A tale of 40 cities: A preliminary analysis of equity impacts of COVID-19 service adjustments across North America

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Abstract

To cope with COVID-19 confinement measures and precipitous declines in ridership, public transport agencies across North America have made significant adjustments to their services, slashing trip frequency in many areas while increasing it in others. These adjustments, especially service cuts, appear to have disproportionately affected areas where lower income and more-vulnerable groups reside in North American Cities. This paper compares changes in service frequency across 30 U.S. and 10 Canadian cities, linking these changes to average income levels and a vulnerability index. The study highlights the wide range of service outcomes while underscoring the potential for best practices that explicitly account for vertical equity, or social justice, in their impacts when adjusting service levels.

Research Question and Data

Public transport ridership in North American Cities declined dramatically by the end of March 2020 as governments applied confinement measures in response to COVID-19 pandemic (Hart, 2020; Vijaya, 2020). In an industry that depends heavily on fare-box recovery to pay for operations and sometimes infrastructure loans (Verbich, Badami, & El-Geneidy, 2017), transport agencies faced major financial strains, even as the pandemic magnified their role as a critical public service, ferrying essential, often low-income, workers with limited alternatives to their jobs (Deng, Morissette, & Messacar, 2020). Public transport agencies also faced major operating difficulties due to absenteeism among operators (Hamilton Spectator, 2020) and enhanced cleaning protocols. These financial and operating challenges have forced public transport agencies to reorganize their services, reducing frequency in some areas while bolstering it in others serving hospitals and essential services. This paper addresses the following research question:

Are the service adjustments imposed by public transport agencies in North American cities disproportionately affecting low-income or otherwise vulnerable areas?

Methods and Data

We measure service adjustments—the percent change in the number of unique trips serving a given area during a weekday—at the census Block Group (BG) (for top 30 US cities by population) or Dissemination Area (DA) (for top 10 Canadian cities by population) levels. For each city, we compare General Transit Feed Specification (GTFS) data for the primary public transport provider before and after the beginning of Covid-related shutdowns: First in February 2020 and then in April 2020 or May 2020, depending on feed availability (working GTFS feeds were not available for Detroit, MI, Minneapolis, MN, and Pittsburgh, PA, and we excluded them

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from this analysis). Table 1 lists the studied cities, main public transport agency, and population of the metropolitan region where the city is located.

Table 1: Study areas*

	City	Metro Population	Main Agency
United States	New York, NY	20,300,000	Metropolitan Transportation Agency
	Los Angeles, CA	12,150,996	Los Angeles County Metropolitan Transportation Authority
	Chicago, IL	9,533,040	Chicago Transit Authority
	Dallas, TX	7,233,323	Dallas Area Rapid Transit
	Houston, TX	6,997,384	Metropolitan Transit Authority of Harris County
	Washington DC*	6,280,490	Washington Metropolitan Area Transit Authority
	Miami, FL	6,198,782	Miami Dade County Transit
	Philadelphia, PA	6,096,120	Southeastern Pennsylvania Transportation Authority
	Atlanta, GA	5,949,951	Metropolitan Atlanta Rapid Transit Authority
	Phoenix, AZ	494,820	Valley Metro
	Boston, MA	4,873,020	Massachusetts Bay Transportation Authority
	San Francisco, CA	4,731,800	San Francisco Municipal Transportation Agency
	Riverside, CA	4,650,630	Riverside Transit Agency
	Seattle, WA	397,985	King County Metro
	San Diego, CA	3,338,330	San Diego Metropolitan Transit System
	Tampa, FL	3,194,830	Hillsborough Area Regional Transit
	Denver, CO	2,932,415	Regional transportation district - Denver
	St. Louis, MO-IL	2,803,230	Bi-state Development Agency
	Baltimore, MD	2,802,789	Maryland Transit Administration
	Charlotte, NC	2,569,213	Charlotte Area Transit System
	San Antonio, TX	2,550,960	VIA Metropolitan Transit
	Portland, OR	2,492,410	Tri-County Metropolitan Transportation District of Oregon
	Las Vegas, NV	2,266,720	RTC Southern Nevada
	Austin, TX	2,227,080	Capital Metro
	Cincinnati, OH	2,221,210	Cincinnati Metro
	Kansas City, MO-KS	2,157,990	Kansas City Area Transportation Authority
	Columbus, OH	2,122,270	Central Ohio Transit Authority
	Indianapolis, IN	2,074,540	Indianapolis Public Transportation Corporation
	Cleveland, OH	2,048,450	Greater Cleveland Regional Transit Authority
	San Jose, CA	1,990,660	Valley Transportation Authority
Canada	Toronto, ON	5,928,040	Toronto Transit Commission
	Montreal, QC	4,098,927	Société de transport de Montréal
	Vancouver, BC	2,463,431	Translink-Vancouver
	Calgary, AB	1,392,609	Calgary Transit
	Ottawa, ON	1,323,783	OC Transpo
	Edmonton, AB	932,546	Edmonton Transit System
	Hamilton, ON	747,545	Hamilton Street Railway (HSR)
	Winnipeg, MB	705,244	Winnipeg Transit
	Durham, ON	645,862	Durham Region Transit
	Waterloo, ON	535,154	Grand River Transit (GRT)

* Service frequency for Washington DC area is obtained for April 2020 in the during confinement period as GTFS data for May was not publicly available.

To calculate percentage changes in service frequency, we spatially intersected GTFS stop-level data from both time periods with the BGs or DAs, eliminating outliers in the top 1-percentile of service increases, which appeared to reflect minor re-routes that shifted service to immediately adjacent areas where there was previously none rather than COVID-related adjustments. These two numbers were then subtracted from each other and divided by the number of unique daily trips before COVID-19. We then plotted the percentage change in service at the BG and DA level against two measures of vulnerability at the metropolitan region level: normalized median income (Z-score) and a composite vulnerability index based on normalized rates of areal sociodemographic characteristics. Income and demographic data were obtained from Statistics Canada and the U.S. Census Bureau. The vulnerability index for BGs in US cities is derived from the sum of Z-scores of: median household income, percentage of non-white residents, and proportion of population with no bachelor's degree, all divided by three. For Canadian cities, the DA-level vulnerability index integrates median household income, percentage of labor force that is unemployed, percentage of population that has immigrated within the last 5 years, and percentage of households that spend more than 30% of income on housing rent, divided by four (Foth, Manaugh, & El-Geneidy, 2013). We did not include the proportion of visible minorities in the Canadian index. While it is beyond debate that racialized and visible minorities face both overt and systemic racism in Canada, residential racial segregation in most Canadian cities generally follows different patterns than in the United States, reducing its utility as a metric of geographically distributed socioeconomic vulnerability (Myles & Hou, 2003). There are at least two important caveats regarding this approach to assessing vulnerability: First, although BGs and DAs are designed to contain roughly comparable population sizes, the number of people in each can vary by location. This means that service reductions in one DA may affect a larger or smaller number of people than identical cuts in another. Relatedly, the use of rate-based, z-scores accounts for the distribution of certain sociodemographic characteristics among the BGs or DAs and does not necessarily reflect the absolute number of vulnerable individuals present within the affected area. Future research may also include other metrics for vulnerability, such as reduced mobility, which will require further knowledge of changes in paratransit services in addition to changes to regular service and is out of the focus of the study. The use of percentage of service adjustments, income Z-score, and a normalized vulnerability index enables us to directly compare the changes in the public transport services across cities.

Findings

Figure 1 shows the percentage change in the number of unique trips in each census area on the Y-axis and the Z-score for income groups on the X-axis. Lower-income areas are represented in the negative side of the chart and higher income in the positive side as Z-score is used for normalization purpose, with Canadian Cities listed in the bottom.

Figure 1: Percentage change in number of trips stopping in a Census Block or a Dissemination Area and Z-score of income (trend line equation showing as proportion)

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Almost all transit agencies applied major service adjustments, albeit at different rates. Chicago's CTA appears to have intentionally avoided making any major service reductions in response to Covid, asserting that public transit represented an essential public service particularly for workers and first responders. (Chicago Transit Authority, 2020). Seattle applied minor service adjustments and cuts with little impact on low income areas. Cities like Miami and Riverside implemented only service cuts, impacting all income groups almost at the same level. New York and Houston applied substantial changes in the service across all income groups including both additions and cutting of services. Toronto and Montreal applied both service cuts and additions that impacted low income areas in a disproportional way.

Figure 2 shows the percentage change in service adjustment on the Y-axis and the vulnerability index on the X-axis (US and Canada (bottom row) use different components for the index), please note that higher levels of vulnerability are represented in the positive side of the chart and affluent or least vulnerable is on the negative side of the chart.

A steep upward trend line in Figure 2 (San Francisco and Portland) indicates more sensitivity in the service adjustments toward vulnerable groups with less cuts and more additions in the services passing through BG or DA with higher concentration of vulnerable groups. While a flat trend line (New York, Los Angeles, and Miami) indicate that service cuts and additions were done almost equally across the different BG or DA. While a downward trend (Montreal and Toronto) indicates that service cuts did happen more in BG and DA with higher concentration of vulnerable groups. It is clear that some agencies accounted for vertical equity (providing more to those who are in need for the service) in their service adjustments while others concentrated more on horizontal equity (providing adjustments equally to all groups). Other measures of equity can be used to evaluate the decisions made by various agencies, yet in this research we concentrated on vertical and horizontal equity. Future research can apply the changes in levels of accessibility to essential services, yet it will require having a list of essential services available in each region at the time of confinement, which was not available for us at the time of conducting this research.

Disclaimer

An earlier version of the manuscript contained two errors. Thanks to Chris Cherry and Anson Stewart for pointing them out. It is important to note that this study reports readily available data posted online by the different public transport agencies, and any errors is a reflection of the posted data.

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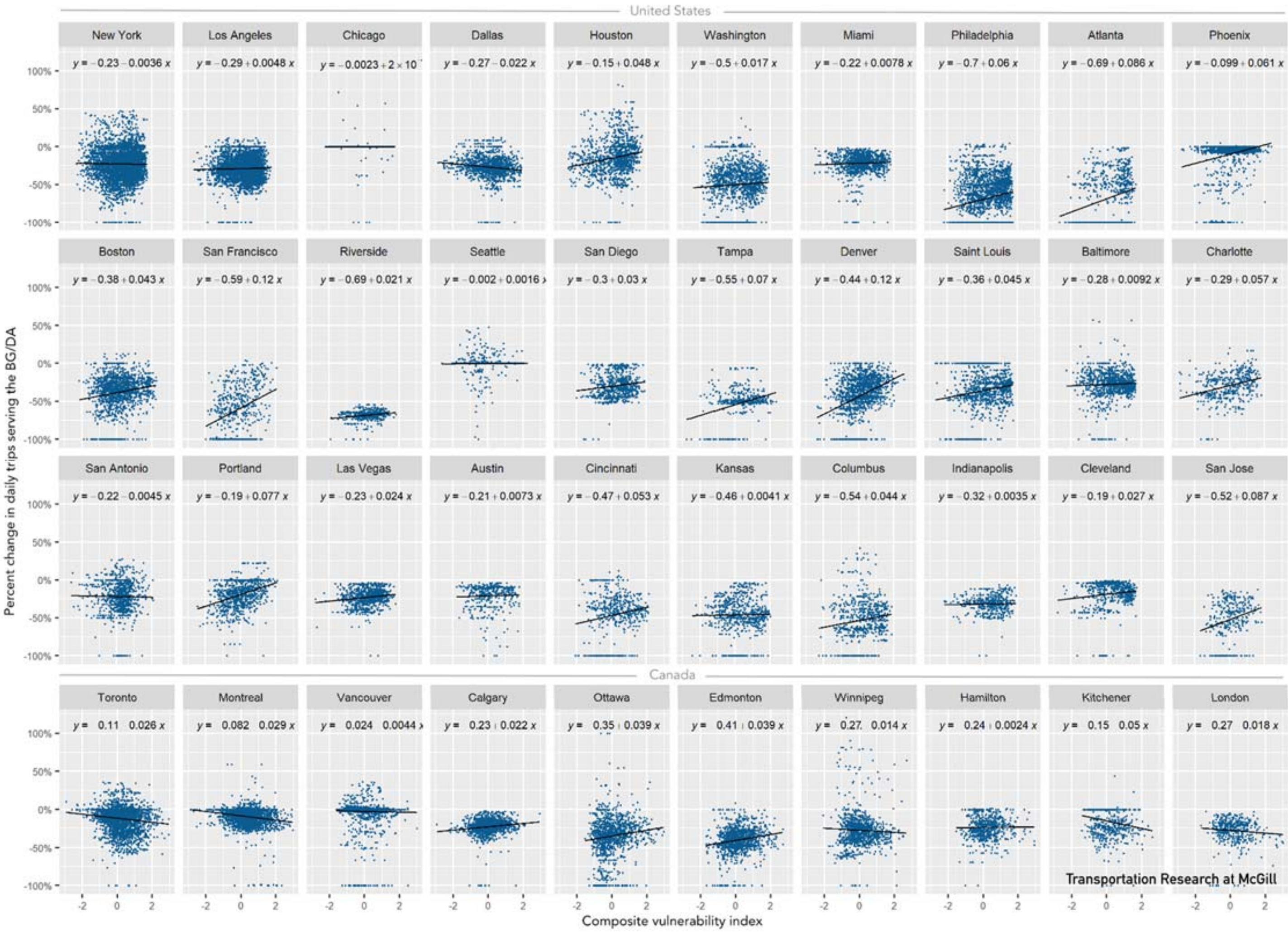

Figure 2: Percentage change in number of trips crossing a Census Block or a Dissemination Area and vulnerability index ((trend line equation showing as proportion)

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