number of stations and bikes as well as the area of the network. In 2015, Citi Bike added more than 100 stations, extending into parts of Bedford-Stuyvesant, Greenpoint, Long Island City, Williamsburg, the Upper East

Side, and the Upper West Side, thereby serving an additional 468,000 people. In 2016 and 2017 Citi Bike added several hundred more stations, and by the end of 2018 the system had 746 stations serving 1,988,000 people in a total service area of 30.7 square miles (Table 1).

Citi Bike is a private operation which receives no public funding, but it operates with a municipally granted monopoly. In practice this is a substantial subsidy, as Citi Bike is immune to competition from other bike sharing services. In July 2018, the ride hailing firm Lyft purchased Motivate, Citi Bike's operator, and at the end of 2018 the firm announced plans to expand the network's stations and service area significantly. Also in July 2018,





Year	Population in service area	# of stations at end of year	Service area size (mi <sup>2</sup> )
2013	827,000	338	12.9
2014	817,000	325	12.6
2015	1,285,000	456	19.7
2016	1,637,000	585	24.5
2017	1,986,000	740	30.5
2018	1,988,000	746	30.7

Table 1. Citi Bike service area expansion, 2013-2018

New York City launched a dockless bike sharing pilot program in the Rockaways, Staten Island, and the Bronx, which was initially planned to run for half a year but has since been extended. The long-term future of the bike sharing landscape in New York is thus uncertain.

## BIKE SHARING AND SOCIAL EQUITY: WHAT DO WE KNOW?

The two central equity questions about bike sharing services are: where are they located, and who uses them? First of all, the siting of bike sharing services is itself an equity question—are stations located in areas serving mostly privileged communities, mostly underprivileged communities, or some combination of the two? This report sets out to answer this question in the case of New York City, building on a body of research that finds low-income communities and communities of color are frequently underserved, both in New York City (Trubetskoy 2017; Ursaki and Aultman-Hall 2015) and elsewhere (Ogilvie and Goodman 2012; Smith, Oh and Lei 2015; Trubetskoy 2017; Ursaki and Aultman-Hall 2015). Fewer than one quarter of bike sharing stations across the US are located in communities with economic hardship, and only 11.9 percent in communities with high levels of economic hardship (Smith, Oh, and Lei 2015).

The second question concerns the users of bike sharing. Specifically, given a particular distribution of bike sharing services, which types of people are more likely to use these services? Scholarly research in the United States and elsewhere in the world has found that the users of bike share programs are disproportionately white and affluent, and usually male. This pattern persists even after controlling for the underlying neighborhood demographics of bike sharing locations (Gavin et al. 2016).

Studies examining equity issues among bike sharing users have tended to single out gender, race, education, and income as the primary demographic equity indicators (e.g. Gavin et al. 2016; Saviskas and Sohn 2015; Smith, Oh, and Lei 2015; Ursaki and Aultman-Hall 2015). Race and income have been identified as two of the indicators with the widest disparity among bike share users (Smith, Oh, and Lei 2015; Ursaki and Aultman-Hall 2015), with lower income and communities of color less likely to use bike share options than other groups (McNeil et al. 2017). For example, only two percent of Washington D.C.'s Capital Bike Share system users in 2012 were black (Fishman, Washington and Haworth 2012). Furthermore, the proportion of white population in a given neighborhood was found to be the best predictor of bike share station

locations in New York City's Citi Bike network (Trubetskoy 2017).

These discrepancies extend to the communities' knowledge of the availability of bike sharing services, with almost thirty percent fewer non-white respondents in one study having heard of bike share compared to their white counterparts (Saviskas and Sohn 2015). This applies not only to those using the bike share service themselves, but also exacerbates pre-existing injustices, burdening lower income communities and communities of color that already tend to have decreased access to transportation options (Smith, Oh, and Lei 2015).

A gender disparity has also been identified among bike sharing users in the United States as well as other countries such as Australia and England (Fishman et al. 2015). These differences are often stark, with female users of London's Barclay's Cycle Hire program representing only 18.4 percent of system users (Ogvie and Goodman 2012). In North America, these numbers reflect an underlying disparity between male and female cyclists. In New York City, men made up 85 percent of bicycle riders in 2007 (New York City Department of City Planning 2009). The exception to this pattern is Montreal, where men and women were found equally likely to use the city's Bixi bike share system (Fuller et al. 2011).

## **BARRIERS TO EQUITABLE BIKE SHARING ACCESS**

Despite increased numbers of bike sharing programs across the country, a number of barriers exist which make it more difficult for certain groups of people to access the service. One of the most prominent concerns questions of

cost, siting and payment options for low-income communities. While the requirement of a credit card is often cited as a positive aspect of bike sharing systems, since it contributes to greater safety and reduction of theft and vandalism (Buck 2013; DeMaio 2009; Fishman 2016), it has also proven to cause barriers to access, in particular within lower-income communities (Howland et al. 2017; Saviskas and Sohn 2015). The use of smartphones and other internet-reliant practices poses similar accessibility problems (Howland et al. 2017). Other barriers include infrastructure barriers, stigma associated with biking or cultural attitudes surrounding cycling, and negative perceptions of bike sharing, such as accident liability or bike responsibility (Howland et al. 2017; Saviskas and Sohn 2015).

In response to these barriers, some bike sharing operators have begun to incorporate equity measures into their bike share program policies. According to a study conducted by Howland et al. (2017), larger operators are more likely to have formalized equity statements than smaller ones; many of them also report equity considerations elsewhere in their programs. The areas receiving the greatest equity consideration were fee structure, payment systems, and station siting. System operations and data collection, on the other hand, received the least equity consideration (Howland et al. 2017; McNeil et al. 2017). Dockless bike and scooter systems have also been suggested as a means to address some of the equity barriers imposed by docked bike share systems (Lime 2019). Evidence suggests that dockless systems can help reduce location access disparities, but that they otherwise produce accessibility barriers for lower income residents comparable to docked systems (Mooney et al. 2019).



### 3. Who has access to Citi Bike, and who doesn't?

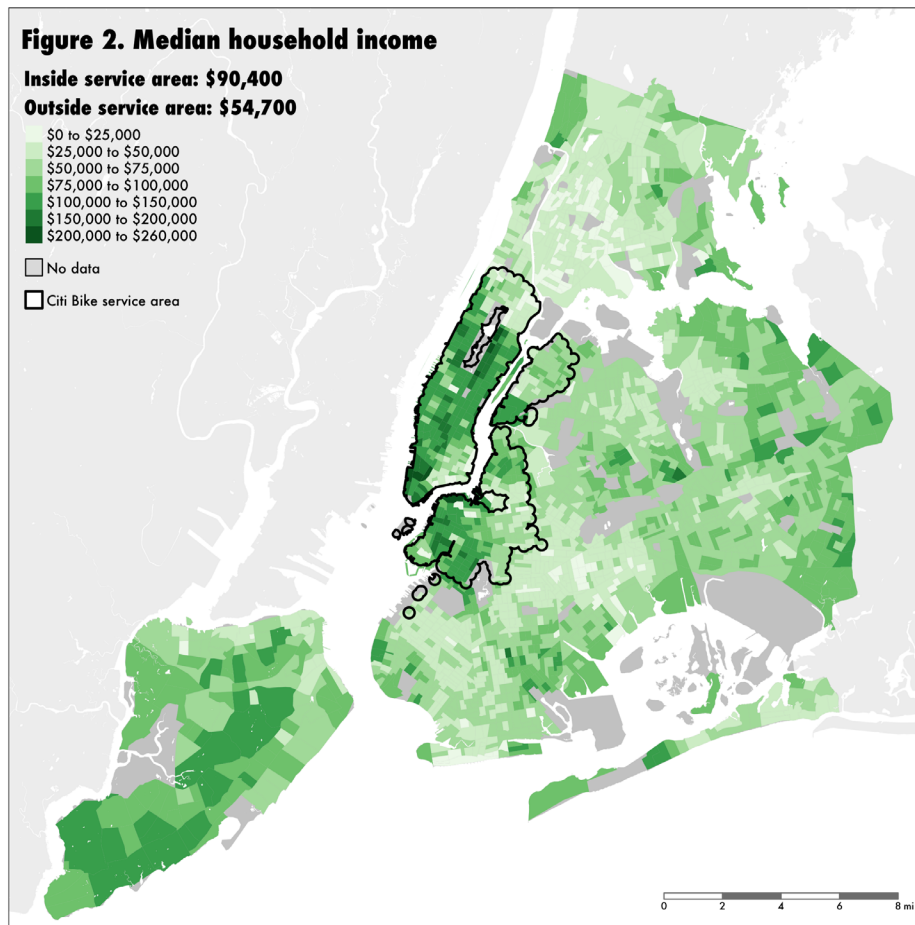
A quarter of New Yorkers have access to Citi Bike, and this is a disproportionately privileged population. People with access to Citi Bike are wealthier than those without access, with a median household income of \$90,400 in service areas compared with \$54,700 outside service areas. Every neighborhood with a median household income higher than \$200,000 has bike sharing access, while over 7 in 10 of the neighborhoods with median household income lower than \$20,000 lack access. Citi Bike serves disproportionately few New Yorkers in poverty: while 20.3% of New Yorkers without bike sharing access live in poverty, this figure drops to 15.9% for New Yorkers with access. Citi Bike's service area is twice as white as the rest of the city: 51.8% of people within Citi Bike's service area are non-Hispanic white, while only 26.2% outside of the service area are white. People with access to Citi Bike are also more educated than those without, with 47.5% of the population with access to Citi Bike holding a bachelor's degree or higher. Only 19.0% of the population without bike sharing access has a bachelor's degree. The vast majority (96.2%) of New Yorkers who do not live within half a mile of the subway also do not have bike sharing access. But 95.3% of those with Citi Bike access also live close to the subway. Only 4.7% of those serviced by Citi Bike did not previously have access to subway service.

#### THE DEMOGRAPHICS OF BIKE SHARING ACCESS

Bike sharing can be an effective means of expanding mobility options for people with greater social need and fewer existing mobility opportunities. To what extent does the Citi Bike network in New York City live up to these promises? In order to answer this question, we compare the demographics of people with and without bike sharing access across the city. We assessed a range of census variables, and present results from four: median household income, percentage of the population below the poverty line, percentage of the population that is non-

hispanic white, and percentage of the population holding a bachelor's degree or higher.

We analyze the distribution of each of these variables across the city, and present aggregate comparisons between areas of the city with bike sharing access (defined as areas within a fifth of a mile of a Citi Bike station) and areas without such access. We additionally compare demographic patterns for areas with and without bike sharing access to areas with and without subway access.



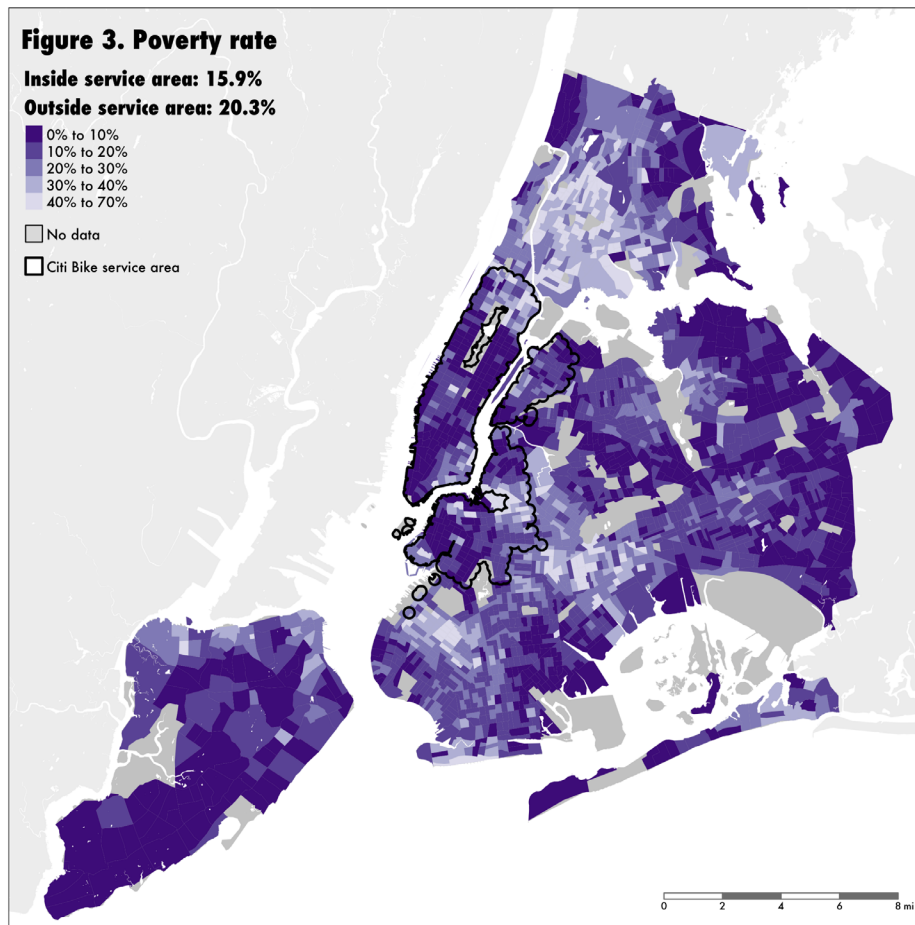
## INCOME

New York City is highly polarized by income; median household income in Manhattan is more than 50 percent higher than in the other four boroughs. This pattern is reflected in bike sharing access, since the Citi Bike network is concentrated in Manhattan and relatively affluent portions of Brooklyn and Queens. On average, New Yorkers with access to Citi Bike in 2018 were considerably wealthier than those without access, with a median household income of \$90,400 compared to \$54,700 for those without access (Figure 2).

The highest concentration of wealthier residents with bike sharing access are located within Manhattan and western Brooklyn. At the same time, a set of lower-income areas are located

at the edges of the bike sharing network. In Brooklyn, the parts of Bedford-Stuyvesant, Bushwick and Crown Heights which have bike sharing access generally have median incomes under \$50,000. Likewise, bike sharing service continues north of Central Park into Harlem, where median incomes drop sharply.

In general, the wealthiest parts of New York City are all located within Citi Bike's service area, while the poorest parts of New York mostly lack bike sharing access. Every neighborhood with a median household income higher than \$200,000 has bike sharing access, while more than 7 in 10 of the neighborhoods with median household income lower than \$20,000 lack access.



## POVERTY

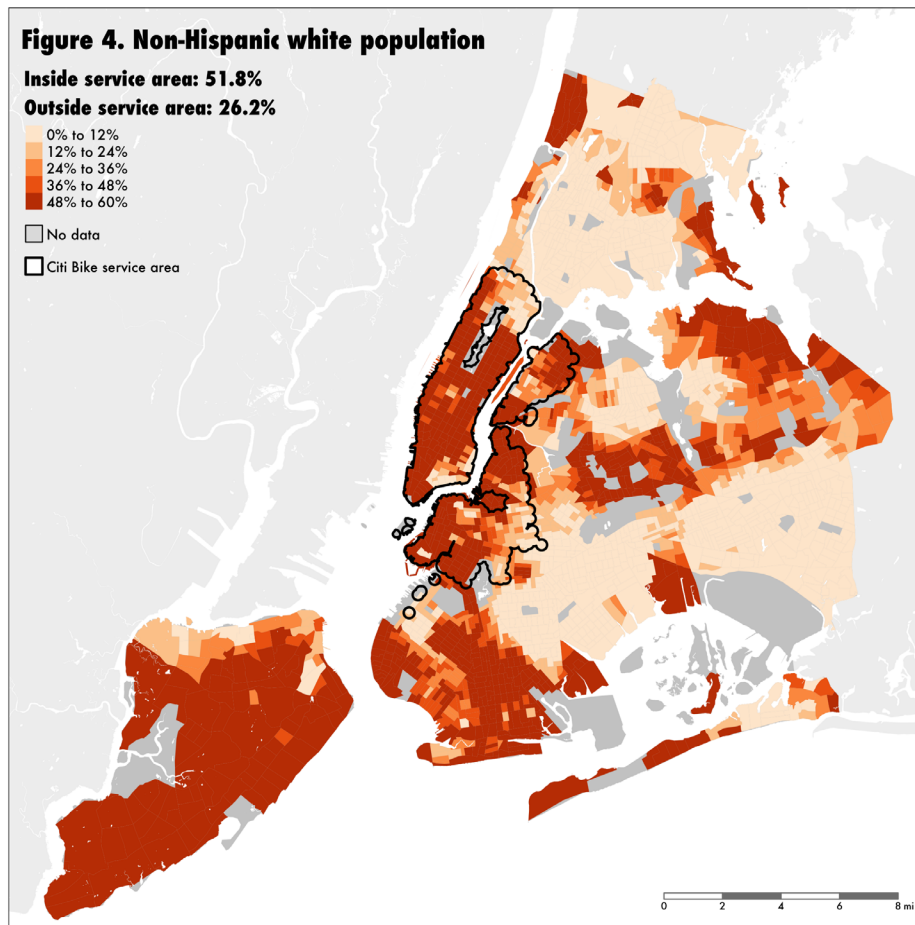
The Census Bureau defines poverty by comparing a family's income to a measure of economic need. Because this poverty measurement is calculated nationally, and does not take into account variations in cost of living, it substantially underestimates the actual prevalence of poverty in New York City, where the cost of living is much higher than the national average (principally because housing is more expensive).

Nevertheless, the official poverty rate is still a useful measure for assessing relative incidence of high social need: which neighborhoods have higher proportions of the populations in poverty, and which neighborhoods have lower? Compared with New York as a whole, Citi

Bike serves an area with relatively low levels of poverty. While 20.3 percent of New Yorkers without bike sharing access live in poverty, only 15.9 percent of New Yorkers with bike sharing access do.

Another way to look at the relationship between poverty and bike sharing access is to note that people living in poverty would benefit disproportionately from living near bike sharing facilities, and yet more than four in five (80.8%) New Yorkers living in poverty lack such access. Meanwhile, three quarters of neighborhoods in extreme poverty (where at least 45 percent of the population is in poverty) are located outside the Citi Bike service area.





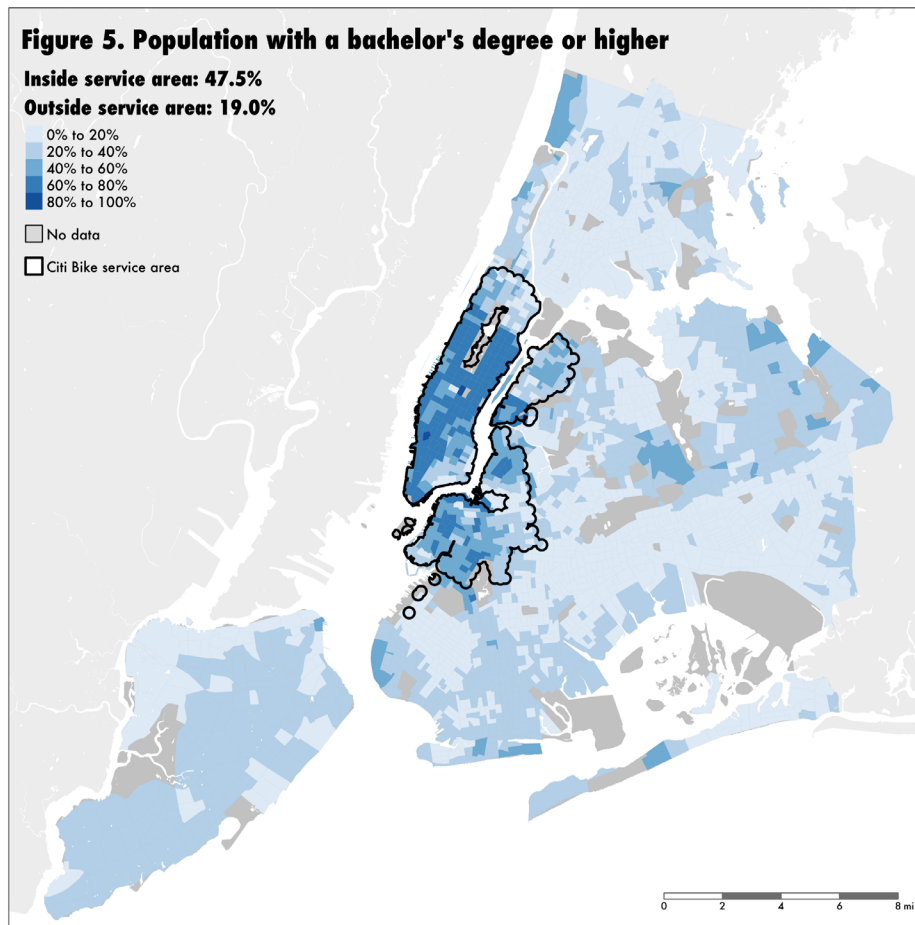
## RACE

New York City is a racially diverse city—32.1 percent of the city’s population is non-Hispanic white, 22.0 percent is non-Hispanic African American, and 29.1 percent is Hispanic. But this diversity exhibits strong spatial segregation, with the city largely divided into discrete majority-white and majority-non-white areas.

Citi Bike mostly serves the former areas (Figure 4). In fact, Citi Bike’s service area is almost twice as white—defined as the proportion of the population which is non-Hispanic white—as the area without access to its bikes. Even though the city as a whole is only a third white, more than

half (51.8%) of the residents with bike sharing access are white, while only a quarter (26.2%) of the population outside of the service area is white.

The partial exceptions to this pattern are Harlem, the Lower East Side, Bushwick and Bedford-Stuyvesant, which have bike sharing access despite being overwhelmingly neighborhoods of color. And yet, in total across the city, only 16.5 percent of people of color in New York City have access to bike sharing services. This is less than half the access rate of white New Yorkers, 37.5 percent of whom live near a Citi Bike station.



## EDUCATION

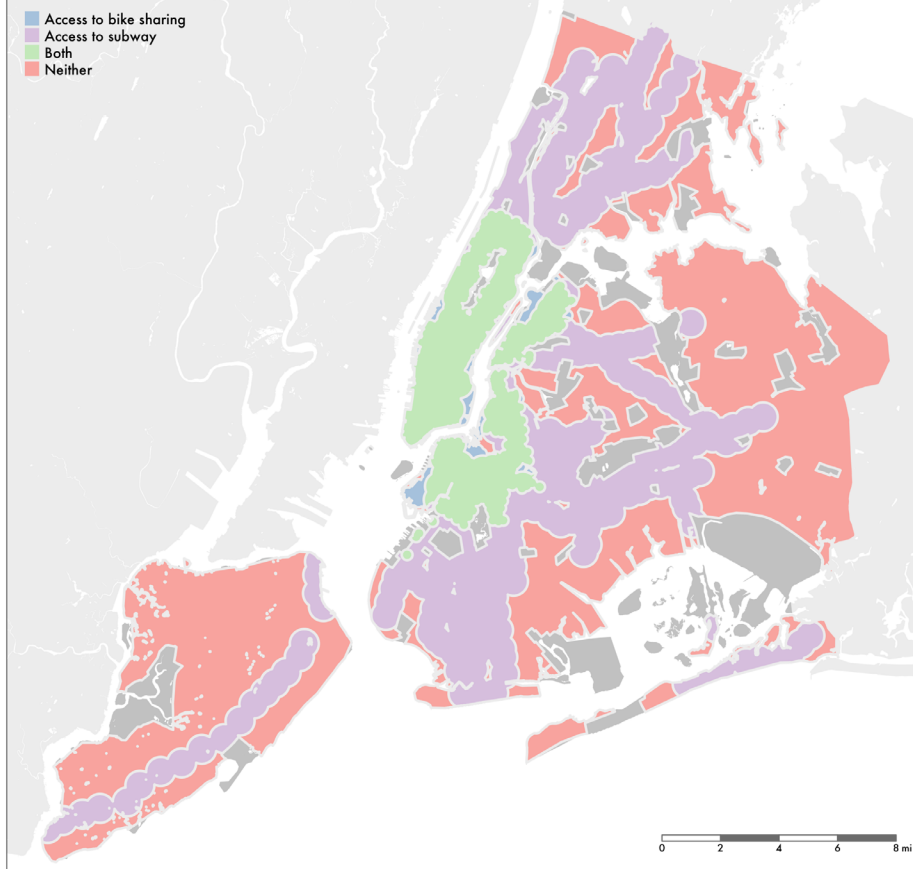
Level of education is perhaps the most disparate of the demographic variables within and outside of Citi Bike's currently serviced areas. New York City displays a strong gradient of educational attainment, with Midtown and Lower Manhattan residents along with residents of the adjacent portions of Queens and Brooklyn typically having university degrees, and residents of the rest of the city typically not having university degrees.

The Citi Bike service area precisely encircles the area of high educational attainment (Figure 5).

Within the service area, 47.5 percent of people have a bachelor's degree or higher, whereas only 19.0 percent of the population without bike sharing access have the same level of education.

While there are several areas with lower average educational attainment in the service area (in Manhattan north of Central Park as well as in Astoria, Queens and central Brooklyn), there are almost no parts of the city with high educational attainment which do not have bike sharing access.

**Figure 6. Bike sharing and subway access**



## SUBWAY ACCESS

Nearly a quarter (23.2%) of New York's population (2.0 million people) has access to Citi Bike. However, this is overwhelmingly a population which already had good access to public transit; only 4.7% of those now serviced by Citi Bike do not live within convenient walking distance (a half-mile) of a subway stop (Fig. 6, in blue). Put differently, only 94,000 (3.8%) of the 2.5 million New Yorkers without subway access have bike sharing access.

Still, for these 94,000 New Yorkers, the existence of nearby bike sharing services should make it easier to access the subway as well as other local destinations, and this population is significantly less privileged than most of those who have bike sharing access in New York. They have a median household income of \$55,900, a poverty rate of

25.1 percent, are 76.7 percent non-white, and 70.6 percent do not have a bachelor's degree. Meanwhile, the other 95.3 percent (1,894,900) of those with bike sharing access already had access to the subway system (green in Fig. 6). This population of New Yorkers who have access to both services are much more white (52.7%) and more educated (48.4% have at least a bachelor's degree), have a lower poverty rate of 15.5 percent, and have nearly double the median household income (\$92,100) of the rest of the city.

Over 2 million, or 27.7%, of New York residents live without access to either the subway or bike sharing services (Fig. 6, in pink). This population has demographic characteristics similar to those outside of subway access but who are serviced by Citi



Bike sharing service	Total population	Median hh. income	Poverty rate	White population	Bachelor's degree	Subway service
Yes	1,988,000	\$90,400	15.9%	51.8%	47.5%	95.3%
No	6,558,000	\$54,700	20.3%	26.2%	19.0%	63.9%

Table 2. Demographic differences in bike sharing access

Bike, with a non-white proportion of 31.3 percent, population with a bachelor's degree or higher at 20.7 percent, poverty rate of 14.0 percent, and median income of \$66,800. The 4.2 million (49.0%) New York residents who live outside of the Citi Bike service areas but live within walking distance to the subway are overall the poorest (median income of

\$47,900 and poverty rate of 23.8%), least white (23.3% non-Hispanic white), and least educated (18.0% have a bachelor's degree) of these four groups (Fig. 6, in purple). This suggests that the subway does a reasonably good job of serving New Yorkers in underprivileged communities—a fact which cannot be said of the bike sharing network.

## IN SUMMARY

A quarter of New Yorkers have access to Citi Bike, and this is a disproportionately privileged population. People with access to Citi Bike are wealthier, less likely to be in poverty, whiter, and better educated than those without access, and they have better subway access as well

(Table 2). The combination of these facts suggests that, whatever other benefits it brings to city residents, the Citi Bike network has so far largely failed to provide new transportation options for vulnerable populations in New York City.



## 4. How has Citi Bike access changed since 2013?

Since the Citi Bike network launched in 2013 serving 800,000 residents, 1.2 million more New Yorkers have gained access to the network. This additional population is only slightly more diverse and less affluent than the population which originally gained bike sharing access in 2013. These 1.2 million residents have a median household income of \$83,700 (compared to \$54,700 in the portion of the city that remains without bike sharing access), a poverty rate of 16.9% (compared with 20.2% in the area of the city without bike service), 49.3% are white (compared with 26.2% in the rest of the city), and 44.2% have at least a bachelor’s degree (compared to 19.0% for the rest of the city).

While the previous chapter documented the large equity deficits of the current Citi Bike network, an important corollary is the question of whether the system is changing in a positive or negative direction. Are the bike sharing equity deficits shrinking? And if so, how quickly? After all, from the pre-launch planning of the Citi Bike network in the early 2010s to the present, equity concerns have been part of the public conversation around New York bike sharing.

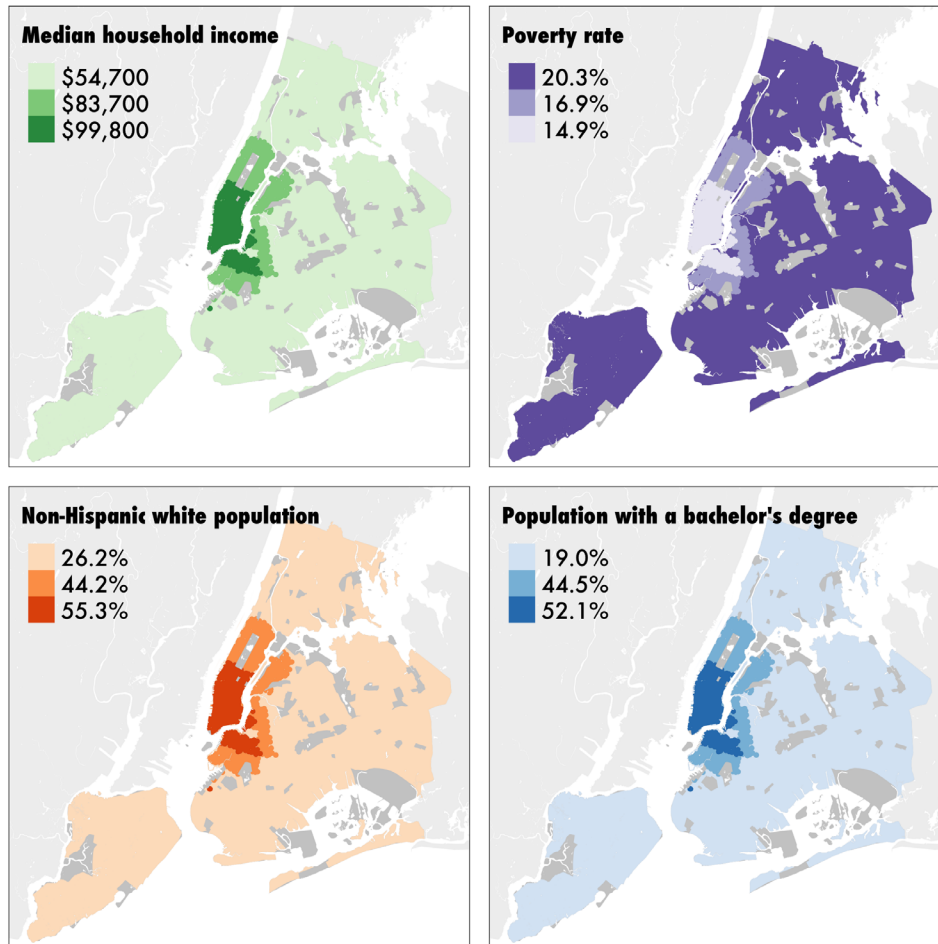
A report from the New York City Department of Transportation (2013), describing the development of the bike sharing network, stated

that “In New York City, DOT chose to address issues of equity and access from both a siting perspective as well as affordability” (New York City Department of Transportation 2013: 14). It outlined a set of equity measures centering on the community engagement process, and set of resulting equity considerations which included discounted annual membership options and Citi Bike stations “within one block of all 29 NYCHA properties in the program area” (ibid). More recently, a report produced by NACTO (2017) detailed efforts to bring equitable bike sharing to Bedford-Stuyvesant, a lower-income community of color with lower ridership rates than other areas with Citi Bike stations.

Service zone	Total population	Median hh. income	Poverty rate	White population	Bachelor’s degree
2013 service	827,000	\$99,800	14.6%	55.3%	52.1%
2018 expansion	1,163,000	\$83,700	16.9%	49.3%	44.2%
No service	6,558,000	\$54,700	20.3%	26.2%	19.0%

Table 3. Demographic differences in bike sharing access, 2013-2018

**Figure 7. Bike sharing service expansion demographics, 2013-2018**



Given that equity has been on the table throughout the entire lifetime of the Citi Bike network, how well has the system taken advantage of opportunities to address equity issues?

When the Citi Bike network opened in 2013, the 827,000 New York residents who had access to the service were overwhelmingly privileged compared to the rest of the city: white (55.3%), well-educated (52.1% had a bachelor's degree), and affluent (median household income of \$99,800 and 14.6% poverty rate).

Since 2013, Citi Bike has expanded service to 1.16 million additional New York residents, bringing the total number of people within access of Citi Bike stations to nearly 2 million. This

additional population as a whole is only slightly more diverse and less affluent than the original 2013 service area. Nearly half are white (49.3%) and hold a bachelor's degree (44.2%), they have a median household income of \$83,700, and only 16.9% living in poverty (Table 3).

Figure 7 summarizes the change in demographics between the population with bike sharing access in 2013 (bottom number in each panel), the population which gained access between 2013 and 2018 (middle number), and the rest of the city (top number). It demonstrates that the Citi Bike network's expansion has only minimally changed the privileged demographics of the population that has bike sharing access in New York.



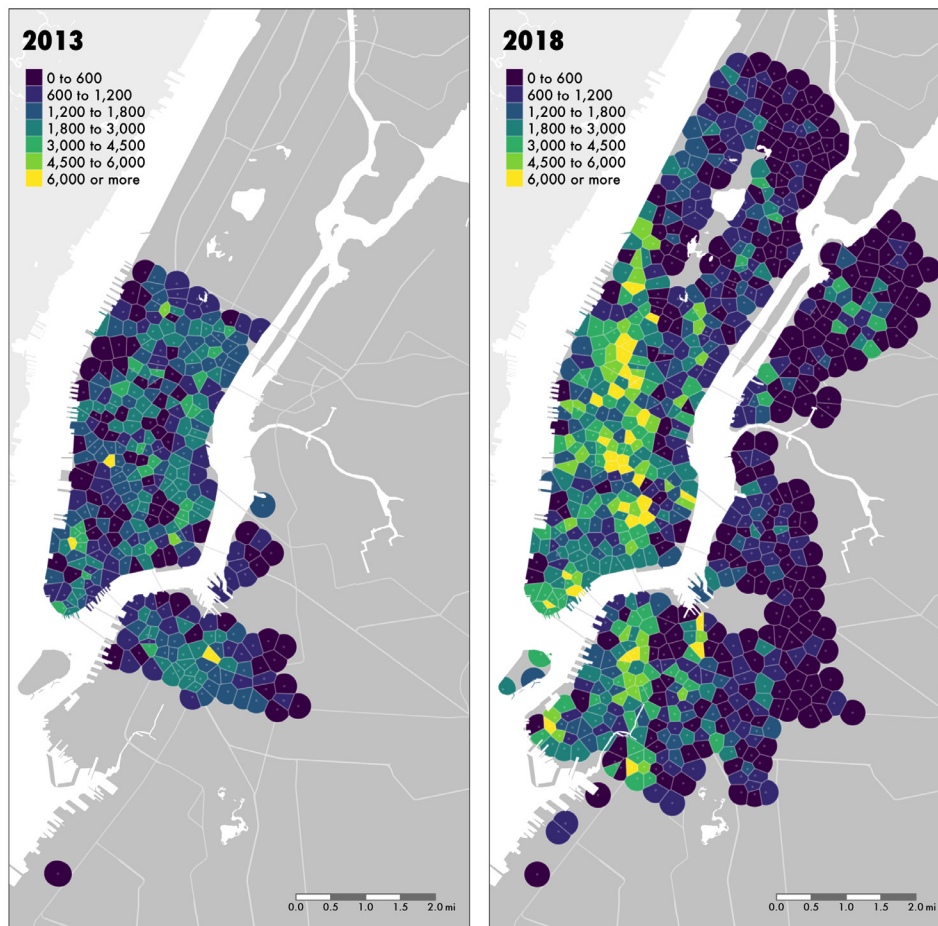
## 5. Which neighborhoods use Citi Bike, and which don't?

**As the Citi Bike network has expanded since 2013, so has ridership per station. Ride density is highest near Broadway in Manhattan, and falls off relatively evenly from there. Citi Bike ridership increases the wealthier, whiter and better educated the surrounding area is, but the effect is small, and largely driven by the fact that ridership is highest near Broadway.**

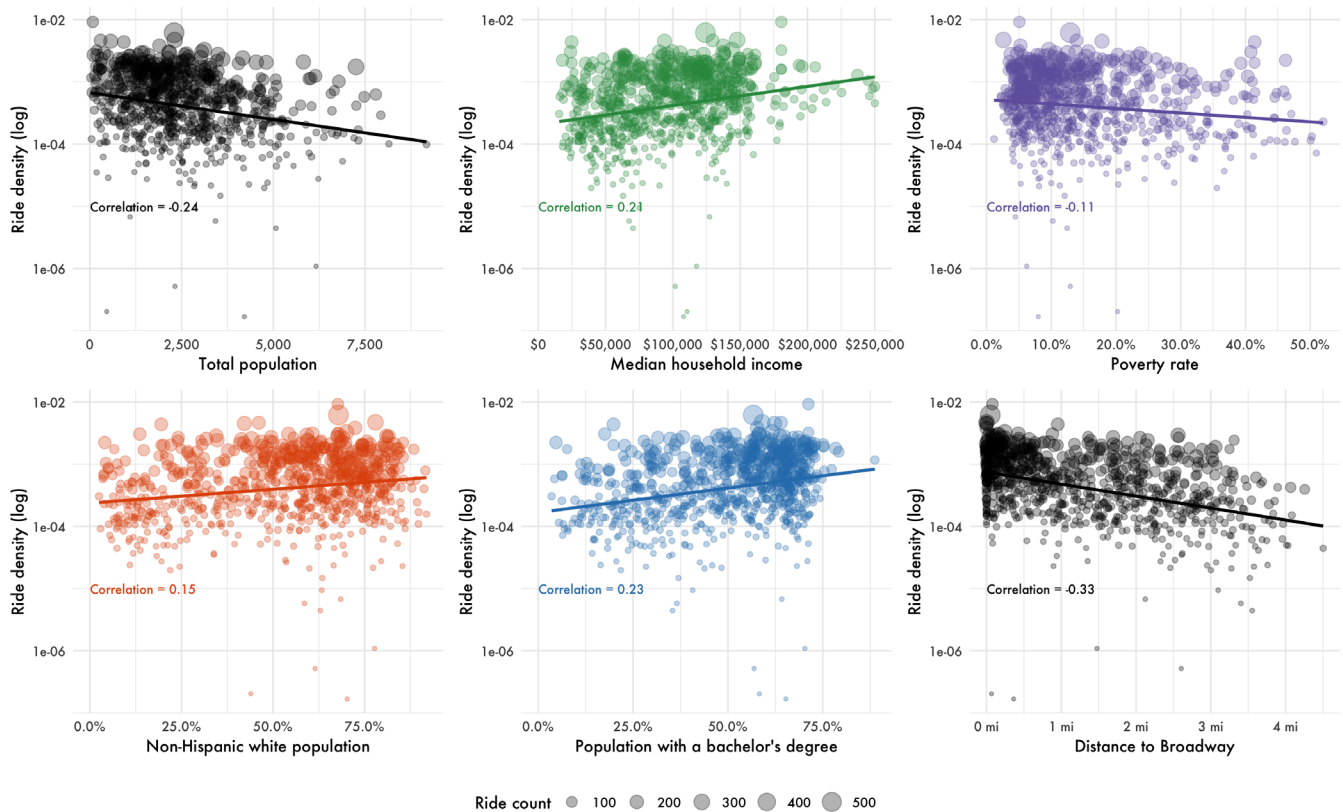
Our analysis so far has analyzed bike sharing in New York as a binary variable: areas with access versus areas without access. However, the fact that a bike sharing station exists does not guarantee that it will be used, and moreover there is a plausible difference between an area

with stations spaced out every half mile and an area with stations every several blocks, although both areas would be classified as having bike sharing service. Accordingly, we now introduce high-resolution data for four million individual trips taken on Citi Bikes in 2013 and 2018, in

**Figure 8. Citi Bike ride density (daily rides per square mile)**



**Figure 9. Ride density correlations**



order to further explore the demographic and equity dimensions of bike sharing access in New York.

In the months of June and December of 2013, Citi Bike users took 1.02 million rides—an average of 16,750 per day. Five years later in 2018, the equivalent numbers were 2.97 million rides in June and December, for an average of 48,700 rides per day. The bike sharing network expanded substantially over these five years, but the average number of daily rides per station increased by 24.1%. Figure 8 shows how these rides were distributed, grouped by the service areas of the bike station at which the ride began. (We estimate service areas using a Voronoi diagram—a set of regions where each point in a given region is closer to the bike station inside that region than to any other bike station.) The results of the maps are intuitive—both years reveal less use along the edges of the service areas than in the center and in 2018 there is

a clear concentration of ridership along the Broadway corridor in Manhattan.

What are the demographic differences in bike sharing ridership across New York? It is impossible to answer this precisely, because Citi Bike does not collect detailed information about its riders. However, a reasonable approximation can be made by correlating the demographics of the service area for each Citi Bike station with the number of rides taken from that station. Figure 9 presents the results of this analysis, showing the correlation between daily ride density per square mile and the four demographic variables analyzed above, in addition to total population in the service area and distance of the bike station to Broadway.

Two main findings emerge from this analysis. The first is that there are positive correlations between ride density and median household income, whiteness and education, and negative correlations between ride density and total

population, the poverty rate, and distance to Broadway. This means that bike sharing stations with higher daily ride densities tend to be located in areas which are richer, whiter, better educated, less populated, and closer to Broadway than stations with lower daily ride densities. However, the second finding is that all of these relationships are relatively weak. The strongest correlation between ride density and any of the variables under examination is -0.33 (this and all other values in Figure 9 are Pearson correlation coefficients) for distance to Broadway, while the correlation between ride density and the poverty rate is -0.11—barely distinguishable from a completely random relationship.

The strength of these findings is attenuated further when the variables are combined into a linear regression model, which allows their independent effects on ridership to be isolated

from each other. Table 4 presents the results of a simple ordinary-least-squares regression where daily rides per square mile in the bike station's service area is the outcome variable and the six demographic and spatial variables from Figure 9 are the predictors. The model finds a very weak relationship between the variables and ride density—they only explain 17.8% of the observed variance in ridership between stations. Moreover, the only strongly significant variables are the total population in the service area and the distance of the station to Broadway, both of which are negatively associated with ridership.

The conclusion is that ridership is not strongly influenced by spatial patterns of social advantage and disadvantage, a finding which suggests the validity of the binary bike sharing service area comparisons (areas with service versus areas without service) elsewhere in the report.

Dependent variable: ride_density	
pop_total	-1.320e-07*** (1.821e-08)
med_income	3.176e-10 (1.250e-09)
poverty	1.026e-03* (5.641e-04)
pop_white	-1.771e-04 (2.346e-04)
education	9.583e-04** (4.116e-04)
dist_to_broadway	-1.295e-07*** (1.834e-08)
Constant	7.974e-04*** (2.837e-04)
Observations	781
R2	0.184
Adjusted R2	0.178
Residual Std. Error	0.001 (df = 774)
F Statistic	29.150*** (df = 6; 774)
Note: *p<0.1; **p<0.05; ***p<0.01	

Table 4. Linear regression model of ride density



## 6. How should New York's bike sharing expand in the future?

**There are 760,000 disproportionately poor and non-white New Yorkers without good subway access who would benefit from an equity-focused bike sharing network expansion. The most equitable way to expand the bike sharing network would be to prioritize areas which are just out of reach of subway access and have high social need. We have identified twelve such neighborhoods across four boroughs. Building new bike sharing facilities to connect these people to the subway would greatly improve accessibility for 760,000 people who are 85.9% non-white with a median household income of \$50,800. In total, under the most aggressive expansion scenario, up to 3.7 million New Yorkers could gain bike sharing access.**

The demographic disparities between New Yorkers with bike sharing access (both those who have had it since the Citi Bike network launched in 2013 and those who gained it in the subsequent years) and New Yorkers without bike sharing access are stark. But this fact can be explained without any suggestion that the bike sharing network was specifically designed to service privileged residents. The original bike sharing service area is the densest part of the city and receives the highest volume of tourists, who are an important bike sharing market. It is simply the case that this area is also a rich, white, well educated area. Since 2013, expansions to the Citi Bike network have mostly occurred in areas contiguous to the existing network. Since the areas surrounding the original network are also largely rich, white, and well educated (although slightly less so than the original network), it is inevitable that the racial and economic disparities present in the original Citi Bike system have only been slightly reduced.

At the same time, as discussed in the previous chapter, equity was a stated priority for the Citi

Bike network from the beginning, and it is clear that the system has failed on this priority. If equity were to be re-introduced as a key system priority, what would a just expansion of the bike sharing network look like? Our framework suggests two possibilities for expanding bike sharing service: neighborhoods with high social vulnerability, and areas with limited existing access to transit. While it may not be possible to expand bike sharing to all of the target areas that would benefit from it, this analysis identifies priority areas according to each expansion priority.

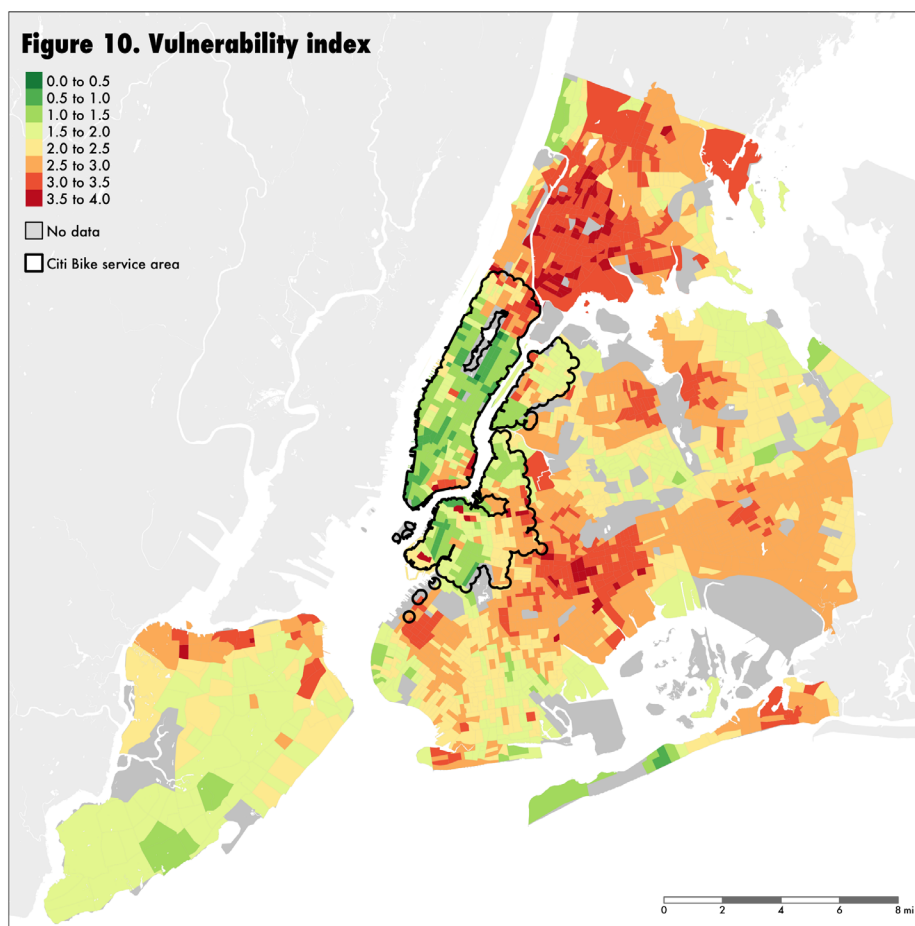
Importantly, our analysis does not assume that bike sharing service expansion should only occur in neighborhoods contiguous to the existing network. While there are obvious service efficiencies to be gained from operating a contiguous network, given that the bike sharing network operates as a municipally granted monopoly there is a reasonable public-interest case to be made for imposing additional requirements on the service operator to meet equity objectives.

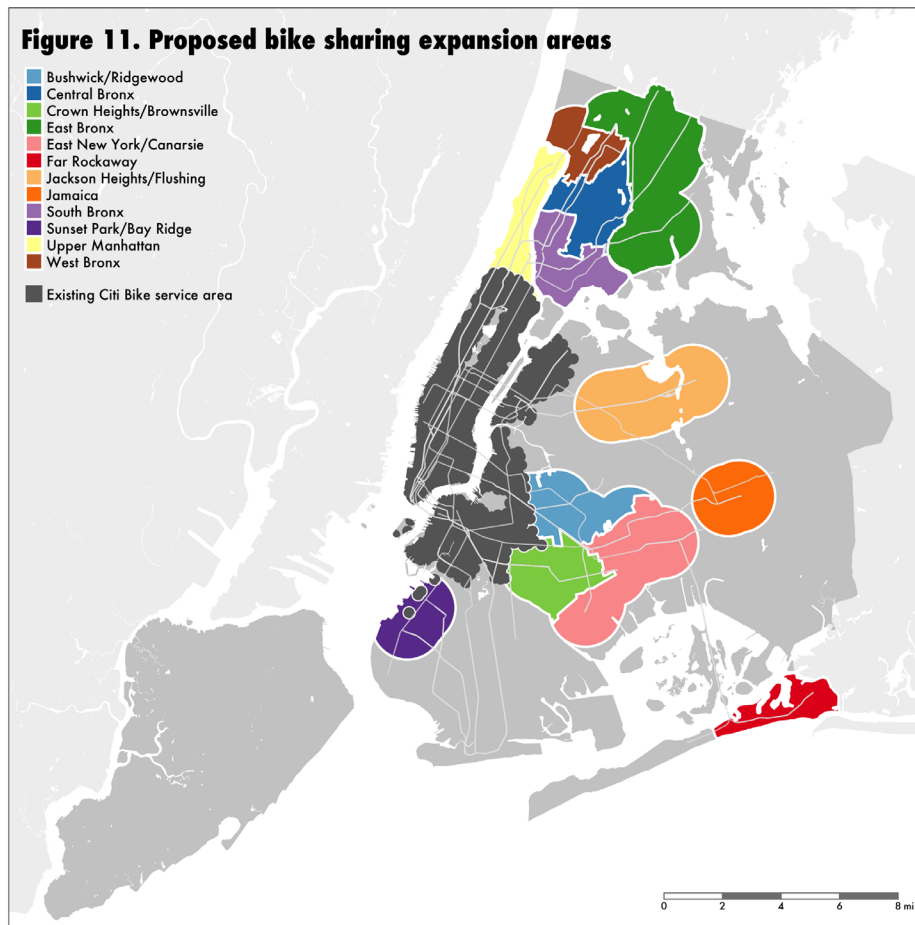
## IDENTIFYING EXPANSION AREAS

We use our two bike sharing service priorities (serving disadvantaged neighborhoods and expanding transit access) to identify potential expansion areas. We construct a vulnerability index, combining the four demographic variables discussed previously in the report (median household income, percentage of the population living in poverty, the percentage of the population which are people of color, and the percentage of the population without a bachelor's degree) into a single synthetic vulnerability index. Figure 10 shows vulnerability by census tract across New York City.

Next we identify extended subway service areas of 1.24-mile-radius circles around subway station,

which is a distance too far to conveniently walk to the subway but feasible to bike. For each of these areas, we measure the average vulnerability score, and areas whose score exceeds 2.75 on our 4-point scale (corresponding to the 67th percentile for individual census tracts) are selected as potential bike sharing expansion areas. We further divide these areas by existing neighborhood boundaries (using the public-use microdata areas from the census, which roughly correspond to New York's community boards), and arrive at 12 priority neighborhoods for bike sharing expansion, distributed throughout Brooklyn, the Bronx, Manhattan and Queens. These are indicated in Figure 11.



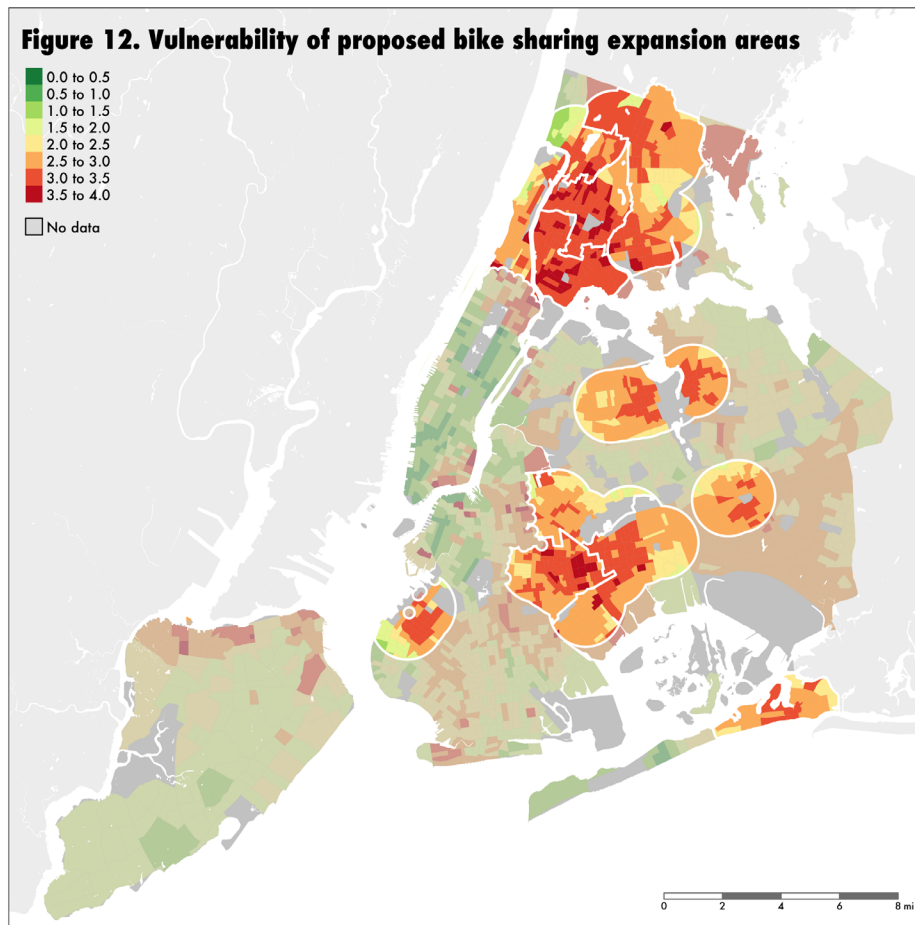


Social vulnerability and existing access to transit present two different and potentially competing priorities in expanding the bike share network. Figure 12 displays the potential expansion neighborhoods from the perspective of social vulnerability, and demonstrates clearly that the Bronx has the most objective need in this regard. Table 5 lists the five neighborhoods which have the greatest vulnerability, and four of the five are in the Bronx. (Crown Heights/Brownsville in Brooklyn is the fifth.) While the West Bronx and South Bronx already have relatively strong transit, and thus bike sharing would not serve to significantly expand subway accessibility in these areas, they are nevertheless areas with high concentrations of residents in poverty and other forms of social need. Implementing bike sharing facilities in these areas would grant access to 1,680,500 of the most disadvantaged

New Yorkers, and would thus represent a major rebalancing of the equity distribution of the existing bike share network.

Figure 13 considers the identified expansion areas from the perspective of where the most effective number of new transit riders would be added. It presents a rather different picture from the social vulnerability analysis; in particular, neighborhoods in Queens which were at the low end of the vulnerability scale (relative to the remainder of the proposed expansion areas) have larger subway accessibility deficits than many of the neighborhoods with more social vulnerability. Table 6 lists the five neighborhoods where bike sharing service would yield the highest potential density of new subway riders, and thus where bike sharing facilities would be most efficient at expanding transit possibilities





Most vulnerable neighborhoods (vulnerability score)	Total population	Population to gain subway access	Population to gain access to subway per mi <sup>2</sup>
South Bronx (3.4)	297,000	9,500	10,400
Central Bronx (3.4)	315,200	84,000	50,800
Crown Heights/Brownsville (3.1)	311,600	54,400	41,200
West Bronx (2.9)	236,500	15,000	20,400
East Bronx (2.9)	520,300	145,800	25,400

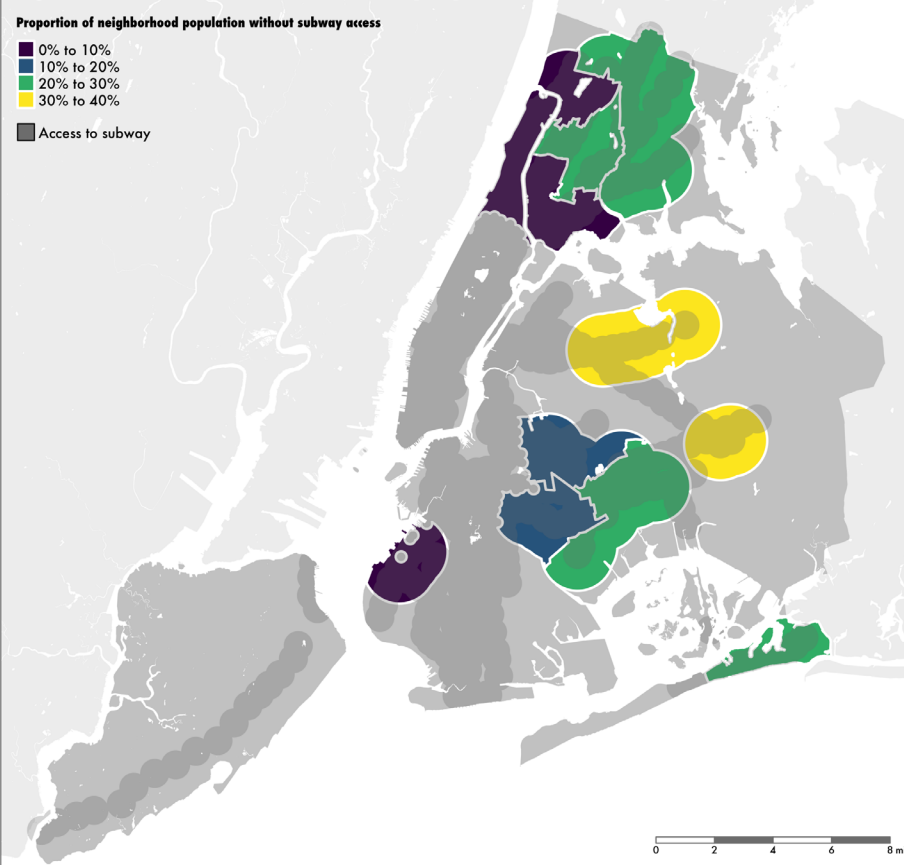
Table 5. Leading potential expansion areas based on vulnerability index

for residents. Central Bronx and Crown Heights/Brownsville continue to be ranked highly, but they are joined by a set of neighborhoods mostly in Queens (Jackson Heights/Flushing, Jamaica, and Bushwick/Ridgewood). Expanding bike sharing facilities to these neighborhoods and incorporating them into the subway access area

would grant bike share access to 1,592,500 New Yorkers, 27.4% of whom do not currently live close enough to a subway station to make daily commuting viable.

Across these twelve possible expansion neighborhoods there are 3.7 million New Yorkers

**Figure 13. Subway accessibility of proposed bike sharing expansion areas**



Transit-poor neighborhoods (% of population without subway access)	Total population	Population to gain subway access	Population to gain access to subway per mi <sup>2</sup>
Central Bronx (26.7%)	315,200	84,000	50,800
Crown Heights/Brownsville (17.4%)	311,600	54,300	41,200
Jackson Heights/Flushing (38.2%)	519,700	198,500	38,000
Jamaica (35.8%)	196,100	70,200	30,500
Bushwick/Ridgewood (12.0%)	249,800	30,100	29,400

*Table 6. Leading potential expansion areas based on subway access*

who would be viable potential recipients of bike sharing service if equity were a priority for the system. In particular, these neighborhoods contain 760,000 disproportionately poor and non-white New Yorkers (85.9% non-white with a median household income of \$50,800) who do not have easy access to the subway. While the existing Citi

Bike network has mostly served wealthy and white residents of central Manhattan and surrounding areas, it is these 760,000 New Yorkers for whom bike sharing could significantly improve their mobility and thus their social and economic prospects. Their interests should be prioritized in future bike sharing expansions in New York.

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## ABOUT UPGO

UPGo, the Urban Politics and Governance research group at McGill University, conducts rigorous, public-interest research into pressing urban governance problems—particularly those that exceed or challenge city boundaries. UPGo has published numerous peer-reviewed journal articles and policy reports on the sharing economy in New York and other cities worldwide, including [“The High Cost of Short-term Rentals in New York City”](#). UPGo is led by Prof. David Wachsmuth, the Canada Research Chair in Urban Governance at McGill University’s School of Urban Planning, and is online at [upgo.lab.mcgill.ca](http://upgo.lab.mcgill.ca).



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