Changing Demand for New York Yellow Cabs during the COVID-19 Pandemic

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Findings

The COVID-19 pandemic has had a profound impact on the life of our cities. While we have observed major disruption to collective activity, aspects of urban life have continued. In this study, we explore the changed spatiotemporal nature of mobility demand. Through a comparative analysis of New York City taxi records data, we observe how relative demand for taxis has displaced across land use zones and concentrated during daylight hours. We also find changes in payment methods that counter public health advice. These findings point to the fundamental mobility needs during the pandemic.

Questions

The COVID-19 pandemic had a far-reaching impact on urban dynamics – bringing established patterns of movement (Zhong et al. 2016) and vibrancy (Sulis et al. 2018) to a halt. Mobility data have revealed the extent to which lockdown policies have affected regional activity (Abdullah et al. 2020; Jenelius and Cebecauer 2020; Gao et al. 2021). While a couple of studies have addressed the impact of the pandemic on taxi travel (Nian et al. 2020; Ale-Ahmad and Mahmassani 2020), there has been limited exploration of interactions with urban geographies (economic, demographics, etc.) at finer spatial and temporal scales. It is important to understand the nature of the continued, fundamental role of urban transport systems in the midst of the pandemic, despite absolute reductions in demand.

This paper describes the relative demand for taxis in New York City during the early stages of the COVID-19 pandemic. We assess the changing nature of travel and its relation to the city, with two key research questions in mind:

- How did relative demand for taxis shift both spatially and temporally during the early days of the pandemic?

- What do relative changes tell us about the nature of mobility in New York City during this period?

Methods

We use publicly available taxi trip records to analyse changes in travel demand during the early stages of the pandemic. This data is released by the Taxi and Limousine Commission (TLC 2021), and for this analysis we focused on the Yellow Cab data, and only on trips originating or ending in Manhattan.

We have used two comparative periods of analysis. In 2020 we chose Monday 9th March to Sunday 7th June, which covers the beginning of a sharp ascent in case numbers in New York City (New York Times 2021), and prior to the restrictions on mass gathering (12th March), the imposition of school closures (16th March) and 'shelter-in-place' and business closure orders (22nd March) (New York Governor 2020). These restrictions were eased from the 8th June 2020. As a comparison, we used equivalent data from 2019, and the corresponding weeks (11-23), the dates of these being Monday 11th March to Sunday 9th June.

Our analysis plan covers empirical changes in pick-up departure times and locations during these time periods. *Relative demand* is calculated as the proportion of trips within a given spatial or temporal unit, relative to the sum of all trips. *Displacement* is a calculation of differences in relative demand between equivalent analysis periods in 2019 and 2020. We also measure changes in *payment types*, as a proportion of trips using card and cash, the two dominant modes, over each time period.

Findings

As expected from previous evidence, we observe a steep drop off in taxi demand during the two periods, reducing from 22,292,199 trips in 2019 to 1,882,670 trips in 2020, a 92% reduction. There are fewer passengers on each trip too, reducing from 1.57 passengers per trip on average in 2019 (where 70% were single-person trips), to 1.4 in 2020 (where 77% were single-person trips).

With respect to displacement in relative demand by hour and day of the week (Figure 1), we observe sharp drops (displacement < -20%) during late hours from Thursday evening, and both early and late hours from Friday throughout the weekend. The other evening hours of the week are either moderately less busy or similar (-1% < displacement < 20%). We also observe positive relative changes in demand during core weekday working hours, particularly between 8am and 5pm on Monday to Wednesday. This increase in demand may be partly due to a choice made by some to avoid public transportation due to perceived health risks.

Exploring relative changes in demand over space, variation in relative demand is similar between pick-up and drop-off locations (Figure 2A). We observe negative to positive displacement in demand from south to north, away from commercial and hotel areas to residential neighbourhoods. There are furthermore indications of displacement aligning with the locations of major COVID-19 hospitals in Manhattan. We can observe displacement more discretely by analysing intersecting land use zone categories (Table 1). This again indicates a shift away from commercial and manufacturing towards residential activity, with trends extenuated around higher density regions. This analysis is performed assuming pickup rates per land use zone are determined assuming their distribution is uniform within each taxi zone.
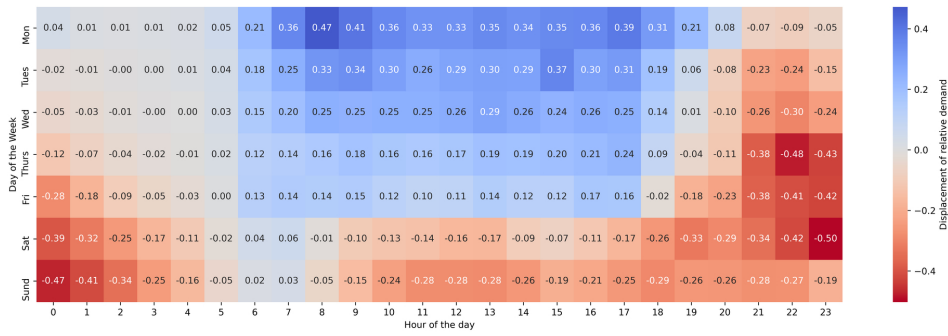
Figure 1. Displacement of relative demand between weeks 11 – 23 of 2019 and 2020, by hour and day of the week.
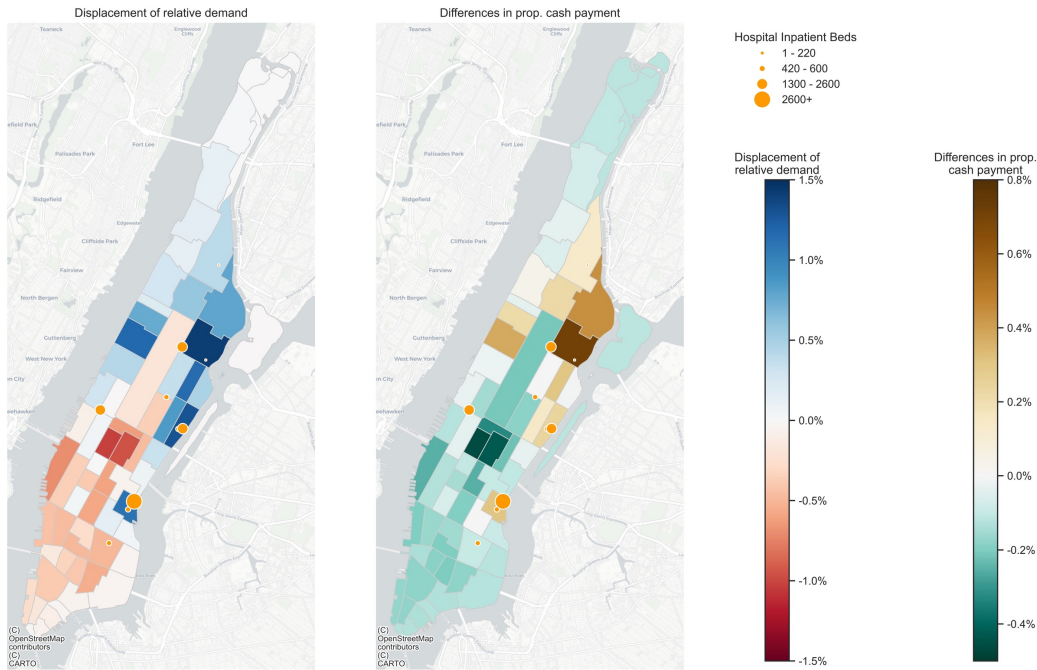

Figure 2. A: Displacement of relative demand by pick-up locations, during week 11 – 23 between 2019 and 2020. **B:** Changes in proportion of cash payments by pick-up locations, during week 11 – 23 between 2019 and 2020.

Orange dots are hospitals located in Manhattan and registered with Centers for Medicare & Medicaid Services (CMS) as of June 1, 2020 (Department of Health & Human Services 2020). In both cases, drop-off trends are nearly identical in distribution and scale, and therefore are not shown.

We furthermore observe a higher proportion of cash payments during the period, and a rate of change that aligns closely with the increasing severity of COVID-19 in New York City (Figure 3). This trend counters advice on reducing virus transmission (UK Government 2020), and points to possible non-adherence to advice in this context, driven by factors relating to the taxi (many Yellow Cab card terminals require physical interaction), or the redistribution of journeys and travellers. Spatial patterns in changes in cash payments (Figure 2B) indicate alignment with relative demand. Proportionate decreases in cash use align with central commercial districts, where tourist

Table 1. Displacement of relative demand in taxi pick-ups by ZoLa land use zone (NYC Planning, 2021).

Zone ID	Summary ZoLa Description	% Trips 2019	% Trips 2020	% Change
C6	High-bulk Commercial	25.65	17.55	-8.10
C5	Central Commercial District	14.05	9.74	-4.31
M1	Multi-story Lofts	5.56	4.29	-1.27
PA	Parks	9.38	9.92	0.54
C4	Regional Commercial Centres	2.95	3.92	0.98
C2	Mixed Commercial-Residential Use	4.04	5.54	1.51
C1	Mixed Commercial-Residential Use	7.95	9.52	1.57
R1	Low-density Residential	5.26	6.83	1.58
R7	Medium-density Residential Apartments	4.17	6.39	2.22
R8	Higher-density Residential Apartments	15.11	19.22	4.11

Drop-off trends are nearly identical and so not shown here. Only zone types with more than 2% of journeys in 2019 are shown.
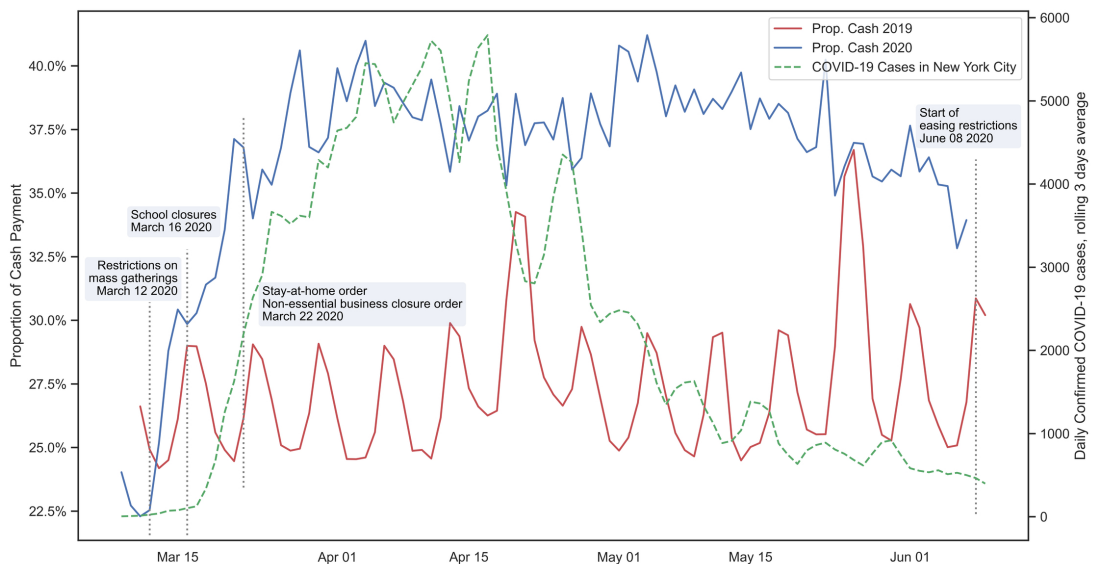

Figure 3. Proportion of cash payment between weeks 11 – 23 of 2019 and 2020, daily confirmed COVID-19 cases in NYC (New York Times 2021), and major government public health interventions.

activity dropped significantly. Increases in cash use are observed in residential areas of East Harlem, an area home to relatively high Hispanic populations (46% in East Harlem neighbourhoods, 29% in New York City), more people on lower household incomes, and relatively high proportions of people relying on public transportation (71%, versus 56% for New York City) (NYC Planning 2021). The higher proportional change in this vicinity may reflect a modal shift to taxis in response to public transportation closures by un- and under-banked populations.

During our window of analysis, it appears that this behaviour change is 'sticky', as we observe no rapid return to 2019 levels of cash use despite significant drops in COVID-19 cases during this period. In more recent times our understanding of COVID-19 transmission has adapted towards a recognition that airborne transmission is a stronger vector than physical contact, and it would be interesting to explore how this understanding impacts future payment patterns.

The COVID-19 pandemic has impacted 'normal' urban life in a myriad of ways, and in many cases these impacts are more or less correlated with reductions in activities brought on by lockdown policies. As we can observe in the temporal shifts in taxi travel, there is a consolidation of activity during daytime hours, as the 'City That Never Sleeps' went into an unprecedented evening slumber. However, there are nuances within these reductions, pointing to the nature of urban mobility during this period. We can see that there is a continued need for access to healthcare, we can observe changes in payment patterns may reflect sentiment around transmission, and more trips are taken alone. These findings, combined with similar preliminary analyses (Teixeira and Lopes 2020; Gkiotsalitis and Cats 2020), provide evidence of behaviour change and travel demand that would be hard to reach through traditional approaches (e.g., surveys), and so have utility in adapting service planning and urban models in uncertain futures. Further work should explore more precise modelling of these effects, in reference to more detailed spatial statistics and accounting over time.

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