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The effect of COVID-19 on public transit revenues in the City of Calgary

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Abstract
Using monthly public transit revenue data and a difference-in-differences strategy, we investigate the effect of the SARS-CoV-2 (COVID-19) pandemic on public transit revenues in the large urban municipality of Calgary in Alberta, Canada. We find that COVID had the largest (statistically significant) impact on adult transit fare revenue, a smaller impact on youth fares, and almost no impact on low-income fares suggesting that youth and low-income transit pass users were less able to substitute away from or forgo public transit during the COVID shock, unlike adults. Reductions in transit services that occurred at the same time were more likely borne by youth and low-income transit users. To minimize service reductions and their inequitable effects, we argue that given municipalities have little financial power and flexibility, higher orders of government should provide transit operating funding during times of transit fare shocks.

Keywords: public transit, municipal finance, COVID-19

Résumé
L'annexion est le processus par lequel une municipalité étend de façon permanente ses limites par l'acquisition de En utilisant les données mensuelles sur les revenus du transport en commun et une stratégie de différence dans les différences, nous étudions l'effet de la pandémie de SRAS-CoV-2 (COVID-19) sur les revenus du transport en commun à Calgary en Alberta, Canada. Nous constatons que COVID a eu l'impact le plus important (statistiquement significatif) sur les revenus des tarifs adultes, un impact plus petit sur les revenus des tarifs jeunes et presque aucun impact sur les revenues des tarifs à faible revenu, ce qui suggère que les jeunes et les utilisateurs d'une carte d'abonnement à faible revenu étaient moins capable de se substituer ou se renoncer au transport en commun pendant le choc COVID, contrairement aux adultes. Les réductions de services de transport qui se sont produites en même temps étaient plus probablement assumées par les jeunes et les utilisateurs de transport à faible revenu. Pour minimiser les réductions de service et leurs effets inéquitables, nous soutenons que, étant donné que les municipalités ont une

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capacité financière faible et peu de flexibilité, les ordres de gouvernement supérieurs devraient fournir un financement de fonctionnement du transport pendant les périodes de chocs tarifaires.

Mots-clés : public transit, municipal finance, COVID-19

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Introduction

In Canadian municipalities, the costs associated with operating public transit is funded in large part by transit fares—fees paid by persons who take public transit. An unexpected shock to the revenue from transit fares can, therefore, have a disruptive impact on the operation of public transit: for example, service levels may need to be decreased to offset transit fare revenue loss. While this may help the public transit authority balance their budget, it can have a disproportionate detrimental effect on particular groups of public transit users who are unable to substitute to other forms of transit or forgo transit during a shock. Given the reliance on transit fare revenues by public transit operators across Canada, it is important to understand the degree to which public transit revenues can cover transit costs during major public health events and similar unexpected shocks. Assessing this information will help policy makers understand who is most impacted by such shocks and inform the development of strategic plans in the event of future shocks. Transit is an essential municipal service and, even in the face of public health events like the SARS-CoV-2 (COVID-19) pandemic, many citizens continued to rely on transit meaning some base level of public transit service has to be maintained regardless of usage (Public Safety Canada 2020).[1]

In this paper, we examine the impact of COVID-19 on transit fare revenues for a large Canadian urban centre—Calgary, Alberta. We consider the impact on different user groups over the pandemic, paying particular attention to the inequitable impacts on transit users. Calgary provides a poignant environment in which to examine the effect of COVID-19 on transit fare revenues for three interrelated reasons. First, City Council has set a general policy whereby 50% of Calgary Transit operating costs are to be recovered through operating revenue, including transit fare revenue (Passifiume 2017). Second, Calgary Transit has a unique program—the fare entry program—that heavily discounts public transit fares to qualifying low-income Calgarians (Tassonyi and Kitchen 2021). The fact that these fare products exist at not only the level of the local transit authority but also that the revenues from these products are tracked separately by the transit authority allows for an equity analysis of the impact of COVID-19 on public transit use that would not be possible in other jurisdictions. Finally, Calgary, like many comparable Canadian cities, was hit hard by COVID-19 caseloads, spread, and public health orders that resulted in the immediate reduction of public transit use.

Employing difference-in-differences empirical strategy, we estimate the impact of the COVID-19 pandemic on revenue from transit fares for Calgary, examining heterogeneity among user types including adults, youth, and low-income transit users. Overall, we find that transit fare revenues from all streams dropped immediately and significantly after the local and provincial declarations of a state of emergency in March 2020 to about 7% of baseline revenues, controlling for seasonal and other effects. Further, the overall decline of transit revenue remained negative and statistically significant in all but one month (December 2020) from March 2020 to December 2021. Drilling down across fare steams, however, paints a heterogenous effect. For adult fares, COVID-19 had a large and statistically significant effect on transit revenues in each and every month from March 2020 to December 2021. For youth fares, the recovery is much more volatile, oscillating between a negative effect and no statistically significant effect throughout the pandemic. The pattern for youth fares is highly correlated with COVID-19 infection waves and, hence, closures to face-to-face learning. In contrast, the impact of COVID-19 on low-income transit fare revenues was not statistically significant outside of the impact of the first wave and again in May 2021, coinciding with the peak of the Delta wave. These results suggest a higher (continuing) dependency on public transit of youth and low-income users during the COVID-19 public health crisis, likely due to a lack of transit alternatives and clustering in essential occupations, compared to adult transit users.

The negative affect on revenues from adult fares had significant repercussions to service levels. Calgary Transit had a high (pre-pandemic) budget reliance on revenues from transit fares, and the majority of these revenues (70%) came from adult fares. In the face of the sharp drop of revenues from adult fares, Calgary Transit had to reduce service

levels by 30% in order to balance its budget. Service reductions likely had a larger impact on youth and low-income transit users who continued to rely on public transit. To reduce inequitable effects of service reductions, we argue that there is very little Canadian municipalities can do in the midst of such a public health shock that causes a significant decline in transit fare revenues, ceteris paribus. Municipalities have been devolved limited authorities and very inflexible revenue sources. Rather, we argue that higher orders of government need to be prepared to provide transit operating funding to close gaps left by declines in transit fare revenue during such shocks, as they did during the COVID-19 pandemic under the Safe Restart Agreement (Prime Minister of Canada's Office 2020).

This paper proceeds as follow. We first provide a brief overview of Calgary Transit and the COVID-19 pandemic in the City of Calgary. Next, we discuss the impact of COVID-19 on transit revenues and expenditures followed by an empirical analysis of the impact of COVID-19 on transit fare revenues. We then discuss the strategies that Canadian municipalities could take in the case of future shocks. Lastly, we provide some concluding thoughts.

Background

The City of Calgary is responsible for operating, developing, expanding, and maintaining the local public transit system. Calgary Transit is the public transit agency that is owned and operated by the City of Calgary to fulfill this responsibility. The Calgary Transit system is comprised of both buses and light rail transit (otherwise known as the "C-train"). Prior to the pandemic, annual ridership on Calgary public transit exceeded 100 million, with the majority of rides being work related (NRG Research Group 2016). Calgary Transit operates under a general policy, set by City Council, whereby at least 50% of Calgary Transit operating costs should be recovered through operating revenues, including public transit fares (City of Calgary SPC on Transportation and Transit 2020). As part of its transit fare strategy to achieve this objective, Calgary Transit offers different types of transit fares to the public—including single ride tickets, monthly, and yearly passes—broadly divided across three classes of users—adults, youth, and low income.[2] In particular, discounted fares are available for youth and low income persons on the basis of equity and affordability concerns (Calgary Transit 2022). Transit fares across these classes generally increase annually (usually on 1 January of each year) according to inflation. While fares were increased up to and including January 2020, before the COVID-19 shut-downs, there were no fare increases in 2021.

The COVID-19 pandemic and the City of Calgary

Calgary was hit hard by the COVID-19 pandemic. The City of Calgary was the first municipality in Canada to declare a state of local emergency on 15 March 2020, two days before the province of Alberta declared a provincial state of emergency (Province of Alberta 2020; The City of Calgary 2020c).[3] Figure 1 shows the daily active case rate per 100,000 persons for Calgary for the period from 1 April 2020 to 31 December 2021.[4] The shaded areas indicate the periods with stricter public health measures[5] and we have also indicated the days when K-12 schools were partially or completely closed to face-to-face learning through province-wide public health orders (which, as we will show, affected transit fare revenue). Figure 1 shows that five waves of COVID-19 hit the City of Calgary from 1 April 2020 to December 2021. These waves coincided with the total or partial closure of K-12 schools.

The declaration of the local state of emergency resulted in the immediate reduction or suspension of many of the City's services as well as restrictions related to occupancy for services that continued. In particular, as part of the local state of emergency order, public transit users were required to board buses using rear doors only and the honor system was used for fare payment (The City of Calgary 2020b), capacity limits on buses and trains were enacted to ensure that Government of Alberta physical distancing requirements could be maintained (Fortner 2020), and the validity of low-income and seniors' transit passes issued in March was extended to May (The City of Calgary 2020a). Further, when the province declared a province-wide state of emergency two days later on 17 March 2020, the province further required all non-essential businesses close immediately and those businesses that were permitted to remain open had strict limits on the number of workers onsite, all workers who could were required to work from home, and all post- secondary and K-12 schools were required to immediately shift to online learning (Shofer, Jaffer, and Stein 2020).

By the height of the first wave (April 2020), it was reported that these measures significantly reduced transit use. Ridership dropped to 10% of 2019 levels, which also meant lower revenues from parking fees at Calgary Transit Park & Ride facilities (Perri 2020). Single tickets and books of tickets were returned for a refund and the post-secondary

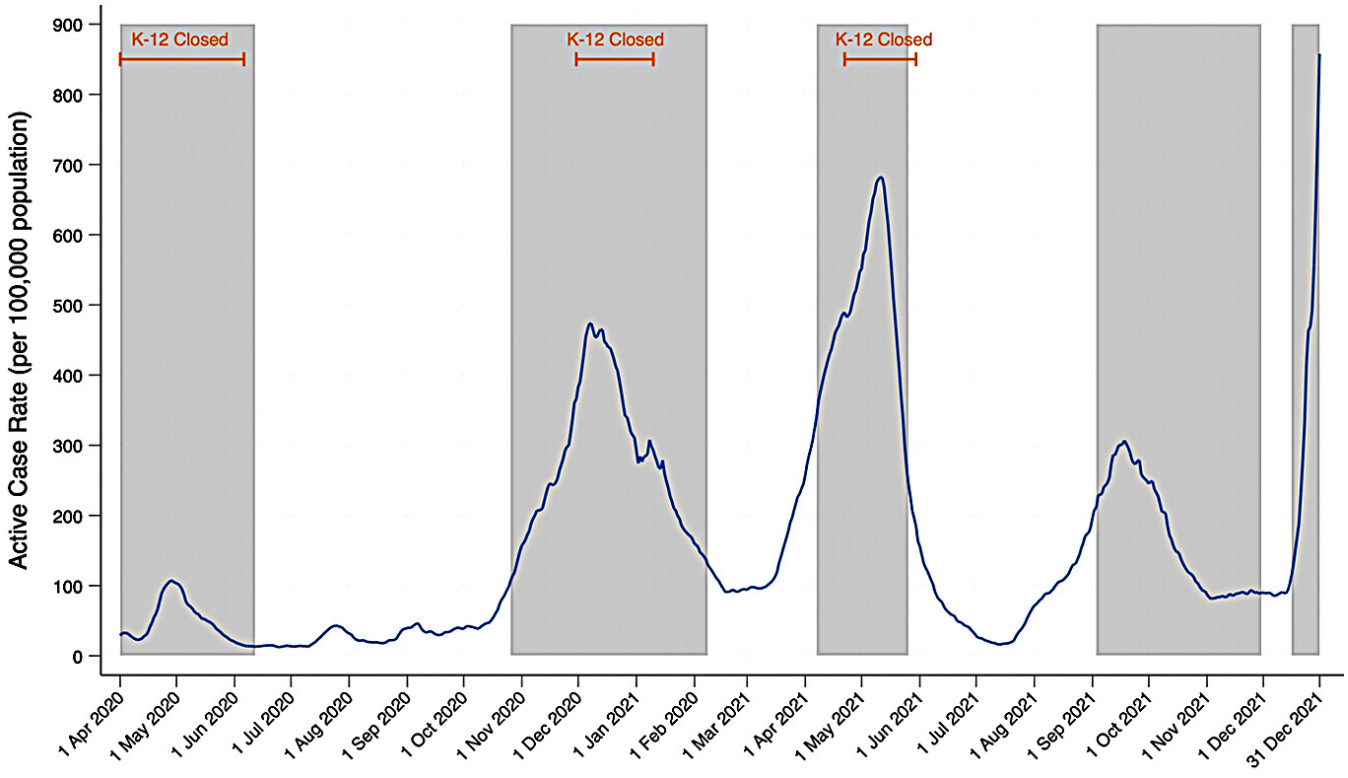

Figure 1
Daily active case rate (per 100,000 population) for Calgary (1 April 2020 – 31 December 2021)
Source: COVID-19 Alberta Statistics and Alberta Govenment

UPass program was cancelled (The City of Calgary 2020a). Fare payments were restricted to non-cash forms (The City of Calgary 2020a). Advertising campaigns on buses and LRT trains were cancelled or suspended. By summer 2020, big summer events like the Calgary Stampede were cancelled, area tourism continued to be down because of international travel and border restrictions, summer camps for kids operated with extremely limited capacity, and many who could work from home continued to do so as capacity restrictions prevented a full return to work.

In Fall 2020, K-12 schools returned to face-to-face learning, but post-secondary institutions remained online (Baker, Koebel, and Tedds 2021). That said, when K-12 face-to-face learning returned, upwards of 30% of students instead chose online learning options (Bench 2020). In addition, Calgary quickly moved into the second COVID wave as cases began to rise again in mid-October 2020 (Fletcher 2020). The re-emergence of the virus resulted in K-12 students, teachers, and staff having to isolate as exposures to the virus in schools led to another round of comprehensive social distancing protections. A second state of public health emergency was declared by the province on 24 November 2020 (Pearson 2021) and a second state of local emergency was declared in Calgary on 25 November 2020 (The City of Calgary 2020d). On 30 November 2020, in-person classes were moved fully online for grades 7-12 provincewide and on 8 December 2020, additional restrictions were imposed until 18 January 2021, with the measures being very similar to those being in place during the first wave. This would be a process that would repeat itself three more times in 2021. In February 2022 the province, followed by the City of Calgary, began permanently lifting COVID protections, with most protections lifted by 1 March 2022. Since we are interested in the interplay between COVID, COVID protections, and transit fare, we limit out analysis to the years 2020 and 2021.

The impact of COVID-19 on the operating budget of Calgary Transit

COVID-19 and the resulting public health measures had an immediate and large impact on Calgary's transit operating budget. Table 1 shows annual operating revenues and expenditures of Calgary Transit from 2017 to 2021. Revenues include own-source revenues[6] collected from various user levies—including transit fares, parking fees, and revenues from advertising—and government transfers—including cash transfers from the provincial government.[7]

As shown in Table 1, by far the largest source of own-source revenue are transit fares. Before the pandemic, from 2017 to 2019, transit fare revenues increased from $160.69 million in 2017 to $169 million in 2019. In the first year of the COVID-19 pandemic, there was a 54% decline in transit fare revenues—from $169 million in 2019 down to $78 million in 2020. Transit fare revenues declined further to $71 million in 2021. This reduced the share of expenditures recovered from transit fare revenues from 36% over the period 2017-2019[8] to 19% and 17% in 2020 and 2021 respectively. Table 1 also shows that adult transit fares are the largest source of own-source revenue for Calgary transit, contributing to over half of total fare revenue both before and after the pandemic. During COVID, adult fare revenue dropped by 55% in 2020—from $118 million in 2019 to $53 million in 20220— and by a further 15% in 2021—to $45 million.

Table 1 also shows annual expenditures for Calgary Transit. Before COVID-19, annual expenditures for Calgary Transit increased from $446 million in 2017 to $471 million 2019. As discussed above, a portion of these expenditures are funded through own source revenues, with the remaining coming from local property taxes and government transfers. With the onset of COVID-19 in 2020, the decline of expenditures was about half of the drop in revenue, declining by $55 million to $416 million in 2020, and by a further $13 million to $404 million in 2021.

While this decrease is notable, it was not larger because many transit costs are fixed costs—such as facilities, equipment, and other durable goods—and cannot be altered in the short term. A smaller proportion of the expenditures are variable costs—such as labour, maintenance, and fuel—which can be and were altered over the course of the pandemic. While these annual numbers provide a high-level picture of the impact of the pandemic on Calgary Transit revenues, we are particularly interested in knowing how fare revenues were impacted throughout each month when COVID-19 protections where in place and how these varied across fare types. This is what we turn to next.

Table 1
Operating revenue and expenses of Calgary Transit by year, 2017–2021 (in Millions)

		2017	2018	2019	2020	2021
Operating Expenditures ($M)		$445.93	$458.63	$471.47	$416.42	$403.46
Operating Revenue ($M)	Transit Fare Revenues: Total	$160.69	$163.58	$168.80	$77.99	$70.33
	Adult	$116.06	$115.71	$117.76	$52.69	$44.93
	Youth	$20.56	$22.54	$23.60	$10.84	$12.41
	Low-income	$24.07	$25.32	$27.44	$14.46	$12.99
	Government Transfers	$0.01	$0.00	$4.75	$3.75	$4.12
	Regulatory/Proprietary: Total	$14.70	$15.35	$14.61	$12.77	$11.06
	Advertising	$8.82	$9.43	$8.62	$6.91	$7.80
	Fines/Penalties	$1.27	$1.52	$1.46	$0.99	$0.57
	Miscellaneous	$0.31	$0.20	$0.50	$0.45	$0.81
	TCA Developer Contribution	$0.00	$0.00	$0.00	$1.75	$0.00
	Other	$1.42	$1.43	$1.26	$1.29	$1.40
	Reserved Parking	$2.88	$2.77	$2.77	$1.37	$0.48
Revenue (% of Expenditure)	Transit Fare Revenues	36.03%	35.67%	35.80%	18.73%	17.43%
	Government Transfers	0%	--	1%	0.90%	1.02%
	Regulatory/Proprietary	3.30%	3.35%	3.10%	3.07%	2.74%

Source: Data from the City of Calgary
Note: * TCA Developer Contribution is a type of development charge, which is a type of regulatory charger. It is a one-time levy on developers to finance the off-site, growth-related capital costs associated with new development or sometimes, redevelopment (Slack et al. 2019). Other includes revenue from service charges, recovered expenses, scrap sales. Miscellaneous includes revenue from proceeds sale assets, non-recuring. These sources of revenue descriptions are from the data provided to the authors by the City of Calgary. The Government Transfers noted in this table are funds transferred from the Alberta government to the City of Calgary to fund the low-income transit pass program.

The impact of COVID-19 on monthly revenue

In this section, we empirically estimate the impact of COVID-19 on monthly transit fare revenues. Following the approach used in Baker, Koebel, and Tedds (2021), we use a difference-in-differences (DiD) approach to compare transit fare revenue from February 2020, immediately pre-COVID, to post-COVID months in 2020 and 2021, accounting for seasonal fluctuations using transit fare revenue from 2019. Specifically, we run the following regression:

$$Y_{imt} = \beta_0 + \beta_1 PostCovid_t + \sum_{m=1,\neq 2}^{12} \beta_{2,m} M_m + \sum_{m=1,\neq 2}^{12} \beta_{3,m} (Year2020_t * M_m)$$

$$+ \sum_{m=1}^{12} \beta_{4,m} (Year2021_t * M_m) + Category_i + \Gamma_{imt} + \varepsilon_{imt}$$

where Y_{imt} is the log revenue from transit passes in category i (e.g., adult, youth, low-income) in month m and year t, $PostCovid_t$ is a binary variable that takes a value 1 if the year is 2020 or 2021 and a value zero if year is 2019. M_m is the month fixed effects. $Year2020_t$ and $Year2021_t$ are the year fixed effects. $Category_i$ is the category fixed effects and Γ_{imt} is a vector of covariates, including events that affect revenue from some categories but not others.[9]

The coefficients $\beta_{3,m}$ and $\beta_{4,m}$ are our parameters of interest and estimate the monthly COVID-19 effects on log revenue. For example, suppose we are looking at the effect of COVID-19 on log revenue in March 2020. We take the difference between the log revenue in March 2020 and February 2020. We then take the difference between the log revenue in March 2019 and February 2019 to obtain the seasonal fluctuation. Finally, the DiD COVID-19 effect on log revenue in March 2020 is calculated by taking the difference between the above two results.[10]

Our primary results for the baseline DiD for revenue from all transit fares are detailed in Figure 2. The COVID-19 effect on the y-axis is the percentage change of revenue relative to February 2020, controlling for all other covariates, including the seasonal effects and fare-type fixed effects. The COVID-19 effects are calculated as $[e^{\beta_{3/4,m}} - 1]$ x 100, where $\beta_{3,m}$ and $\beta_{4,m}$ are the coefficients that we obtain from the equation (1). The shaded areas in Figure 2 indicate months during which there were stricter COVID-19 policies consistent with Figure 1.[11] Overall,

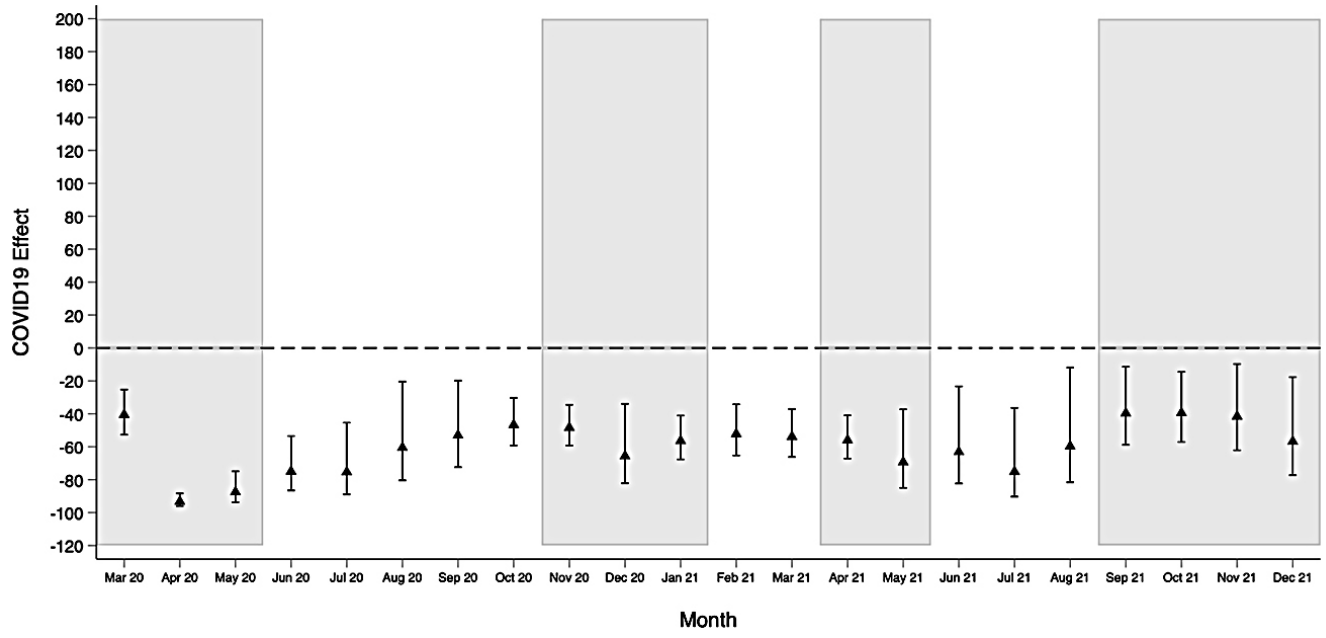

Figure 2

The effects of COVID-19 on transit fare revenue: regression results

Note: The COVID-19 effect is calculated as , where and are the coefficients that we obtain from equation (1). The vertical bars denote the 95% confidence intervals. The shaded areas indicate the periods with more strict public health measures. The standard errors are clustered at category-year level.

we find the DiD coefficients are negative and statistically significant for nearly the entire post-covid period. Transit fare revenue in March 2020 declined by 40.5%, further declining by 93.2% in April 2020. Over the summer months, when the first lockdown was loosened, the negative impact of COVID-19 on revenue slowly decreased. By October 2020, the revenue increased to about 53.3% of revenue in February 2020, controlling for all other covariates. As the second wave of COVID-19 hit, revenue fluctuated between 34.4% and 51.6% of revenue in February 2020.

In May 2021, due to the third wave of COVID-19 (the Delta wave), revenue declined again to 30.65% of February 2020 revenue, controlling for all other covariates. During the summer months of 2021, the negative impact of COVID-19 on revenue was high due to the cancellation of the summer camps that limited parents' ability to work from the office since there were very limited options for other forms of childcare during this time. During the fourth wave of COVID-19, the revenue stabilized at about 60% of revenue in February 2020, controlling for all other covariates. However, the negative COVID-19 effect increased again to 56.76 % in December 2021.

To examine the heterogenous effects of COVID-19 on different types of transit fares, we estimate equation (1) for the revenue from adults, youth and low-income fares separately. The estimates are shown in Figure 3. As in Figure 2, the COVID-19 effect on the y-axis is the percentage change of revenue relative to February 2020, controlling for all other covariates, including the seasonal effects and fare-type fixed effects. The DiD coefficients for adult transit fares are negative and statistically significant for all post-covid periods. Our estimation results suggest that for adult fares, during the first two months of the pandemic when work-from-home orders were in place, revenue from adult fares experienced a large and significant decline. During the summer months, we see a slow recovery, but still negative and statistically significant. By the end of 2021, revenue from adult transit fares had still not recovered.

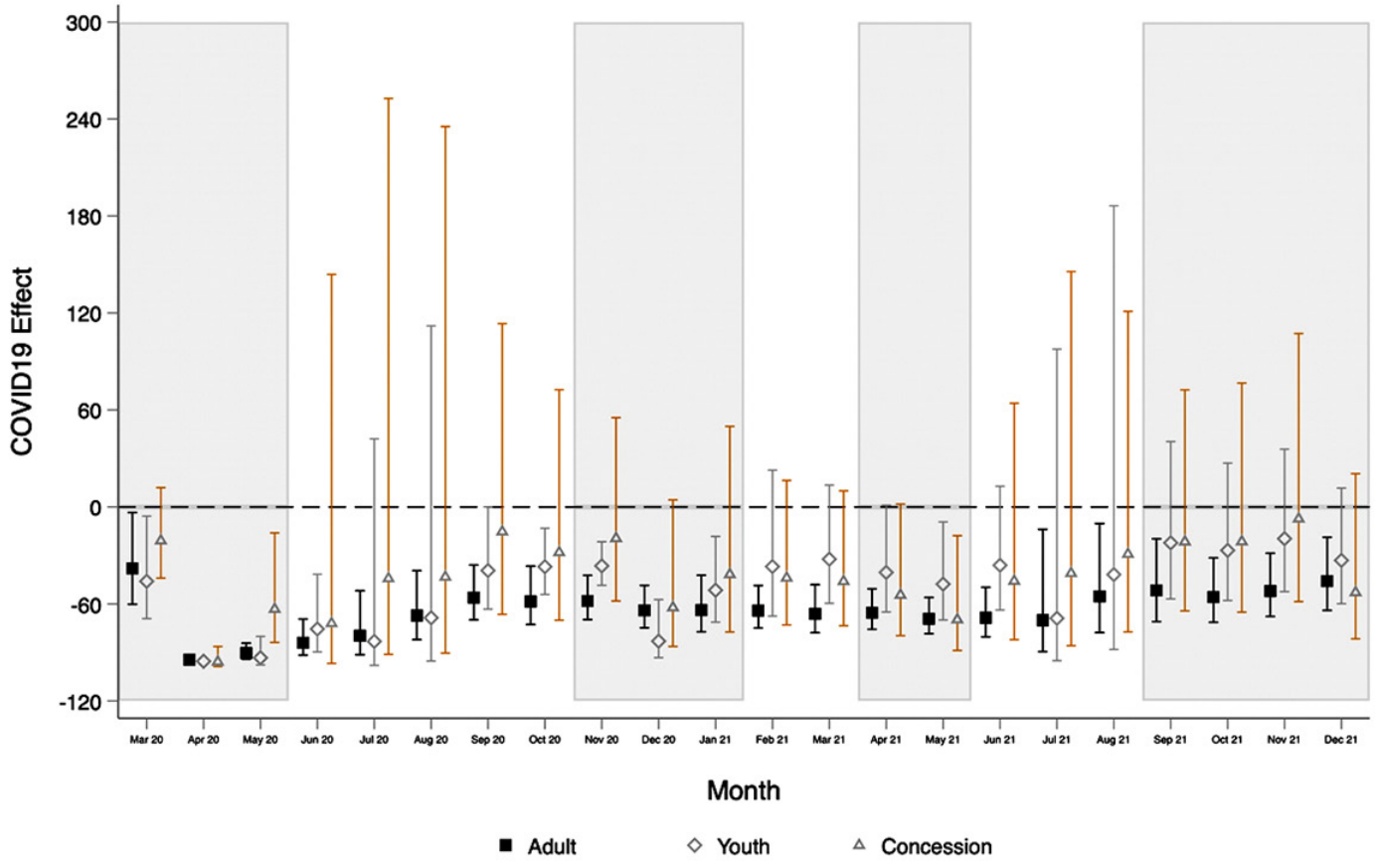

Figure 3

The effects of COVID-19 on adult, youth and low-income transit fare revenue: regression results

Note: The COVID-19 effect on the y-axis is calculated as , where and are the coefficients that we obtain from equation (1). The vertical bars denote the 95 % confidence intervals. The shaded areas indicate the periods with more strict public health measures. The standard errors are clustered at category-year level.

Figure 3 shows that revenues from youth fares were much more volatile than adult fares. Our estimation results suggest that, during the first two months of the pandemic when in-person learning was initially shut-down, revenue from youth fares experienced a large and significant decline. During the summer months, there is no statistically significant impact on youth fare revenues, however, starting in September 2020 when in-class K-12 school resumed, youth fare revenues again show a negative and significant decline. This decline holds until February 2021 when revenues from youth fares show not statistically significant impact from COVID-19. A statistically significant decline only shows up one more time, in May 2021, during the Delta wave. For the rest of 2021, there is no statistically significant effect. Overall, examining the impact of COVID-19 after controlling for seasonal and fixed effect, youth transit fare revenue appears sensitive to school closures.

Finally, the estimates for revenue from low-income transit passes is also shown in Figure 3. The revenue from low-income fares dropped significantly after the occurrence of COVID-19 in March 2020 and this effect is statistically significant. However, after April 2020, the effects are much smaller, and coefficients are not statistically significant for the majority of months after the occurrence of COVID-19, outside of the delate wave in May 2021. These results suggest a high (continuing) dependency on public transit of youth and low-income users during the COVID-19 public health crisis compared to adult transit users.

Discussion

Overall, our regression results show that transit fare revenue, used to fund over one-third of Calgary transit operating expenses pre-pandemic, dropped immediately and significantly after the declaration of a state of emergency in March 2020 and remained lower throughout the pandemic. We also show that the drop in revenue from transit fares differed across fare categories. In particular, there was an immediate, large, negative, and statically significant decline in adult transit fare revenue, which remained more impacted than youth and low-income transit fare revenue and which failed to recover in subsequent COVID waves. This suggests that at the onset of the pandemic and as the pandemic stretched out, adults substituted away from public transit towards private modes of transport or forwent transit. Comparatively, transit fare revenue from youth passes saw statistically significant declines due to the onset of the pandemic, but the impact was (mostly) smaller than for adult transit fare revenue, and the decline in youth transit fare revenue appears significantly responsive to changes in the modal delivery of education (which somewhat lined up with COVID waves). This suggests that while youth were less likely to require public transit while schools were closed to face-to-face learning, when schools returned to in-person learning, youth were less able to substitute away from public transit compared to adults, making youth more dependent on public transit. Finally, revenues from low-income transit passes were not statistically significantly impacted by COVID-19 outside of the first wave of the pandemic and the Delta wave, suggesting that low-income transit users were the least able to substitute away from public transit. Together, this suggests that youth and low-income transit users are more dependent on public transit than adult public transit users, being less able to forgo or substitute away from public transit.

The problem with the large, sudden, and significant drop in transit fare revenues that we show is associated with the reliance public transit operators have on fare revenue to fund transit operations. Before the COVID-19 pandemic, fare revenue accounted for 51% of operating costs of public transit in Canada (Canadian Urban Transit Institute 2021), and can account for as much as 80% (Slack and Bird 2019). In the case of Calgary Transit in particular, Council had set an explicit policy for recovering at least half of its operating expenses from transit fares and pre-pandemic was able to maintain around a target of 36%. When fare revenue drops, as we show it did for Calgary Transit during the pandemic, what options are available to public transit operators that rely on fare revenue to fund operating expenses?

One option would be to increase transit fares on the assumption that revenues would rise. However, the economic literature related to price elasticity of demand does not support this approach. Previous literature finds that the bus-fare elasticities are around -0.4 in the short run, -0.55 in the medium run, and in excess of -1.0 in the long run (Paulley et al. 2006). Additionally, the calculation of these fare elasticities does not account for the social benefits of public transit. The two main social benefits of public transit are reducing greenhouse gas emissions and increasing labour mobility. Increasing transit fares could increase greenhouse gas emissions if sufficient transit riders substitute for driving cars. Increasing transit fares could also reduce labour mobility as the cost of transit shifts the cost consideration related to working further away from home. On top of these effects, the elasticity estimates excludes the fact that youth less than ten years old tend to be accompanied by adults (Cain, Hamer, and Sibley-Perone 2005). The

loss of revenue from increasing regular adult tickets could be more significant than the literature has estimated since parents could find it is cheaper to drive their kids around. Compounding this, Goodwin et al. (1983) argue that those who were regular transit users when they are young were more likely to use public transit in their adult life.

A second option would be to find alternative own source funds to substitute towards the public transit budget in the face of such a shock. However, for municipal run public transit authorities in Canada this is not as simple as it may seem on the surface. There are several reasons for this. First, municipalities in Canada cannot run operating deficits: they must balance their operating budgets, and cannot borrow to fund current operating expenses (Gillezeau, Tedds, and Petit 2020). In short, municipalities cannot deficit spend. Second, the revenue gap caused by a transit fare shock could be closed by allocating more property tax revenue to transit. However, municipalities set property taxes once per year and they are generally tied to service provisions. For example, Calgary determines the expenditures on services, subtracts other sources of revenues such as user fees, license fees, permits, and provincial grants. The remaining amount is what must be collected from property taxes and rates are set as such (City of Calgary Financial Task Force 2020). As a result, re-allocating significant amounts of property taxes to unplanned costs during an in-year revenue shock will create expenditure shortfalls elsewhere. Third, the other significant source of municipal own-source revenues for are from user levies. User levies are a charge on users to ensure that those that directly benefit from a service pay, in whole are in part, for that service. There are significant legal limits on the use of revenues from user levies. In particular, the revenue must be used to recover costs and the use of those revenues must be reasonably connected to the costs incurred of providing the good or service (Tedds 2019). These legal constraints mean that user levies collected from other municipal services cannot be used to fund public transit. Fourth, while there is some variation across the provinces, municipal own source revenues are typically limited to property taxes and user levies, municipalities could appeal to their respective provinces to have their enabling legislation modified to expand the revenue tools they have at their disposal. However, provincial governments have traditionally been unenthusiastic about granting additional authorities to municipalities. Finally, municipalities could use reserves to fund the revenue shock, but the ability to use reserves in such a fashion is dependent on there being a large reserve stocked with flexible use funds. Many municipalities have small or no reserves—for example, the City of Calgary had already used most of their reserves to fund property tax relief throughout the oil price collapse and to fund a new event centre—and those that have reserves, the funds are typically already earmarked for various capital projects. Overall, Canadian municipalities have very limited financial power and this means that when a revenue shock occurs, such as that which occurred during COVID-19, there are limited avenues to plug the resulting revenue gap. That is, finding a way to replace revenues that resulted from COVID-19 was a nearly herculean task for municipalities.

Another option is to reduce expenditures. That is, when a revenue shock occurs, the gap between revenues and expenditures could be addressed by reducing expenditures which directly means reducing services, in this case transit services. However, as we noted previously, many transit costs are unavoidable fixed costs. As a result, the only expenditures that could be cut were variable costs—notably labour, maintenance, and fuel—directly translating into service reductions. In the case of Calgary, as Table 2 shows, expenditures were cut by 11.7% in 2020 and a further 3.1% in 2021. This decline in expenditures was driven largely by a decline in labour costs (e.g., salary, wages, and benefits) as well as contract and general services costs (e.g., contracted service providers, consultants, insurance, security, and communication services)—all variable costs that can be relatively quickly adjusted. Costs related to materials, equipment, and supplies, and utilities—less variable costs— did not see as large as a decline.

Translating this expenditure reduction into what this meant for transit services in Calgary, as of 30 March 2020, buses and trains dropped from a frequency of four minutes to a frequency of 10 minutes (Dormer 2020). Throughout April and May 2020 transit services were further reduced by 30% from March 2020 levels. This included: removing 25 routes, reducing the frequency of service over 30 routes on weekdays and 19 routes on weekends, and the closing of maintenance and bus facilities (City of Calgary SPC on Transportation and Transit 2020). While there has been limited research done of the equitable effects of public transit service cuts (e.g., whether service reductions were concentrated in low-income or high-income neighborhoods) in Canada because of the pandemic, DeWeese et al. (2020) provide a high level analysis across 40 cities in North America, including Calgary. They found that in Calgary transit service cuts were slightly less likely to occur in low-income and vulnerable communities. It is important to note that studying the equitable effects of changes in public transportation services is fraught with complexity, particularly because low-income and vulnerable communities are already relatively transit poor (see, for example, Allen and Farber 2019). By focusing solely on transit trips, as DeWeese et al. (2020) do, the relative equitable impact on in low-income and vulnerable communities may appear small when compared to transit rich areas while the actual

equitable impact of even more loss of accessability may prove to be a tipping point in these communities (Linovski et al. 2021; Peterman 2023).

What our findings and the ensuing service cuts documented above suggest is that in Calgary, youth and low-income transit users who had less ability to substitute away from public transit were more likely to experience the service cuts despite continuing to pay for the service. The impact of the service cuts was inequitable, falling more heavily on youth and low-income transit users and less heavily on adult transit users. Further, public transit ridership is more sensitive to service quality changes. Schimek (2015) argues that in a large city, the elasticity of transit ridership with respect to service quality is -0.45 in the short run and -1.12 in the long run and De Grange et al. (2013) find that the elasticity of bus ridership with respect to service quality is -1.18. This is an additional argument for minimizing service reductions during a shock. It is also suggestive of the fact that the ongoing drop in Calgary Transit's fare revenues could have been exacerbated by the continued reduced services. This puts municipalities in a catch-22.

The funding model for public transit in Calgary is not unique. Many Canadian municipalities (or regions, dependent on the level of government responsible for transit) rely on transit fares as a major source of funding for transit. How could Calgary—and Canadian municipalities more generally—reduce inequitable impacts of service cuts in the case of a future shock to transit fare revenue? That is, how could municipalities close the gap in funding caused by a decline in transit fare revenue so that service cuts can be minimized? We have shown here that there are limited avenues for municipalities to make up for such a shock with other own source revenue sources, leaving municipalities with little option other to reduce services, but that reduction in services has a large inequitable impact. Given that it falls on municipalities to provide public transit and municipalities cannot deficit spend, higher orders of government could fill in the gaps. Higher orders of government do not have the same financial constraints as local governments: pointedly, they can borrow money and deficit spend, and have more revenue sources with a larger revenue base. Further, municipalities receive money from higher orders of government in the form of grants.

With respect to provincial governments, municipalities are constitutionally in the jurisdiction of the province, and the province also has constitutional jurisdiction over inter-provincial transit (The Constitution Act 1987, s. 92). Effectively, it is in the jurisdiction of the province to support transit operating budgets during times of public health shocks and reduce inequitable effects of transit service reductions on youth and low-income transit pass users.[12] Furthermore, while it is doubtful that the federal government could directly provide aid to local transit authorities to help with their operating budget,[13] they could provide conditional funds to the provinces for the purpose of operating budgets of public transit. This would be consistent with the federal government's climate commitments (Environment and Climate Change Canada 2020; Government of Canada 2023). The City of Calgary did receive a grant from the combined provincial and federal governments to cover the transit revenue shortfall of $82 million; however, this grant was only made in April 2022 and unable to even cover the projected transit revenue shortfall of $89 million in 2022 let alone 2020 or 2021 (Villani 2022). Further, it is rare that (large) government grants are provided to aid with transit operating budgets: they are more often provided for capital budgets.[14] For example, the new Calgary LRT line, the "green" line, was provided $1.7 billion from the province and $1.64 billion from the federal government to cover capital costs (City of Calgary 2023).

Conclusion

This City of Calgary transit case study shows that COVID-19 had large, statistically significant short- and medium-run effects on public transit fare revenue. Further, we show that COVID had the largest impact on adult transit fare revenue, a smaller impact on youth fares, and no impact on low-income fares suggesting that youth and low-income transit pass users were less able to substitute away from public transit during the COVID shock, unlike adults. Calgary's situation is not unique: transit authorities across the country faced a serious policy problem—how to fund public transit during a transit fare revenue shock. While service reductions were a common solution given municipality's lack of financial power, particularly the restriction against deficit financing, these service reductions were likely borne most heavily by youth and low-income transit users. We argued that for future shocks, service reductions could be minimized through the help of funding from higher orders or government whose jurisdiction public transit falls into (e.g., provincial governments) and for whom such funding would be consistent with policy commitments (e.g., the federal government).

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Appendix

Transit Pass Types

The following is an explanation of the transit fare types shown in Table A1:

•An adult single/hourly use ticket is an adult (ages 18+) one-time use ticket, which is valid for 90 minutes.
•An adult day pass ticket is an adult multiple-use pass, which is valid from the time of purchase until the end of service that day.
•An adult monthly pass is an adult multiple-use pass, which is valid for one calendar month.
•An adult bulk tickets/admission are adult single/hourly use tickets that are bought in books of 10.
•An adult monthly concession pass is an adult multiple-use pass, which is valid for one calendar month and is purchased at discount.
•A youth single/hourly use ticket is a child (ages 6-17) one-time use ticket, which is valid for 90 minutes.
•A youth day pass ticket is a child multiple-use pass, which is valid from the time of purchase until the end of service that day.
•A youth monthly pass is a child multiple-use pass, which is valid for one calendar month.
•A youth bulk tickets/admission are youth single/hourly use tickets that are bought in books of 10.
•A youth monthly concession pass is a youth multiple-use pass, which is valid for one calendar month and is purchased at discount.
•A senior yearly pass is a senior (ages 65+) multiple-use pass, which is valid for one calendar year.
•A senior yearly concession pass is a senior multiple-use pass, which is valid for one calendar year and is purchased at discount.
•A student pass is a universal pass that is offered to all students.

Table A1
Calgary Transit fare types and prices, 2017-2021

	Year	2017	2018	2019	2020	2021
Adult	Adult Monthly Pass	$101.00	$103.00	$106.00	$109.00	$109.00
	Adult Single Ride	$3.25	$3.30	$3.40	$3.50	$3.50
	Adult Day Pass	$10.00	$10.50	$10.75	$11.00	$11.00
	Adult Ticket Book	$32.50	$33.00	$34.00	$35.00	$35.00
Youth	Youth Monthly Pass	$70.00	$75.00	$77.00	$79.00	$79.00
	Youth Single Ride	$2.25	$2.30	$2.35	$2.40	$2.40
	Youth Day Pass	$7.00	$7.50	$7.75	$8.00	$8.00
	Youth Ticket Book*	$22.50	$23.00	$23.50	$24.00	$24.00
Low-Income	Student Pass-Winter	$130.00	$140.00	$145.00	$151.00	N/A
	Student Pass-Fall	$140.00	$145.00	$151.00	$155.00	N/A
	Band A Low-Income Transit Pass	$5.05	$5.15	$5.30	$5.45	$5.45
	Band B Low-Income Transit Pass	$35.35	$36.05	$37.10	$38.15	$38.15
	Band C Low-Income Transit Pass	$50.50	$51.50	$53.00	$54.50	$54.50
	Seniors' Annual Pass-Regular	$95.00	$135.00	$140.00	$145.00	$145.00
	Seniors' Annual Pass-Low Income	$15.00	$20.00	$25.00	$25.00	$25.00

Sources: Data from the City of Calgary.
* means that the effective date of the fare is September 1st each year, otherwise fare increases are effective the first day of January each year.
Note: The student pass was not available in Fall and Winter 2021 as the UPass program between post-secondary institutions and Calgary Transit was suspended in Fall 2020 and did not fully resume until 2022.

Table A2
Income Ranges for Three Bands of Calgary Transit Low-Income Monthly Passes by Household Size

Household Size	Band A $5.60/month	Band B $39.00/month	Band C $56.00/month
1 person	Less than $12,474	$12,475 - $21,206	$21,207 - $24,949
2 persons	Less than $15,530	$15,531 - $26,401	$26,402 - $31,061
3 persons	Less than $19,092	$19,092 - $32,457	$32,458 - $38,185
4 persons	Less than $23,181	$23,182 - $39,407	$39,408 - $46,362
5 persons	Less than 26,291	$26,292 -$44,695	$44,696 - $52,583
6 persons	Less than $29,652	$29,653 - $50,408	$50,409 - $59,304
7 persons	Less than $33,013	$33,014 - $56,122	$56,123 - $66,027

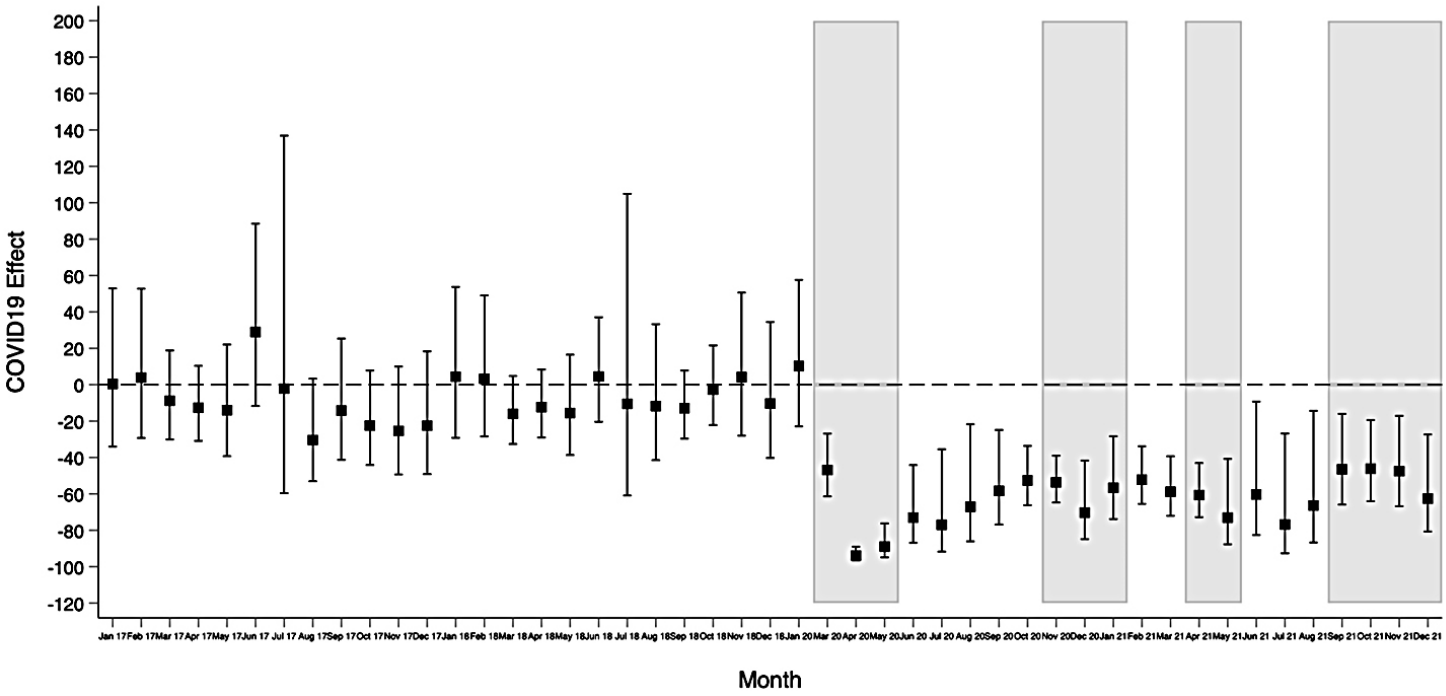

Figure A1
Difference-in-Differences Estimates for Pre-trends
Note: The covid-19 effects on the y-axis is calculated as , where and are the coefficients that we obtain from equation (1). The Diff-in-Diff specification considers year 2019 as the baseline year. The calculation of the COVID-19 effect is as follows. For example, suppose we are looking at the effect of COVID-19 on log revenue in March 2020. We take the difference between the log revenue in March 2020 and February 2020. We then take the difference between the log revenue in March 2019 and February 2019 to obtain the seasonal fluctuation. Finally, the Diff-in-Diff COVID-19 effect on log revenue in March 2020 is calculated by taking the difference between the above two results. The vertical bars denote the 95 % confidence intervals. The shaded areas indicate the periods with more strict public health measures. The standard errors are clustered at category-year level.

End notes

[1] While there is a growing movement around the world for governments to offer fare free public transit, public transit authorities in Canada have not widely embraced this movement, with only the City of Calgary offering free public transit within the downtown core (currently sponsored by the TD Bank Group) and BC Transit allowing children 12 and under to ride for free in the City of Victoria and dozens of other communities in the province. In this paper, we take that status quo—relying on transit fares to fund a portion of public transit operating costs—as given and ask what options are available when there is a sudden and temporary shock to transit fare revenues.

[2] Transit fare details are provided in the Appendix. This includes explaining the various fare types available, showing the prices of transit fares across different groups and fare types (Table A1), and detailing the thresholds for the low-income transit pass, which was introduced in 2015, showing the three "band" categories that depends on family size and income (Table A2).

[3] Alberta was the third province to declare a state of emergency. Quebec made their declaration on 14 March 2020and Prince Edward Island made theirs on 16 March 2020 (McCoy et al. 2020).

[4] 1 April 2020 is the date the government started providing active case number by geographic location. We only know the cumulative number of cases between March 6, 2020 and March 31, 2020.

[5] Alberta Health Services issued health enforcement orders after the occurrence of COVID-19 in March 2020. In the context, the timing of stricter public health measures refers to the issue of health enforcement orders restricting businesses, schools, private social gatherings, etc.

[6] Remaining transit operating costs, not covered by transit own source revenues, are funded through property taxes. This means that the revenue/cost ratio is about 45% which falls short of the 50-55% guiding target set by City Council (The City of Calgary 2018).

[7] Apart from payments-in-lieu-of-taxes (PILT), the federal government can only flow funding to municipalities through agreements with the provinces and territories (e.g. The Canada Community-Building Fund (formerly known as the Gas Tax Fund)).

[8] Far short of the 50% target set by City Council.

[9] Four covariates are included in the regression. First, the City of Calgary launched the "My Fare" app in July 2020. Since the "My Fare" app doesn't provide bulk tickets, consumers could have substituted away from bulk tickets (mainly adults), while other categories are unaffected. To control this event, we created a dummy variable that equals one if the revenue category is adult bulk tickets and the year is 2020. Secondly, all kindergarten to Grade 12 schools were moved to online learning in May 2021, which mostly affects the revenue from youth monthly tickets. To control this event, we created a dummy variable that equals one if the revenue category is youth monthly pass and the year is 2021. Thirdly, the validity of March low-income transit passes was extended to the end of May. This change only affects adult and youth monthly concession passes because senior concession pass is a year pass. To control this event, we created a dummy variable that equals one if the revenue category is adult and youth monthly concession passes and the year is 2020. Lastly, the revenue for the senior yearly pass was adjusted in December 2020. To control this event, we created a dummy variable that equals one if the revenue category is senior concession pass and the year is 2020.

[10] A key assumption underlying the DiD estimation is that the treatment and control groups have parallel trends in outcomes in the absence of the treatment. This means that the difference between the treatment and control group is constant before the happening of COVID-19. Although there is no statistical test for this assumption visual inspection can be used. Our visuals are presented in the Appendix (Figure A1). We see that our parallel trends assumption hold: prior to treatment, transit fare revenues for both our control (February) and treatment groups (January, March – December) were following the same trends and were not statistically significantly different from zero.

[11] In Figure 1, the x-axis is daily while in Figure 2, the x-axis is monthly. Because there were only several days between the last two waves shown in Figure 1, that gap does not show up in Figure 2.

[12] An additional solution is to extend borrowing powers to local governments; however, this is highly contentious.

[13] It is unlikely that the federal government can provide funding direct to municipalities for transit operations as they have no constitutional jurisdiction to do so. The federal government does allocate the Community-Building Fund (previously called the Gas Tax Fund) direct to local governments; however, it is used for public transit infrastructure projects (Government of Canada 2022).

[14] Prior to 1998, the Ontario government did subsidize transit operating costs.