The first six months of 2020 were probably among the most disruptive events in New York City's history. It goes to follow that NYC's Citibike program should probably have been impacted by an event as consequential as a global pandemic as well.

**Citibike data shows that the pandemic did not arrest the sustained growth of the Citibike program.**

As **Plot 0.1** demonstrates, the months prior to the pandemic showed a pattern of activity consistent with a regular workday: twin peaks of trip activity to reflect a morning and afternoon rush hour.

After NYC was placed under lockdown in March 22, the morning peak disappeared in April's data.

In May, activity bounced back as restrictions were prematurely loosened, even as the morning peak of activity failed to return. Instead, the afternoon peak became more pronounced. This level o activity again declined in July as the second wave prompted a return to lockdowns.**Plot 0.2** reflects this trend as well as it sows a sharp decline in the number of trips recorded in April in response to the lockdown, then a sustained increase through June.

**Plot 0.3** demonstrates a concurring trend where the lockdown is almost impossible to identify amongst the sustained increase in activity.

**Phenomenon 1: There is highly uneven utilization among the bicycles in the Citibike program**

**In general, Plot 1.1 appears to show that there is a weak correlation between the number of trips a specific bike is rented; and the cumulative total of time ia bike was rented in a particular month. Most bikes do appear to fall along or close to this trend line with hundreds of bike units that seem to be rented fewer times while logging long cumulative duration totals.**

Plot 1.2 shows the top 1000 bicycle units by cumulative rental duration per mnnth. This plot suggests that the units to the left of the plot may be of most need of quality assurance inspections.

Unit 43151, for example, has been recorded as having been rented for 777,777 hours in just 14 recorded trips.

Where Plot 1.1 suggests a prevalence of frequent; but short trips, this is indeed an outlier among various bike units. The data suggests that many of the long duration units may have spent more time idled in home garages than being ridden in trips around the city. It also appears that most of the city's bike are rented fewer than 12 times a month for a cumulative total of less than 2 hours.

The mystery of the utilization data is better contextualized by this second phenomenon observed wherein subscribers and customer users of the Citibike program show different patterns of behavior as Plot 2.1 demonstrates across several months.

**Phenomenon 2: Customers and subscribers behaved differently than one another.**

**Plot 2.2** demonstrates that customer users tend to log longer average durations fir their trips while subscribers tend to account for the vast majority of trips logged in **Plot 2.3**.

This suggests that the outliers observed in Plot 1.1 may be due to one-time customers, who pay per trip, behaving differently than the majority of users who are subscribers.

Financial incentives may explain this differential behavior. Customers who pay per trip may be incentivized to prolong each individual "trip" instead of promptly returning a unit to a station. Subscribers who pay a fixed rate regardless of use may be fine with taking shorter more frequent trips.

**Phenomenon 3: The pandemic changed where users came from ; and where they returned their bicycles**

What Plot 3.1 demonstrates is a fairly consistent pattern among the top stations in NYC for starting trips. Indeed,the pattern does not seem to have ubstantially changed until the bite of the March 22 lockdown, which is reflected in the radical decrease in activity recorded in April data, although May showed a substantial "bounceback" that continued into June.

Plot 3.2 might appear like an afterthought to Plot 3.1; but the city's bottom 10 stations for starting tripswere also fairly consistent for most of the first half of 2020. The atterns of activity here also reflect the bite of the March 22 lockdown; but June records showed an increase in activity in the bottom stations that exceeded pre-pandemic levels. Unlike much of the city, the Citibike program appears to have thrived under the conditions of the pandemic.

**Plot 3.3** supplements **Plots** **3.1** and **3.2** by showing how the most active Citibike origination stations evolve for each hour of the day. At midnightm during the baseline low activity for the program, many trips appear to originate along length of First Avenue. Many first avenue stations remain popular origination points during the pre-pandemic morning rush hour and throughout the day. First Avenue runs along the length of the east side of Manhattan in close proximity to busy areas like the UN, the Downtown Business District, Wall Street, the Upper East Side, Spanish Harlem, etc.

This phenomenon suggests the program has some popularity even among the fairly well-off of New York; or that the pandemic has made altermatives unattractive to users.

**Map 1: Origination point activity evolved as a result of the pandemic**

In March, there was a slight increase in activity coinciding with the beginning of spring. Despite the start of the lockdown on March 22, Citibike activity appears to have increased somewhat in April.

This is possibly due to people using Citibike more as traditional transport modes like public trasport, taxicabs, and Uber became transmission risks. The opening of new stations in the Bronx and Queens may have contributed to the sustained increase activity through May; while the onset of warmer summer weather probably caused the June spike in activity. In any case, the continued expansion of the Citibike program appears to be a case of increasing utilization as more stations open although Lower Manhattan has remained the focal point of origination activity throughout the whole period.

**Map 2: Return point activity also changed in response to the pandemic**

At the start of 2020, end station activity was fairly standard for New York City's wintertime conditions. This does not sappear to have changed through March, though fewer bicycles were returned in the frequently busy Midtown stations that are often the focal point of the program. In April, we see the first noticeable change in activity as the March 22 lockdown depressed Citibike return activity throughout the city. . Given the lack of commensurate decline in origination activity in **Map 1**, it is possible that more people simply opted to take Citibike bicycles home for their repeated use. This decline was temporary, however, as normal return activity returned in May; and through the start of summer in June.

**Map 3 and 4: Throughout the first half of 2020, average hourly activity reveals some interesting patterns.**

Even at midnight, the map shows light origination activity throughout the city. And this actovity appears to remain unchanged for most of the early morning. At 6am, average daily activity suggests that there is an increase in origination activity in Midtown Manhattan; and origination activity steadily increases through 8am, coinciding with the pre-pandemic morning rush hour.

By noon, there is less origination activity from Midtown; and more from the neighborhoods in Lower Manhattan. Origination activity slowly increases in the afternoon and hits a peak during a traditional afternoon rush hour. At 5pm, origination activity is highest around Downtown , as might be expected. After 5pm, activity throughout the city decreases but doesn't completely halt.

While not definitive, this map offers a glimpse to how New York City's rhythms have adjusted to a pandemic.

First of all, there is a low but constant baseline level of return activity throughout the city even at midnight and before sunrise. This reflects the baseline origination activity that is reported in **Map 1**.

By 6 am, the first noticeable increase in activity looks to appear in Midtown and the Lower East Side. . Again, this may be a relic of the pre-pandemic morning rush hour. By 8am, destination return activity increases across Lower Manhattan. For noon, destination activity appears to increase around Central Park in Manhattan and Prospect Park in Brooklyn which continues throughout the afternoon. Around the traditional afternoon rush hour, return activity increases in the Lower East Side and in Williamsburg.

One explanation may be that the pandemic has led New Yorkers to use the Citibike program to facilitate recreation rather thn their commutes. End styion return activity lags as an indicator and does not return to the low baseline until well into the evening.

**What drove the growth of the Citibike program in 2020? Evolving user behavior.**

There is a chicken or egg argument that might be had about whether the program grew because of increased demand; or the increased demand followed the increase in the number of stations.

In Plot 4.1 we see that the two main metrics of user activity: the number of trips originated, and the total duration of all recorded trips.,, both grew substantially. By comparison, the number of stations in the program only saw marginal increases. What appears to have driven the increase in utilization, is that subscribers substantially changed their behaviors.

Presumably, the lockdown slowed the fast-paced city to a crawl; and Citibike subscribers, who now no longer had commutes to their workplaces, suddenly had subscriptions they didn't need to use for commuting anymore..

One effect the pandemic might have had was to lead New Yorkers to use their bicycles for recreatio instead of commuting, A twice-daily commute became frequent trips to parks or open spaces across the city.. Subscribers, who paid fixed fees, were particularly incentivized to take more frequent Citibike trips.

**Questions for the future: Will changed habits last?**

As **Plot 0.1** demonstrates, the months prior to the pandemic showed a pattern of activity consistent with a regular workday: twin peaks of trip activity to reflect a morning and afternoon rush hour.

After NYC was placed under lockdown in March 22, the morning peak disappeared in April's data.

It is highly unlikely that the morning commutes that appear to have disappeared during the pandemic won't return when the pandemic ends.

However, the permanence of the disruptions to New York City's rhythms will be an important question moving forward.

The possible return of regular workday rhythms might undermine the recreation time that led subscribers to take more frequent trips. Additionally, the return of subways, busses and taxis may pull back some of the Citibike users who turned to Citibike as an alternative to the MTA Until such questions are answered, the city might be wise to reconsider next steps.

**Recommendations Moving Forward**

1. Phenomenon 1 suggests the program needs to give special attention to the most heavily "rented" bikes.

While it's possible, if not likely, that units recorded with long "trip"duration periods spent more time idling rather than being ridden, the program should put a premium in identifying heaily utilized units and confirming if this hypothesis is true. The program may also opt to shuffle units for maintenance

2. Phenomenon 2 suggests a need to restructure user incentives

If, as it appears, Customer users are incentivized to make longer "trips" while subscribers take shorter more frequent ones, the program should consider imposig penalties on overdue "returns; or better weeding out users who create problems for the program's sustainability.

Additionally, the program might be well-served to encourage more customers to become subscribers to guarantee usage even when post-pandemic conditions cause habits to change again.

3. Usage times and pandemic-era data suggest that recreation, rather than commuting drove increased use of the Citibike program.

If confirmed, this is good news. The city may be able to continue expanding the program with less fear of displacing New York City's robust network of public transport. An increased use for recreational purposes may also be beneficial to the health of the city’s residents; and also concurrently increase attendance to the city’s green spaces.

Of course, this is assuming that New Yorkers will continue to use these bicycles for recreation long after normal schedules return.

4, The City should consider expanding the program beyond Manhattan and its environs.

It appears apparent that the epicenter of Citibike program activity has consistently been lower Manhattan. Citibike stations decrease in density and activity further from Manhattan; but even the newer stations in the New Jersey suburbs still remain fairly active. The same is true for the Brooklyn and Queens stations further away from the city’s center, and for suburban Staten Island. Given the increased use of Citibike for recreation, as the data suggests, the program might be well-served to add more stations in the outer neighbrhoods of the New York Metropolitan Area.