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Dai, Tianxing

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RESEARCH REPORT

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Examining US Transit Vehicle Passenger Loads during the COVID-19 Pandemic

Tianxing Dai, Graduate Student Researcher, Department of Civil and Environmental Engineering, Northwestern University
Brian D. Taylor, Professor of Urban Planning and Public Policy; Director, UCLA Institute of Transportation Studies

January 2023

UCLA Institute of Transportation Studies

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16. Abstract Transit ridership plummeted at the onset of the COVID-19 pandemic, and what constituted passenger crowding contracted dramatically as well. We examine trends in average passenger loads and their correlates in a national sample of U.S. transit operators during the first year of the pandemic and find that passenger loads in high-transit-ridership areas and on the largest systems fell the most early on. Passenger loads were actually somewhat more likely to increase in places where COVID-19 rates were higher during the first year of the pandemic, which suggests that pandemic transit riders had fewer options to travel by other means.		
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Transit Crowding in the Pandemic

The definition of passenger crowding on public transit changed during the COVID-19 pandemic, particularly early on when social distancing was widely enforced as a public health measure. Transit agencies around the U.S. and the globe radically altered their definitions of and standards for crowding with the emergence of the COVID-19 pandemic in early 2020, as many public health authorities enforced social distancing requirements (Tirachini and Cats, 2020). Nearly half (46%) of 192 US transit agencies surveyed in the fall of 2021 adopted reduced, pandemic-specific crowding standards (Dai and Taylor, 2022).

Given falling demand and this abrupt shift in what constituted crowding, we asked: 1) How did passenger loads on buses change during the first year of the COVID-19 pandemic? 2) What factors were associated with changes in passenger loads over the course of that first year? To answer these questions, we measured average levels of crowding by dividing the monthly unlinked passenger trips (UPT) by the monthly vehicle revenue hours (VRH). This UPT/VRH measure renders average agency-wide passenger load over a month.

We hypothesized that transit agency size (measured by pre-pandemic monthly UPT), mode share of transit among commuters in the primary county of operation, and local COVID-19 infection densities (measured by countywide reported COVID-19 infection caseload divided by primary county population) may each have contributed to changes in average passenger loads from before the pandemic to the beginning of the pandemic, and from the beginning of the pandemic to one full year into the pandemic (Table 1).

Table 1. Hypothesized relationships with average passenger loads

Factor	Hypothesized relation with passenger loads from Feb 2020 to April 2020	Hypothesized relation with passenger loads from April 2020 to Feb 2021
Unlinked passenger trips (UPT)	-	+
Mode share of transit among commuters	-	+
COVID-19 density	-	-

Data and Methods

We focused on the change in average vehicle passenger loads in two time periods: 1) from just before to just after the onset of the pandemic in the US (February 2020 - April 2020) and 2) from the beginning of the pandemic to the period where vaccines began to be widely available in the US (April 2020 - February 2021). We selected all 229 transit agencies in the National Transit Database (NTD) monthly database that reported unlinked passenger trips (UPTs) and vehicle revenue hours (VRHs) of service in February 2020, April 2020, and February 2021. While average passenger loads indicate general levels of crowding, they don't account for how vehicle crowding varies by time-of-day and across routes on a given system; unfortunately such disaggregated data are not available across systems nationally.

We obtained the data for the three independent variables from various sources. The UPT data are from the NTD, the county-wide transit mode-share data are from the most recent American Community Survey (ACS) data, and the county-wide COVID-19 density data are calculated by dividing cases through December 2020 (as reported by the New York Times (n.d.)) by population (from the ACS (2020)). To examine the factors associated with changes in average vehicle passenger loads during these two time periods, we estimated ordinary least square (OLS) regression models for each period. We converted UPT and mode share of transit among commuters to natural logarithm forms to better fit the data.

Findings and Conclusions

According to the NTD data for 229 US transit agencies, average bus passenger loads (UPT/VRH) decreased 60 percent from 20.0 in February 2020 (before the pandemic) to 8.0 in April 2020 (at the beginning of the pandemic). While average passenger loads increased 20 percent to 9.6 by February 2021 (one year into the pandemic), the year-over-year decline was still 52 percent (National Transit Database, 2021).

To examine how falling transit demand and changing definitions of crowding in response to public health recommendations for social distancing collectively influenced passenger loads, we classified all of the transit systems analyzed into tertiles: systems with low (below 50% of the national average), moderate (between 50% and 100% of the national average), or high (above 100% of the national average) average passenger loads in each period. We found that the relative passenger loads for many transit systems shifted quite substantially, and often from one tertile to another, over the first year of the pandemic indicating considerable variability across systems (Figure 1). This shift by many transit systems from the high load category to the moderate and, in a few cases, the low load category at the start of the pandemic was all the more significant considering that what constituted a "high load" in April 2020 and February 2021 was considerably lower than in February 2020.

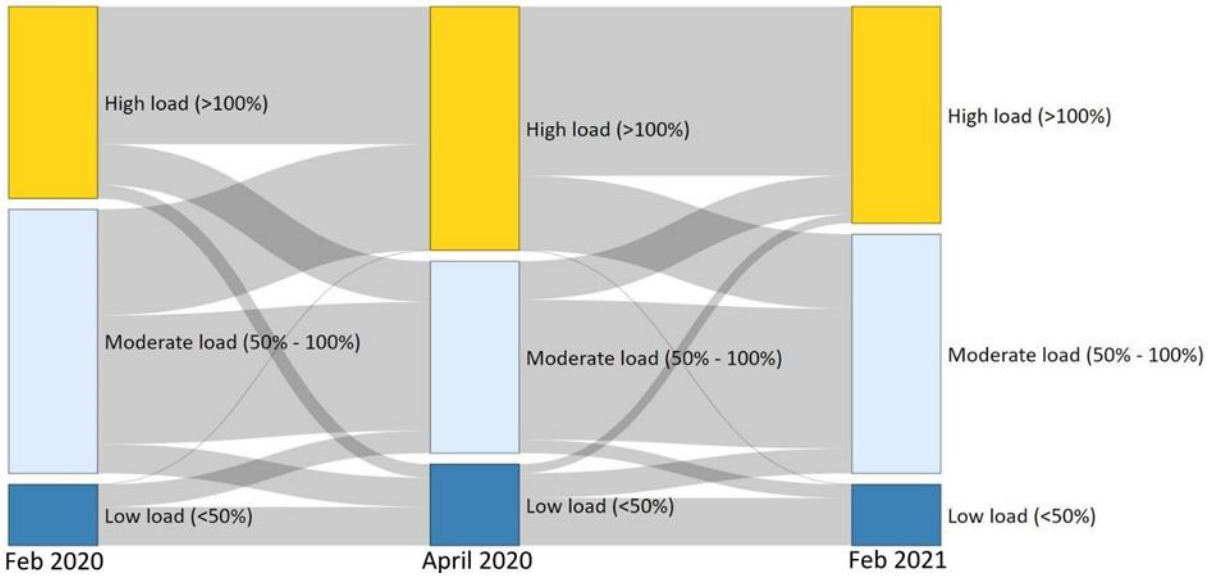

Figure 1. Sankey diagram of changes in relative passenger loads from Feb 2020 to Feb 2021

Table 2 below shows the OLS regression results for the change of UPT/VRH from February 2020 to April 2020 and from April 2020 to February 2021.

Table 2. Linear regression of the change of UPT/VRH from February 2020 to April 2020 and from April 2020 to February 2021

N = 229	From Feb 2020 to April 2020			From April 2020 to Feb 2021		
	Std. Coef.	Std. Error	p-value	Std. Coef.	Std. Error	p-value
(Intercept)	-12.03	0.63	<0.001***	1.53	0.23	<0.001***
Ln (Transit Mode Share)	-2.35	0.77	0.003***	0.46	0.28	0.103
COVID-19 Density	-0.87	0.63	0.172	0.64	0.23	0.006***
Ln (UPT)	-3.15	0.77	<0.001***	0.20	0.28	0.472
R^2	0.22			0.06		

Note: * = p<0.10, ** = p<0.05, *** = p<0.01

The substantial negative intercept in the first (pre- to early pandemic) model likely reflects the traumatic society-wide disruptions early in the pandemic and the by-now well-documented industry-wide transit ridership losses in the spring of 2020 (when average UPT/VRH plunged from 20.0 to 8.0). The negative and statistically significant coefficients for county-wide transit mode share and overall pre-pandemic ridership levels indicate that overall passenger loads fell most in higher ridership places and on bigger systems with the most riders to lose.

The second (early- to mid-pandemic) model measures a period when average passenger loads increased modestly (from 8.0 UPT/VRH to 9.6), and its overall explanatory power is comparatively modest as well. While all the coefficients are positive, only the intercept and core county COVID-19 density are statistically significant, and with the latter variable positively associated with increased crowding. We think it implausible that modest increases in average passenger densities increased local COVID-19 infection rates, and even more unlikely that higher infection rates motivated people to ride transit more. This suggests to us that the relationship between infection rates and passenger loads is either spurious or that both variables were affected by some other, unobserved cause. In either case, the gradual increase in passenger loads in spite of infection rates in many locations likely reflects the fact that transit users during the first year of the pandemic were disproportionately low-income workers who had few travel options other than to ride transit, irrespective of local public health conditions (Parker, et al., 2021; He, et al. 2022).

References

American Community Survey. 2020. *Mode by County_2019 ACS 5-year Estimates*. Washington D.C: United State Census Bureau. https://data.census.gov/cedsci/table?q=commuting%20mode&g=0100000US%240500000&tid=ACSST5Y2019.S0801&hidePreview=true&moe=false

Dai, Tianxing, and Brian D. Taylor. 2022. "When is Public Transit Too Crowded, and How Has This Changed During the Pandemic?" *University of California Institute of Transportation Studies*. Los Angeles, CA. https://doi.org/10.17610/T60S34

He, Qian, Dana Rowangould, Alex Karner, Matthew Palm, and Seth LaRue. 2022. "COVID-19 pandemic impacts on essential transit riders: Findings from a U.S. Survey." *Transportation Research Part D: Transport and Environment*, 105, 103217. https://doi.org/10.1016/j.trd.2022.103217

National Transit Database. 2021. *February 2021 Raw Database*. Washington D.C.: Federal Transit Administration. https://www.transit.dot.gov/ntd/data-product/monthly-module-raw-data-release

NYTimes COVID-19 data bot, Albert Sun. n.d.. *COVID-19 data/US-Counties*. Github.com. https://github.com/nytimes/covid-19-data/blob/master/us-counties.csv. Accessed Dec 7, 2020.

Parker, Madeleine E.G., Meiqing Li, Mohamed A. Bouzaghrane, Hassan Obeid, Drake Hayes, Karen T. Frick, Daniel A. Rodríguez, Raja Sengupta, Joan Walker, and Daniel G. Chatman. 2021. "Public transit use in the United States in the era of COVID-19: Transit riders' travel behavior in the COVID-19 impact and recovery period." *Transport Policy*, 111, 53–62. https://doi.org/10.1016/j.tranpol.2021.07.005

Tirachini, Alejandro, Oded Cats. 2020. "Covid-19 and Public Transportation: Current Assessment, Prospects and Research Needs." *Journal of Public Transportation* 22(1): 1-21. https://doi.org/10.5038/2375-0901.22.1.1