Journal of Urban Mobility 1 (2021) 100006

Contents lists available at ScienceDirect

Journal of Urban Mobility

journal homepage: www.elsevier.com/locate/urbmob

Employer-paid transit subsidies and travel behaviour: Experimental evidence from Vancouver hotels

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ARTICLE INFO

Keywords:
Transit
Subsidy
Commute
Workplace
Vancouver
Hospitality
Transportation
Mode Choice
Travel Behavior
Transport benefits
Equity

ABSTRACT

We report findings from an experimental study of the impacts of employer-paid transit subsidies on workers at downtown hotels in Vancouver, British Columbia, Canada. Partnering with the union and management of seven hotels, the regional transit agency and city government, we collected representative surveys of commuting behavior in three waves, each six months apart, in 2018 and 2019. Four of the hotels had offered a 15% transit subsidy prior to the study. We grouped six of the hotels in three similarly located pairs with the same initial subsidy condition. After the first survey wave, we provided an experimental subsidy at four hotels: 25% at one hotel in each of three pairs, and 15% at the seventh hotel. After the second survey we further increased the subsidy to 50% at two hotels. The larger the transit subsidy offered, the more employees become transit riders and the more transit-only commuting increased. Overall, a modest increase in transit-only commuting was accompanied by a reduction in auto-only and auto-and-transit commuting. It appears that transit subsidy acceptance and effectiveness can be dampened by factors such as the availability of cheap parking, or greater distance between the workplace and rapid transit, leading to variability in outcomes.

Introduction and literature review

Employer-specific commuting data is rarely accessible to transportation researchers. This shortage of information has contributed to a knowledge deficit regarding the effects of transit subsidies on employees in specific industries and demographic groups. This study sought to help fill a part of that gap by analyzing the mobility impacts of an employer-paid transit subsidy for workers at downtown hotels in Vancouver, British Columbia, Canada. Specifically, we sought to better understand how various levels of transit subsidy affected these workers' commuting patterns, mode choices, and transit ridership. Our findings add new evidence and insight to the literature on how economic incentives can influence a modal shift to public transportation.

Understanding the effect of subsidies on travel behavior has long been of interest to transport researchers (Bueno et al., 2017, Ghimire and Lancelin, 2019, Transportation Research Board and National Academies of Sciences et al., 2005, Serebrisky et al., 2009, Hamre, 2017, Altshuler, 1969, Lachapelle and Frank, 2009, Block-Schachter and Attanucci, 2008). In Canada, analysis of the now defunct Public Transit Tax Credit program found that the tax credit increased public transit use between 0.33% and 0.89% during the decade following its introduction in 2006 (Rivers and Plumptre, 2018), although the effects were lower in Vancouver (Rivers and Plumptre, 2018, Chandler, 2014). That subsidy offered a tax credit rather than an employer-paid subsidy, with benefits only received up to a year later at the annual income tax filing. The more immediate reward of an employer-paid subsidy might be expected to exert a greater influence on travel behavior.

Studies of employer sponsored transit benefits elsewhere have found consistent effects on their influence of travel behavior. For example, Bueno et al. found that commuters who received employer-paid public transportation benefits were about nine times more likely to use transit than to drive alone in the New York-New Jersey region. However, this study did not differentiate among the various levels of public transportation subsidies offered by different employers (Bueno et al., 2017). Ghimire and Lancelin analyzed both sociodemographic and economic factors to determine which incentives were positively or negatively associated with transit use in Atlanta, Georgia. They found that employees with a subsidized transit pass had a 156% higher likelihood of commuting by transit (Ghimire and Lancelin, 2019). However, neither the study by Bueno et al. nor the one by Ghimire and Lancelin obtained employer-linked data which meant that their findings could not determine the impact of specific types and levels of subsidies offered to employees. As noted by Zhou, Wang and Schweitzer, the lack of publicly available data sources on employee type by unique employer means that there is a gap of employer-based commuting studies (Zhou et al., 2012). Our research results start to fill this gap by analyzing how subsidy incentives affected the travel behavior of specific employee subgroups and sociodemographic segments within the workforce of participating hotels.

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https://doi.org/10.1016/j.urbmob.2021.100006
Received 22 November 2020; Received in revised form 31 July 2021; Accepted 2 September 2021

A 2005 Transit Cooperative Research Program Report (TCRP) analyzed 21 surveys in 12 United States of America metropolitan regions and found that overall, transit benefit programs increased transit mode share by an average of 2 to 17 percentage points. The study highlighted that between 10 and 40 percent of benefit recipients in these programs were new transit users (National Academies of Sciences, Engineering, and Medicine 2005). In 2008, Gould and Zhou's studied a specific employer's transit incentive program at the University of California. They found that only 30% of participants who had received a paid transit pass from their employer decided to return to solo driving after the three-month free transit pass ended. (Gould and Zhou, 2011). Our focus on Vancouver's hospitality sector extends the scope of knowledge about the effect of transit pass subsidies, both to a different group of workers and to a different national setting.

Assessing the implications of employer-paid transit subsidy initiatives and their effects on travel behaviour will be strengthened by exploring the equity impacts within subsets of our study population. Although Rodríguez et al. only looked at subsidy acceptance, the authors found that women and the employed were more likely to make use of the income-based transit subsidy in Bogotá (Rodríguez et al., 2016). The preliminary results of a 2019 Boston study by Rosenblum et al. found that low-income subsidy accepters took about 30% more trips than those transit adopters who were above the poverty line (Rosenblum et al., 2019). But there is evidence that those workers who could be most influenced by transit pass subsidies are the least likely to receive such incentives from their employer. Lachapelle's 2018 study of Atlanta commuters found that people who earned less than $30,000 or who worked in sales or service occupations were less likely to be offered a transit pass by their employer (Lachapelle, 2018). Our research not only considers different subsets who will accept or take up the subsidy, but also demonstrates the impact of providing such subsidies to lower income service workers in the hospitality sector.

The literature on employer provided transit subsidies does demonstrate that such incentives can influence both the travel behaviour and the socioeconomic experiences of participants in their commute to work, however, it is often not as simple as introducing a transit subsidy. For example, a study by Hamre and Buehler found that the proximity of free parking could negate the effects of public transportation benefits (Hamre and Buehler, 2014), although Krechmer, Spielberg and Milione note that high costs of parking provision create an incentive for employers to support or implement transit subsidy programs (Krechmer et al., 1982). Our findings extend and deepen this body of evidence by offering specific insight into the travel behavior of hospitality workers centered in a large urban area with relatively good public transport options (at least, by pre-pandemic North American standards).

We were able to shed light on this under-explored dimension of urban transportation behaviour because Vancouver's hospitality workers brought their transportation and housing challenges to the attention of their union, Unite Here Local 40. The union negotiated a 15% subsidy on monthly transit passes at four of the seven hotels prior to this study, an agreement which essentially transfers a portion of total employee compensation from those who do not use transit to those who do. After being approached by the union and hotel management, the City then asked us to examine the relationships, if any, between transit subsidies and the commuting choices of this segment of the urban workforce. It is because of the organizing and outreach by the union and hotel management, and the support of the City government and regional transit agency, TransLink, that we had the opportunity to collect data from employees at the downtown hotels, allowing us to fill a knowledge gap of existing transit subsidy research.

Study Design and Methods

The formal hypothesis guiding this study was that increasing an existing transit subsidy or introducing a new transit subsidy, would increase transit use and transit commuting by downtown hotel workers. At the same time, this study was an example of applied phronesis (Flyvbjerg and Landman, 2012) in which one goal of research is to help social actors acquire the knowledge required to address their own needs. The study design and methods were chosen to answer our partners' specific questions and concerns about transit subsidies. For these actors, decisions are taken at the level of the workplace; everyone who is part of the same workplace collective bargaining unit is treated the same, and policies have effects which extend beyond the individual employee/commuter to others who inhabit the same space. For this reason, we treated the workplace (each hotel) as a primary unit of analysis. There were further reasons why our study assigned subsidy levels to the various hotels, rather than randomly selecting individuals across the seven hotels.

First, we wanted to learn how burdensome it was for the hotels to manage the subsidy for all their employees. This was important because the study was designed to help answer union and hotel management questions about implementation. Second, because this was a policy focused study, we wanted to learn at what subsidy level people would be willing to go through the administrative process to get a subsidized transit pass. Randomly assigning subsidies to participants would not capture that initiative. Third, randomly assigning the subsidy would mean directly giving people the subsidy, and therefore, we would not be able to measure subsidy awareness at the workplace scale. Fourth, we wanted to ask participants why they did not take up (or accept) the subsidy, in addition to why they did not use the subsidy. The two questions are fundamentally different, in that they acknowledge that there are different barriers faced between getting a subsidy and using a subsidy. Fifth and finally, there was also the possibility that employees could share their transit payment cards at their workplaces if, due to random assignment, some could access the subsidy while others could not.

Fig. 1 shows the major transit routes for the Vancouver metropolitan area at the time of the study, as well as the general downtown area where the study hotels are located. We made the conscious choice not to associate the names of the hotels directly with the aggregate data (hotels were labeled as A, B, C, etc.), even though five of the seven hotels gave their consent for their names to be revealed (and are acknowledged below) because they wanted to be recognized for their leadership role on this policy issue. We choose not to associate any single hotel with its aggregate data because we did not want any of the hotels to have their business at risk by being judged in comparison to each other. This was a research project designed to answer policy and industry specific research questions, and we did not want to risk the participation (during all three waves of the survey) of the hotels.

In designing the study, we grouped six of the hotels into three similarly located pairs, with the seventh, unpaired, hotel providing another point of comparison (see Table 1). Since the workers at all hotels belonged to the same union, there was a high degree of similarity in working conditions and arrangements. Administration of the experimental subsidies required that hotels participate in the payroll deduction program of the local transit authority (TransLink). This payroll deduction program is called "Compass for Organizations" (CFO), the "Compass" being the name of TransLink's digital payment card. A data-licensing agreement with TransLink allowed us to analyze aggregated data on the travel behaviour of subsidy accepters at those hotels with 35 or more subsidy accepters.

We conducted representative surveys of hotel workers at all seven hotels at three points in time. The baseline survey in March 2018 (Wave 1) was conducted before any experimental subsidies were offered. Our follow-up surveys, conducted in September 2018 (Wave 2) and March 2019 (Wave 3), examined how workers' travel behaviour changed after the experimental transit subsidies became available (Table 2).

Hotels were matched in pairs based on size, location relative to rapid transit stations, and pre-study transit subsidy conditions. After we conducted the baseline survey, we offered workers at one hotel in each pair a new or enhanced subsidy, while leaving the subsidy level at the other hotel unchanged. For example, at the two hotels adjacent to a SkyTrain station, one (Hotel A) had a 15% transit subsidy before the study, and

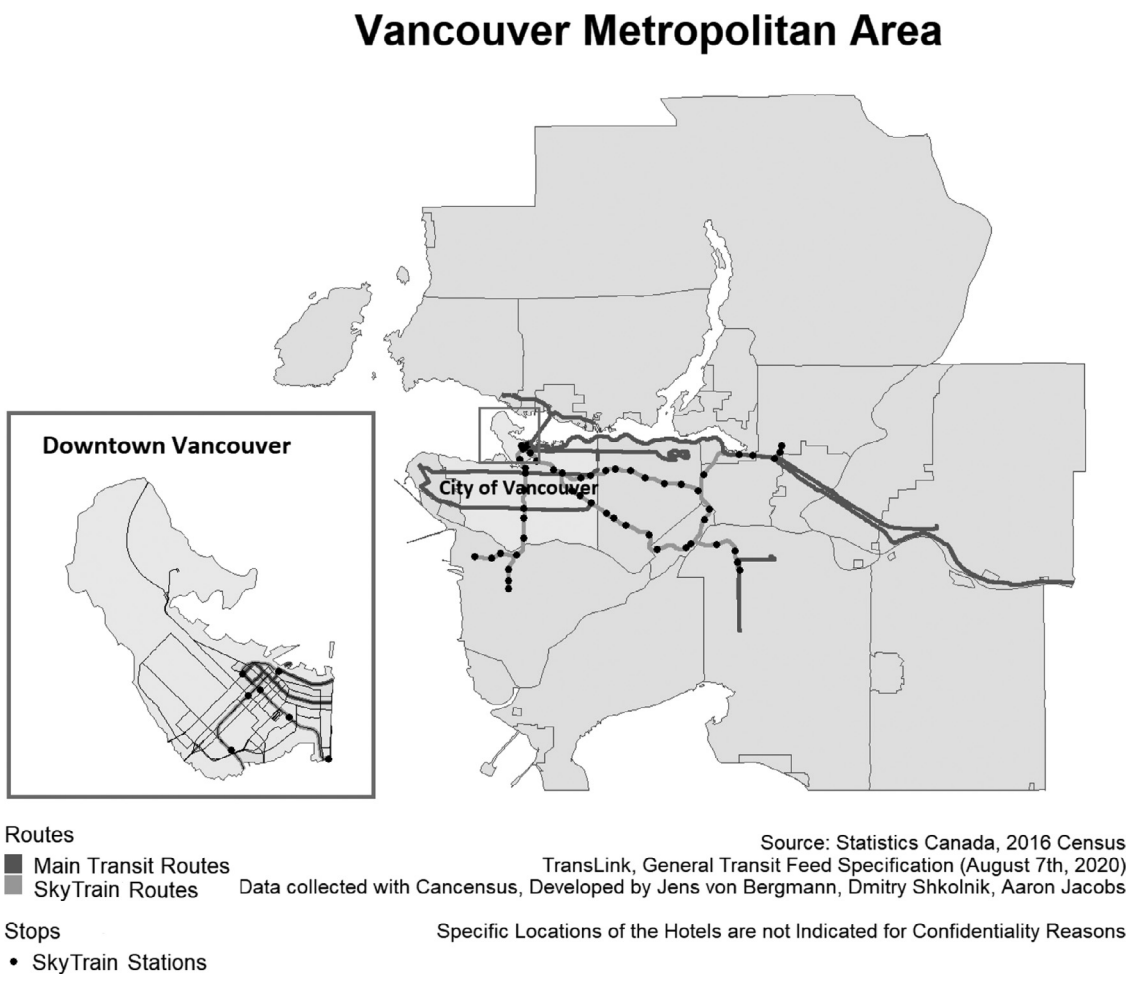

Fig. 1. Downtown Vancouver and regional rapid transit routes.

Table 1
Summary of hotel characteristics and subsidy treatment.

Hotel	Relative size	Location relative to downtown SkyTrain stations	Staff Parking Provision (subsidizedrate)	Pre-study transit subsidy	Study treatment transit subsidy	
					May–Oct.2018	Nov. 2018–Apr. 2019
A	Larger	Adjacent to SkyTrain	None	15%	25%	
B			Some ($10 per day)		None, stayed at 15%	
C	Larger	West of SkyTrain, 5 min. walk	Some ($147 per month)	15%	None, stayed at 15%	
D		West of SkyTrain, 15 min. walk	Plenty ($47 per month)		25%	50%
E	Smaller	West of SkyTrain, 10 min. walk	None	None	15%	
F	Smaller	South of SkyTrain, 10 min. walk	Some ($80 per month)	None	25%	50%
G			Some ($120 per month)		None, stayed at 0%	

Note: the three shaded row pairs highlight comparable hotel pairs. Hotel E was not paired.

we increased it to 25% after the baseline survey. At the other hotel in this pair (Hotel B), we left the subsidy at a constant 15% throughout the study. To gain insight into the impact of even higher transit subsidy levels, we further increased the subsidy to 50% at two hotels (hotels D and F) after the Wave 2 survey, while their paired hotels (hotels C and G respectively) remained unchanged.

We informed the hotels that their workers would be receiving the experimental (new or enhanced) subsidy after completion of the baseline survey, in the first weeks of April 2018. Workers who wished to take advantage of the (new or enhanced) subsidy at their hotel were required to enroll in TransLink's CFO program since it provided the mechanism for the study to reimburse them for the subsidy. However, worker participation in all aspects of the study remained voluntary and subject to individual consent. We designed the consent process so that employees could receive the experimental subsidy without answering any of the surveys, just as they could take part in the surveys without availing themselves of the subsidy.

The overall response rate to the paper-based questionnaire used to conduct the surveys was more than 40% in each of the three waves (copies of the three questionnaires, with data keys and

Table 2
Major commute modes by hotel, Wave 1.

Hotel	Transit subsidy at baseline	Transit-only %	Walk-only %	Auto-only %	Auto & transit %	*Other %
A	15%	59.8	12.3	8.7	16.1	3.1
B		59.7	7.4	14.8	15.7	2.4
C	15%	66.0	6.1	12.3	9.4	6.2
D		34.3	3.8	48.1	11.4	2.4
E	None	63.3	7.8	21.1	7.8	0.0
F	None	47.8	9.8	29.3	6.5	6.6
G		50.6	10.1	30.4	6.3	2.6
All		54.0	7.7	22.5	12.5	3.3

Note: the three shaded row pairs highlight comparable hotel pairs. Hotel E was not paired.
* Other includes cycle only and various combined mode commutes.

anonymized datasets are available at the [Federated Research] Data Repository, [URL https://doi.org/10.25314/dc305c6b-72c4-40b2-aff5-51c8b6c22c55]). Recruitment took place at the participating hotels, with explicit support of hotel management and the union. Recruitment followed standard consent and incentive procedures, with an assurance of individual confidentiality through the aggregation of data.

We were able to match some respondents across the three survey waves, creating a quasi-panel that we then analyzed to see how the same individuals changed their travel behaviour in response to changes in the transit subsidy. Using the quasi-panel as a study subgroup allowed us to isolate respondents' transit behaviour while keeping other factors, especially unobservable personal details, constant. However, since this study was not specifically designed as a panel study, we do not regard the quasi-panel as strictly representative of the study population. This is also why we chose to call this subset a quasi-panel, since it is neither a true panel nor is it a pseudo-panel, as described in the relevant scholarly literature (Baltagi, 2004). The quasi-panel over-represents long-term employees, and it is reasonable to assume that this group was more likely to have more established commuting routines.

We focus on the 444 individuals who responded in both Wave 1 and Wave 3 surveys, since this enabled a before-after subsidy treatment, same-month one year apart, comparison. At Hotel G, we matched 28 respondents between waves 1 and 3, which corresponds to the month of March one year before and after the experimental subsidies began. This was sufficient for statistical analysis. We matched more than 30 respondents at all other hotels, with 102 matched respondents at Hotel D.

Commute mode at baseline

At the outset of this study, we expected to find that that our sample of Vancouver hotel workers would be highly engaged with the transit system, and this proved to be the case. By transit engagement, we mean behaviours that range from having a Compass Card, to including some transit in one's commute, to purchasing a monthly transit pass product, to accepting a transit subsidy, to commuting exclusively by transit.

In Wave 1 of the survey, 89% of respondents reported having taken public transit in Metro Vancouver in the past month. This is considerably higher than the 52% of employed Metro Vancouverites who reported doing so in the 2018 Transit Incidence Survey conducted by the Mustel Group for TransLink (Mustel Group 2019). In the same survey, 77% of the total respondents living in the City of Vancouver and 46% of those living in the rest of Metro Vancouver reported using public transit in the last 30 days.

Overall, 54% of our respondents were transit-only commuters on the days we surveyed them for the Wave 1 survey in March 2018. Data from the 2016 Census helps to put those baseline travel patterns in broader perspective, though the census question was worded somewhat differently than in our survey. In the City of Vancouver, only 30% of people used transit as the way they "normally get to work," while in the Vancouver CMA, only 20% did (21). The percentage of hotel workers using transit to get to and from work in our study population was also substantially higher than the share of trips to work by transit reported in trip diaries completed for TransLink's 2014 *Transportation Panel Survey,* which was based on a representative sample of 3,071 Vancouver region residents at least 15 years old (TransLink 2014). In that data, 27% of trips to work were by transit, 41% by auto, 9% by bike and 23% by walking. In our first survey, only 23% of hotel workers had auto-only commutes on the reference day, though another 14% combined auto with transit or some other mode. Our study population was also less likely to commute by walking or cycling than city residents overall, though the use of active transportation was comparable to those for the region.

Considerable variation in commute mode among employees at different hotels also became apparent. This is no surprise, given the locations of the pairs of hotels in relation to transit and parking. Hotel D was farthest away from transit and had a correspondingly low transit-only commute percentage and the highest percentage of auto-only commuters, despite the pre-study availability of a 15% transit subsidy. Hotel E was closer to transit than Hotel D and, despite the absence of a subsidy at the time of the Wave 1 survey, had a much higher percentage of transit-only commuters.

Changes in commute mode

We hypothesized that increasing an existing transit subsidy or introducing a new transit subsidy would increase transit use and transit commuting by workers. Our data supports both hypotheses. Recall here that a key aspect of the study design involved selecting and pairing hotels based on their similar locations relative to transit and then making the experimental subsidy available to only one hotel in that pair. Table 3 shows change in transit commuting as follows:

- Hotel A (increased subsidy from 15% to 25%) had a larger increase in transit use than Hotel B (no change to subsidy level of 15%).
- Hotel D (increased subsidy to 25% and then 50%) had an increase in transit use, while Hotel C (no change to subsidy level of 15%) had a decline.
- Hotel F (new subsidy at 25% and then 50%) had a larger increase than at Hotel G (no subsidy and no change).

Table 3 provides data on the Wave 1 to Wave 2 (March to September 2018) and Wave 2 to waves 3 (September 2018 to March 2019) changes, but these comparisons are sensitive to seasonal effects, which may be substantial, and may also be unevenly distributed among our study hotels. For example, March is associated with Vancouver's conference season and September with the height of the cruise season, and different hotels are more or less active in these markets. Hence, we focus our discussion here on changes from waves 1 to 3 of the survey, since that March-to-March (2018 to 2019) period allowed the most time for workers to take advantage of the experimental subsidies and change their commuting choices accordingly, and also because the March-to-March comparison eliminates seasonality effects.

Table 3
Summary of main commute mode percentage changes by hotel, waves 1 to 3.

Hotel	Subsidy treatment	Change from Wave 1 to Wave 2 in (selected) main commute mode				Change from Wave 2 to Wave 3 in (selected) main commute mode				Change from Wave 1 to Wave 3 in (selected) main commute mode			
		Transit-only %	Walk-only %	Auto-only %	Auto and transit %	Transit-only %	Walk-only %	Auto-only %	Auto and transit %	Transit-only %	Walk-only %	Auto-only %	Auto and transit %
A	15% to 25%, then constant	10.7	-5.5	-0.1	-5.7	-3.5	3.2	-2.1	3.7	7.2	−2.3	−2.2	−2.0
B	15%, no change	1.3	-1.0	-1.0	-1.1	-0.6	2.4	0.2	-0.2	0.7	1.4	−0.8	−1.3
C	15%, no change	-7.6	3.8	4.4	-0.2	-3.0	1.2	2.5	1.2	−10.6	5.0	6.9	1.0
D	15% to 25%, then 50%	-1.3	0.4	1.2	-0.2	9.3	1.1	-7.0	-4.1	8.0	1.5	−5.8	−4.3
E	New 15%	-6.6	-2.2	5.6	3.3	4.9	0.2	-2.3	-5.3	−1.7	−2.0	3.3	−2.0
F	New 25%, then to 50%	7.6	2.1	-3.6	0.4	-5.4	-1.0	-1.2	2.2	2.2	1.1	−4.8	2.6
G	0%, no change	6.0	-2.9	-3.9	-1.5	-4.9	4.3	1.1	2.1	1.1	1.4	−2.8	0.6
All		0.8	-1.0	1.4	-1.4	1.0	2.0	-2.3	-0.1	−1.5	1.0	−0.9	−1.5

Note: the three shaded row pairs highlight comparable hotel pairs. Hotel E was not paired.

Table 4
Quasi-panel: transit- and auto-only commuting and transit use in the past month, by hotel.

Hotel	Subsidy treatment	Transit use in past month			Transit-only commuting			Auto-only commuting		
		Wave 1 (%)	Wave 3 (%)	% change in share	Wave 1 (%)	Wave 3 (%)	% change in share	Wave 1 (%)	Wave 3 (%)	% change in share
A	15% to 25%, then constant	96.7	94.5	−2.2	65.3	69.5	4.2	8.4	7.4	−1.1
B	15%, no change	95.5	94.4	−1.1	62.6	64.8	2.2	12.1	11.0	−1.1
C	15%, no change	93.5	80.6	−12.9	66.7	65.1	−1.6	14.3	15.9	1.6
D	15% to 25%, then 50%	79.8	73.7	−6.1	36.6	39.6	3.0	50.5	46.5	−4.0
E	New 15%	80.6	67.7	−12.9	59.4	56.3	−3.1	25.0	31.3	6.3
F	New 25%, then to 50%	73.5	79.4	5.9	35.3	38.2	2.9	35.3	32.4	−2.9
G	0%, no change	92.9	78.6	−14.3	64.3	57.1	−7.1	32.1	28.6	−3.6
All		88.9	83.6	−5.3	55.6	57.0	1.4	24.3	23.2	−1.1

Note: the three shaded row pairs highlight comparable hotel pairs. Hotel E was not paired.

Hotel A, a workplace that is well served by transit, appears to represent a case in which price elasticities of transit demand were high. Its subsidy level moved from 15% to 25% from waves 1 to 3 and its percentage of transit-only commuters grew from 60% to 67% over the same period, reaching 71% in Wave 2 before dipping back down again. The other three main commute modes each decreased by approximately 2% from waves 1 to 3. Meanwhile, there was almost no change in the percentage of transit-only commuters at the paired Hotel B over this period, and very little change to any other commute-mode percentages. This result is consistent with our hypotheses that economic incentives will influence travel demand to boost public transit usage when the supply side offers reasonable travel options.

At Hotel D, where the subsidy was increased from 15% to 25%, and later to 50% over the course of the study, we only saw a jump in transit-only commuting after the second increase to the experimental subsidy, i.e., in the Wave 3 survey results. There was essentially no change in transit-only commuting when the subsidy was increased from the baseline of 15% to 25% between waves 1 and 2. However, from waves 2 to 3, the transit-only commuting share increased from 33% to 42%. This shift to transit was accompanied by a corresponding decline in auto-only and auto-and-transit commuting at Hotel D. This is notable considering Hotel D's location is the least well served by SkyTrain. Hotel D also had the largest percentage of auto-only commuters at the outset of the study. By the end of our study period, this percentage had decreased by about 6%. These results indicate that a larger subsidy was needed to move workers from auto to transit commuting at a location that was less well supplied with convenient and accessible transit. Even after the decrease, Hotel D still had the highest share of auto-only commuters, and in the Wave 3 survey, 30% of respondents at Hotel D gave "driving" as the reason why they did not accept the subsidy, or as a comment about their commute. This rate was more than twice that reported at the hotel with the next highest rate of "driving" reasons or comments.

At the paired Hotel C, which received no enhancement to its existing subsidy, there was a decrease in transit-only commuting over the study period, while walk-only and auto-only commuting both increased noticeably. We think that the changes here, despite no change in subsidy level, are due to a high degree of staff turnover that is in turn due to an unrelated renovation and expansion of this hotel's conference business. Table 4, which includes only those respondents to wave 1 and wave 3 (in other words, no new employees), does not show such a large change in transit- and auto-only commuting. Hence the relative changes at this hotel pair (C and D) are also an expected result that supports our hypothesis that economic incentives can trigger a shift to greater public transit use.

Hotel F's increased transit-only commuting (48% to 50%) between waves 1 and 3 also represents a small, but expected response to the new, relatively high-value experimental subsidy offered here. It was surprising, however, that the transit-only commute mode decreased from waves 2 to 3, after the additional increase of the experimental subsidy (25% to 50%). We think that this decrease is because of the summer seasonal hiring of student workers at this hotel. While these high transit-users would have been included in the wave 2 survey (September), they would have fallen out again by the wave 3 survey (March). Table 4 which includes only those respondents in wave 1 and wave 3 (in other words, no seasonal employees) shows a wave 1 to 3 increase in transit-only commuting.

The lack of response to the even higher subsidy after wave 2 at Hotel F also highlights the differences with Hotel D. At Hotel D, cheaper parking and lower transit accessibility meant that a larger subsidy (50%) was required to shift travel behaviour. In contrast, with its more expensive parking and better transit access, Hotel F is similar to Hotel A in its supply side mobility conditions, and so the lower subsidy level (25%) achieved the shift in behaviour; thereafter, the subsidy may have had diminishing returns.

The percentage of auto-only commuters at Hotel F did decrease by 5% from waves 1 to 3 of the survey, which is another expected result. Hotel G, which had no subsidy throughout the study period and was paired with Hotel F, saw a small increase (1%) in transit-only commuting over the entire study period, as well as seasonal changes (an increase in transit-only commuting from wave 1 to wave 2, followed by a decrease from wave 2 to 3). While the overall increase was smaller than the non-subsidized Hotel F's increase in this mode, this result tells us something about the limits of a subsidy to influence mode shift among a group that already had high baseline rates of transit commuting. Overall, results for this pair of hotels are moderately consistent with our hypotheses.

The decline in transit commuting at the unpaired Hotel E (new subsidy at 15%) and the increase in auto commuting there was unexpected, especially because this hotel is relatively well located for transit. One factor (not shown in the tables) that could have influenced the outcome at Hotel E is that 10% of our survey respondents stated that the transit subsidy was not available to them, which is statistically significantly different from the 6% rate for respondents at all hotels. However, this explains lower subsidy acceptance more directly than transit commuting per se.

The rightmost columns of Table 3 present net percentage changes in commute modes by hotel, from waves 1 to waves 3. They reveal that the two hotels with the biggest gains in transit-only commuting were hotels A and D, which were both targeted for increases in their existing 15% subsidy levels between March 2018 and March 2019 (waves 1 and waves 3 of the survey). Transit-only commuting at these hotels increased by 7% and 8% respectively, while their auto-only and auto-and-transit commuting shares simultaneously declined.

It is important to recognise that the magnitude of the positive impact of the subsidies on transit-only commuting did vary. For example, we found that at Hotel A, a 67% subsidy increase (from a 15% to 25% subsidy) increased the share of transit-only commuting to 67% of workers (a 12% increase in the number of transit-only commuters at that hotel, or a 7 percentage point increase in the transit mode's share of travel to work at Hotel A). It is relevant here that Hotel A was adjacent to a SkyTrain station and surrounded by expensive parking. Furthermore, at least 60% of its workers were already transit-only commuters at the start of our study, according to the baseline survey in March 2018 (Wave 1). In contrast, Hotel D—which was farther away from a SkyTrain station and where only 34% of workers were initially transit-only commuters—saw a 233% subsidy increase (from 15% to 50%) which increased the transit-only commuting share to 42% of workers (a 23% increase in the number of transit-only commuters at that hotel, or an 8 percentage point increase in the transit mode share).

The contrasting incentives behind the mobility shift at Hotels A and D highlight that while the total share of transit-only commuting increased by about the same amount (a 7 or 8 percentage point increase) at both hotels, it took a much larger subsidy increase to achieve that result at the hotel that was physically farther away from the SkyTrain (Hotel D) compared to the one that was adjacent to the SkyTrain (Hotel A). Supply side conditions on public transit can thus either facilitate or constrain the effect of economic incentives on travel behavior.

Subsidy acceptance

Overall, subsidy acceptance among our study population increased by an average of 6%. In our baseline survey (Wave 1), we found that a little over a quarter (28%) of total employees at the seven hotels accepted the transit subsidy. Of those who worked in the four hotels and were eligible for the 15% subsidies at the start of the study, 31% accepted the subsidy. By the 3rd survey wave, when 15%, 25% or 50% subsidies were being offered at six hotels, 36% accepted the subsidy.

We also investigated how subsidy acceptance changed between wave 1 to wave 3, among subgroups of the quasi-panel of 444 respondents. Here we found distinct and statistically significant patterns of subsidy acceptance (using a chi-squared test with $p<0.05$). The following groups were more likely to start accepting the subsidy between waves 1 to waves 3:

- Those who worked weekends: 21% accepted the subsidy versus 12% of those who did not work weekends. We suggest that this reflected the current pricing advantage of lower transit fares on weekends, which, when combined with the experimental subsidy, was sufficient to trigger acceptance.
- Households with children at home: 26% accepted the subsidy versus only 13% of households without children at home.
- Renters: 22% of renters accepted the subsidy versus 13% of homeowners.
- Newer employees: 29% of those who had worked up to one year accepted the subsidy versus 15% of employees who had started work before 2016.

Change in transit use: Quasi-panel analysis

Fully 79% of matched respondents exhibited no change in commuting behaviour between waves 1 and waves 3. This shows that commuting is patterned behaviour, and like other established habits it can be resistant to change. In the quasi-panel overall, there was an increase in transit-only commuting from 56% to 57%. Further, this change did not come at the expense of active transport commuting modes: walk-only and bike-only commuting also increased slightly, as did the combined active mode. The total share for transit and active modes increased from 64% to 66%. This two-percentage-point shift came from declines in auto-only (down from 25% to 24%) and combined commutes involving auto and transit (down from 11% to 9%).

The link between commuting by public transit and the subsidy change was confirmed when we examine the mode-specific changes in the quasi-panel for our hotel pairs. In Table 4, we show that transit-only commuting increased by a higher rate, and transit use decreased by a lower rate, at the hotels with an experimental subsidy increase (A, D and F) than at their no-change paired comparison hotels (B, C and G). Note, however, that the decrease in transit-only commuting at Hotel E still represents an anomaly, and that the overall proportion of transit use in the past month declined for the matched group, as it did for the overall study population.

Table 4 also reveals an important finding from our research: the larger the experimental subsidy, the larger the relative shift toward transit-only commuting. Compare, for example, the 4% increase where the subsidy increased from 15% to 25% (Hotel A) versus the 2% where there was no change to the subsidy increase (paired Hotel B). See also Hotel D, where the subsidy went from 15% to 50%, with a 3% increase in transit-only commuting versus Hotel C, where there was no subsidy change, with a 2% decrease in transit-only commuting. Finally, Hotel F, where the subsidy went from 0 to 50%, saw a 3% increase in transit-only commuting versus Hotel G, which had no subsidy change, saw a decrease of 7% in transit-only commuting.

Again, looking at our quasi-panel, we found that within this group, people who commuted during off-peak hours (those who reported leaving home or work between 6:30 p.m. and 1:00 a.m. on weekdays) became more likely to incorporate some transit in their commute between March 2018 and March 2019. This finding is statistically significant (chi-squared test with $p = 0.014$). This propensity to choose transit for off-peak work travel might be motivated by the additional savings embedded within the transit fare structure.

TransLink, the Vancouver region transit authority, currently uses a zone-based fare system. The City of Vancouver comprises Zone 1. The inner suburban municipalities to the south, north and west of the city comprise Zone 2. The outer suburban municipalities farther to the east and south of the city comprise Zone 3. The fare for a journey depends on the mode and on the zone boundaries crossed. All journeys by bus are priced as one-zone fares. Journeys by rapid transit (SkyTrain and

SeaBus) start as one-zone fares and increase each time a zone boundary is crossed. All transit travel is charged at a one-zone fare after 6:30 p.m. on weekdays and all day on weekends and public holidays.

The combined savings available through off-peak travel and a transit subsidy may have been enough to persuade commuters to incorporate transit into their commutes. This evidence aligns with findings in the literature that highlight the attractive influence of providing free, or highly discounted, public transit services in other cities (Tuisk and Prause, 2018, Cools et al., 2016).

TransLink's fare zones also reflect service levels which correlate with the propensity to commute by transit. Residents of TransLink's Zone 1 and 2 are well served by transit, but Zone 2 residents are more likely to have commutes involving transit than those in Zone 1, some of whom live close enough to work to use active commute modes. Residents of downtown Vancouver, also part of Zone 1, are also less likely to accept the subsidy (see Table 4). Zone 3 commuters live farther from their downtown workplaces and in many cases, have longer distances from their homes to the SkyTrain or to places where frequent bus service is available. Hence Zone 2 residents are the most likely to use transit as part of their commute.

We also identified some demographic subgroups of workers that were more likely to change their commute with the subsidy, although these differences were not statistically significant. Those who might be more likely to switch from some other mode to transit-only commuting between waves 1 and waves 3, included residents of inner suburbs such as Richmond, Burnaby and the Tri-Cities (Coquitlam, Port Coquitlam and Port Moody); workers who started in their jobs more recently; visible minorities; housekeepers, food and beverage workers, along with front of house workers.

Conclusions

We estimate that between 4% and 10% of Vancouver hotel employees became new transit commuters when a new 15% transit subsidy was made available. And we estimate that between 9% and 14% of these employees became new transit commuters with a 50% subsidy. The overlap in the estimate suggests that a variety of factors, such as the location of the workplace relative to a rapid transit station and the provision of parking at or near the workplace, influenced the magnitude of the transit subsidy's incentive effect. The appeal of these subsidies was also subject to diminishing returns, and it is thus unlikely that even free transit would induce all commuters to take transit.

About one-quarter of those who accepted the novel or enhanced transit subsidies at the study hotels were new transit riders. This is a larger percentage of first-time participation than was found by Rivers and Plumptre in their study of the effects of the Canadian Public Transit Tax Credit, which was available from 2006 to 2017. They found that 3%–9% of those accepting the 15% tax credit were new transit riders (Rivers and Plumptre, 2018). The higher rate of conversion to public transit commuting was to be expected in our study because downtown Vancouver hotels are better served by transit than almost all other workplace locations across Canada. Also, unlike the tax credits, in which commuters had to wait up to a year to receive the financial incentive, the benefits of these employer transit subsidies were made available immediately.

The effectiveness of transit subsidies also appears to be mediated by factors which are amenable to public policy intervention and transit agency action, such as parking prices and the design and administration of the subsidy. For example, easy subsidy administration was welcomed by all study participants, but written comments by respondents on their questionnaires indicate that higher transit service levels and longer transit service operating hours might encourage more transit commuting. Depending on how these factors combine, some workplaces will be even more conducive to subsidy acceptance and modal shift to transit commuting.

Our research demonstrates the positive effect of employer provided transit subsidies on promoting modal shift to public transportation, even among a group of workers who were already heavy transit users. However, we also note that the relationships between commuting choices, transit subsidies and hotel employment are complicated. Some will continue to rely exclusively on active modes, such as walking or cycling, while those with automobiles who live in places poorly served by transit, or who have multi-destination commutes, will continue to drive. However, in this experiment, employer-paid transit subsidies demonstrated their effectiveness in attracting users to a more sustainable mode of transportation.

Declaration of Competing Interests

None

Acknowledgments

Funding was provided by the City of Vancouver, with in-kind contributions from Unite Here Local 40; TransLink; and the seven participating downtown hotels, including the Westin Bayshore, Pinnacle Harbourfront, Holiday Inn Downtown, Hyatt Regency and Blue Horizon.

References

Altshuler, A. A. (1969). Transit subsidies: by whom, for whom? *J. Am. Plan. Assoc., 35*(2), 84–89. 10.1080/01944366908977578.

Baltagi, B. (2004). Panel Data Analysis. In M. S. Lewis-Beck, A. Bryman, & T. F. Liao (Eds.), *The SAGE Encyclopedia of Social Science Research Methods* (pp. 783–785). Thousand Oaks, CA: SAGE Publications 1. 10.4135/9781412950589.n684.

Block-Schachter, D., & Attanucci, J. (2008). Employee transportation benefits in high transit mode share areas: university case study. *Transp. Res. Record: J. Transp. Res. Board, 2046*, 53–60. 10.3141/2046-07.

Bueno, P. C., Gomez, J., Peters, J. R., & Vassallo, J. M. (2017). Understanding the effects of transit benefits on employees' travel behavior: evidence from the New York-New Jersey region. *Transp. Res. Part A: Policy Pract., 99*, 1–13.

Chandler, V. (2014). The effectiveness and distributional effects of the tax credit for public transit. *Canadian Public Policy, 40*(3), 259–269. 10.3138/cpp.2013-073.

Cools, M., Fabbro, Y., & Bellemans, T. (2016). Free public transport: a socio-cognitive analysis. *Transp. Res. Part A: Policy and Pract., 86*, 96–107.

Flyvbjerg, B., Landman, T., & Schram, S. (Eds.). *Real social science: Applied phronesis*. Cambridge, UK: Cambridge University Press, 2012.

Ghimire, R., & Lancelin, C. (2019). The relationship between financial incentives provided by employers and commuters' decision to use transit: results from the Atlanta Regional Household Travel Survey. *Transp. Policy, 74*, 103–113.

Gould, J., & Zhou, J. (2011). A commitment to continue? comparing women and men commuters who choose transit over Driving Alone. *Transp. Res. Board Confer. Proceed., 2*(46), 154–162.

Hamre, A. K. M (2017). *A Transport Justice Evaluation of Employer-Based Transit Subsidies*. Virginia Polytechnic Institute and State University. Retrieved from https://vtechworks.lib.vt.edu/bitstream/handle/10919/81911/Hamre_AK_D_2018.pdf?sequence=1.

Hamre, Andrea, & Buehler, Ralph (2014). Commuter mode choice and free car parking, public transportation benefits, showers/lockers, and bike parking at work: evidence from the Washington, DC Region. *J. Public Transp., 17*(2), 67–91. 10.5038/2375-0901.17.2.4.

Krechmer, D., Spielberg, F., & Milione, V. (1982). Evaluation of employer-based transit pass programs. *Transp. Res. Record, 857*, 58–60.

Lachapelle, U., & Frank, L. D. (2009). Transit and health: mode of transport, employer-sponsored public transit pass programs, and physical activity. *J. Public Health Policy, 30*(SUPPL. 1), 73–94. 10.1057/jphp.2008.52.

Lachapelle, U. (2018). Employer subsidized public transit pass: assessing disparities in access, use, and latent demand. *Case Stud. Transp. Policy, 6*(3), 353–363 Cambridge, MIT. 10.1016/j.cstp.2017.08.006.

Mustel Group (2019). TransLink Transit Incidence Survey.*TransLink, Dataset 1* Accessed.

National Academies of Sciences, Engineering, and Medicine (2005). *Analyzing the Effectiveness of Commuter Benefits Programs*. Washington, DC: The National Academies Press. 10.17226/21979.

Rivers, N., & Plumptre, B. (2018). The effectiveness of public transit tax credits on commuting behaviour and the environment: Evidence from Canada. *Case Stud. Transp. Policy, 6*, 651–662. 10.1016/j.cstp.2018.08.004.

Rodríguez, C., Gallego, J. M., Martinez, D., Montoya, S., & Peralta-Quiros, T. (2016). Examining implementation and labor market outcomes of targeted transit subsidies: subsidy by Sistema Nacional de Selección de Beneficiarios for Urban Poor in Bogotá, Colombia. *Transp. Res. Record: J. Transp. Res. Board, 2581*(1), 9–17.

Rosenblum, J., Zhao, J., Arcaya, M., Steil, J., and C. Zegras. How Low-income Transit Riders in Boston Respond to Discounted Fares: A Randomized Controlled Evaluation - Preliminary Results. 2019 Cambridge, MIT.

Serebrisky, T., Gómez-Lobo, A., Estupiñán, N., & Muñoz-Raskin, R. (2009). Affordability and subsidies in public urban transport: what do we mean, what can be done? *Transp. Rev., 29*(6), 715–739 https://search.library.wisc.edu/catalog/999973488702121/cite. 10.1080/01441640902786415.

TransLink (2014). *Exhibit 4-9—Comparison of Panel Survey Trips to Work*. Publication Transportation Panel Survey Final Report, Translink, 2014.

Tuisk, T., & Prause, G. (2018). Socio-economic aspects of free public transport. In *International Conference on Reliability and Statistics in Transportation and Communication* (pp. 3–13). Cham: Springer.

Vancouver,CY [Census subdivision], British Columbia and Vancouver [Census metropolitan area], British Columbia (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E. Accessed July 23, 2020.

Zhou, Jiangping, Wang, Yin, & Schweitzer, Lisa (March 1, 2012). Jobs/housing balance and employer-based travel demand management program returns to scale: evidence from Los Angeles. *Transp. Policy, Urban Transp. Initiat., 20*, 22–35. 10.1016/j.tranpol.2011.11.003.