UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Agglomeration Economies: The UBC-Broadway Corridor

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Executive Summary:

The UBC-Broadway Corridor Millennium Line extension would connect UBC with Broadway Corridor (UBC-Broadway Corridor) and other parts of Vancouver. This would create added economic benefits resulting in wider benefits created by agglomeration economies. This report investigates the procedure of monetizing this value to incorporate the impact of agglomeration economies within existing CBA. The methodology is to examine the predictive changes in the industry related output of our measured zone after a potential project implementation. Due to insufficient data, we've opted to aggregate all traffic zones into one super-zone that covers the whole corridor. The 3 industries for the computation within the super-zone includes the technological, healthcare and other industries that do not fall under previous categories.

The first part is to measure the Effective Density (ED), which is an index that represents the proximity between zone area in respect to its employment population. By obtaining data on industry employment and generalized travel cost we have found a resulting relative change in ED of 6.38%. This indicates that a reduction in generalized travel cost would lead to an increase in ED. The agglomeration benefits of a transport scheme are linked to the effects of generalized travel costs and effective density: firms and workers in their existing location will be relatively closer to each other. As generalized costs fall firms and workers may relocate in response to the change in transport costs and thereby have further effects on density.

Using the industry specific agglomeration elasticity gives us the resulting impact within each industry occurring through relative changes in ED. It provides clear insight on the effects of the changes in productivity within each industry in relation to a change in proximity. The result of our computations shows that the impact on Healthcare/Social Assistance Industry as 0.945%, impact on High Tech Industry as 0.198% and impact on Other Industries as 0.178%. This tells us the Healthcare/Social Assistance industry would be the most sensitive to project impacts.

To quantify the benefits, we then use the changes in GDP per worker with the forecasted employment levels to aggregate, average and discount the benefits over a 25-year period. The result of the project indicates that the total agglomeration economic benefits of the project will potentially be $735 to $860 million ($2016).

Introduction and Our Case Study:

The population of Metro Vancouver according to the Canadian census of 2016 is 2.46 million and is projected to reach 3.4 million by the year 2040. Metro Vancouver consists of 21 municipalities and one Electoral Area. There are three Skytrain lines which connect 53 stations in 7 of these municipalities which had 151 million boardings in 2017. The Millennium Line is planned to be extended by adding 6 new stations covering the 6 kilometers from VCC-Clark to Arbutus Street. Construction on this project is set to begin in 2020 and completed by 2025. A separate investment of an expansion into UBC is expected to occur within the next 30 years.

UBC is one of the biggest knowledge hubs within the city. It is home to scientific innovation and the third largest career center in the City of Vancouver. Broadway City Hall is Canada's largest technological hub and is home to the growing Vancouver technological sector. A Millennium line extension spanning the UBC-Broadway Corridor would connect these areas and result in additional economic opportunities and wider benefits within the region. The project will also connect other parts of Vancouver with UBC including its largest career center downtown Vancouver.

Ridership numbers in the region are forecasted to grow with the population of Vancouver. The 99 UBC / Commercial-Broadway Station B-Line currently runs down this corridor and saw 17.4 million boardings in 2017. The 99 B-Line currently covers 13.0 kilometers down the corridor with an average operating speed of 22.9 kilometer per hour and end-to-end journey time of 34 minutes. An expansion of the millennium line to UBC would alleviate traffic in this corridor by reducing congestion and improving travel time for commuters and private vehicle owners. An extension would cut this journey times to 18.5 minutes and would see 116.8 million boardings by 2041.

Objectives:

Cost Benefit Analysis (CBA) is a framework used to aggregate value of social welfares raised from a public project. It approximates the changes within consumer, producer and government surplus to best estimate the social impacts (positive or negative) associated with a project. However, this conventional surplus based computation only captures a subset of potential benefits as it only accounts for the explicit effects of the project. In the case of an transportation improvement, the economic effects of a CBA would estimate the

- Benefits of time saved through better connectivity within the city
- Reduced environmental admission effects
- Increase in comfort and satisfaction of users from better transportation system

However it doesn't account for the additional benefits that arise from better connectivity such as increasing business opportunities for the labour pool. These additional benefits are what we refer to as Wider Economic Benefits (WEB). These WEB are major contributors that create significant positive impacts on productivity and GDP as they resolve the problems within market imperfection such as structural unemployment. The WEB typically occur near population centers where businesses and economic activity are most concentrated.

They arise partly due to Localization Economies which provide advantages due to knowledge spillovers, labor market pooling and the sharing of intermediate inputs. They are also attributed to Urbanization and a cities productivity being proportional to its size.

The differences between CBA and our agglomeration analysis is that our analysis covers the effects of the agglomeration that are not measured in CBA. In a CBA, the effects of the agglomeration would often be ignored or just measured without any explanation, as the impact of agglomeration is not something stakeholder would directly affiliate with the project in respect to benefits such as time saving. Our analysis explains in detail the computation and purpose of the regarding agglomeration analysis. Essentially our analysis is the value added on to existing CBA that allows it to incorporate the overall impact and effect of the project.

A rapid rail transit investment will result in a bigger city with a bigger labour market. People within the city will have increased access to better public services, culture, entertainment and leisure. Across the world, urbanization continues to increase, and the United Nations reports that by the end of 2008, one-half of the world will live in cities. The overall effect is the result of easier access to resources, higher density and a level of cooperation between business. These are known as agglomeration economies. The objective of this paper is to investigate the potential agglomeration economies as a result of the new Millennium Line Transit extension.

Agglomeration Economies:

Transport schemes do not minimize the distance one has to travel and therefore do not enhance proximity. Nonetheless they do make travelling more efficient and thus minimize costs allowing for further increases in output. Transportation costs must be interpreted broadly and they include the difficulties in exchanging goods, people, and ideas. Agglomeration economies is an important concept due to its effect on the economic wellbeing not only on the areas it directly affects but the extended areas as well. Declining transport costs have facilitated trade between China, India, and the rest of the world.

Agglomeration economies is a concept closely linked to *"agglomeration elasticities"* which will be frequently mentioned in this report. Agglomeration elasticities measure the relationship between how well connected an area is and the productivity of its employed population. This allows us to measure the potential impact of extending the Millenium line to UBC in terms of industry GDP.

Daniel J. Graham and Stephen Gibbons describe a detailed methodology for quantifying the benefits, which is used in the UK. Research on the topic has shown that agglomeration facilitates higher productivity. Positive elasticities that were calculated in the study illustrate the existence of agglomeration economies. One of these methods used to measure agglomeration by Graham and Gibbons involves estimating changes in economic mass due to reduced travel costs.

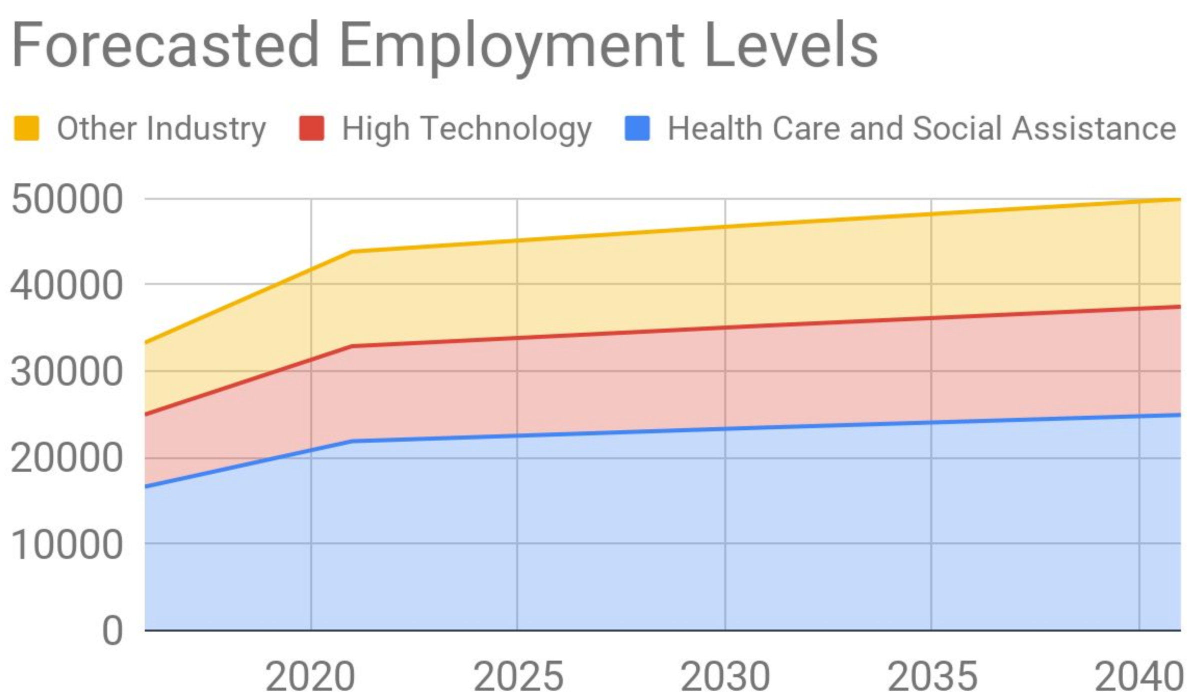
This gives effective density (ED), which represents proximity within an area in respect to its employment population. Measuring the changes in ED captures how changes could affect the working population.This provides us with representation of agglomeration.

Data:

Industry Employment Levels:

Census Data taken from 2016 gave us the total amount of people employed in our region of interest. We then used predicted forecasts updated in 2017 for employment levels in 2021, 2031 and 2041. The labor force survey conducted by Work BC in 2015 also indicated percentages of the regions total employment within Health Care Services and Technology.

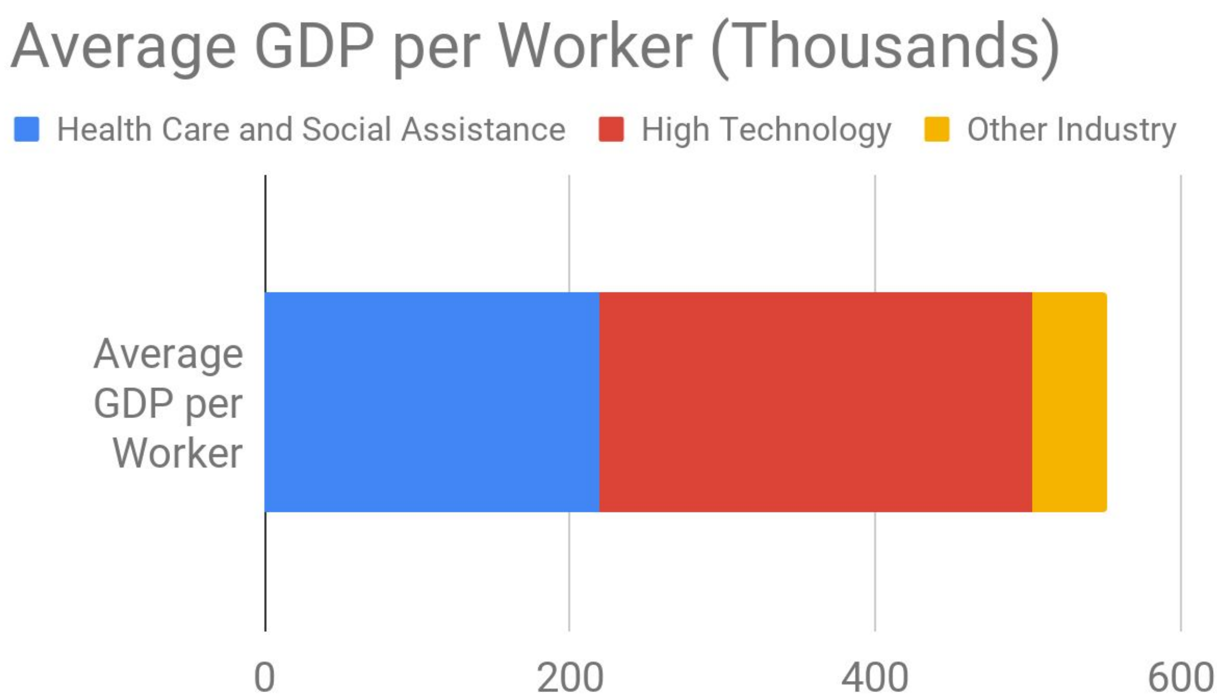
Given the analysis of Dun & Bradstreet Data by KPMG which shows a percentage of the total business counts in Health Care and Social Assistance, High Technology and Other Industries of the City of Vancouver located in the UBC-Broadway corridor. We made the assumption that business counts could be used as an estimate of employment share and that this estimate stands throughout all periods.



Average GDP per Worker in Each Industry:

Statistics Canada has the GDP of Greater Vancouver as of 2013 and the GDP of BC as of 2013 is provided by the Government of BC. We found that Greater Vancouver accounts for 56.51% of the GDP in BC and updated it for 2016. We then found industry specific GDP of High Technology and Healthcare And Social Assistance as a share of BC GDP in 2016. We made the assumption that industry specific shares remained the same in the context of Greater Vancouver.

We used Dun & Bradstreet Data under the assumption that business counts can be used percent share of GDP in Vancouver. The average GDP per worker was industry GDP divided by employment levels within the corridor. For the average GDP per worker in Other Industries we have opted to take the average employment income of the City of Vancouver in 2015 adjusted for inflation.



Travel Costs:

The Conference Board of Canada provides an estimate of generalized travel costs in 2014 values. There was a relative change in effective density of 6.38% which will be used along with agglomeration elasticities to find changes in productivity.

Agglomeration Elasticity:

Understanding that the agglomeration elasticity of the experiment will significantly affect the results of our analysis we have decided to choose to ignore the differences between economic situations and pick an agglomeration elasticity completely based on industry. We picked three separate elasticities corresponding to High Technology, Health Care and Social Assistance and All Other Industries.

We have chosen agglomeration elasticities from “A Meta-analysis of Estimates of Urban Agglomeration Economies” by Patricia C. Melo, Daniel J. Graham and Robert B. Noland. The primary objective of the paper is to make sense of the range of values for agglomeration economies found in the literature by identifying some key characteristics that affect the results. The paper categorises elasticities by industries, country, response variables (e.g. labour productivity, wages) and urban agglomeration. We have chosen different elasticities from this study to represent different industries. It is worth noting that for “Other Industries” we have chosen to use a median value in order to account for the fact that we are unable to find an elasticity for every individual business in “Other Industries” category. The median elasticity also allows us to avoid the problem of using a negative elasticity which corresponds to the mean for Canada.

Agglomeration Elasticities			
Industry,Category	The Healthcare Industry, Service Industry	The High Technology Industry, Economy Industry	Other Industries, Elasticity for Canada
Mean Agglomeration Elasticity (Median Elasticity for Other	0.148	0.031	0.028

Industries)			
Range	-0.219,0.503	-0.8, 0.25	-0.310, 0.3

The results show the explicit effects of the relative change in effective density has on individuals within each industry. For instance a relative change of 10% in effective density in the corridor would result in wider benefits amounting to a 0.31% change in GDP per worker in the High Technology.

Research Methodology:

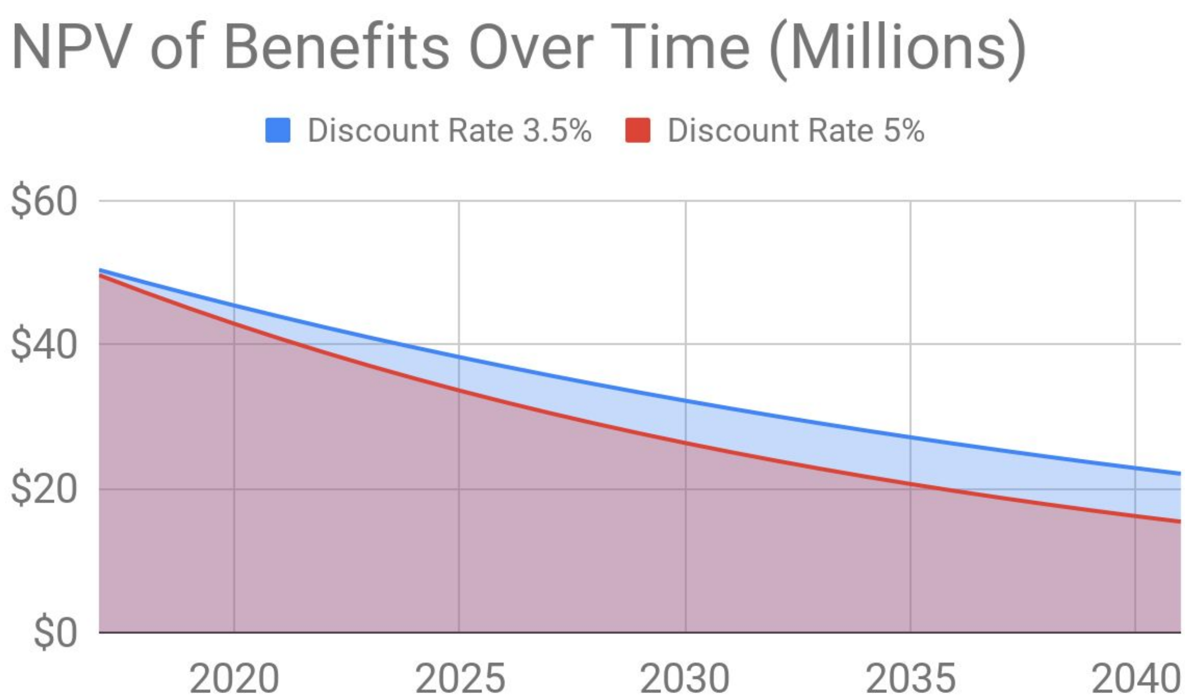
The first step was finding effective density within the corridor. We opted to use generalized travel costs found by the Conference Board of Canada along with employment levels found in 2016. This gives us an estimate of how travel costs for workers and firms within the corridor will change. The planned Millenium line extension was not included in our analysis.

Typically this requires dividing the entire Broadway-Corridor into various traffic zones which each being a couple km away but we have opted to aggregate all zones into one super zone. The super zone in this case represents all land mass between UBC and Commercial Broadway. One of the reasons for doing this is that the majority of the benefits from the agglomeration occur within the 10km radius and our analysis relies on the superzone from the Dun & Bradstreet Data.

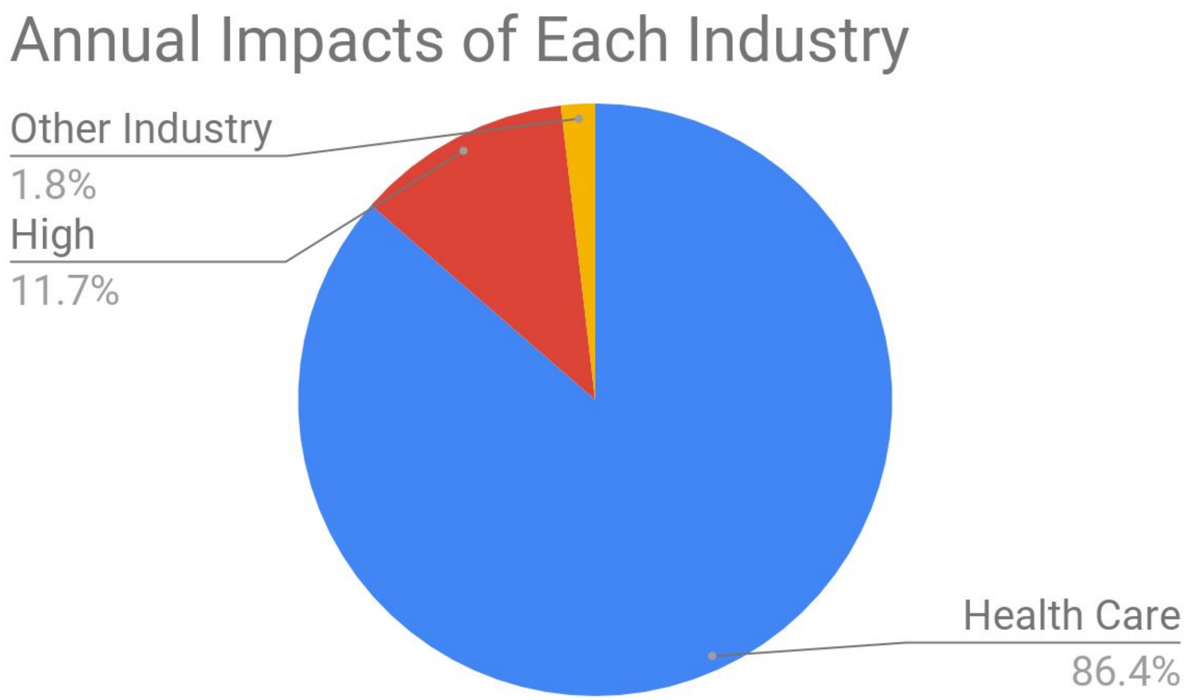
Our time frame is 25 years, 2016 to 2041. We looked at employment levels and the change in GDP by industry in the years 2016, 2021, 2031 and 2041. Using estimations of agglomeration elasticities for specific industries within the corridor gave us the changes in GDP over time. This allowed us to understand the predictive effects of a RRT investment and account for changes in growth in the future. The average change in GDP was summed across 25 periods and future benefits were discounted with an interest rate of 3.5% to 5%.

Results

The shaded area within the graph below shows that the results of the incremental agglomeration economies of the RRT extension was 735 to 860 million ($2016). By applying 2 different discount rates (3.5 % and 5%), we have obtained a result with a 120 million ($2016) spread. As a result of agglomeration economies, this increased value is the effect of localization and specialization which is unaccounted for in a CBA analysis. The intuition of localization and specialization was that by reducing general travel cost the relative distance between different suppliers and firms within the Corridor would shrink. This would reduce the overall spatial distance in relative terms which increases economic advantages such as knowledge spillovers, labor market pooling and the sharing of intermediate inputs.



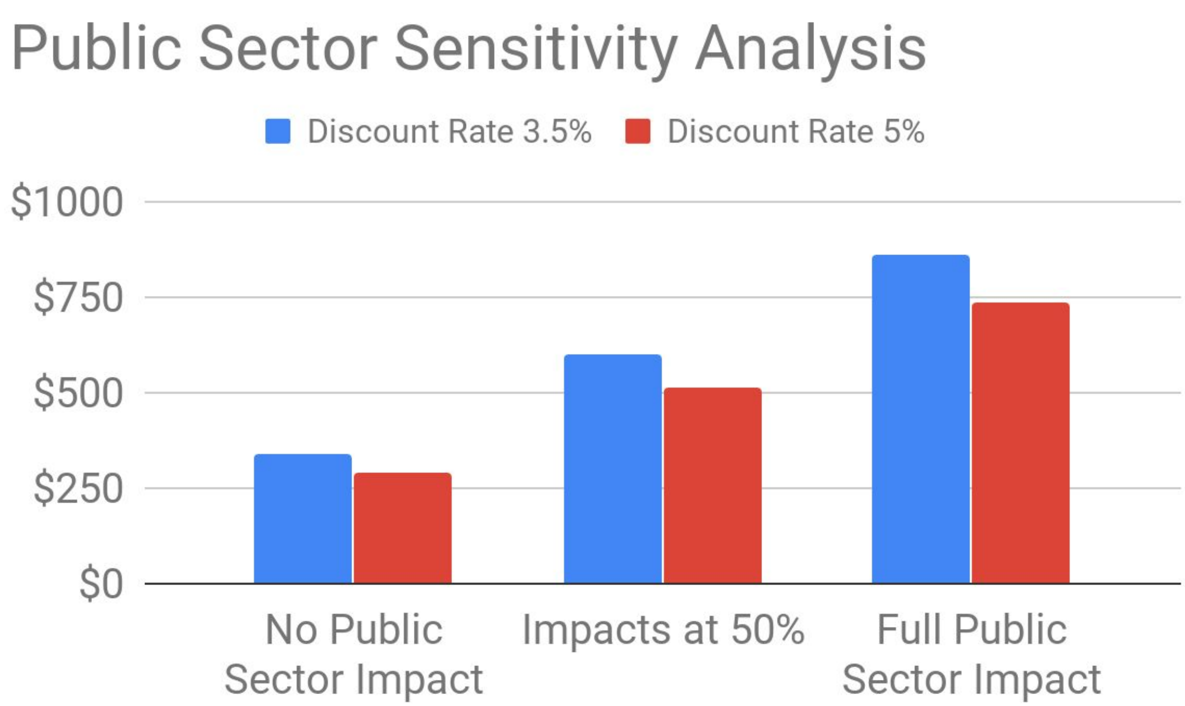
The most surprising finding was the impact on the The Health Care and Social Assistance Industry. Though it did contain the largest amount of business counts within the UBC-Broadway Corridor and the largest share of GDP, it only had the second largest average GDP per worker at $219,000 ($2016) falling largely behind the High Technology Industry at $283,000 ($2016). Despite this it had the largest effect on the change in GDP capturing a total of 86.4% of total annual impacts. This was not due to size or the GDP per worker but because of its corresponding elasticity. The Health Care and Social Assistance Industry had the largest change in productivity resulting from an RRT investment with an added 0.94% in productivity per worker in comparison with 0.19% in the High Technology Sector and 0.17% in Other Industries. This resulted in an average change of $45 billion over 25 years which was over 7 times larger than the second largest change in the High Technology Sector.



The reason that the Health Care and Social Assistance Industry would be so heavily affected by the project is its dependence on human capital. Edward L. Glaeser, in the report “Agglomeration Economics”, notes that service sectors are strong predictors for urbanization. Hospitals that are surrounded by higher quality hospitals tend to improve in quality as doctors in one hospital learn how to practice medicine better by interacting with doctors in nearby hospitals. In the case of this industry, higher productivity does not require more physical capital but enough human capital to use low-cost and high-value procedures. As the Health Care and Social Assistance

Industry in Canada exists mostly within the public domain there is a constraint on human capital due to limited government resources. Areas with a privatized Health Care and Social Assistance Industry also allow for highly skilled individuals to establish their own practices thus increasing spatial concentration.

This is reflected in the result that areas with less non government doctors and a higher skill base are more likely to deliver higher quality services. We have opted to do a sensitivity analysis because in Canada the private sector only accounts for 30% of health care expenditures. This resulted in large variations which show that if there is no impact in the public sector the lower bound is set to be 290 to 340 million ($2016).



Finally we have done an analysis consisting of different elasticities chosen relative to ones previously specified. The elasticities were picked from analyses with the most and second most observations for Health Care and Social Assistance and High Technology. The Other Industries elasticities were calculated using standard error for agglomeration elasticities found within Canada and the median to avoid using the associated negative mean.

Industry (Category)	Elasticity 1	Elasticity 2	Basecase
Healthcare and Social Assistance (Service)	0.035	0.097	0.148
High Technology Elasticities (Economy)	0.025	0.034	0.031
Other Industries Elasticities (Canada)	-0.051	0.107	0.028

The lower bound was 250 million ($2016) corresponding to the 0.035 elasticity for Health Care and Social Assistance with a discount rate of 5%. The upper bound was 900 million ($2016) corresponding to the Other Industries elasticity of 0.107 and a discount rate of 3.5%. The average was an impact of 630 to 740 million ($2016).

Limitations and Further Research:

In our findings we relied on:

1. The results from the KPMG/MMK analysis of Dun & Bradstreet Data, that business counts in the corridor consisted of 40% Health Care and Social Assistance, 25% High Technology and 20% Other Industries of all businesses in Vancouver. We then made the assumption that business counts shares were equal to the shares in employment and over our time frame did not change. This coupled with the

employment projections done by Metro Vancouver were key in finding proper employment levels of each industry and used in our metric of effective density.

2. The generalized travel costs provided by the Conference Board of Canada report on The UBC-Broadway Corridor. These generalized travel costs however make the assumption that over time travel costs will not increase which may not hold if there is further congestion within the corridor. This was used in our calculation of finding effective density. It was also used to find the change in effective density with and without the RRT investment.

3. Due to the lack of data on the specific industry GDP in Vancouver which is required to compute the relative GDP of each industry within Broadway Corridor. First of all, according to statistics from Statistics Canada, Metro Vancouver accounted for 56.51% of the GDP in BC. We used this number in place of GDP of the City of Vancouver as we were unable to find a reliable number through public sources. We then made the assumption that the share of GDP in BC by sector could be extrapolated to the share of GDP in Vancouver by sector and that these shares did not change over time.

4. The agglomeration elasticities applied were extrapolated from a meta-analysis of agglomeration elasticities created by Patricia C. Melo, Daniel J. Graham and Robert B. Noland. We then assigned the each of our 3 Industries an elasticity corresponding to the analysis. The Health Care and Social Assistance Industry was assigned the mean of elasticities found in the Service Industry, the High Technology Industry was assigned the mean of elasticities found in the Economy Industry and Other Industries were assigned the median of all elasticities found within Canada. The elasticities were then used to find the impact of the RRT investment on GDP resulting from the change in effective density.

5. The use of a super zone in order to aggregate all results.

The result of 740-860 million dollar should be incorporated within the CBA of the RRT UBC Broadway Corridor extension line as an economic value added to the overall project for a better measurement of feasibility of the project . We also believe further research is warranted. There should be an analysis carried out using planned infrastructure of the 6 station extension rather than current infrastructure to see if the remaining benefits of agglomeration are negligible. With our current framework there are improvements that could be made. Enhancements to current estimations could be done by improving the current logistical variables within the framework.

Enhancing current estimation:

While conducting our research we found shortcomings in accessing the data we needed. Future research would use the actual GDP of the City of Vancouver instead of the GDP of Metro Vancouver. It would also aim to not extrapolate the share of GDP in BC to the share of GDP in Vancouver. While the High Technology Sector accounts for 6.63% of the GDP in BC, we relied on the assumption that this was distributed equally, in reality it may be possible that most of the High Technology sector is located within the City of Vancouver. This could extend to the Health Care and Social Assistance sector as well. It is also very possible that business counts can not be used as an estimate for share of GDP or share of employment and further analysis would aim to find actual estimates of both these variables.

As effective density is our measure of agglomeration, our change in effective density multiplied by the agglomeration elasticities of each respective industry will be the impact of an RRT investment on the productivity of each sector. One key assumption here is that general travel costs remain the same over our time frame. If a transit investment does not occur there would be further congestion in the corridor and future general travel costs would increase. Further analysis would try to forecast these costs in order to find a better estimation of effective density in future time periods.

We picked elasticities based on industry sectors alone. It would also be beneficial to conduct the calculation using different agglomeration elasticities from cities with similarities to Vancouver regarding density, employment, industry and demographics. The range of outcomes could then be analyzed to provide an on average impact of the change in GDP resulting from a RRT investment.

Further research would also aim to incorporate the average GDP per worker and employment levels of as many industries as possible. In our research we grouped industries not pertaining to Health Care and Social Assistance or High Technology as Other Industries. This accounted for 20% of the business counts in the UBC-Broadway Corridor and should not be disregarded. Each industry within this category may have a corresponding agglomeration elasticity that could respond immensely to a change in effective density. The GDP per worker for separate industries may also be vastly different with additional differences in employment levels. Further analysis should account for these impacts.

Additionally, we have established that the majority of previous research has focused on the wider benefits that occur in the private sector and therefore we have encountered difficulties in trying to find the agglomeration elasticity suitable for the Healthcare Industry, as in Canada it is part of the public sector.

Finally the use of the super zone is a limitation by itself, as it aggregates the results therefore not accounting for the extreme values that might occur in every single zone. Consequently, even though our results show the trend that will also be seen if individual zones were taken into account, it will be rather generalized.

Appendix:

Agglomeration Economies*:*

Empirical work on agglomeration has tested for productivity impacts by estimating elasticity of productivity with respect to agglomeration. As estimation of a positive elasticity is consistent with the existence of agglomeration economies. One of these methods involves measuring connectivity through the use of economic mass with respect to the costs of travel. This is a three step process which requires:

1. Calculating access to economic mass (ATEM) via effective densities, provides us with a metric on how proximity will change.
2. Estimating agglomeration elasticities, which allows to see the impacts in each sector.
3. Quantifying the agglomeration benefits arising from the transport scheme involves aggregating all industries within all zones across the area of interest

Calculating access to economic mass (ATEM) via effective densities:

The effective density (ED) of an index represents an areas generalized travel costs in respect to its employment population. By measuring the changes in ED we can capture changes in proximity. The first step will provide a representation of agglomeration. Each zone affected by the RRT must be indexed and these zones will be used to calculate the effective density.

$$\rho_i = \frac{1}{n}\sum_{j=1}^{n} m_j f(d_{ij}).$$

p_i - is effective density which is our measure of proximity in relation to workers.

m_j - is the measure of economic mass at zone j, in our case we will use (industry specific) employment and population within these zones.

$f(d_{ij})$ - is the impedance function which represents the generalized cost of travelling from zone i to j. This is obtained by finding data on daily travel count within traffic zone then multiplying it by a generalized cost for public and private transportations.

Generalized cost of traveling is a major part of estimating ED because it determines economic concentration through their access to economic mass. A reasonable prediction in the case of the Corridor is that proximity and generalized cost are negatively correlated. It should be noted that d_{ij} should not be the estimate of the distance, as it rarely decreases with the implementation of the transport schemes.

Estimating agglomeration elasticities:

Due to lack of data we have opted to pick an agglomeration elasticity, however the analysis would be more accurate if we could find our own estimation. This could be done by obtaining data which reflects the productive distribution across the spatial units in consideration. This could be either the wage, output or input data in to display productivity. We would have to note the specific location of each firm or specific group of individuals. Once this data is catalogued, we will assign an index to every single spatial unit. The next step would be to specify either the production function or the wage function being used with the ED agglomeration variable included in the measure of the productivity:

$$y_i = g(\rho_i) f(x_i),$$

y_i - is the output at location i.

$g(p_i)$ - is a vector of factors that affect production levels at location i (agglomeration economies). An example of the variable could be the employment amount or value of capital.
$f(x_i)$ - is a vector of input factors used at location i

$$w_i = g(\rho_i) f(z_i)$$

w_i - wage rate at location i.
$g(p_i)$ - is the environmental factors which affect wage rate (agglomeration economies).
z_i - is a vector of covariates relevant for wage determination.
Then to obtain estimates of agglomeration elasticity for each industrial sector at each given area is as follows:

$$\delta^s = \partial \log y^s / \partial \log \rho_i, \text{ or } \delta^s = \partial \log w_i / \partial \log \rho_i$$

δ^s - The value of our agglomeration elasticity.
s - Is the indexed industry.
i - Is the indexed location.

Quantifying the agglomeration benefit arising from the transport scheme:

The third step assumes that all values remain equal apart from the changes in the travel costs/travel times: $f(d_1)$-$f(d_0)$. Consequently, we can find that:

$p^0 = \sum mf(d_0)$ and $p^1 = \sum mf(d_1)$

p^0 – measure of agglomeration
p^1 - predicted value of agglomeration on productivity after the transport scheme has been implemented.
m - values apart from change in travel cost / valued remained equal

Then we proceed to calculate the actual productivity estimate. Productivity percentage change is essentially difference in logs/the percentage change in effective density for each spatial unit multiplied by elasticity of productivity with respect to effective density and aggregate them across every single zone in the area we are looking at.

$$\sum_{s=1}^{S}\sum_{i=1}^{n}\Delta y_i^s(\Delta\rho_i) = \sum_{s=1}^{S}\sum_{i=1}^{n}\left[y_i^s(\rho_i^1) - y_i^s(\rho_i^0)\right] = \sum_{s=1}^{S}\sum_{i=1}^{n}\left[\left(\frac{\rho_i^1}{\rho_i^0}\right)^{\delta^s} - 1\right] y_i^s(\rho_i^0)$$

This equation implies that in order to calculate agglomeration elasticities we need to aggregate the changes in the measure of economic output across the selected spatial units where:

$y_i^s(p_i^0)$ - measure of economic output in industry *s*, at zone *i*, multiplied by the measure of agglomeration at zone *i*.

δ^S – the agglomeration elasticity associated with industry s.

p_i^0- measure of agglomeration in zone *i,*

p_i^1 - predicted value of agglomeration economies in zone *i,* after the transport scheme has been implemented.

Formulas:

Effective Density:

$$Effective\ Density = \frac{Total\ Industry\ Employment}{Generalized\ Travel\ Costs}$$

Industry Employment Level:

$$\begin{aligned} &Employment\ Level\ in\ Industry\ in\ Corridor \\ &\qquad = Employment\ Levels\ in\ Vancouver \times Percentage\ of\ Region\ Employment\ Levels \\ &\qquad \times\ Percentage\ of\ Buisness\ Counts\ in\ the\ Corridor \end{aligned}$$

GDP of Industry:

$$GDP\ of\ Industry = Percentage\ of\ GDP\ by\ Industry\ in\ BC \times GDP\ of\ Vancouver \times Percentage\ of\ Buisness\ Count\ in\ the\ Corridor$$

Average GDP per Worker by Industry:

$$Average\ GDP\ per\ Worker\ in\ Industry = \frac{Total\ GDP\ in\ Industry}{Employment\ Level\ in\ Industry}$$

Measure of Impact in Industry:

$$Measure\ of\ Impact\ in\ Industry = Agglomeration\ Elasticity\ of\ Industry \times Relative\ Change\ in\ Effective\ Density$$

Change in GDP per Worker of Industry:

$$\Delta\ GDP\ per\ Worker\ of\ Industry = Measure\ of\ Impact\ in\ Industry \times Average\ GDP\ per\ worker\ of\ Industry$$

Change in GDP of Industry:

$$\Delta\ GDP\ of\ Industry = \Delta\ GDP\ per\ worker\ in\ Industry \times Employment\ Levels\ of\ Industry$$

Average Change in GDP of Industry:

$$Average\ \Delta\ GDP\ of\ Industry = \frac{Total\ \Delta\ GDP\ of\ Industry}{4}$$

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