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Subways and COVID-19: A Literature Review

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Zoning and Land Use Planning

Subways and COVID-19: A Literature Review

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At the start of the COVID-19 pandemic, New York City suffered far more than the rest of the country from COVID-19; although New York City has less than 3 percent of U.S. population,[1] the city had one-sixth of all U.S. cases as of late April 2020.[2] New York's suffering has led some commentators to claim that New York's density and high transit use is the cause of its high infection rate, and that COVID-19 therefore justifies automobile-dependent development,[3] and (by implication) the zoning codes that mandate such

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[1] *See* Sarah Janssen, ed. The World Almanac and Book of Facts 2020, at 605 (U.S. had just over 327.1 million residents in 2018), 613 (city had just under 8.4 million residents then).

[2] *See* Jeffrey E. Harris, The Subways Seeded the Massive Coronavirus Epidemic in New York City, at http://web.mit.edu/jeffrey/harris/HarrisJE_WP2_COVID19_NYC_24-Apr-2020.pdf. The rest of the United States has partially caught up with New York: by mid-August 2020, only about 4.3.3 percent of U.S. infections were in New York City. See At Least 167,000 people have died from coronavirus in the U.S., Washington Post, August 18, 2020, at https://www.washingtonpost.com/graphics/2020/national/coronavirus-us-cases-deaths/ (5.41 million cases in nation as a whole; just over 230,000 cases in five counties of New York City).

[3] *See, e.g.*, Joel Kotkin, Angelenos like their single-family sprawl. The coronavirus proved them right, Los Angeles Times, April 26, 2020, at https://www.latimes.com/opinion/story/2020-04-26/coronavirus-cities-density-los-angeles-transit. But cf. James Brasuell, Density Debate Rages Alongside the Pandemic, Planetizen, April 27, 2020, at https://www.planetizen.com/blogs/109173-density-debate-rages-alongside-pandemic (citing articles on all sides of issue).

development.[4] Even transit agencies have tried to discourage non-essential workers from riding public transit, in order to encourage the "social distancing" that keeps people too far apart to infect each other.[5]

Some recent research has focused on the role of the New York subway (or lack thereof) in spreading COVID-19. The purpose of this article is to describe a recent paper suggesting that the subway played a major role in spreading the epidemic, as well as some extensive blog posts criticizing the paper.

I. The Harris Paper: Blaming the Subway?

An April paper by Massachusetts Institute of Technology economist Jeffrey Harris[6] concluded that the New York subway system "was a major disseminator — if not the principal transmission vehicle — of coronavirus infection during the initial takeoff of the massive epidemic that became evident throughout the city during March 2020."[7] Harris's argument rests on 1) the timing of COVID-19 infection increases; 2) where infections increased most rapidly; and 3) the high infection rates among employees of New York City's MTA (Metropolitan Transit Authority).

A. When

Harris notes that there is a correlation between when subway ridership decreased and when COVID-19 infections stopped increasing. During the first half of March, new COVID-19 cases doubled every 1.4 days, while subway rider-

[4] Cf. Michael Lewyn, Why (And How) Conservatives Should Support Smart Growth, 42 Real Est. L.J. 388, 393–402 (2013) (describing some relevant types of regulation).

[5] *See* Alon Levy, Is the United States Giving up on Public Transportation?, Pedestrian Observations, May 15, 2015, at https://pedestrianobservations.com/2020/05/15/is-the-united-states-giving-up-on-public-transportation/ (citing examples) ("Levy Public Transportation"); Terry Nguyen, Should You Take Public Transportation During A Pandemic?, Vox, March 13, 2020, at https://www.vox.com/the-goods/2020/3/13/21177324/public-transit-pandemic-coronavirus ("people should try to stay about six feet from a sick person to minimize the risk of catching the virus. Generally speaking, close contact with people in crowded spaces (whether that be a subway, airplane, or office) makes a person more susceptible to transmission").

[6] *See* Harris, supra note 2 at 1 (listing author's institutional affiliation).

[7] Id.

ship was stable.[8] By the third week of March, subway usage had decreased by 68 percent from ridership during the first week of March, and by the fourth week, ridership had decreased by 86 percent from that period.[9] During the last two weeks of March, the number of new cases doubled every 19 days, a far slower rate of increase.[10]

One possible response to Harris's theory is that Manhattan is the most transit-dependent borough in New York, and yet has a lower infection rate than either the outer boroughs or the city's suburbs. Only 25 percent of Manhattan commuters have an automobile in their household, as opposed to 46 percent in Brooklyn and a majority of commuters in the other three boroughs.[11] Similarly, 60.7 percent of Manhattan households use public transit to get to work, more than in any other borough.[12] Yet as of mid-May, Manhattan had 1447 COVID-19 cases per 100,000 people- less than half the rate of suburban Westchester and Rockland Counties (both of which had over 3000 cases per 100,000 people), fewer than

[8] Id. at 3.

[9] Id. at 4.

[10] Id.

[11] *See* United States Census Bureau, Exploring Census Data, at data.census.gov (Table B08141) (54 percent of Bronx commuters, 70 percent of Queens commuters, and 92 percent of Staten Island commuters have an auto in their household).

[12] Id. But here the gap between Manhattan and the other boroughs is narrower: 60.6 percent of Brooklyn commuters, 58 percent of Bronx commuters, 51 percent of Queens commuters, and 29 percent of Staten Island commuters use public transit to reach their jobs. Id. The reason that Manhattan's transit commuting rate is only barely ahead of Brooklyn's is that 26 percent of Manhattan residents walk to work or work from home, as opposed to 13 percent of Brooklyn residents. Id. It is unclear whether this means Manhattanites spend more time on subways: their lower car ownership rate suggests that they may use transit for nonwork trips more than would other commuters. *See* Alon Levy, The Subway is Probably Not Why New York Is A Disaster Zone, Pedestrian Observations, April 15, 2020, at https://nyc.streetsblog.org/2020/04/17/that-mit-study-about-the-subway-causing-covid-spread-is-crap/ ("Manhattan's per capita subway usage is probably higher than that of the rest of the city counting discretionary trips, so 65 percent off the usual ridership in Manhattan may still be higher per capita than 56 percent off in Brooklyn or 47 percent in Queens.") ("Levy Blog"). On the other hand, each individual subway ride may be longer for outer-borough commuters.

any of the four outer boroughs, and also fewer than suburban Orange, Nassau, and Suffolk Counties.[13]

Harris suggests, however, that Manhattan's subway ridership trends support his theory. He points out that Manhattan ridership fell more rapidly than ridership in other boroughs. By March 23, ridership at Manhattan subway stations (measured by subway turnstile entries) had already fallen to 10 percent of its early March level, while Bronx subway ridership had only fallen to 25 percent of that level and Staten Island ridership even more slowly.[14] And by the end of March, Manhattan's infection rate was rising more slowly than that of any other borough.[15] The story Harris tells is that Manhattanites stopped riding the subway first, and so they were less likely to get infected.[16] One weakness of this argument is that a majority of the region's jobs are in Manhattan;[17] thus, Manhattan's lower subway ridership was a reflection not of changed behavior by Manhattan residents, but of the citywide loss of jobs as the city locked down.[18]

B. Where

Harris also relies on the pattern of infections by zip code-and in particular, infections in zip codes along subway lines, because any given rider of a subway line can be infected not only by residents of their own neighborhood, but also by rid-

[13]Citizens Planning and Housing Council, Density and COVID-19 in New York City 9, at https://chpcny.org/wp-content/uploads/2020/05/CHPC-Density-COVID19-in-NYC.pdf ("Citizens"). In later months, Manhattan continued to have fewer infections than other boroughs. By mid-August, Manhattan had 1926 cases per 100,000 residents, while the four outer boroughs and the three suburbs mentioned above had between 2457 (Kings) and 4328 (Rockland) cases per 100,000 residents.

[14]*See* Harris, supra note 2, at 5-6.

[15]Id. at 6.

[16]He hypothesizes that the reason for this is that Manhattanites were more likely to be in well-paid white-collar jobs that enabled them to work from home, while outer borough residents were more likely to be in jobs that required a physical commute. Id.

[17]Office of the New York State Comptroller, New York City Employment Trends 6 at https://www.labor.ny.gov/stats/nyc/ (59 percent of city's jobs in Manhattan).

[18]New York State, Department of Labor, Labor Statistics for the New York City Region, at https://www.labor.ny.gov/stats/nyc/ (city lost over 20 percent of its jobs in April alone).

ers who enter at other subway stations on the rider's route. He finds that some subway lines had more drastic declines in ridership than other subway lines-and that the subway lines with more dramatic declines in March ridership also had lower infection rates as of early April.[19]

C. Transit Employees

Third, Harris points out that transit agency employees were more likely to suffer from COVID-19 than other workers. In particular, the infection rate among transit workers was 600 per 10,000 workers, roughly three times the rate in the most heavily infected outer-borough neighborhood.[20]

II. Responding to Harris's Arguments

At least two commentators have responded to Harris' paper: Salim Furth of the Mercatus Center at George Mason University[21] and Alon Levy at New York University's Marron Institute.[22]

Furth focuses on the relationship between car use and COVID-19 infections, pointing out that there is a strong positive correlation between the two.[23] Furth divided the city into 55 areas; of the eight areas where 60 percent or more of workers commuted by car, six had 5 or more COVID-19 cases per 1000 residents.[24] By contrast, in the eight areas where 10 percent or fewer used cars, not one had such a high infection rate.[25] Even though areas at the end of subway lines

[19] *See* Harris, supra note 2, at 13.

[20] *See* Harris, supra note 2, at 17

[21] *See* Mercatus Center, Salim Furth, at https://www.mercatus.org/scholars/salim-furth (describing his credentials).

[22] *See* Alon Levy, Stop blaming the subways: The best evidence suggests that public transit was not responsible for the coronavirus' spread, New York Daily News, April 22, 2020, at https://www.nydailynews.com/opinion/ny-oped-stop-blaming-the-subways-20200422-oswffzvzfndm7ob5jcdl3zmb3m-story.html ("Levy Daily News").

[23] *See* Salim Furth, Automobiles Seeded the Massive Coronavirus Epidemic In New York City, Market Urbanism, April 19, 2020, at https://marketurbanism.com/2020/04/19/automobiles-seeded-the-massive-coronavirus-epidemic-in-new-york-city/.

[24] Id. (Figure 1).

[25] Id. (Figure 1).

often had high infection rates, this was also true of nearby areas with no subway service.[26]

Furth also points out that Harris's survey overlooks a wide variety of counterexamples. For example, New York's suburbs are not on the subway, but the five largest suburban counties all have higher COVID-19 case rates than do New York City.[27] Similarly, cities with large subway systems in other nations do not tend to have unusually high infection rates.[28]

Furth also responds to Harris's arguments. As noted above, Harris claims that the subway caused the infection because when subway travel declined in late March, COVID-19 infections rose less rapidly than before.[29] Furth responds that when subway travel was declining in late March, restaurant use[30] sharply declined as well.[31] Thus, one could just as easily argue that the decline in restaurant use caused the infection rate to slow down.

As noted above, Harris relies on Manhattan's massive decline in subway ridership in late March. Furth responds that even though Staten Island's ridership was far below that of other boroughs, its COVID-19 cases grew more rapidly in early April than in other boroughs.[32]

Furth concludes by asking: why would automobiles spread COVID-19 more than subways? He suggests that former subway users might have been more willing to stay home in March and April, while non-subway users (perceiving their

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[26] Id.

[27] Id.

[28] Id.

[29] *See* supra notes 8–10 and accompanying text.

[30] As measured by opentable.com, an online restaurant reservations service. See Furth, supra.

[31] Id. (Figure 3).

[32] Id. In particular, the highest growth rate was in a part of Staten Island where 60 percent of residents commuted by car, and two other areas with even higher car use had above-average growth rates. Id. (Figure 2).

cars to be more safe than the subway) might have driven to a wide variety of destinations where they could get infected.[33]

Levy does not reject Harris's claim that subway ridership declined more rapidly in Manhattan than in other boroughs-but he notes that this was primarily true of job-rich Midtown and Lower Manhattan, where ridership fell by 90–95 percent.[34] But in residential areas of Manhattan, ridership fell at the same rates as the citywide average.[35] Thus, Harris's claim that Manhattan residents quit riding the subway before outer borough residents did so may be incorrect.

Levy adds that Harris's reliance on data from subway turnstiles is misleading in one technical but important respect. If a Manhattan stops riding the subway to a Manhattan job, this means there are two fewer subway turnstile entries for that person. On the other hand, if a Queens resident stops riding the subway to a Manhattan job, this means there is one fewer Queens entry and one fewer Manhattan entry.[36] Why does this matter? Suppose that on March 1, there were 100 Manhattan-to-Manhattan commuters and 100 Queens-to-Manhattan commuters, and a week later 30 of each group stop riding the subway. Because there were 90 fewer turnstile entries at Manhattan stations (60 from the first group and 30 from the second group), one might think Manhattan subway ridership declined by 45 percent, when in fact it declined by only 30 percent.

Finally, Levy responds to Harris's claim that MTA employees suffered high infection rates by pointing out that some of these workers are subject to risks that riders are not subjected to; for example, "[t]rain cleaners have to remove contaminated trash from the platforms and vehicles without any protective equipment; [the transit agency] not only didn't supply workers with protective equipment, but also prohibited them from wearing masks on the job even if they'd procured them privately."[37] Conversely, not all MTA employees ride the subways when it is busiest, so ordinarily com-

[33] Id.

[34] Id.

[35] Id.

[36] *See* Levy Blog, supra note 12.

[37] Id.

muters are subject to risks that do not affect MTA employees.[38]

III. The Broader Issue

One issue beyond the scope of these papers is the broader policy issue of the relationship between public transit and COVID-19. It could be argued that public transit is necessarily a vector for this disease because it necessarily places people closer together, or because the level of population density required for public transit requires people to be too close together to avoid infecting each other. On the other hand, it could be argued that even if Harris is right, the problems of the New York subway are caused by factors unique to the United States, such as Americans' failure to wear protective masks in the early months in the pandemic,[39] the United States's slowness in encouraging social distancing,[40] or the United States' failure to quickly test persons who were infected.[41] Even within the subset of American cities with extensive rail systems, New York performed poorly. For example, San Francisco, which has the third highest transit ridership in the United States,[42] required business

[38] *See* Levy Daily News, supra note 22.

[39] *See* Levy Public Transportation, supra note 5.

[40] *See* Britta L. Jewell and Nicholas P. Jewell, The Huge Cost of Waiting to Contain the Pandemic, April 14, 2020, at https://www.nytimes.com/2020/04/14/opinion/covid-social-distancing.html ("an estimated 90 percent of the cumulative deaths in the United States from Covid-19, at least from the first wave of the epidemic, might have been prevented by putting social distancing policies into effect two weeks earlier, on March 2").

[41] *See* Laura Bicker, Coronavirus in South Korea: How 'trace, test and treat' may be saving lives, BBC News, March 12, 2020, at https://www.bbc.com/news/world-asia-51836898 (South Korea tests a higher percentage of its population for COVID-19 than any other nation, and quarantines infected patients); Michael D. Shear et. al., The Lost Month: How A Failure to Test Blinded the U.S. to Covid-19, New York Times, April 1, 2020, at https://www.nytimes.com/2020/03/28/us/testing-coronavirus-pandemic.html (pandemic was especially severe in United States due to large-scale failure to test population for infection).

[42] *See* Travel Mode Shares in the U.S., The Transport Politic, at https://www.thetransportpolitic.com/databook/travel-mode-shares-in-the-u-s/ (Table referring to "Commuting by Transit, 1960–2017, Major Transit Cities" shows that as of 2017, 55.8 percent of New York City commuters

closures more rapidly than New York did,[43] and had one-tenth the number of coronavirus cases.[44] Two comparisons are instructive: a comparison between New York City and its car-oriented suburbs, and a comparison between U.S. cities and other cities with major transit systems.

A. New York vs. its suburbs

If New York's subway system was uniquely infectious, one would find that New York City (and especially its most transit-dependent boroughs, such as Manhattan) suffered more than its automobile-dependent suburbs. Table 1 compares New York and its suburbs, as of early June:

TABLE 1: New York vs. its suburbs

	COVID-19 cases per 100,000 Residents[45]	Percent of commuters using transit[46]
New York County (Manhattan)	1652	60
Kings County (Brooklyn)	2175	60
Bronx	3177	58
Queens	2721	51
Richmond County (Staten Island)	2873	29

used public transit, 35 percent of Boston commuters, and 34.7 percent of San Francisco commuters).

[43] *See* Indermit Gill, Coronavirus lessons from New York and San Francisco, at https://www.brookings.edu/blog/future-development/2020/04/07/coronavirus-lessons-from-new-york-and-san-francisco/.

[44] Id. (as of March 31, San Francisco has 1/10 the population of New York City, and less than 1/100 the number of coronavirus cases).

[45] *See* Joe Fox et. al., at least 106,000 people have died from coronavirus in the U.S., Washington Post, June 4, 2020, at https://www.washingtonpost.com/graphics/2020/national/coronavirus-us-cases-deaths/?itid=hp_hp-top-table-main_web-gfx-death-tracker%3Ahomepage%2Fstory-ans; (nation had 1.8 million cases, while five boroughs of New York had just over 205,000 cases).

[46] *See* Exploring Census Data, supra note 11 (Table S0801); supra note 42 and accompanying text.

Westchester County	3485	22
Rockland County	4102	6
Orange County	2768	5
Nassau County	3001	17
Suffolk County	2698	6
Hudson County (New Jersey)	2761	43
Bergen County (New Jersey)	1979	15
Fairfield County (Connecticut)	1677	10

This table does not show a strong correlation between transit use and COVID-19 cases. The two most transit-dependent boroughs are Manhattan and Brooklyn; Manhattan has a lower infection rate than any suburban county, and Brooklyn has a lower infection rate than six of the eight suburban counties listed. Even within the pool of suburban counties, there does not seem to be a strong correlation between transit use and COVID-19. Rockland County has a below-average level of transit use and the highest infection rate; Hudson County has a higher level of transit use than any other suburban county, but has a lower infection rate than four suburban counties.

B. The Rest Of The World

Because municipal data outside the U.S. is difficult to find, it is not clear how much individual cities have suffered from COVID-19. However, some cities with high levels of transit ridership are in places with almost no COVID-19 deaths, which suggests that those cities have suffered far less than American cities.

For example:

*65 percent of Seoul trips are by public transit.[47] Even if every single South Korean infection had been in that city, Seoul would still have only 116 infections per 100,000

[47] *See* Passenger Transport Mode Shares in World Cities, Journeys 54, 61 (Nov. 2014), at https://pdfs.semanticscholar.org/2580/2966b8cff0aeaf730d8c5a1c65eb383c7899.pdf. ("World Cities").

residents- less than 1/10 the rate of most New York City suburbs.[48]

*51 percent of Tokyo trips are by public transit.[49] Even if every single Japanese infection had been in Tokyo, that city would still have only 185 infections per 100,000 residents- less than 1/10 the rate of most New York city suburbs.[50]

*35 percent of Taipei trips are by public transit,[51] more than in all U.S. cities other than New York or Boston.[52] Even if every single Taiwan infection had been in Taipei, that city would have 16 infections per 100,000 residents, far below that of even Tokyo.[53]

It is unclear why these cities have such low infection rates. Generally, East Asians are more likely to wear protective masks.[54] In addition, South Korea, Japan and Taiwan have have more aggressive COVID-19 testing programs than the United States. Taiwan has conducted 318.5 tests per confirmed case, South Korea has conducted 60.3 tests per case, and Japan has conducted 19.4- all far more than the U.S. ratio of 14.2 tests per case.[55]

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[48] I calculate as follows: Seoul has 10.4 million residents. Id. South Korea had 11,668 COVID-19 cases as of early June. *See* Washington Post Staff, Mapping the worldwide spread of the coronavirus, Washington Post, June 5, 2020 ("Worldwide Map.") 11,668 cases in a city of 10.4 million residents equals 116 cases per 100,000 residents.

[49] *See* World Cities, supra note 47, at 63.

[50] I calculate as follows: Japan had 16,957 COVID-19 cases as of early June. *See* Worldwide Map, supra note 48. Central Tokyo has 9.1 million residents. *See* World Cities, supra note 47 at 63. 16,957 infections in a city of 9.1 million is statistically identical to 185 infections in a city of 100,000.

[51] *See* World Cities, supra note 47 at 62.

[52] *See* supra note 42 (Boston has an identical level of public transit usage).

[53] I calculate as follows: Taiwan had 443 infections as of early June. *See* Worldwide Map, supra note 48. That city has 2.7 million residents. *See* World Cities, supra note 47, at 62. 443 infections in a city of 2.7 million equals 16 infections per 100,000.

[54] *See* Levy Public Transportation, supra note 5 (noting that masks "universal" on Taipei subway).

[55] *See* Joe Hassell, et. al., Coronavirus (COVID-19) Testing, at https://ourworldindata.org/coronavirus-testing.

IV. Conclusion

The role of New York's subway system in spreading COVID-19 is unclear. Presumably, some people were infected during subway rides. On the other hand, it is clear that not every place with high transit ridership has a high infection rate, and that not every place with low transit ridership has a low infection rate.