UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Employee Transit Pass

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Executive Summary

Overview

UBC aims to promote sustainable travel as part of their environmental goals. After the success of the student U-Pass program, UBC is interested in evaluating the costs-benefits of a potential institutionally subsidized Employee Transit Pass Program. Therefore, the purpose of this project is to identify an optimal subsidy amount, its subsequent change in transit ridership and highlight the potential costs and benefits for UBC.

Methodology

We conducted a cost-benefit analysis while evaluating the potential costs in terms of the direct cost of subsidy to UBC, implementation costs and tax implications for the faculty and staff. The benefits were analyzed through change in consumer surplus calculated at different subsidy rates. We conducted our analysis with three different models in consideration: Opt-In Single Three-Zone Pass, Individual-Zone Passes & a Mandatory Single Three Zone Pass. We also expanded our research on TransLink's end, that is, how can we keep TransLink revenue neutral.
We assumed that those who buy the transit pass will use public transportation as their primary mode of commuting to campus and that UBC would fund the cost of the subsidy in all the three models. It is important to note that we did this analysis assuming that UBC would fund the subsidy. In reality, TransLink might accept a model closer to the Student U-Pass. In this model, UBC might be able to negotiate an increase in ridership from faculty and staff in exchange for a lower price, and that would change the cost benefit analysis.

Limitations and Assumptions

There is a lack of data from the 2017 and 2011 UBC Transportation Survey that we used to evaluate the demand curve and elasticity. Without the microdata from the two UBC transportation surveys, we are unable to isolate the elasticity of demand of faculty and staff from students. If we were able to develop a more rigorous estimate of the elasticity it would in turn change our estimate for the change in ridership that would result from the subsidy. We assumed that those who listed public transit as their primary mode of transportation to campus use a monthly transit pass. In addition, we used the same relationship between quantity and price for the analysis of both the single three-zone pass and each individual zone passes. This may not be a realistic assumption as the elasticity

may vary from zone-zone due to factoring in of variables such as time costs. Moreover, currently given the excess demand for parking, we are uncertain how parking revenue would be affected. As a result, it is not included in our analysis.

Recommendations

UBC will incur a net financial loss under all the three models. However, if UBC values the intangible goals of environmental and reputational benefits at the size of the negative monetary value, then the project could still be worthwhile. If UBC is to continue with this project we recommend an optimal subsidy amount under the partnered TransLink model. Therefore, the most cost-effective strategy is to negotiate with TransLink. We recommend making this program optional because there is then a greater likelihood that those who purchase the discounted pass will use it to commute to UBC rather than driving. If it was a mandatory program, then there would still be a fraction of the population who would drive, and this would be an ineffective use of the subsidy on those individuals. If unable to negotiate we would recommend the Individual Zone Model rather than the Single Three-Zone Model as it is less expensive and produces approximately the same quantity of passes purchased.

Areas for Further Research

Looking further into whether changes in parking costs have a greater impact in shifting from driving to public transit than a public transit fare subsidy, as there might be a waitlist. It would also be helpful to develop a model to analyze how an increase in public transit mode share impacts UBC's decisions for future infrastructure development, such as parking and housing. We would also like to have an accurate elasticity for all the three transit zones individually, which would require data collection.

Introduction

In keeping with UBC's 2014 Transportation Plan UBC seeks to promote sustainable travel, reduce single occupant vehicle use, and reduce traffic congestion on UBC campus. As a growing institution, UBC has faced an average increase in auto trips to and from campus of approximately 6% per year. In an effort to mitigate the increased pressure on parking resources and auto-related infrastructure costs, as well as encourage investment in a rapid transit system to campus and achieve long term sustainability goals, UBC is considering an institutionally subsidized Employee Transit Pass program. This project seeks to evaluate the net benefit of this program through a cost-benefit analysis.

Our question of focus will be:

i. Should UBC Vancouver subsidize an Employee Transit Pass program? What would the optimal subsidy amount be?

We will specifically research:

ii. What is the effect of an employee subsidized transportation pass on UBC employee ridership to campus?
iii. What is the financial impact on UBC of a subsidized employee transit pass? As well as the financial impact on UBC employees and TransLink.

Our key parameters are:

iv. The impact of the subsidy will depend on how much TransLink ridership changes. In order to estimate the increase in ridership, we need to look into the elasticity of demand for public transit passes with respect to price. The difference in travel time that is associated with taking transit over other modes of transportation is reflected in the consumer's choice to switch to transit given a subsidy on transit passes and is therefore captured in the elasticity.
v. We must estimate the immediate cost of the subsidy to UBC by estimating the quantity of subsidized passes sold, and the subsidy amount per pass. The subsidy will be viewed as a taxable benefit to employees, therefore we must determine the annual subsidy amount pass holders will receive and the marginal income tax rate to evaluate the tax implications. We also must estimate the general and

administrative costs to UBC of implementing this program which we will refer to as the implementation costs.

Background Overview

According to the 2014 UBC Transportation Plan, UBC is committed to developing sustainable transportation systems and infrastructure. It lays out the key transportation targets that UBC would like to achieve. The following are the key UBC transportation targets:

1. By 2020, at least two-thirds of trips to and from campus should be made by walking, cycling, or public transit, as well as maintaining at least 50% of all trips to and from campus on public transit.
2. Reduce Single Occupancy Vehicles (SOV) travel to and from UBC by 20% from 1996 levels and maintain at least a 30% reduction in daily SOV trips per person from 1997 levels.
3. Maintain or reduce daily automobile traffic at or less than 1997 levels.

Where does the subsidized Employee Pass fit into this?

It is our hypothesis that a subsidized UBC Employee Pass would help UBC achieve its transportation targets. By reducing the cost of transit for employees, the subsidized Employee Pass would increase TransLink ridership, as well as reduce the need for single occupant vehicle travel to UBC. This is consistent with UBC's Transportation Plan, as well as the subordinate Neighbourhood Plans, Land Use Plan, Vancouver Campus plan and the Strategic Transportation Plan UBC has set out.

Whose interests are at stake?

UBC as an institution

Given UBC's stated transportation goals, its reputation stands to benefit from subsidised employee transit which will get it closer to its targets. The financial impact of the subsidy on UBC is also key.

Members of UBC's faculty and staff, as well as its student population

The UBC faculty and staff stand to benefit directly by having cheaper transit. This is true of employees who already rely on transit, as well as employees who use private vehicles who find that the discount outweighs increased time costs.

The entire UBC population stands to benefit from fewer cars on campus because fewer cars makes walking and cycling easier and decreases traffic for anyone (employees and students) who drives anyway.

Neighbourhoods around UBC

Neighbourhoods around UBC stand to benefit from decreased car travel in the form of decreased pollution of all kinds (noise pollution, air pollution) from vehicle traffic. There is also a potential for increased safety from reduced traffic. They also stand to benefit from decreased parking in their streets from people who could not find parking on campus.

This needs to be weighed against any potential increase in bus travel through neighbourhoods which could affect pollution.

TransLink

UBC is explicitly committed to working with TransLink to achieve its sustainability goals. TransLink can benefit in the form of increased revenue depending on how the subsidy is structured. For example, if UBC can buy bus passes in bulk at a discount, the size of the discount TransLink offers will determine if TransLink benefits or is no worse off.

It is worth pointing out that there might be some cost to TransLink in the form of increased strain on its network capacity.

The City of Vancouver

Vancouver has its own transportation goals. For example, it also has the goal of achieving a two-thirds share of commuting trips to be by public transit, cycling and walking by 2040. This subsidized Employee Pass would have an impact on the city's goals in the same way it would UBC's goals but on a smaller scale.

One of the more significant barriers to public transit usage is the associated "disutility of time cost, due to its lower overall speed and multiple stops" (Agarwal and Collins, 2016). In a study done by Agarwal and Collins discovered that respondents "reported changing their commute modes according to seasons" (2016). The key barriers for employees using public transit was "proximity to workplace, car ownership, public transit being too time-consuming, and the need to make

multiple stops during the journey to work" (Agarwal and Collins, 2016). A subsidized pass would increase the rider's elasticity of demand for public transit thus potentially reducing a significant barrier to public transit use.

Current Situation

The only analogous policy that exists is the U-Pass program, which is a subsidy that exists for student transit. There is currently no policy for subsidized employee transit besides the current charges for parking that effectively act as a subsidy to transit.

The success of the Student U-Pass program brought benefits to UBC in terms of increasing student access to TransLink services, reduced parking demand and helped UBC pursue its Trek 2010 goals and commitment to sustainability. Benefits to TransLink were seen through increased ridership and guaranteed revenue along with building ridership loyalty. Recognizing this success of the U-Pass Program, TransLink and UBC explored opportunities for U-Pass expansion to include staff and faculty groups at UBC.

Prior to 2014 there was an employee pass program (EPP) introduced by TransLink where a transit pass was offered at a 15% discount; however, this was discontinued in 2014. UBC is well-aware of the benefits of such a program and is interested in better understanding the potential for an institutionally-subsidized Employee Transit Pass program for staff and faculty at UBC Vancouver to shift travel behavior, avoid/defer auto- related infrastructure costs and strengthen the case for rapid transit to campus.

Economic Framework and Methodology

In our cost benefit analysis of the program, we evaluate the benefits as the change in consumer surplus of transit commuters from the introduction of the transit subsidy. First, we calculate the elasticity of demand for a transit pass with respect to price of a transit pass. We are assuming that all commuters who claim public transit as their primary mode of transportation all purchase monthly transit passes. This is a necessary assumption as we have no available data at this point in time that tells us how many transit commuters use monthly passes versus daily fares. We are evaluating an opt in model where faculty and staff have the option of purchasing a monthly transit

pass at a specified discount. Using the elasticity, we derive the demand equation for transit passes, and from the demand equation we evaluate the change in consumer surplus at subsidy levels.

To evaluate our total costs, we separate costs into three main categories: direct cost to UBC of the subsidy (Subsidy amount x quantity sold); tax implications to faculty and staff seeing as the subsidy will be considered a taxable benefit; and implementation costs. To calculate the direct cost to UBC we use the demand equation to determine the increase in quantity of transit passes demanded at various subsidy levels and multiply these quantities by the respective subsidy amounts. To calculate the tax implications, we estimate the proportion of faculty and staff in each tax bracket and calculate the additional income tax that faculty and staff will pay at the marginal tax rate. The implementation costs are estimated using the implementation costs of SFU's U-pass program. There is also potential for a transit subsidy to reduce parking revenue as SOV and HOV commuters switch to public transit. To calculate the change in parking revenue we would use the cross-price elasticity of mode share of SOV and HOV commuters with respect to a change in the price of a transit pass and use this value to determine the decrease in quantity of faculty and staff who choose to drive as their primary mode of transportation to campus. We then multiply this quantity by the average monthly cost of a parking pass. Here we are assuming that all people who cite driving as their primary mode of transportation to campus (either HOV or SOV) purchase a monthly parking pass. However, given current excess parking demand, we are uncertain of what the impact on parking revenue would be, and so we did not include this in our analysis

Finally, UBC stands to gain other benefits by achieving its transportation sustainability goals, such as reputational and environmental benefits that come with increased transit ridership. These are benefits that are difficult to measure monetarily. We could use a shadow price to assign a monetary value to such benefits. If we arrive at a net negative value from the whole project, that does not necessarily mean that the project is not worth doing. There is a theoretical shadow price for these benefits at which this project would be worth doing. In order for the project to break even (assuming it would otherwise have a negative value), then UBC must value its reputational and environmental goals at least as much as the net negative value. Consequently, it must value each additional rider at a shadow price:

$$\text{shadow price} = \frac{\text{total negative value}}{\text{increase in ridership}}$$

We will use the 2017 Transportation Survey to estimate the demand curve for transit passes, and demand for passes at a subsidized rate. The 2017 Transportation Survey has figures from 2011 and 2017, which are respectively before and after the removal of TransLink's employee pass program (EPP) which offered a 15% discount on transit passes. These figures provide data on the number of UBC faculty and staff and students who use each mode share to commute to UBC. Using the assumption that people who have a monthly pass take transit to commute, as the proposed program will be optional and not mandatory, the estimated demand curve will provide an estimate for the increase in demand for passes.

We will use the U-Pass Final Report by Urban Systems in order to calculate the implementation costs (using the SFU implementation costs as their population size aligns closer to the staff and faculty population size at UBC than the listed implementation costs for the UBC U-pass program).

a) SFU has incurred implementation costs of $141,000 as well as 3,450 hours of staff time.

We will also be calculating an average tax cost using an aggregated salary average as the visible salaries are only above $75,000 and we do not know those below it.

b) Knowing that UBC has 14,934 faculty and staff, and in the FIA report for March 31, 2017 had a total remuneration of $1,199,732,217. Taking this to get an average salary by $1,199,732,217/14,934 = $80,335.62.
c) The marginal federal and provincial income tax rates for this tax bracket are 20.50% and 14.70% respectively. Combining the two gives a marginal income tax rate of 35.20%. Using the full price of a transit fare pass being subsidized, yields a total expense of $174(12) = $2088. Then the additional tax amount in this bracket would be $2088(35.20%) = $734.98. An example for the mandatory model, is shown by aggregating this number by the total population of faculty and staff yields a total amount of $734.98(14,934) = $10,976,131.58.

Assumptions

We assumed those who take the transit use the monthly pass. We used the same relationship between quantity and price for the analysis of both the single three-zone pass and each individual zone passes.

Data Analysis

Elasticity Calculation:

Total number of faculty and staff = 14934

2011 transit mode share $= 65\%$ therefore $(0.65)\text{x}(14934) = 9707$ transit commuters

2017 transit mode share $= 52\%$ therefore $(0.52)\text{x}(14934) = 7766$ transit commuters

We are looking for the elasticity after the 15% EPP discount was removed (i.e. a 17.65% price increase from \$147.9 back to the full price of \$174).

$$\text{Elasticity} = \ln\left[\frac{Q_1/Q_0}{P_1/P_0}\right] = [\ln 7766 - \ln 9707] - [\ln 174 - \ln 147.9] = -0.385611$$

where Q_1 is the quantity in 2017 and Q_0 is the quantity of transit users in 2011

Demand Equation:

$$E^D = -0.3856$$

$$\ln Q = \ln a - 0.3856 \cdot \ln P$$

$$\ln 7766 = \ln a - 0.3856 \cdot \ln 174$$

$$\ln 7766 + 0.3856 \cdot \ln 174 = \ln a$$

$$\ln a = 10.947$$

$$a = e^{10.947}$$

$$a = 56774.48$$

$$Q^D = 56774.48 \cdot P^{-0.3856}$$

Quantity Sold:

$$\text{Quantity Sold} = 56774.48(174 - \text{individual subsidy amount})^{-0.3856}$$

*quantity sold at transit pass price of \$174 is 7730 is due to rounding as opposed to 7766 from 2017 mode share calculation

Change in Quantity:

$$\text{Change in Quantity} = \text{Quantity Sold} - 7730$$

where 7730 is quantity sold when transit pass price is $174

Consumer Surplus:

$$\text{Consumer Surplus} = (174 - P) \cdot \frac{(7730 + Q)}{2}$$

where 174 and 7730 are the original price and quantity respectively before the price is discounted

P is the $174 minus the individual subsidy amount and Q is the corresponding quantity

*This is a first order approximation for consumer surplus

Tax Implications:

Average Income for Faculty and Staff = $80,335.62

Marginal Income Tax Rate at specified income = Federal Income tax rate at specified income + provincial income tax rate at specified income = 20.50% + 14.70% = 35.20%

$$\text{Tax Implications} = [(\text{Subsidized Amount per Monthly Pass})(12)](35.20\%)(\text{Quantity Sold})$$

Net Benefit to Faculty and Staff:

$$\text{Net Benefit to Faculty \& Staff} = \text{Change in Consumer Surplus} - \text{Tax Implications}$$

Direct Cost of Subsidy to UBC:

$$\text{Direct Cost of Subsidy to UBC} = (\text{Subsidy Amount per pass})(\text{Quantity Sold})$$

Implementation Costs to UBC:

$$\text{Implementation Costs to UBC} = \$141{,}000 + (3{,}450 \text{ staff hours}) \cdot \left[\frac{\$80{,}335.62}{52}\right] \div 5 \div 8$$

$$= \$141{,}000 + (3{,}450 \text{ staff hours})(\$38.62 \text{ wage rate})$$

$$= \$141{,}000 + \$133{,}248.99$$

$$= \$274{,}248.99$$

Total Cost to UBC:

$$\text{Total Cost to UBC} = \text{Direct Cost of Subsidy to UBC} + \text{Implementation Costs to UBC}$$

Net Benefit of Program:

$$\text{Net Benefit of Program} = \text{Net Benefit to Faculty \& Staff} - \text{Total Cost to UBC}$$

Shadow Price:

$$\text{Shadow Price} = \frac{\text{Net Benefit of Program}}{\text{Change in Quantity}}$$

The resulting shadow price can be interpreted as the value of reputational and environmental benefits required per rider for the project to breakeven or be worthwhile.

Table 1.0: Annual Costs and Benefits of Employee Transit Pass Program

Discount Factor	Price of Transit Pass (per month)	Quantity sold	Change in quantity (A)	Consumer Surplus (B)	Tax Implications (C)	Net Benefit to Faculty and Staff (B-C)	Implementation Cost (D)	Direct Subsidy Cost to UBC (E)	Total Cost to UBC (D+E)	Difference between net benefit to faculty & staff and cost to UBC (F)	Shadow Price to UBC(F/A)
0%	$174	7730	0	$0	$0	$0	$0	$0	$0	$0	$0
10%	$157	8051	321	$1,647,571	$591,751	$1,055,819	$274,249	$1,681,112	$1,955,361	-$899,542	$2,800
20%	$139	8426	696	$3,373,439	$1,238,625	$2,134,815	$274,249	$3,518,820	$3,793,069	-$1,658,255	$2,382
30%	$122	8873	1,143	$5,199,939	$1,956,343	$3,243,597	$274,249	$5,557,791	$5,832,040	-$2,588,443	$2,265
40%	$104	9417	1,687	$7,160,714	$2,768,590	$4,392,124	$274,249	$7,865,311	$8,139,560	-$3,747,436	$2,221
50%	$87	10105	2,375	$9,309,794	$3,713,403	$5,596,390	$274,249	$10,549,442	$10,823,691	-$5,227,300	$2,201
60%	$70	11015	3,285	$11,741,887	$4,857,459	$6,884,428	$274,249	$13,799,598	$14,073,847	-$7,189,419	$2,189
70%	$52	12310	4,580	$14,645,570	$6,333,514	$8,312,057	$274,249	$17,992,937	$18,267,186	-$9,955,129	$2,173
80%	$35	14399	6,669	$18,482,174	$8,466,344	$10,015,830	$274,249	$24,052,115	$24,326,364	-$14,310,534	$2,146

Table 1.1: Annual Costs and Benefits of Opt-In Employee Transit Pass Program Zone 1

Discount Factor	Price of Transit Pass (per month)	Quantity Sold	Change in Quantity	Consumer Surplus	Tax Implications	Net Benefit to Faculty & Staff	Implementation Cost	Direct Subsidy Cost to UBC	Total Cost to UBC	Difference between Not Benefit to Faculty & Staff and Total Cost to UBC	Shadow Price to UBC
0%	95	5412	0	$0	$0	$0	$0	$0	$0	$0	0
10%	85.5	5636	224	$629,708	$226,160	$403,548	$91,333	$642,501	$733,835	-$330,287	$1,472
20%	76	5898	486	$1,289,278	$473,343	$815,934	$91,333	$1,344,725	$1,436,058	-$620,124	$1,275
30%	66.5	6210	798	$1,987,220	$747,541	$1,239,679	$91,333	$2,123,696	$2,215,029	-$975,349	$1,222
40%	57	6590	1178	$2,736,357	$1,057,779	$1,678,578	$91,333	$3,005,055	$3,096,388	-$1,417,810	$1,203
50%	47.5	7070	1659	$3,557,276	$1,418,552	$2,138,724	$91,333	$4,029,977	$4,121,311	-$1,982,587	$1,195
60%	38	7706	2294	$4,486,057	$1,855,260	$2,630,797	$91,333	$5,270,624	$5,361,957	-$2,731,160	$1,191
70%	28.5	8610	3198	$5,594,527	$2,418,468	$3,176,058	$91,333	$6,870,648	$6,961,981	-$3,785,923	$1,184
80%	19	10067	4656	$7,058,351	$3,231,846	$3,826,505	$91,333	$9,181,382	$9,272,715	-$5,446,211	$1,170

Table 1.2: Annual Costs and Benefits of Opt-In Employee Transit Pass Program Zone 2

Discount Factor	Price of Transit Pass (per month)	Quantity Sold	Change in Quantity	Consumer Surplus	Tax Implications	Net Benefit to Faculty & Staff	Implementation Cost	Direct Subsidy Cost to UBC	Total Cost to UBC	Difference between Net Benefit to Faculty & Staff and Total Cost to UBC	Shadow Price to UBC
0%	128	1615	0	$0	$0	$0	$0	$0	$0	$0	0
10%	115.2	1682	1682	$253,242	$90,952	$162,290	$91,333	$258,387	$349,720	-$187,430	$111
20%	102.4	1760	1760	$518,493	$190,359	$328,134	$91,333	$540,792	$632,125	-$303,991	$173
30%	89.6	1853	1853	$799,176	$300,629	$498,547	$91,333	$854,061	$945,394	-$446,847	$241
40%	76.8	1967	1967	$1,100,448	$425,394	$675,053	$91,333	$1,208,506	$1,299,840	-$624,786	$318
50%	64	2110	2110	$1,430,586	$570,482	$860,105	$91,333	$1,620,687	$1,712,020	-$851,916	$404
60%	51.2	2300	2300	$1,804,103	$746,107	$1,057,996	$91,333	$2,119,623	$2,210,956	-$1,152,960	$501
70%	38.4	2570	2570	$2,249,883	$972,606	$1,277,277	$91,333	$2,763,085	$2,854,418	-$1,577,141	$614
80%	25.6	3005	3005	$2,838,571	$1,299,712	$1,538,859	$91,333	$3,692,365	$3,783,698	-$2,244,839	$747

Table 1.3: Annual Costs and Benefits of Opt-In Employee Transit Pass Program Zone 3

Discount Factor	Price of Transit Pass (per month)	Quantity Sold	Consumer Surplus	Tax Implications	Net Benefit to Faculty & Staff	Change in Quantity	Implementation Cost	Direct Subsidy Cost to UBC	Total Cost to UBC	Difference between Net Benefit to Faculty & Staff and Total Cost to UBC	Shadow Price to UBC
0%	128	828	$0	$0	$0	0	$0	$0	$0	$0	0
10%	115.2	862	$129,834	$46,630	$83,204	862	$91,333	$132,472	$223,805	-$140,601	$163
20%	102.4	903	$265,825	$97,594	$168,230	903	$91,333	$277,257	$368,590	-$200,360	$222
30%	89.6	950	$409,727	$154,129	$255,598	950	$91,333	$437,866	$529,199	-$273,601	$288
40%	76.8	1008	$564,185	$218,094	$346,091	1008	$91,333	$619,585	$710,918	-$364,828	$362
50%	64	1082	$733,443	$292,478	$440,964	1082	$91,333	$830,905	$922,238	-$481,274	$445
60%	51.2	1179	$924,940	$382,519	$542,420	1179	$91,333	$1,086,702	$1,178,036	-$635,615	$539
70%	38.4	1318	$1,153,485	$498,642	$654,843	1318	$91,333	$1,416,597	$1,507,930	-$853,087	$647
80%	25.6	1541	$1,455,298	$666,345	$788,952	1541	$91,333	$1,893,026	$1,984,360	-$1,195,407	$776

Table 1.4: Total Cost and Benefits for Individual Zones Model (Zone 1 + Zone 2 + Zone 3)

Discount Factor	Quantity Sold	Change in Quantity	Consumer Surplus	Tax Implications	Net Benefit to Faculty & Staff	Implementation Cost	Direct Cost of Subsidy to UBC	Total Cost to UBC	Difference between Net Benefit to Faculty & Staff and Total Cost to UBC	Shadow Price to UBC
0%	7855	0	$0	$0	$0	$0	$0	$0	$0	0
10%	8181	2769	$1,012,784	$363,743	$649,041	$274,000	$1,033,360	$1,307,360	-$658,318	$1,746
20%	8561	3149	$2,073,595	$761,296	$1,312,299	$274,000	$2,162,774	$2,436,774	-$1,124,475	$1,670
30%	9013	3602	$3,196,124	$1,202,299	$1,993,825	$274,000	$3,415,622	$3,689,622	-$1,695,798	$1,751
40%	9565	4154	$4,400,990	$1,701,267	$2,699,722	$274,000	$4,833,146	$5,107,146	-$2,407,424	$1,882
50%	10262	4851	$5,721,305	$2,281,512	$3,439,793	$274,000	$6,481,569	$6,755,569	-$3,315,776	$2,044
60%	11185	5773	$7,215,100	$2,983,886	$4,231,213	$274,000	$8,476,949	$8,750,949	-$4,519,736	$2,231
70%	12497	7086	$8,997,894	$3,889,716	$5,108,178	$274,000	$11,050,330	$11,324,330	-$6,216,152	$2,445
80%	14613	9201	$11,352,220	$5,197,904	$6,154,316	$274,000	$14,766,773	$15,040,773	-$8,886,457	$2,693

We also considered a subsidy program in which participation of Faculty and Staff is mandatory, much like the U-pass for students. It is important to note that under this program we can no longer make the same assumption that everyone who purchases a subsidized pass will use transit as their primary mode of transportation. This is because under this model all faculty and staff are required to purchase a pass regardless of their intentions to use public transit. While we can no longer make the same assumptions about changes in ridership, from such a program, Table 1.5 summarizes the anticipated costs of a mandatory program at various subsidy rates.

Table 1.5: Annual Costs and Benefits of Mandatory Employee Transit Pass Program

Discount value	Price of pass	Quantity Sold	Subsidy Cost to UBC (A)	Implementation costs (B)	Tax Implications (C)	Total Cost of Program (A+B+C)
0%	$174	14934	$0	$0	$0	$0
10%	$157	14934	$3,118,219	$274,000	$10,976,132	$14,368,351
20%	$139	14934	$6,236,438	$274,000	$10,976,132	$17,486,570
30%	$122	14934	$9,354,658	$274,000	$10,976,132	$20,604,789
40%	$104	14934	$12,472,877	$274,000	$10,976,132	$23,723,008
50%	$87	14934	$15,591,096	$274,000	$10,976,132	$26,841,228
60%	$70	14934	$18,709,315	$274,000	$10,976,132	$29,959,447
70%	$52	14934	$21,827,534	$274,000	$10,976,132	$33,077,666
80%	$35	14934	$24,945,754	$274,000	$10,976,132	$36,195,885

Recommendations

From a purely financial perspective, the policy has a negative net benefit at all subsidy rates. At any given discount factor, the net costs of the subsidy exceed the benefit to consumers. Moreover, the net value of the subsidy project is increasingly negative as we increase the size of the subsidy. This means that, from a strictly monetary perspective, the project is not feasible and the cost minimizing point is at a zero subsidy.

With that being said if UBC values the intangible goals of environmental and reputational benefits at the size of the negative monetary value, then the project could still be worthwhile. In other words, UBC must value the environmental and reputational benefits that each additional rider

brings at the listed shadow price for the project to make sense financially. As shown in Figure 1.0, taking the example of 30% discount on transit passes, if UBC values the reputation and environmental benefits of each additional rider at $2,265, then the program would still be worthwhile. We estimate the actual environment benefits would be about $38.63 per rider each year. We got this number by taking an average of the distances of each zone from UBC, weighting those distances by the proportion of faculty and staff who live in each zone, then multiplying that distance by the cost of emissions per kilometer provided by the Victoria Transport Institute.

$$\text{Estimated environmental savings per rider} = \text{Weighted Average Distance } x \text{ \$0.0074 } x \text{ 180 days } x \text{ 2 trips per day}$$

We expect this value to be small because the majority of UBC faculty and staff live in either zone 1 or zone 2, so travel times and distances are similar between single occupant vehicles and public busses. This means that UBC must value the reputational benefits of each rider at the difference of the estimated environmental benefit and the necessary shadow price for the project to be worthwhile. So, if UBC values its reputational benefits alone at about $2,225 then the project would be worthwhile.

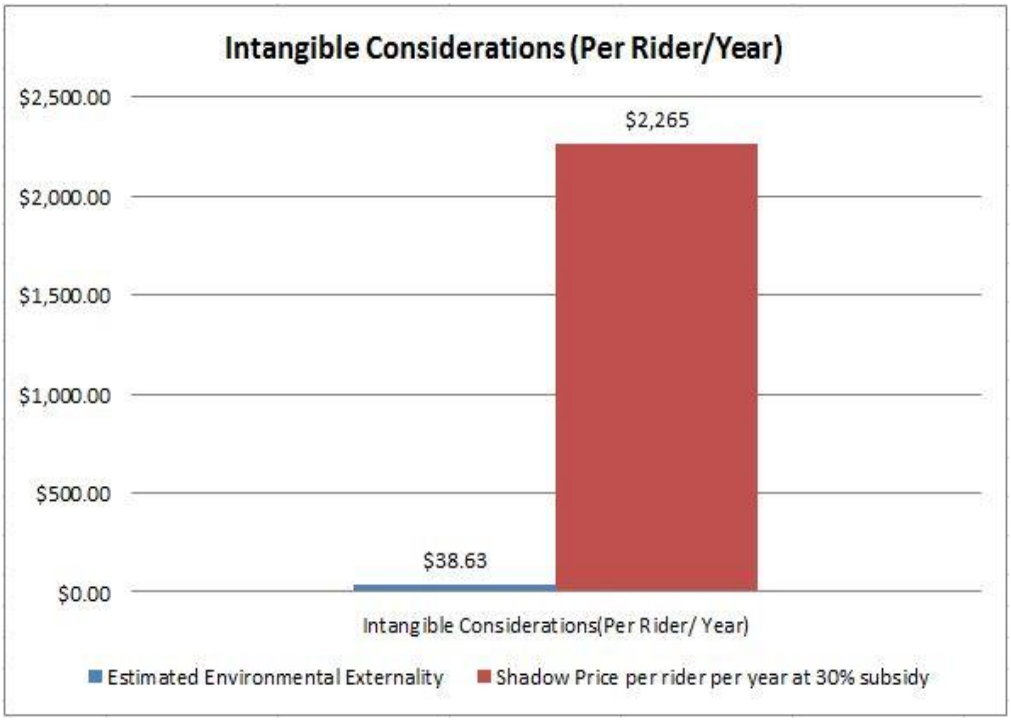

Figure 1.0: Intangible Considerations for Employee Transit Pass at 30% discount.

We also considered a scenario in which TransLink provided the subsidy. To do this, we looked at what would happen if UBC guaranteed a certain number of users and negotiated a price that would keep TransLink revenue neutral (i.e., if we guarantee X riders, what price will keep TransLink's revenue at $1,345,020 which is the current estimated revenue from faculty and staff). Our findings are summarized below.

Table 2.0: TransLink Partnership with UBC

Current TransLink Revenue from Faculty and Staff	# of Passes Guaranteed by UBC	Price to keep TransLink Revenue Neutral	Subsidy
$1,345,020.00	8000	$168.13	3.38%
	9000	$149.45	14.11%
	10000	$134.50	22.70%
	11000	$122.27	29.73%
	12000	$112.09	35.58%
	13000	$103.46	40.54%
	14000	$96.07	44.79%
	15000	$89.67	48.47%

If UBC is able to negotiate a lower price with TransLink, then covering the difference between the quantity TransLink requires and the true quantity would be cheaper for UBC than subsidizing at that amount.

For example, if TransLink were to set a price of $122, it would require at least 11,000 faculty and staff riders in order to remain revenue neutral. Based on our demand function, at that price, there would be only around 8,873 riders. The financial cost to UBC to keep TransLink revenue neutral would be (11,000-8,873) x $122 = $259,494 per month. The subsidy cost to UBC to make the price of the pass $122 (ie. a discount factor of 30%) is $474,899 per month. This is illustrated below in the Figure 1.1. In Annual terms, that comes out to about $3,141,086 and $5,832,040 respectively.

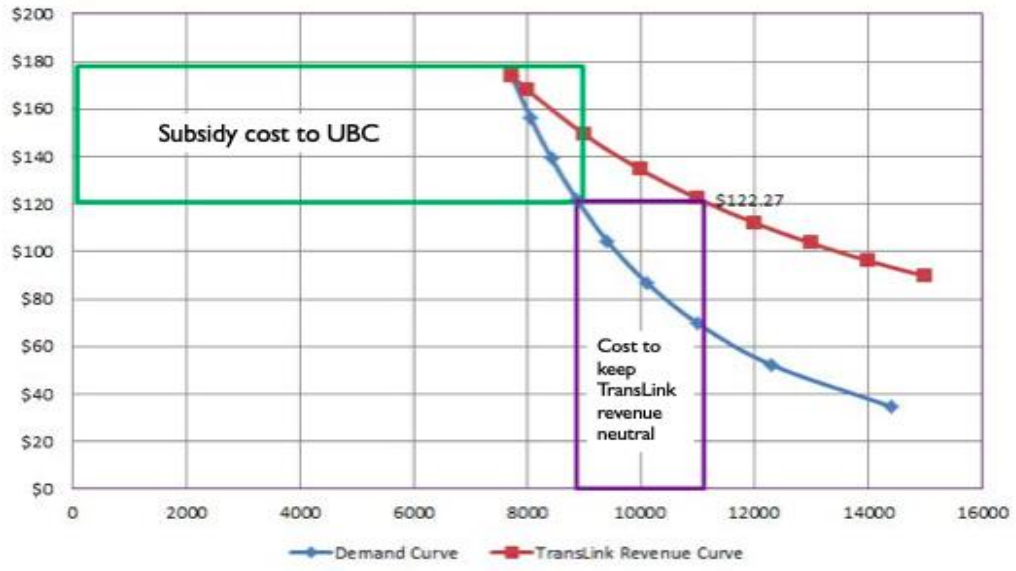

Figure 1.1: Subsidy cost versus Cost with Partnership with TransLink.

This figure demonstrates that in order to keep TransLink revenue neutral at the price of $122, 11,000 faculty and staff are required to switch. However, our estimated demand curve tells us that only just under 9,000 faculty and staff would switch. Therefore, if UBC compensates TransLink for the approximately 2,000 people remaining (the difference) rather than subsidizing the pass for faculty and staff on its own, it would be more cost effective. This is highlighted by the purple and green rectangles in the figure above.

Area (Subsidy cost to UBC) > Area (Cost to keep TransLink revenue neutral)

If UBC is able to negotiate a lower price with TransLink using the guarantee model, then we would recommend doing that as it substantially decreases the cost to UBC. If negotiating with TransLink is not an option, then we recommend the individual zone opt-in model as it is more cost effective than a single three-zone model. The quantities of passes purchased would be similar between model but provide UBC with lower costs. We suggest using an opt-in model rather than a mandatory model, as in a mandatory model you cannot guarantee everyone who now purchases a pass will be using it. This would cause UBC to be spending an excessive amount without there being any benefit as we expect a similar change in ridership as in the opt-in model.

Areas for Further Research

Ideally, we would like to know how the increased mode share of transit, and the corresponding decreased mode share of Single Occupancy Vehicle (SOV) and High Occupancy Vehicle (HOV) trips, would impact parking revenue as well as the demand for new parking facilities in proposed construction projects around campus. With regard to parking revenue, we are able to estimate the cross-price elasticity of SOV commuters with respect to the price of transit at 0.205. This means that for a 10% decrease in price of transit we expect a decrease in SOV commuters of approximately 2%. This cross-price elasticity does provide an estimate of the reduction of SOV commuters. However, given the current scarcity of parking on campus there is strong reason to believe that any reduction in SOV and HOV commuters stemming from a transit subsidy would be replaced by a current waitlist of commuters who would drive if there were adequate parking available. It would be beneficial to further research the effect of this parking waitlist.

*Cross-Price Elasticity calculations

Total number of faculty and staff = 14934

2011 transit mode share $= 18\%$ therefore $(0.18)\text{x}(14934) = 2688$ SOV commuters

2017 transit mode share $= 26\%$ therefore $(0.26)\text{x}(14934) = 3883$ SOV commuters

We are looking for the cross-price elasticity of SOV commuters after the 15% EPP discount was removed (i.e. a 17.65% price increase from $147.9 back to the full price of $174).

$$\text{Elasticity} = \ln\left[\frac{Q_{1(SOV)}/Q_{0(SOV)}}{P_{1(transit)}/P_{0(transit)}}\right] = [\ln 3883 - \ln 2688] - [\ln 174 - \ln 147.9] = 0.205$$

where Q_1 is the quantity in 2017 and Q_0 is the quantity of SOV users in 2011

Calculations for HOV commuters were not included because there was no change in mode share of HOV commuters between 2011 and 2017

With regard to demand for construction of new parking facilities, there are potential savings from future parking stalls that come from stalls that UBC would have built that they may no longer need to build to satisfy the demand. We need access to comprehensive parking plans to get an idea for

UBC's future parking demand, and then we also need a model to figure out how the change in parking demand would affect the future parking plans. We don't expect that it would be a simple linear subtraction of the number of people who would no longer use parking stalls as a consequence of switching to using public transit, as this also needs to be measured against the change in total UBC population. Increased transit use might also take people away from other modes of transit such as biking and carpooling.

According to other studies another method to disincentivize SOVs is by pricing parking to the level of causing employees to seek out less expensive options such as public transit (ACT Canada, 2005). Agarwal and Collins found that "prohibitively expensive on-campus parking" as the primary facilitator to increased public transit usage (2016). Dong et al. also explains that "an increase in the cost of parking at work sites could significantly reduce the percentage of people who drove alone to work (2016). Dong et al. found that workplace characteristics and employment density at the workplace affected car use more than the residential environment (2016). Dong et al. found that "after controlling for the built environment at workplace, the distance from home to work did not show a strong effect on the probability of using public transit for simple and complex tours," aside from those living farther away being less likely to walk or bike (2016).

Pending More Data

There are also a number of other considerations that we would like to implement in our analysis if we had more data. The most pressing among these is our lack of the micro data from the 2017 and 2011 Transportation surveys. If we had access to the microdata from two UBC transportation surveys, we could develop a more rigorous estimate of the elasticity. That would in turn refine our estimate for the change in ridership that would result from the subsidy.

Limitations

We assumed, for our figures to get the quantity of people using a monthly pass, that everyone in the survey who said they use public transit as their main mode of commuting was also using a monthly pass. In reality, there is a more itemized breakdown where some individuals might use a daily fare, a weekly fare, or any other combination of fares. We also assumed that the price elasticity of demand for transit was the same for faculty staff and students, seeing as we only had access to aggregated mode share statistics. We expect that in reality faculty and staff would have

a more inelastic demand for transit than students given the difference in average age and income level of faculty and staff compared to students. In addition, we used the same relationship between quantity and price for the analysis of both the single three-zone pass and each individual zone passes. This may not be a realistic assumption as elasticity may vary from zone-zone due to factoring in of variables such as time costs. Moreover, currently given the excess demand for parking, we are uncertain how parking revenue would be affected. As a result, it is not included in our analysis. Another limitation to our analysis is that in estimating our demand equation we only had data on one price and quantity change (the removal of the EPP). Therefore, we assumed a constant elasticity at every point on the demand curve. As a result, estimations of quantity changes become less reliable as we evaluate higher subsidy levels. Based on this assumption, the demand equation predicts that larger discount values correspond to larger incremental changes in quantity of passes purchased, when in reality we do not expect this to be the case at all subsidy values.

Conclusion

To conclude, UBC will not incur a cash inflow at any point with this subsidy program. Moreover, at any subsidy level across the 3 models, the cost of the program will always be greater than the predicted benefit to employees. However, if UBC decides to continue with the program, the optimal decision would be to negotiate with TransLink for an Individual Zone Opt-In Model at the best case, or secondly, a Single Three-Zone Opt-In Model. If UBC is unable to negotiate with TransLink, then implementing the Individual Zone Opt-In Model is recommended as it would minimize the cost to UBC and would result in a similar, but slightly greater change in ridership.

Works Cited

Association for Commuter Transportation of Canada (ACT Canada). (2005). *Report on Canadian Alternative Transportation Programs*.https://www.ccme.ca/files/Resources/air/mobile_sources/jia_trnsprt_alt_rpt_e.pdf.

Agarwal, A., & Collins, P. (2016). Opportunities and Barriers to Promoting Public Transit Use in a Midsize Canadian City. *Canadian Journal of Urban Research*, *25*(2), 1-10.https://search-proquest-com.ezproxy.library.ubc.ca/docview/1867015468/abstract/C509A06EE9014C7DPQ/1?accountid=14656.

Dong, H., Ma, L., & Broach, J. (2016). Promoting sustainable travel modes for commute tours: A comparison of the effects of home and work locations and employer-provided incentives. *International Journal of Sustainable Transportation, 10*(6), 485-494.https://www-tandfonline-com.ezproxy.library.ubc.ca/doi/pdf/10.1080/15568318.2014.1002027?needAccess=true.

Lachapelle, U. (2018). Employer subsidized public transit pass: Assessing disparities in access, use, and latent demand. *Case Studies on Transport Policy, 6*, 353-363.https://ac-els-cdn-

com.ezproxy.library.ubc.ca/S2213624X17302389/1-s2.0-S2213624X17302389-main.pdf?_tid=fd74f33d-b7b9-474f-ab42-60858b5c55ad&acdnat=1537060172_bcbd10febc607e5bca28c6cd23bbdbe8.

Litman, T. (2004). Transit Price Elasticities and Cross-Elasticities. *Journal of Public Transportation,* 7(2), 37-58.

The University of British Columbia. (2014). *UBC Transportation Plan.* https://planning.ubc.ca/sites/planning.ubc.ca/files/documents/transportation/plans/UBC-Transportation-Plan-2014_Oct.pdf

Litman, T. (2009). 5.10 Air Pollution. In Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications(2nd ed.). Victoria, BC: The Victoria Transportation Institute. http://www.vtpi.org/tca/tca0510.pdf

The University of British Columbia. (2007). *Staff and Faculty U-Pass Program at UBC Report.*