INTRODUCING ACCESS-BASED RATE VARIATION TO THE TRANSPORTATION PROPERTY TAX IN METRO VANCOUVER

by

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Abstract

Municipalities in Metro Vancouver share a transportation system managed by a regional authority, TransLink. Approximately one-quarter of transit costs are funded by property tax revenue collected throughout the region. The tax-rate is virtually constant but access to public transit is highly variable, which leads to a critique of the tax based on its 'fairness' – people with less service often perceive an unjust distribution of costs relative to benefits.

To better understand the relationship between transit access and property tax, I derive the marginal value of transit access by regressing the assessed values of a sample of residential properties in Vancouver and Surrey on a number of relevant characteristics in a hedonic model. Finding the relationship inconsistent across the region, I suggest there is just cause for a variable rate, and analyse three types of value capture instruments in order to determine if the property tax can be levied so as to raise the same amount of revenue, but with greater equity.

Keywords: Property Tax; TransLink; Hedonic; Value Capture; Public Transportation.

Executive Summary

Municipalities in Metro Vancouver rely on a public transportation system managed by a regional authority, TransLink, and contribute local property tax revenue to fund roughly one-quarter of regional transit costs. The tax rate is virtually uniform, but access to public transit (and other region-wide benefits) vary widely - this leads to a critique of the tax based on its 'fairness', whereby people with less service often perceive an unjust distribution of costs relative to benefits.

However, urban economic theory as well as a plenitude of empirical findings suggest that land values respond positively to the provision of public transit – if the relationship is sensitive enough, than the application of a uniform tax rate (on which the controversy hinges) may be misleading because the value of the property, and therefore the tax paid, would be fluctuating with the provision of transit.

To better understand the marginal effect transit access has on property values, I used a sample of single family detached houses to regress assessed values on a number of structural and neighbourhood variables, including one to measure the 'amount' of transit access available from the census tract in which a given property lay. I find that in the context of Metro Vancouver, transit benefits are incorporated into property values under some conditions, and not under others. In fact, the results suggest a spectrum of effects, based around the idea of the presence of some level of transit threshold – the point at which transit service levels are sufficiently high as to incorporate into one's daily transit choices and location preference buying property. I hypothesis the following broad range of transit effects:

1. Under threshold: witnessed in Surrey, transit provision is too low to be incorporated into property values;

2. Peak effect: the mid point of the spectrum, exemplified by Vancouver East - many areas have transit well above the threshold but many others may fall below, and so the premium on having access is high;
3. Saturation: as in Vancouver West, the overall transit level is above the threshold across the entire sub-region, normalizing the effect; also the average value of property has risen so high, the modest effect of transit is subsumed by the total value.

Because of the great variance in transit access (and other benefits) region wide, and based on the wide-range of effect on property values as revealed by the regression analysis, I suggest there is a case for varying the property tax rate between municipalities. Any change in tax rates would need to be revenue neutral given the transit authority's financial position, which means that for some areas the tax rate would increase and for others it would decrease. In order for this to be politically acceptable to those receiving an increase now I suggest the application of value capture financing policies whereby as areas or municipalities accrue benefits in the future from transit expansion, they commit to a greater proportion of the costs required to fund those expansions. The policies analyzed are (1) Land Value Tax; (2) Area Benefiting Tax; and (3) Tax Increment Financing.

I use a number of simulations to identify the advantages and disadvantages inherent in each tool. Recognizing that this research constitutes a pilot study, I find that two options, area-benefitting taxes and tax-increment financing, could - under particular circumstances and with more research - be utilized by TransLink in order to satisfy a portion of future revenue requirements.

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1: Introduction

Municipalities in Metro Vancouver rely on a public transportation system managed by a regional authority, TransLink, and contribute local property tax revenue to fund roughly one-quarter of regional transit costs. The tax rate is virtually uniform, but access to public transit (and other region-wide benefits) vary widely across the region - this leads to a critique of the tax based on its 'fairness', whereby people with less service often perceive an unjust distribution of costs relative to benefits.

Access to public transit is only one way in which transit delivers benefit to the inhabitants of the region. It also generates benefits through improved goods and people movement, cleaner air, and a stronger regional economy. A regional authority can better deliver these benefits by achieving economies of scale in the provision and operation of transit infrastructure, through ensuring a form of equity by charging one fare paid across the jurisdiction for public transit, by providing better service through integrated planning, and by managing growth much more effectively then a collection of municipal agencies. Thus, the property tax is an appropriate and effective way to tax households and business for the provision of a service that benefits the entire region. Again though, the fact that this tax is applied at a uniform rate leads to mistrust of the "everyone benefits" argument.

However, contrary to the apparent inequity, a large body of economic theory and empirical studies suggests that urban land values rise due to the provision of public transit. If the market price of a house varies with the amount of transit service accessible from that location, then the property tax, depending on the amount of tax collected, may correspond to the owner's benefits from the transportation network. Hence, the property tax may be an equitable tax to the extent that it captures benefits and serves as a proxy for willingness to pay. This paper tests for the marginal effect of transit access on house prices in the region, accounting for other factors that influence house prices using a hedonic model. I focus only on residential property as the determination of land values for business locations (industry and commercial) is beyond my scope due to the complexity of obtaining data that represent the determinants of land values for these sectors. For this study, I use only data from the City of Vancouver and the City of Surrey. These are the two largest municipalities (by a significant degree) in Metro Vancouver, but have very different land use patterns and transit availability, and so should provide a representative explanation of the forces at work in the region.

The study is topical due to the challenge of funding the operating and capital costs of transportation authorities in metropolitan areas. TransLink's legislated funding sources include residential and business property, fares, a tax on motive fuels, a parking tax, and vehicle levy. The existing levels of funding support operation of the current system, but are insufficient to expand the system to meet regional transportation growth needs. There are limits to increases in tax rates due to TransLink's legislation or opposition by the public and politicians. I use the hedonic framework to compare the current level of the property tax to what the model predicts are the benefits provided by proximity to transportation. The model can also help examine alternative formulations of a property tax and alternative land value taxes. The goal is to assess whether changes to the property tax can raise revenue with greater equity than the current system and are administratively feasible.

2: Background: Transportation – Land Use Connection

This section lays out the argument behind the transportation-urban land value connection, and shows that the application of public transportation in Metro Vancouver explicitly recognizes this relationship, as evidenced by the regional scope and by current and long term planning documents. I also introduce the property tax component of TransLink's funding, and while among current revenue sources it is the most linked to land values, I show the transportation-land use connection has influenced other types of tax mechanisms in use elsewhere that are more explicitly based on the idea of 'value capture'.

2.1 TransLink & Property Tax

In July 1998, the *Greater Vancouver Transportation Authority Act* (becoming since the *South Coast British Columbia Transportation Authority Act)* was passed in the BC legislature creating a regional transportation authority, TransLink, and delegating to it the responsibility of not only public transit, but also the region's major road network (2,300 lane kilometres of regionally-significant roadways) and the control of vehicle emissions (through administration of the *AirCare* program); because of this wide ranging set of powers, the regional scope, and the variety of funding tools provided for in legislation, the 'TransLink Model' was virtually unique in the world and marked a new era of regional control of transportation operation and planning. (TransLink, 2008a)

In the years since forming, the organizational structure and the funding tools have continued to evolve. In its current form, TransLink's governance structure consists of a board of directors that is responsible primarily for preparing and implementing long term transportation and financial strategies, and supervising the management affairs of the company. In turn, the Mayors' Council on Transportation, composed of all the mayors in Metro Vancouver and Chief of Tsawwassen First Nation, appoints the board, and maintains ratification authority over any introduction of new funding tools, or increases to existing ones (beyond annual increases allowed for in the *SCTTA Act*). A third party, the commissioner, provides a venue for public complaint, and is responsible for reviewing the board's financial plans as a security that parameters in plans are reasonable. (TransLink, 2008b) The provincial government is also involved in setting transportation policy and establishing priorities for expansion. Both the federal and provincial governments contribute typically 1/3 each of large capital projects.

In 2010 TransLink relied on three major sources of revenue: fares and advertising (approximately 37% of total revenues); a fuel excise tax (28% of revenues); and a portion of the property tax (providing 23% of total 2010 revenues). Parking fees, tolls from the Golden Ears Bridge, a levy on BC Hydro accounts, and small contributions from senior government make up the remainder of total revenues for the year. (TransLink 2010).

Upon its formation in 1998 a significant portion of property tax was allocated to TransLink as source of revenue. Prior to this, Metro Vancouver was responsible for about 40% of hospital infrastructure funding, and so levied a property tax to pay for that cost. The province assumed the role of funding the hospital infrastructure and transferred access of those revenues to the newly formed TransLink. (Kitchen, 2010) Legislation permits annual increases in property tax revenue of 3%, but rate increases beyond that level require the approval of the Mayors' Council. According to TransLink's 2011 Supplemental Plan (TransLink, 2010a), the tax represents one of only three available sources of revenue increase for the transportation authority at the present time because all their other legislated revenue instruments are at their maximum. The only other available revenue sources provided by their legislation at present are fare increases and the introduction of a vehicle levy. The concern with raising fares is that ridership will erode and thus not lead to an increase in revenue. The vehicle levy requires support from the provincial government to implement a mode of collection.

2.2 Transit-Oriented Planning

A major benefit to having public transportation as a regionally integrated system is the ability to incorporate the benefits of transit into land use planning. Municipal and regional planning documents, such as Metro Vancouver's *Regional Growth Strategy* or TransLink's own *Transport 2040* place a priority on the development of transit-abundant and population-dense areas; this general approach is referred to as transit oriented planning, and is a central feature of 'new urbanism' – the postmodern approach to urban planning.

The heavy reliance on personal automobiles and the virtually all-consuming role road building played in city planning through much of the latter half of the twentieth century has been well documented for its negative environmental and social consequences. Significant to our discussion is the ability of the 'automobile-city' to locate houses and business nearly anywhere. This resulted in a fracturing of the transportation – land use connection that had existed for as long as there have been cities. In the past, with much higher travel costs, people would not locate their homes far from where they worked, but with cars, cheap gasoline, and heavily subsidised road expansion projects dominating the cityscape, these travel costs were greatly reduced. (Newman & Kenworthy, 1996) To regain this connection between land-use and transportation (thus countering the negative effects of the automobile-city) many cities worldwide are in the process of expanding their public transportation networks while encouraging the densification of populations around these new transit lines.

The vision presented of the Metro Vancouver region thirty years hence includes integrated land use and transportation plans, with more people living in complete communities serviced by frequent transit networks providing them reliable and frequent service along designated corridors (TransLink, 2008); simply put, this is how an urban area should be built in the twenty-first century. In fact, Newman & Kentworthy (1996) argue that a city that remains reliant on automobiles is destined to fall as have those that remained over-industrialized at the time of transition to the high tech and 'ideas' economy at the end of the twentieth century.

2.3 Basic Urban Land Economics

As noted above, there is a natural connection between transportation and land values. In simple terms, urban land values tend to be a function of a location's accessibility to the things people want, be it employment, leisure, commercial activity, and community attributes such as safety, access to parks, schools, and transportation. These accessibility benefits translate into higher land prices, because living in areas with low accessibility forces people to incur higher travel costs to reach the more desirable places. All else considered equal the average willingness to pay for land declines as the cost of access rises. However, since public transportation, and the new urbanism ideal of 'transit-oriented development' reduces the barriers to accessibility and the resulting travel costs, the provision of public transit should then raise land values. In fact, the provision and expansion of transit service is thought to form a positive feedback loop with increased property values; increased accessibility due to public transportation networks increases the desirability of land, creating in turn greater demand for accessibility, greater desirability for residents and commercial ventures, and the cycle continues. (Iacono, et al.)

The increase in property values comes not through a direct investment by the owner of the property, but simply from holding land in an increasingly desirable location. This 'lift' in value can be thought of as additional land rents (Dye & England, 2008); and the receivers of such surpluses can be thought of as ‘non-user beneficiaries’ (Iacono, et al.) - a third (though not mutually exclusive) group of people who benefit from transit alongside the general public and direct users.

The literature provides empirical evidence of this relationship through multiple regression analysis that assesses the degree of capitalization of transit accessibility into housing prices. Hess and Almedia (2007) test for this effect in Buffalo, New York and find that homes located within one-half of a mile of a light rail station had a 2-5% premium above the city’s median home value. Atkinson-Palombo (2010) used data from Phoenix, Arizona to study the effect of zoning changes facilitating transit-oriented development and found a 37% premium for condominiums in such areas. Agostini & Palmucci (2010) use data from Santiago, Chile, to test for anticipated capitalization with the announcement of new lines and as planning begins, finding a positive increase of between 3.6% and 5.3%. A recent survey discussing the results from studies conducted with data from the U.S. cities of Atlanta, Dallas, Miami, Queens, Philadelphia, Portland, Sacramento, San Diego, San Francisco, San Jose, St. Louis, and Washington, D.C., found that the relationship was positive in all cases except for two, where increased criminal activity near stations brought down general property values. (Hess and Almedia, 2007) The Centre for Transit Oriented Development also reviewed a number of studies, finding the premium on single family residential property to be between 2% and 32%, condominiums 2% to 18%, and office and retail space showing a wide range of effect, from 1% to 167%. (CTOD, 2008)

Metro Vancouver has not been the subject of these types of studies; however the strong ridership and other anecdotal evidence (such as proximity to stations being advertised in apartment and real estate advertisements) suggest a measurable effect in the region.

2.4 Value Capture

The economic phenomenon of surplus rents and the prevailing expectation for major network expansions and 'transit oriented development' has stimulated the study of a new suite of funding tools, known collectively as 'value capture' mechanisms. The term 'value capture' typical describes policy tools that local governments, or in this case transit authorities, can use to either re-direct incremental tax increases, or introduce new taxes or fees, as public investment in transit infrastructure generates higher land rents. While many transit authorities refer to these policies as desirable additions to funding levers, they remain difficult to design and implement. The approaches used most commonly to capture values accruing from transit investment are: (1) a special tax charged to the land owners in the geographic area receiving the benefit, known as an area-benefiting tax; (2) tax-increment financing, whereby the incremental addition in property values in a defined area (post-project) are charged at a special tax-rate to service the bonds used to fund the project; and, a (3) a development impact fee, where large property developers contribute to transit upgrades serving the development.

Other methods of value capture exist, mostly directed at property developers through 'joint development' or similar public-private partnerships where costs, revenues, and risk are shared between a private firm and the state. These approaches function based on the same principle of capturing the lift in value caused by development of transit or transit communities, but they are outside the scope of this paper. I use the general approach of value capture in the final section of this paper to generate policy options.

3: Methodology – Quantifying 'Access' and its Impact

3.1 Introducing Hedonic Evaluation

As explained in the introductory section, the first step involved is to estimate the relationship between transit accessibility and property values and assess if the tax obligation of a given property varies with its access to the public transportation network. I test for the effect of access by regressing the assessed value of residential properties (detached 'single-family' dwellings) in Vancouver and Surrey on a number of structural and neighbourhood characteristics, including a variable for the level of access to the public transportation network afforded to the census tract within which the given house lies. By holding all else constant, the marginal effect of the transit variable is 'revealed' through mathematical estimation.

Rosen introduced the hedonic model, showing that "when goods can be treated as tied packages of characteristics, observed market prices are also comparable on those terms." (Rosen, 1974, p54) In the context of a housing market, the price for which a given house sells reflects the willingness to pay for that house's "basket" of characteristics. A house is not simply a house, but a combination of attributes that each property buyer may value differently; the purchaser's choice is some 'best' combination of available preferred attributes, beneath a given budget constraint (for most of us). The difference in average sales price between two houses with identical features - save for one - is the average willingness to pay for (or for the absence of) that single different characteristic.

To test for the effect a single characteristic may have on the price of the 'basket' in its entirety, researchers can use a large data set containing all of the (known) relevant independent variables that determine the behaviour of a dependent variable. With econometric computer software, various regression methods hold chosen variables constant, while testing the effect of each on the change in dependent variable, thereby revealing the implicit average willingness to pay, or the 'hedonic' value for the given variable. The method is applied extensively with the housing market to estimate the willingness to pay for a variety of neighbourhood or environmental characteristics, such as the availability of good schools, clean air, or quietude; and, as noted above, dozens of papers have tested for variation due to public transportation access.

Most studies testing for the marginal effect of transit access explain housing prices as a function of structural and neighbourhood characteristics. Following the relevant literature, my control variables for the housing characteristics are the age of the building (AGE), the area of the house (SQFT), the number of bedrooms (BED) and bathrooms (BATH), and the size of the property (LTSZ). For neighbourhood characteristics, I use the median income of the Census Tract (CTINC), the distance to the city centre (DCBD) – (either Downtown Vancouver or Surrey Central) The variable of interest (TRANSIT) is based on the number of opportunities per day there are to access the transportation network from a given census tract. I also control for three geographic areas: Vancouver-East, Vancouver-West, and Surrey.

Many studies include a variable to capture the level of crime in a given location. My study does not, but I expect the impact to be negligible or captured to some extent by the geographic variables and average income of the census tract. With regards to transit specifically, some studies have shown crime to be higher at stations and thus cause lower values. If this is the case in my sample, then it would merely mean my regression underestimates true marginal value of transit access. However, from an informal assessment of the region, this is unlikely to be of any significant impact system wide. Concerning any other neighbourhood characteristics, such as access to parks for instance, I assume that the effect on average assessed value, if there is one, is random and evenly distributed throughout the sample – most importantly, I assume there is no endogeny between, for instance, the availability of parks and the value placed on transit.

3.2 Data Collection

The data for my study came from various publicly accessible databases or other online sources; these databases are not designed for mass data extraction, so it was a very time consuming procedure.

I chose the sample from among the properties listed for sale in Vancouver and Surrey on the Multiple Listings Service (MLS) website from October 15th – 30th, 2010. MLS covers nearly all of the realtors operating in the area and so this source provided a large enough sample to ensure robust econometric analysis. I chose the sales listings as the source of the sample because they provided the relevant housing characteristics needed in order to conduct the regression analysis. Information regarding housing characteristics is also available from BC Assessment, but at a financial cost. Other independent variables particular to the census tract level come from the 2006 Canada Census. For the dependent variable, the 2010 Assessed Value, I accessed land and improvement values for each of the houses in the sample through the 'property-inquiry' function on the respective city's website. This service allows users to download the assessed value and tax bill for any property.

Table 1. Dependent and Independent Variables. Description and Data Source.

Variable	Description	Source

Measure of Value		
Y	Assessed Value of Land & Improvements (2010)	City of Vancouver/ City of Surrey
LAND	Assessed Value of Land (2010)	Property Inquiry
IMPROV	Assessed Value of Improvements (2010)	“
Structural Attributes		
AGE	Age of building in years	Multiple Listings Service
SQFT	Area of structure in square feet	“
LTSZ	Area of Lot Size in square feet	“
BATH	Number of bathrooms	“
BED	Number of bedrooms	“
Site/Community Attributes		
REGION	Vancouver East, Vancouver West, Surrey	Map
CTINC	Average income of Census Tract, 2006	2006 Census Tract Profiles
DCBD	Distance in metres to central business district (Downtown Vancouver or Surrey Centre)	Batchgeo.com
TRANSIT	Number of ‘opportunities’ to access the public transportation system in a given census tract	Translink.ca; Transit & Census Tract Maps

After compiling the initial data, I took steps to prepare a consistent data set that contained all of the relevant explanatory variables. I removed any cases with missing data from the final sample, as well as the most expensive properties (anything beyond three standard deviations from the mean assessed value). In the initial data set, some properties lay over 15 S.D. from the mean (valued at over $10 million) and their value is likely reliant on factors not relevant to the rest of the properties, and so not accounted for by the variables under study. In a few instances, I also made very small modifications by combining census tracts without a TRANSIT value (because of no bus-stops and a smaller then average footprint) with the neighbouring tracts (9330003.01 combined with 9330003.02; 9330187.07 combined with 9330187.11). Table 2 shows the descriptive statistics for the final data set.

Table 2. Descriptive Statistics (Surrey N=783 ; Vancouver N=732 (West=351, East=381)

Variable	City	Mean	Std. Deviation	Min	Max
Measure of Value					

Y	Surrey	$503,705	$132,354	$209,000	$1,121,000
	Vancouver East	$705,554	$196,586	$427,800	$1,995,667
	Vancouver West	$1,553,180	$533,989	$347,000	$3,090,033
LAND	Surrey	$315,002	$51,818	$118,000	$558,000
	Vancouver East	$561,775	$102,623	$407,000	$1,203,000
	Vancouver West	$1,186,024	$352,176	$225.000	$2,587,000
IMPROV	Surrey	$188,702	$111,884	$5,300	$608,000
	Vancouver East	$143,779	$137,749	$4,900	$1,017,000
	Vancouver West	$367,156	$358,384	$7900	$1,760,000
Structural Attributes					
AGE	Surrey	20.6	15.3	2	99
	Vancouver East	40.1	27	2	105
	Vancouver West	39.7	32	2	102
SQFT	Surrey	2960	1153	700	8524
	Vancouver East	2419	661	985	5337
	Vancouver West	3496	1172	1260	8320
LTSZ	Surrey	7291	2428	2325	15768
	Vancouver East	4473	661	985	5337
	Vancouver West	6693	2726	1750	16059
BATH	Surrey	3.9	1.6	1	8
	Vancouver East	3.3	1.3	1	8
	Vancouver West	4.4	1.6	1	8
BED4	Surrey	5.3	1.8	0	12
	Vancouver East	5.2	1.5	1	12
	Vancouver West	4.9	1.4	0	12
Site/Community Attributes					
CTINC	Surrey	$60,314	$13,124	$36,153	$89,234
	Vancouver East	$51,100	$5,790	$29,590	$63,390
	Vancouver West	$85,148	$25,366	$51,699	$155,346
POPDENS	Surrey	4330	1951	307	7844
	Vancouver East				
	Vancouver West				
DCBD	Surrey	5761	3151	380	14800
	Vancouver East	6593	1434	1920	9340
	Vancouver West	5262	1337	406	7940
TRANSIT					
Total	Total Op				
	Surrey	414	288	31	1774
	Vancouver East	998	416	194	1952
	Vancouver West	1189	380	488	3174
/100 People	/100 People				
	Surrey	7.9	6	0.4	39
	Vancouver East	16.2	7	5	45
	Vancouver West	23	9.4	11	52.9

	/Km2				
/Km2	Surrey	192	157	4.6	1352
	Vancouver East	959	648	33	4034
	Vancouver West	824	444	178	4921

3.2.1 Measuring Transit Access

The vast majority of hedonic studies in the literature use the distance from a given property to a transit access point, a light rail station for instance, as the measure for ‘access’. Using either a dummy for houses within a certain distance of a transit node, or a continuous variable representing physical distance to the node, these studies estimate the change in house value as the distance to the node changes. The approaches for estimating distance to the node may vary in degree of sophistication. For instance, Armstrong & Rodriguez (2006), in their study of commuter rail in eastern Massachusetts, used the driving distance from a given house to the nearest station, and dummy variables indicating if a property lay within a municipality with a station, and if so, another dummy indicating if they fall within ½ mile of that station. Hess & Almedia (2007) use two measures to capture the proximity of houses to the transit node, both a straight-line distance (as the bird flies, so to speak) and an estimated walking distance, simulating the actual pedestrian route that a person would travel between the house and the station.

For my study, I used a different approach, but one designed to capture the same overall effect, which is access. Rather than focus on nodes I attempt to measure the overall availability of transit available from within a given census tract. Rather than each property in the sample having a TRANSIT variable that is a function of its relationship with a single station, it is the aggregated amount of transit available from the census tract containing the property.

Using a system-wide approach provides an overall approximation of how transit availability affects housing prices across the region, rather then simply along the light rail line; but I also chose it because of necessity. My initial research plan involved completing a nodal based study that more closely resembles the studies in the literature, but I could not do this because of prohibitive financial costs involved in compiling the data. As noted above, I relied on public real estate listings for the structural data, but in order to test with accuracy the effect present at a single node, I would need to have structural data for all of the houses within the test area (500-1000m), and sales data alone cannot provide the density of sample required.

Both the orthodox approach of measuring distance to a node and my measure are effectively proxies for accessibility, but admittedly, the major potential weaknesses with my proxy for access is the fact that it does not account for the variation within census tracts, so a house directly beside a stop and one at the furthest point away possible are deemed to receive the same benefits from the transit network, when this is obviously not the case.

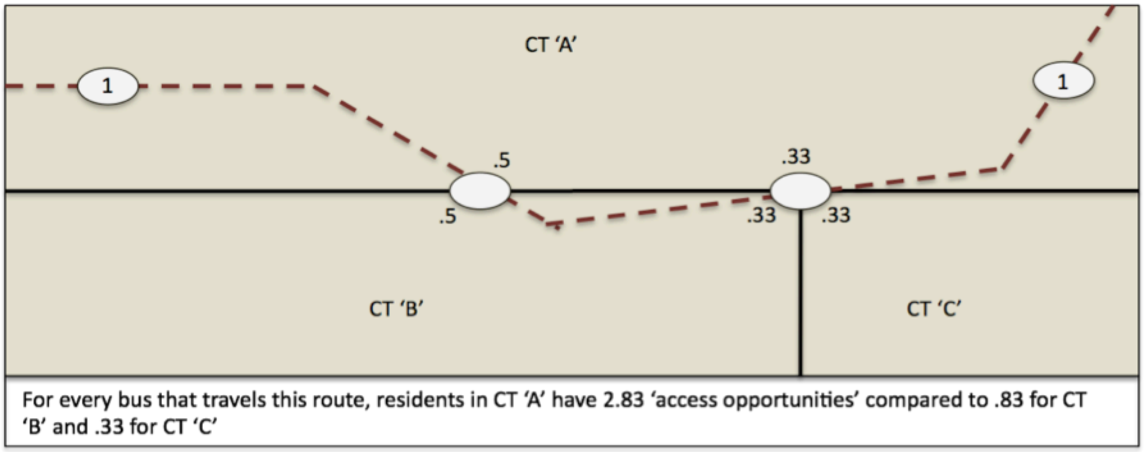
In order to calculate the TRANSIT variable, I used the TransLink website to access the route-maps and stop-locations for every bus route in Vancouver and Surrey, and assigned the stops to the census tracts in which they lay. Thirty-one bus-lines and three light rail lines pass through 93 Vancouver census tracts; 31 bus-lines and one light rail line cross 64 Surrey census tracts. Multiplying the total number of buses or Skytrain-cars per day by the number of stops gives the base number TRANSIT, which is essentially the number of opportunities to access the transit system per day (in a given direction) from a given census tract. Finally, I used the 2006 Census to facilitate per-capita and per-square kilometre comparisons between census tracts.

The number of buses-per-day and the location of stops I used represent one direction of travel on a given route. For instance, all of the buses and stops on a route's eastward trajectory were accounted for and the westbound travel is assumed the same in all respects. Where there are significant differences in service, such as different routes for large segments, or portions serviced by only one direction (e.g. in the early morning) then I have done my best to account for these variations; such occurrences are, however, uncommon. Minor incongruities, such as a single-block difference in west- and east- bound stops are not directly accounted for, but they are on average too small of a variation to either affect the outcome of my work, or to justify the additional time my data-gathering methods would have needed to be employed.

3.2.2 Further Considerations

In designing the TRANSIT variable, I had to consider how to interpret bus-stops that lie at the junction of multiple census tracts. As a reminder, the TRANSIT variable is the number of buses multiplied by the number of stops in a given census tract, but since both bus routes and census tracts follow major roadways, overlap between them is common. Where overlap occurs, I have assigned to each census tract a proportion of the overlapping stop's 'value' relative to the number of census tracts sharing in the overlap. So if a stop is completely within a census tract then that census tract is credited with a complete stop; if the stop it is on a border between two census tracts, then each are credited with .5 of a stop; for stops at junctions of 3 or 4 census tracts, I applied weights of .33 and .25 respectfully.

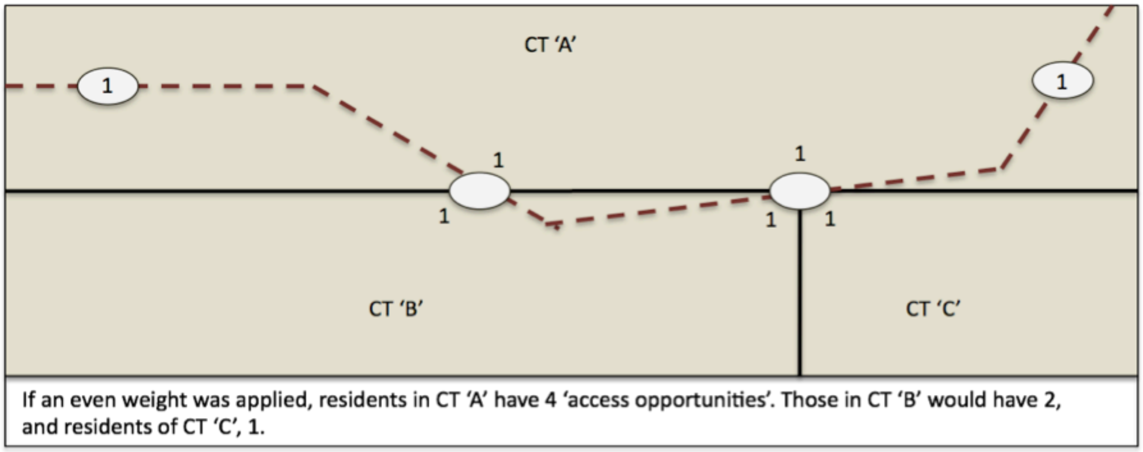
Figure 1. Weighting Example #1.



I justify the partial-weighting approach through consideration of alternatives. For instance, I could have delineated between east and west travel, and then the stops could not be on the junction of two census tracts, just the extreme edge of one. However, many stops are not at junctions of census tracts, so the additional work would be merely accounting to each census tract a similar number of total stops and buses. Further, residents of an area use both stops, one while leaving their home and one retuning, hence the two stops act as a single unit and should be counted as such. One direction of travel can serve as a suitable proxy for complete service, and one direction is as good as the other. I assume that any errors are small enough that they do not significantly affect my results.

The other alternative I considered was to credit each census tract touching the stop with a full value, show below in Figure 2.

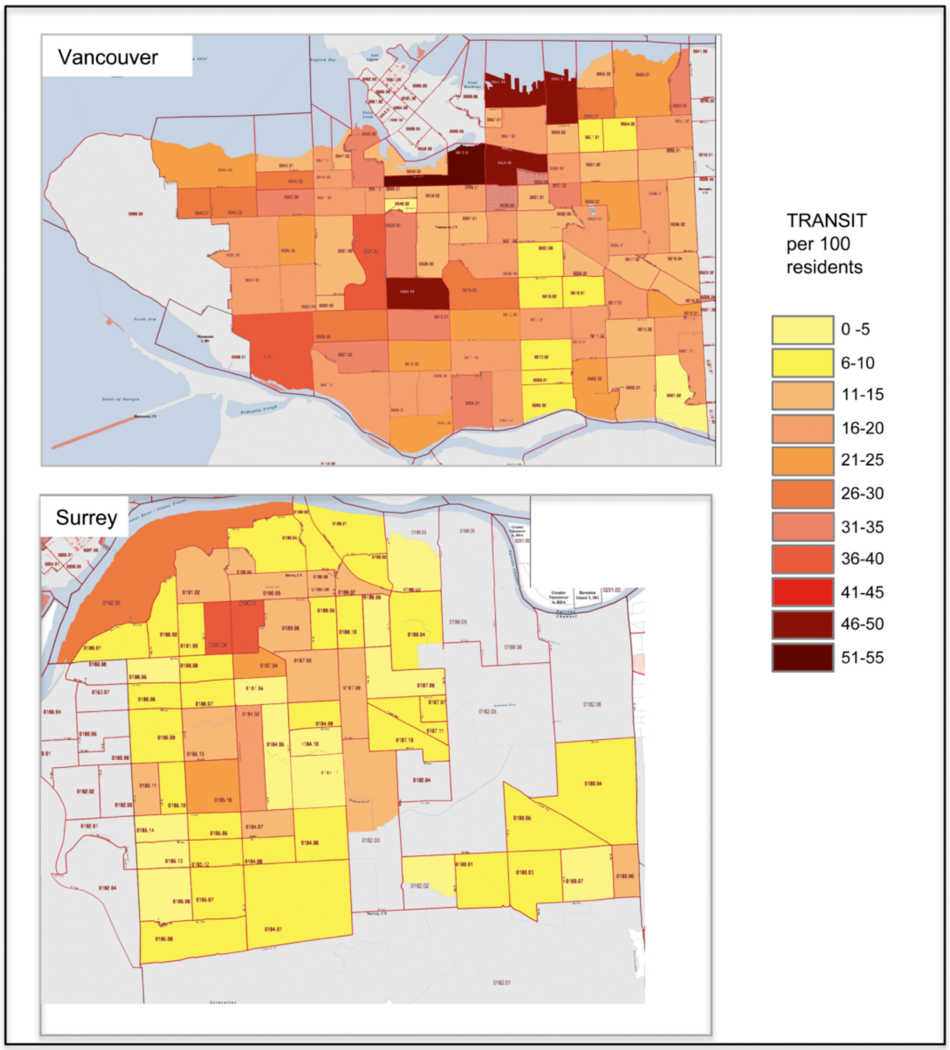
Figure 2. Weighting Example #2.



However, the approach of applying full values to each census tract is flawed in that it does not hold constant the value of a bus at a bus stop. Therefore, the metric no long remains tied to the number of opportunities to board transit, as the value of a single bus stopping at a single stop could be counted as one, two, or three, or even some higher value. In the example above, for instance, one bus stopping four times would count, illogically, as seven opportunities to access the system. Comparing across census tracts would be irrelevant, and routes with relatively infrequent service could appear mathematically similar to the service provided in heavily serviced area depending where stops and routes lie.

Beyond dismissing alternative approaches, my confidence in the approach (i.e. weighting stops less then 1 on junctions) is that unintended consequences would likely not bias my outcomes in a way that would exaggerate the impact, but rather they would minimize it. For instance, a bus travelling on the periphery of a census tract (i.e., the border with another) provides less total access to the residents of the census tract – and in this method, is counted as such. This is because the sum of the total distance of all residents in a given census tract to a route or stop would be minimized with the route directly through the middle, and maximized when the route is at the extreme edge (assuming an even distribution of houses within the census tract). Lastly, the correlation coefficient between my final un-weighted and weighted numbers is .967, so when it comes to the regression both would likely give the same result. Figure 3 shows the distribution of the final TRANSIT variable per 100 people.

Figure 3 – TRANSIT by Census Tract in the Regions Studied



Source: adapted from Census Tract Reference Maps, by Census Metropolitan Area, Catalogue No. 92-146-UIB; Vancouver maps 3. 4, & 7.

3.3 Outstanding Methodological issues:

The sample I use is not truly random, based as it is on sales data. However, the bias is simply that all the houses in the sample are for sale at the time of data extraction; considering the wide sample area, it seems doubtful that there is any reason for endogeneity between transportation access and the decision to sell.

Second, my study does not account for intra-census tract spatial variation among the sample, i.e. a constant TRANSIT value applies to each house in a given CT, even though we know that the likelihood of variation in value to proximity is very high. A perfect geographic distribution within each and every census tract would reduce the problem; ideally, application of GIS technology and more advanced spatial econometric analysis could be used to solve this problem.

Third, I use the assessed value of property for the dependent variable, and not the sales price; however since Vancouver and Surrey have very active real estate markets with a large number of transactions, the assessed value is reflective of the sales price, albeit with a time lag. I assume any variation in the relationship between sales and assessed values due to individual Property Assessors is random and normally distributed.

4: Hedonic Regression Specifications and Results

4.1. Specifications

For my regressions, I rely on the Ordinary Least Squares (OLS) method. This is the most frequently used method of obtaining estimates of regression coefficients from a set of data. A number of assumptions must hold true with the behaviour of the data and the residual values when using this method – these are detailed in Appendix 2. The dependent variable for all specification discussed below is the 2010 total assessed property value (land & improvements combined).

My first three specifications (see Table 1, Appendix 1) focus on deciding between linear (1), log-linear (2), and double-logged (3) functional forms for the basic model. Of these, the double-log form (3) had the highest goodness-of-fit ratio, with an adjusted R^2 of 0.90. That the double-logged form performed best was somewhat expected. When variables are in their natural logged form outliers have less relative impact, and so in cases (like the real estate market) where there is a wide variance in the dependent and independent variables, the goodness-of-fit tends to improve with the use of logged functional forms. All variables were very significant and had the expected signs, with the exception of the variable BED – the number of bedrooms. This variable was negative and highly significant, though I had expected a positive sign. This result can be explained simply though – remember, the coefficient represents the marginal effect of a given independent variable on the dependent variable, *all else held constant*. So, if holding everything constant, particularly the SQFT variable (the area of the house), then an increase in the number of bedrooms would by definition mean a decreases in the size of each other room and is probably related somewhat to age (older houses having more small rooms compared to a newer house having fewer, but larger rooms). However, since the structural data are from sales advertisements, there may be a tendency in the data to over- estimate the number of bedrooms, being generous with the definition of a bedroom when possible, and so the data for that variable may just not be completely reliable.

With the double-logged form (3), I used the next three specifications to decide on the form in which to use the TRANSIT variable (see Table 2, Appendix 1). I tested between the total TRANSIT value un-weighted (4), divided by the area of the census tract in square kilometres (5), and divided by the population of the census tract (6). Each measure showed a significant relationship with assessed value (and choice of measure did not affect the significance or signs of the other variables), but the specification with TRANSIT measured by population showed a higher t-score for significance, and the equation as a whole had a slightly higher f-statistic then the other two forms. Levelling TRANSIT by population makes perhaps the most intuitive sense as well, and it normalizes the distribution of transit availability more so than the unweighted number or the by kilometre-squared forms which both have much more extreme variance in absolute value – and so the TRANSIT variable used in all subsequent regressions is, formally: (TRANSIT/POPULATION of CT) *100. This basic form (specification 6, Table 2, Appendix 1) provides a very high goodness of fit, and has all variables very significant and expected in sign (the discussion of BED, above, notwithstanding).

A common problem with hedonic regressions of the housing market is the presence of heteroskedasticity. This awkward term simply means that the size of the error term varies across the data set, or put differently, the model predicts the value for some properties better than for others. Determining the exact cause of heteroskedasticity once diagnosed can be difficult, but it typically results when there is an omitted variable bias or a misspecified functional form. If an important independent variable is absent from the equation, the error term will contain the effect of this missing variable on the dependent variable, biasing the ideally random residual value. A misspecified functional form biases the residuals differently, for example, by fitting a straight line to non-linear data. Since my regression results had such high adjusted R-squared values and because I followed the literature on the variables best included (given what I had access to), my approach to addressing the heteroskedasticity relied on introducing greater flexibility to the functional form, so as to better describe the nuanced effect of the independent variables on assessed value. To do this, I perform two types of adjustments.

For some variables (AGE, SQFT, LTSZ) I introduce a squared version of the same variable as a new independent variable. The second term (the original variable squared) allows for a 'corrective' force on the slope of that variable. For instance, the variable AGE is suspected to cause heteroskedasticity in hedonic studies because of the variable effect of depreciation associated with age over the lifecycle of a house. The older a house the less it is worth, but the depreciation is far from constant over the life cycle because of the increased likelihood of renovations taking place (and so adding value) as a house ages and because of the market-premium on antiquity. (Goodman & Thibodeau, 1995). Introducing the squared AGE term into the equation means that as AGE rises, the coefficient applied to the squared term become more important. For AGE, the effect is negative, but the coefficient on the squared term is positive (albeit much smaller in absolute value), so as the house gets older, the growing importance of the positive coefficient reduces the impact of the negative coefficient on age. The same logic explains the use of squared terms for the other variables.

The second type of manipulation was to introduce a series of interactive terms using my three geographic controls (VANEAST, VANWEST, and SURREY) and each of the neighbourhood attributes, TRANSIT, CTINC, & DCBD, to account for the very different nature of the three areas. This change affected the coefficient for MUN (Municipality = Vancouver or Surrey) in Table 3. It is negative when the relationship is positive based on the data set: there is no possible way that a house in Vancouver is less expensive than one in Surrey simply because it is in Vancouver, but that is what the results look like. However, the cross products change the municipality from 1 to 0 (Vancouver to Surrey), thereby affecting more than the MUN term. While the effect on MUN is negative for Vancouver, the effect on all the other cross products is positive. Put differently, the coefficient is the marginal effect of a variable, holding all else constant – but it is impossible to change only MUN and hold all else constant. Thus, one should not interpret the MUN term as implying that marginal effect of having a house in Vancouver relative to Surrey is negative.

In sum, these changes improved the goodness of fit, raising the adjusted R-squared to 0.920, but did not completely solve the problem of heteroskedasticity; for this reason then, the final formula uses Eviews' 'Heteroskedasticity-Consistent Standard Errors' function to correct for the potentially biased standard errors. The final equation and results are below:

$$
\begin{aligned}
LOGY = {} & 0.1139(LCAP*EAST) + 0.02413(LCAP*WEST) - 0.02167(LCAP*SUR) - 0.01421AGE + \\
& (2)(0.000108)AGE - 0.1439LBED + 0.0441LBATH + 0.00018SQFT - (2)9.21e\text{-}09SQFT + \\
& 0.0001LTSZ - (2)(4.29e\text{-}09)LTSZ + 0.6437(LCTINC*WEST) + 0.5064(LCTINC*EAST) + \\
& 0.0398(LCTINC*SUR) - 0.23717(LCBD*WEST) - 0.09173(LCBD*EAST) + \\
& 0.0220(LCBD*SUR) - 3.6978MUN + 11.897
\end{aligned}
$$

Table 3. Final Regression Results. N=1512.

Variable	Effect Represented	Expected Sign	Coefficient	T-test
Log TRANSIT*SUR	Surry's Transit	Unknown	-0.0216***	(-3.881)
Log TRANSIT*EAST	Vancouver East's Transit	Positive	0.1139***	(6.486)
Log TRANSIT*WEST	Vancouver West's Transit	Positive	0.0241	(0.998)

AGE	Age	Negative	-0.0142***	(-15.52)
AGE^2	Corrective for Old Age	Positive	5.13e-05***	(11.156)
Log BED	Number of Bedrooms	Positive	-0.143***	(-7.387)
Log BATH	Number of Bathrooms	Positive	0.0441***	(2.523)
SQFT	Area of House	Positive	1.86e4***	(10.892)
SQFT^2	Corrective for decreasing marginal effect of SQFT	Unknown	-9.29e-09***	(-4.217)
LTSZ	Size of Lot	Positive	1.11e-04***	(15.902)
LTSZ^2	Corrective for decreasing marginal effect of LTSZ	Unknown	-4.29e-09***	(-10.166)
Log CTINC*SUR	Effect of CTINC in Surrey	Positive	0.0398*	(1.885)
Log CTINC*EAST	Effect of CTINC in Vancouver East	Positive	0.506***	(13.492)
Log CTINC*WEST	Effect of CTINC in Vancouver West	Positive	0.643***	(19.040)
Log DCBD*SUR	Effect of DCBD in Surrey	Negative	0.022***	(3.185)
Log DCBD*EAST	Effect of DCBD in Vancouver East	Negative	-0.0917***	(-3.217)
Log DCBD*WEST	Effect of DCBD in Vancouver West	Negative	-0.2371***	(-5.161)
MUN	Vancouver=1 Surrey=0	Positive	-3.697***	(-6.935)
C	Constant	N/A	11.897***	(48.978)

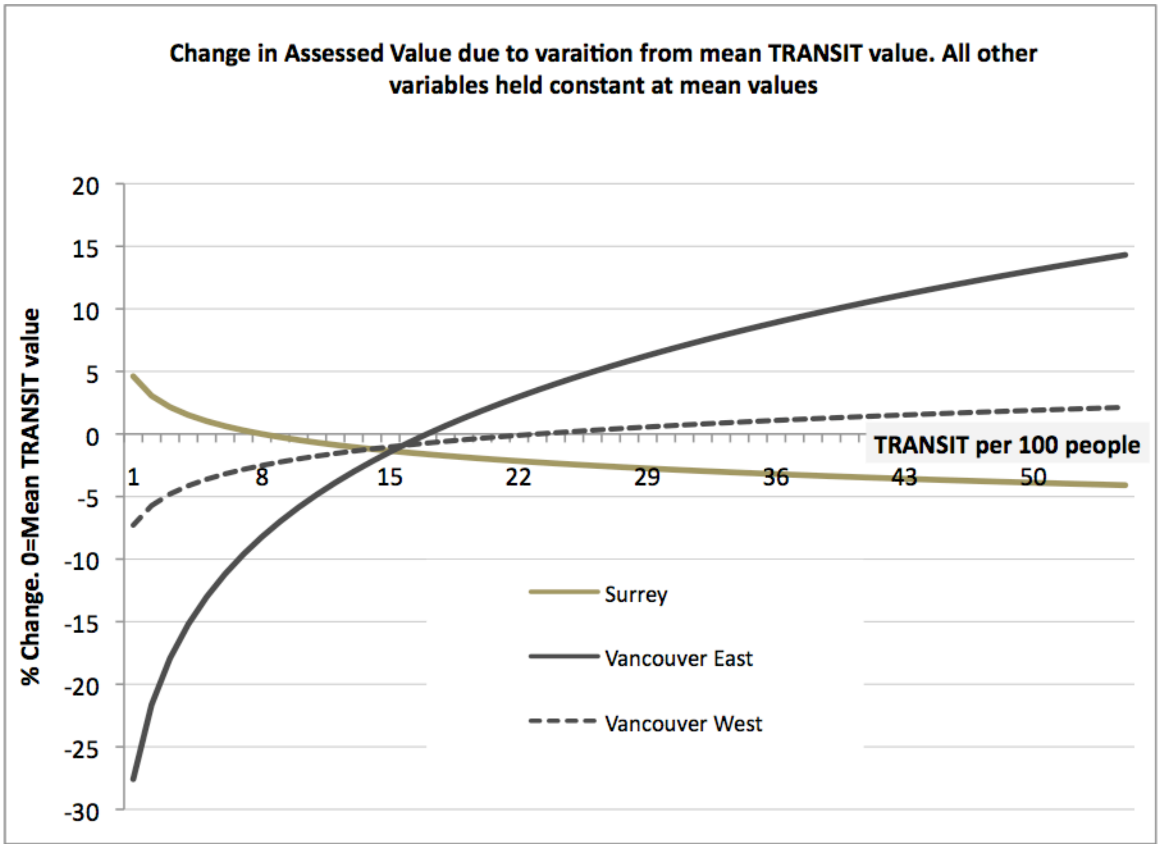
R-bar2 = 0.923
Beta's significant at 1%***, 5%**, 10%*.
Durban Watson 1.981
F-stat 1016.68
White NR2 = 573.3

4.2 The marginal effect of TRANSIT on Assessed Values

Before discussing the implications of the regression results, a reminder that this study includes only single family, detached residential property. It does not include other types of residential property (e.g. condos) or non-residential properties (e.g. commercial or industrial). Collecting data for the relevant determinants of value for these other types of properties is challenging due to difficulty accessing the data and complexity of determining the relationship between commercial and industrial property values and transportation. My results should thus be interpreted as a pilot study, but cannot describe all the effects of transit on all types of property. However, as noted above, other studies in the literature have found that the marginal effect of transit access on commercial property and on residential condos tends to be even higher than for single-family detached dwellings like those used in my study. Considering this, and the fact that as density increases around transit lines and nodes it typically will be in the form of condos and not detached houses, my results likely underestimate the true potential effect of transit access on property values throughout Metro Vancouver.

As shown in the results table above, the marginal effect of TRANSIT on the assessed value of properties is markedly different in the three areas sampled. In Vancouver EAST, the results are positive and highly significant (and of the greatest magnitude of impact among the three); in Vancouver WEST, the estimated effect is positive but the results are not statistically significant; and in Surrey the effect is highly significant, but negative. Figure 3, below, shows the relationship between access and average property values graphically: the point on each geographic area's marginal effect line where X=0 represents the mean TRANSIT value for each region. The graph shows the change in average property value as the amount of TRANSIT changes – holding all other variables constant at their mean values. For example, in Vancouver East, the positive relationship between transit availability and housing causes the line to slope up from the mean as TRANSIT increases, and slope downwards as TRANSIT decreases. In Surrey, however, the negative relationship found in the regression analysis inverts the line, suggesting lower house values where transit is highest (all else constant).

Figure 4. Marginal Effect on housing prices due to change in TRANSIT, by city



1

Major differences exist between the three geographic areas that help explain why the effect of TRANSIT varies so significantly. Most significant, unsurprisingly, is the amount of TRANSIT available. I think it is reasonable to accept that with the provision of transit there exists a certain threshold beyond which transit access is of a critical level that allows it to be relied upon as a frequent and convenient transportation option for people, thus initiating the surplus land rent cycle described in the background section (sec 2.3) of this paper. The threshold idea is intuitive. If transit departs frequently and from close proximity to a given residential location, and goes near to the locations that the average person most values (e.g. work or school) in a similar or even shorter amount of time and at less financial cost then could be achieved with a personal automobile, then the overall demand for such a location is going to increase as the travel costs decrease. On the other hand, a relatively slow bus that serves a suburban house on a relatively infrequent basis gives little reason to expect the average person to be willing to pay more to live there simply for the access provided by the bus route. The threshold thesis provides the primary explanation for the negative relationship estimated by the regression model for Surrey. For most locations in Surrey, TRANSIT is not at such a level high enough to be incorporated into market decisions.

Other factors may influence why transit availability does not affect the average property value in Surrey positively. Surrey grew as a suburb, and the summation of planning decisions reflect the abundance of space and the use of personal automobiles. The average population density for census tracts in Vancouver is 30% higher than in Surrey, and land use patterns are generally more conducive to reliance on transit in Vancouver than in Surrey. Take for instance the differences between land use surrounding SkyTrain stations: in Vancouver, the stations are almost exclusively located in residential neighbourhoods, whereas Surrey's light rail stations tend to be located in settings that are more industrial or surrounded by parking lots. Bus routes as well allow for greater integration of transit into daily life in Vancouver; take for instance the route along Broadway Avenue in Vancouver (the region's busiest bus route). The ten-kilometre route from the city's busy east-side transit hub at Commercial-Broadway to the University of British Columbia is lined nearly entirely with small storefronts and sidewalk access with very limited parking and frequent transit. The busy bus routes in Surrey however, tend to travel along routes that if commercially developed, are lined with strip-malls and parking lots - encouraging car use, not facilitating the transit-accessibility land-value loop.

None of the above should be interpreted as evidence that people in Surrey do not value public transportation, or that they would prefer an alternative scenario under which they have even less; it simply means that transit access is not incorporated into decisions over residential property demand. In fact, Surrey seeks greater investment in transit and a transition to more 'transit-oriented development', and as this happens, it is likely that the negative relationship will turn positive. This will lead to increasing demand for land near Skytrain stations and residential and commercial properties will come to replace the parking lots that now surround the stations. The increase of transit travellers along future frequent transit networks will initiate and contribute to the value creation loop, and the strip mall-parking lot design will yield to the front-to-front design typical of a more dense urban area.

For Vancouver, as noted, the regression analysis showed both east- and west- side with a positive effect, however the effect in Vancouver-west was very slight, and not statistically significant. I think the reason for the difference between the results for east- and west-side Vancouver is two-fold. First, continuing on the threshold theses, the higher overall TRANSIT values in Vancouver-west compared to Vancouver-east (the mean TRANSIT value for Vancouver-west is 40% higher then for Vancouver-east). A larger proportion of the Vancouver-west sample falls within in census tracts with access-levels above any threshold – this in effect acts to normalize the benefits available throughout the region, thus explaining the lack of statistical confidence in the results from the regression. In Vancouver-east however, the lower mean TRANSIT value is reflective of the fact that some areas fall above a threshold and some below, creating a clear benefit, with respect to transit-access, of some areas over others.

The second explanation for the lack of statistical significance on the Vancouver-west TRANSIT variable is the strength of the real estate market and the high overall price level. As the price increases towards some maximum average amount the market can support, property becomes more and more inelastic to nearly all factors; prices in general are less dependent on services available and more on the simple existence factor of being on the west-side of Vancouver.

The wide variation shown throughout the sample with respect to transit access and property values serves to highlight the fact that across the entire region one witnesses many different effects. However, I consider Surrey, Vancouver East and Vancouver West as good examples of the range of a typical progression. Beginning with Surrey, the disparate nature of the city and the low transit levels mean that people do not place a high economic value on living near transit. In Vancouver East, many areas have transit well above the threshold but many others may fall below, and so the premium on having access is high. In the final stage, exhibited by Vancouver West, the overall level is above the threshold. Thus, the marginal effect normalizes across the area, reducing the premium of any one spot versus another with regards to transit access. Because the average value of housing has risen so high, the modest effect of transit is subsumed by the total value and the elasticity of price with regards to all service attributes is weakened.

Of course, the explanation I provide requires further examination to help identify the location of the threshold (and if that effect persists). Ideally, such a study would be longitudinal and cover the entire region. It needs to compare the change in marginal effect of transit over time and change in transit levels over time. For the analysis that follows, I assume that the relationship seen in Vancouver East represents the greatest variation in assessed values owing to transit access and therefore it represents the maximum extent to which the property tax is currently able to respond to varying levels of access.

5: Policy Option Analysis: Modifications to the Flat-Rate Property Tax

5.1. Direction of Analysis

Since it is the flat-rate variable-access dynamic is the source of the policy problem, the only 'solution', by definition, would be to make the tax-rate variable in some respect based on access. However, any change in tax rates across the region would have to be revenue neutral, as TransLink simply cannot afford a net decrease in property tax revenue (without the introduction of new funding tools). The condition of revenue neutrality means that a decrease for some municipalities in the region requires an increase in tax rate for others. It also means that keeping the tax rate at the status quo but implementing the types of policies discussed below (which rely on the benefiting area to pay more) could lead to a perversity whereby a municipality with still worse service may pay far more in total taxes then another, simply because of a recent upgrade. Again, this stresses why the only solution is to introduce some variation to the rate.

The intent of my research is not to provide guidance about the best way to measure access or total benefit accruing to each municipality from the public transit network for the purpose of actually setting new rates. It is not appropriate based on my work to rank each municipality by the proportion of 'benefit' they receive from the transportation network, or to determine the rate-decrease or revenue-distribution that would be 'best'. This is because property value 'lift' is only one attribute of the benefits from the transportation network – roads plus public transit. One would need to assess the value of the network's total attributes not just public transit availability.

Rather, the approach I have taken begins by outlining the status quo and considered how a shifted tax rate might impact ratepayers in each municipality. The bulk of the analysis then assumes that rates do change, but that in order for municipalities facing tax increases in the short term to agree, there would need to be some additional agreement that municipalities receiving a decrease in tax rate now would pay an increasing share as their own access improves. I take particular note of how likely the particular mechanism is to achieve the purpose (i.e. shifting some share of revenue responsibility onto the area receiving a new benefit) as well as how the mechanism may affect vertical equity between people of different economic classes, and how administratively complex the implementation and operation may be.

5.2. Status Quo

The *SCBCTA Act* permits TransLink to increase property tax revenues by 3% per annum. This takes into account any increase in assessed property values region wide, so the 3% increase in revenues comes through an adjustment year to year of tax rates to match assessed value changes with a 3% overall increase in revenues; this means that tax rate can vary slightly between municipalities, but remain roughly uniform. In 2010, the transportation tax rate for both Surrey and Vancouver was $38.00 per $100,000 of assessed value. Table 4 shows the amount of TransLink directed property tax owed on six 'average houses', each with a different level of transit access, in each of the 3 regions. An average property in this example is the value derived from the regression with all independent variables at their mean values – the changes in total tax owed reflect the changes in the independent variable (assessed value) due to changing the TRANSIT variable in the regression while keeping all else constant.

***Table 4*. TransLink Tax bill on average house, by TRANSIT**

City	TRANSIT per 100 people (Mean in Surrey=7.9; Vancouver East=16.9;Vancouver West=23)					
	0	10	20	30	40	50
Surrey	$198	$188	$185	$184	$183	$182
Vancouver East	$178	$231	$250	$262	$270	$277
Vancouver West	$371	$392	$398	$402	$405	$407

For Vancouver East, where the access-property value effect is most noted, the maximum effect on property values owing to access is 36% - so even among the highest served areas, 64% of the tax owing to TransLink on an average house is independent of extent of access. In Vancouver West this margin of change is much lower, with a maximum accessibility premium of 9%. In Surrey, the maximum negative change is 8%.

5.2.1. Surplus Rents?

If the distibution of costs relative to benefits is inequitable to those with low levels of service, then it likely follows that to others accrue considerable surplus land rents. To determine this we ask: as transit access or the overall levels of transit increases over time, does the incremental value owing to this increase (i.e. the real change in property value owing only to the change in transit access) fall below or above the amount that property's owner would have paid to TransLink in the same period of time?

Between 2003 and2008, TransLink's overall service hours increased by approximately 20% (TransLink 2008b). Though obviously not precise, assume for argument's sake that this means that the TRANSIT variable system-wide also increased by 20% over the same time-period. Table 5 uses the marginal effect of TRANSIT calculated in the regression to simulate how average property values in Vancouver-east would change over 5 years due to a progressive increase of TRANSIT by 20% over those 5 years. It also shows the calculated sum of the property tax that would be paid to TransLink on the property over the same time period (based on the 2010 tax-rate). Note the large surplus rents ($16,477 accrued versus $1,203 paid).

Table 5 – Surplus Rents? Comparing Property tax paid over time to simulated property value increase due to increases in TRANSIT					
Year	TRANSIT Value (Opportunities to access the network, per 100 people)	Mean house price at TRANSIT value	Change in Property Value due to increase in transit access	TransLink tax	Surplus Land Rents
1	12.9	$626,834	NA	$238	NA
2	13.7	$631,276	$4,442	$239	$4,202
3	14.5	$635,488	$4,211	$241	$3,970
4	15.4	$639,493	$3,818	$243	$3,761
5	16.2 (20% higher than year 1)	$643,312	$3,542	$244	$3,574
Change in (real) Assessed Value due to TRANSIT, 2003-2008 = $16,477 **Total Property Tax paid to TransLink, 2003-2008 = $1,203**					

The examination of the status quo in light of the regression findings shows that, where the transit network is sufficient to be reflected in property values, the uniform property tax does reflect a variation due to transit-access – people with more transit pay more in property tax because of it - in Vancouver-East at least. Since the effect is inconsistent and subject to many factors region-wide, there is no system-wide variation in tax obligation due to access, and so for most residential property owners there is very little variation in transit tax due to transit access. The huge variance in transit access region-wide and the relative insensitivity of the property tax with respect to access, combined with the information in Table 5 showing the potential existence of significant surplus rents within areas with abundant transit, gives ample support to the notion of changing the rate structure in some fashion.

5.3 Variable Rates by Municipality

The simplest and perhaps only 'fix' to the problem of a uniformly applied rate is to make it non-uniform, or variable (however tautological that may be). Transit-access varies within municipalities, of course, but for simplicity, I will assume that the unit at which the tax rate would vary would be the municipality. I want to determine how feasible it might be to reduce taxes for some and increase them for others, as per the assumption made earlier requiring revenue neutrality. Table 6 shows fourteen municipalities and their total assessed property values for 2010. The remaining seven municipalities in the TransLink service area had their assessment roll values combined together, or were not reported in the same manner by BC Assessment and so I do not have them listed; I did however, include their combined missing values when determining the share of total residential property tax revenues owing to each of the listed municipalities. Rather arbitrarily, I assigned either a 50% or a 25% decrease to each municipality other than Vancouver, and relied on Vancouver to singularly compensate for the lost revenue from all other municipalities. This is an extreme example; in reality, there are other municipalities in the region with quite substantial transit service, so the final distribution would likely be much different from the example provided.

Table 6 - Calculating increase needed in Vancouver tax rate to facilitate reduction in rate for all other municipalities

Municipality	Total Residential Property Value (‘000,000)	Share of Total Revenue Burden*	New Tax Rate /$100,000 (2010 = $38)	New Share of Revenue Burden	Gain in Municipal taxing space
Vancouver	$188,218	31.8%	$59.70 (+ 57%)	50%	- ($40,890,000)
25% Reduction					
Burnaby	$51,552	8.7%	$28.50	6.5%	$4,890,000
Coquitlam	$24,396	4.1%	$28.50	3.1%	$2,317,000
New Westminster	$11,296	1.9%	$28.50	1.4%	$3,219,000
North Vancouver	$12,768	2.2%	$28.50	1.6%	$3,363,000
Port Coquitlam	$9,494	1.6%	$28.50	1.2%	$2,705,000
Port Moody	$6,809	1.2%	$28.50	0.9%	$1,940,000
Richmond	$48,800	8.3%	$28.50	6.2%	$13,908,000
Surrey	$74,700	12.6%	$28.50	9.5%	$21,289,500
50% Reduction					
Anmore	$786	0.13%	$19.00	0.06%	$149,340
Belcarra	$446	0.07%	$19.00	0.03%	$84,740
Delta	$21,500	3.6%	$19.00	1.8%	$4,085,000
White Rock	$4,600	0.8%	$19.00	0.04%	$874,000

*Based on ½ of $270 million: TransLink’s total budgeted property tax revenues 2010, approximately half of which come from residential property

The information in Table 6 shows that despite the extreme nature of the exercise, Vancouver could compensate for significant tax rate reductions region wide through a 57% rate increase, or an additional $21.70 per $100,000 of assessed value. As noted, my choice of new rates was arbitrary (save for Vancouver's, which is a function of the others) but of course the most important factor would be establishing the rationale for the new rates – i.e., who would see decreases, by how much, and for what reason? As noted, the purpose of this paper is not to establish the 'best' share of revenue obligations.

Regardless of how the new rate is set, or the degree of variation deemed acceptable, some municipalities will see an increase, and as argued above, this may only be politically acceptable given alternative mechanisms for recouping greater amounts from other municipalities as their service increases. For the remaining analysis I use the concept of 'value capture' introduced in section 2.4 to focus on three ways to capture an increasing proportion revenues from municipalities where service increases over time.

Of course, the options below could each be avoided by repeatedly calibrating the level of the tax to reflect the proportionate share of total aggregate transit benefits held by each municipality. However, this is likely impossible to measure to the degree necessary to be accepted by all involved parties. There is enough of a variation in benefit across Metro Vancouver to accept the idea that there could be different tiers of tax rate. But ranking 21 municipalities based on the exact proportion of benefits accruing to them, and constantly changing this ranking and subsequent tax rates over time, seems a nearly impossible task.

5.4 Policy Options for Future Increases

Assuming that some recalibration of rates by municipality occurs and this results in some people paying more and some people (with less service) paying less, I examine three policy options. These are (1) Land Value tax; (2) Area-Benefiting Tax; and (3) Tax-Increment Financing. Each represents a way to shift a portion of the costs of future transit network expansion onto those who accrue the most direct benefit from the investment and subsequent effects on land values and/or land use. To consider the advantages and disadvantages in the application of each I consider how they might perform given three different transit-expansion scenarios: (1) Evergreen Line; (2) UBC Line; (3) Surrey Frequent Transit Network. A brief description of each expansion project or scenario follows. Each scenario represents the most specific examples of planned expansion of transit in the upcoming years.

5.4.1 Expansion Scenarios

Evergreen Line

This project is a rapid transit line that will connect Coquitlam to Vancouver via Port Moody and Burnaby. It is scheduled to begin construction in 2011. The estimate of total cost is $1.4 billion, with the regional share of funding approximately $400 million. The 2011 TransLink Supplemental Plan forecasted the revenue needed through property tax increases (absent of the introduction of a new funding mechanism) at $75 million in revenues per year.

UBC Line

This expansion will improve service along an already busy bus route in Vancouver, while incorporating peripheral areas into this rapid transit service. It will stretch from the east side across the entire city to the University Of British Columbia at the western terminus. The project is still in planning stages, so costs estimates vary widely among the six alternative plans proposed; the average capital cost for the options is $1.74 billion. For use in the simulations below, I assume that the 1/3 cost-sharing between federal, provincial, and municipal (TransLink) level governments will continue, so as to make the municipal share roughly $600 million. I use the $75 million deemed needed in the 2011 supplemental plan regarding the $400 million Evergreen Line costs as a basis suggesting that the revenue requirement for this project would be 1/3 higher at $100 million.

Surrey Frequent Transit Network

This scenario derives from TransLink's Surrey Rapid Transit Study, and while still in the first phase of study and so without cost estimates and other specific details, I have included as an example of upcoming expansion in an area we know is currently below the transit threshold. Because there are no public cost estimates, I use same cost as for the UBC Line.

5.5 Policy Option 1: Land Value Tax

The total assessed value of residential property is divided into two components, land and improvements (i.e. buildings), and it is the combined value of the land and improvements that form the total value for taxation purposes in Metro Vancouver – the $38.00 per $100,000 levied by TransLink is applied on both land and improvements and makes no distinction between the two. A land-value tax would shift the entire tax burden onto the land component (or continue to charge both components, but land at a higher rate).

The idea of land-value taxation dates back at least to Henry George's 1879 study "Poverty and Progress", where he argues that taxing land only rather than land and improvements would increase efficiency and equity. Modern advocates of the land-value tax those who think the transition to such a tax could limit urban sprawl because of the incentive to maximize returns from land (and so maximizing density). Others suggest the tax could replace income taxes as a more progressive tax (as the wealthy own much more land and realize significant surplus rents due to public investment). (Dye & England, 2010)

The motivation for examining a land-value tax does not rest in the idea of limiting sprawl or any other large impacts, however desirable they may be, because the proportion of total property tax accounted for by the transportation tax is too low to have the land use impacts that motivate advocates of pure land value taxation. I chose it because it is land value (and so the amount of property tax) that is a function of services and accessibility/travel costs at a given site, and not of the improvement portion, per se. For instance, the cost of a window or a door or an entire house should not fluctuate with access to services, but the desirability of land clearly does. The other main reason it is an option is that if implemented along with the rate change, it could act as an 'automatic' process for increasing tax share of municipalities as their transit access increases.

I say 'automatic' because over the next thirty years, forecasts predict an expected one million more people will settle in Metro Vancouver. As settlement patterns come to resemble those laid out in the regional planning documents, the relative price of land in real terms is likely to rise in municipalities throughout Metro Vancouver, and do so in areas of lower land values at rates faster than the rate of increase where the price of land is already relatively expensive, such as in Vancouver. If this increase in the real value of land rises in some proportion to transit upgrades, then a land value tax would work to capture value increases as they occur.

Figure 5, outlines more clearly the relationship between increasing revenues given growth in real value and a land value tax, by showing the proportion of my sample falling within a given 'land-to-total value' ratio – or the proportion of the total assessed value of a property accounted for by the land value. Organized by land-to-total value ratio, properties in Vancouver are distributed much differently than are properties in Surrey. The average ratio in Vancouver is 80% and in Surrey the mean ratio is 65%, meaning that many more properties in Surrey have closer to equal land and improvement values than in Vancouver, whereas many more properties in the Vancouver sample have their total-value highly dominated by the land-value component. But as the real price of land grows faster in Surrey then land in Vancouver (and faster than 'improvements' in either city) then the amount of tax revenue available at a given rate will increase accordingly, and grow at a quicker rate than if the tax is applied to both land and improvements.

Figure 5:

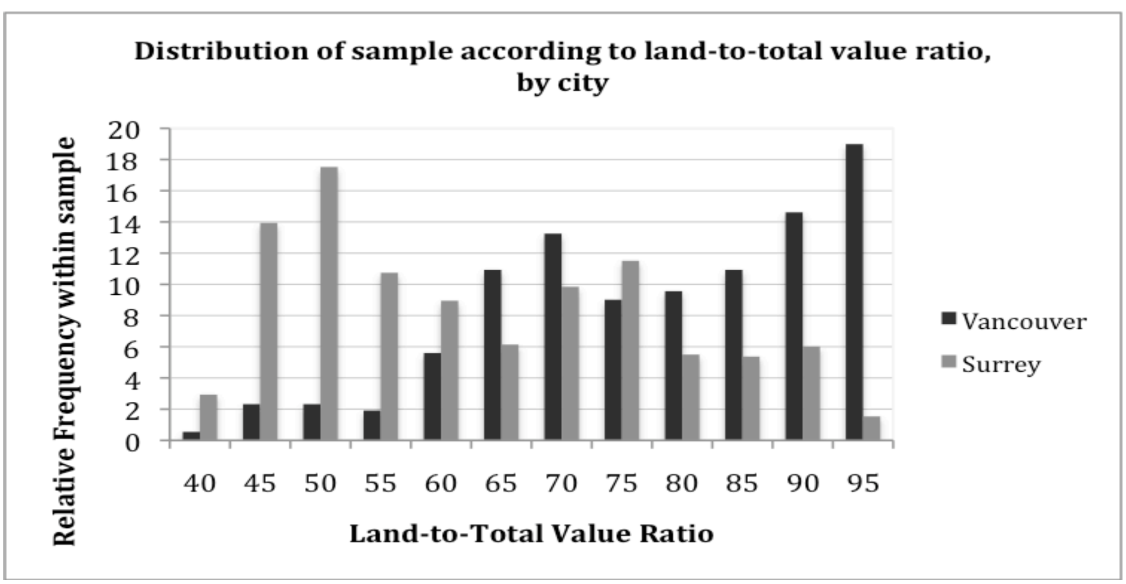
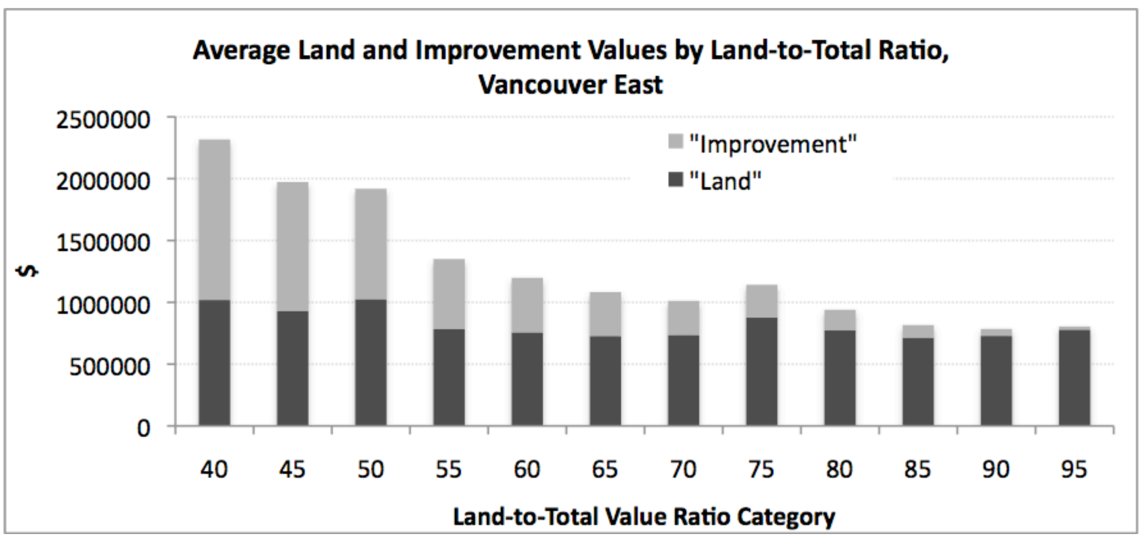


Figure 6 shows the relationship between the ratio category of a given person's property and their likely economic status; properties with low ratios have more expensive homes on them than do properties with high ratios, for example: low ratio properties in the Vancouver East sample (e.g. ratio category '40') have, on average, a $1.3 million house on a $1 million lot, whereas those with a high ratio have by definition much less valuable houses because of the low variation in the cost of land throughout Vancouver – at the ratio category 95, we see an average property consisting of a $24,000 house on an $800,000 lot. So when considering across municipalities the transition to a Land-Value-Tax would shift the tax onto municipalities with high land values from those with lower land values, but within municipalities the transition would shift tax burden from those with relatively expensive homes to those with far less valuable homes.

Figure 6



To further illustrate to how administratively complex and harmful with regards to vertical equity the transition to this type of tax would be, consider land value tax on three properties in Vancouver: one with a very high land/improvement ratio, one a low ratio, and one in which the land is worth exactly ½ of total value. If the new tax rate is set so that the median house sees no change in tax amount (by dividing the current tax rate by that ratio: (.00038)/(.5) =.00076) then properties with ratios greater then .5 would see their taxes increase, and those lower ratio would see their TransLink tax bill drop – see Table 7, below.

Table 7.Effect of a land-value tax on tax bill if rate set at revenue-neutral for median house

Land	Improvement	Ratio	Tax at Status quo	Land Tax	Change in tax
500,000	10,000	.98	$193	$380	+99%
500,000	500,000	.5	$380	$380	Neutral
500,000	1,000,000	.33	$570	$380	-33%

As we see from table 7, implementing this tax can be very regressive, by increasing the rate on high land/improvement ratio properties (low improvement value and likely lower income) and reducing if for those with low ratios (high improvement value, and likely higher incomes). Of course, the rate could be based on a different ratio class, but avoiding large increases in rate for high ratio (lower income) only leads to reduced total revenues. For instance, consider the same houses as Table 7 above, but with the tax based on providing revenue neutrality to the homeowner with the least expensive house. As we see in Table 8, below, the higher focal point for the initial transition would balance the tax bill for the owner of the $10,000 house (removing the regressive concerns) but only by cutting by half or more the taxes received from most others, and significantly reducing the total revenues.

Table 8. Effect of a land-value tax on tax bill if rate set at revenue-neutral for lowest-value home

Land	Improvement	Ratio	Tax at Status quo	Land Tax	Change in tax
500,000	10,000	.98	$193	$193	Neutral
500,000	500,000	.5	$380	$193	-96%
500,000	1,000,000	.33	$570	$193	-166%

A land value tax is appealing in that it would tie the tax directly to land values, which in a theoretical way is the preferable tax base, and it would allow for 'natural' adjustments to the proportion each municipality would be paying insofar as the increase in real land values mimics changes in transit access. However, the implications with regards to vertical equity along people of different economic classes are significant – tax burden within municipalities (or among any areas with similar average land values) would be shifted upon implementation from those with higher incomes to those with lower incomes (insomuch as lower incomes correlate to low improvement values). Granted, the negative effect of the transition to such a tax would only fall upon those who owned property at the time of transition, and so an argument could be made that once the increased tax is capitalized into the land value, than the willingness to pay for property will decrease, hence lowering the cost of housing for the next generation of property buyers. However, similar to the earlier refutation of the ability of the land value tax in the TransLink context to influence land use and lead to greater density, in this case too I think the actual sum of money represented by the transit share of property taxes is too small to alter greatly the value of housing, regardless of economic theory. Fundamentally, and inescapably, adopting a land value tax with regards to the TransLink portion of the property tax would mean the existence of a more regressive property tax than currently exists.

Policy Option 2: Area Benefiting Tax

An 'area benefiting tax' is a commonly referred to approach of value capture financing. Property owners in a given geographic area (those to whom the benefit is expected to accrue) pay an increased property tax for the length of an agreement to pay for a specified portion of costs. A recent U.S. government survey of the use of such tools in transit funding found that just 10 of 55 reporting agencies indicated use of special assessment districts, but when the mechanism had been used, it was typically for development of local streetcar systems – and it has proven to be quite successful at raising funds. For instance, the four-kilometre South Lake Union Streetcar in Seattle, WA. had 47% of the $53 million cost raised through a special assessment on property falling within roughly four blocks of the streetcar line. The city issued bonds to the transit developer and will repay them with the stream of funds from the property owners. (GAO, 2010)

5.6.1. Simulations Based on Expansion Scenarios:

The following simulations (Tables 9 – 11, below) compare changes in tax rate needed to fund the expansion scenarios, with and without an area benefiting tax in place. These are only simulations – and are simplified: they suppose an entire municipality to be the 'benefiting area' despite the likelihood that a narrower geographic definition would be closer to reality; also, the simulations are based on the current tax rate of 0.00038%, despite the premise being that this would be a policy implemented after a rate adjustment. The added calculations to improve upon the simplified aspects of the calculations are not needed – $38 is the average price per $100,000 of assessed value regardless, and any errors would only magnify the advantages and disadvantages revealed about this mechanism.

Table 9 – Evergreen Line Comparing a property tax increase with and without an area benefiting tax

Municipality	2010 Residential Property Tax Rate per $100,000	TransLink Property Tax Revenue-2010	2010 Revenue + $75,000,000	New Tax Rate
Scenario 1 – Evenly Shared				
Entire Region	$38.00 (Average)	$271,000,000	$346,000,000	$48.51 (+28%)
Scenario 2 – 50% of new revenue coming from area benefiting; 50% from all others				
Coquitlam & Port Moody	$38.00	$14,363,000	$51,863,000	$137.21 (+261%)
All others	$38.00	$256,637,000	$294,137,000	$43.55 (+15%)

Table 10 – UBC line Comparing a property tax increase with and without an area benefiting tax

Municipality	2010 Residential Property Tax Rate per $100,000	TransLink Property Tax Revenue-2010	2010 Revenue + $100,000,000	New Tax Rate
Scenario 1 – Evenly Shared				
Entire Region	$38.00	$271,000,000	$371,000,000	$52.00 (+36%)
Scenario 2 – 50% of new revenue coming from area benefiting; 50% from all others				
Vancouver	$38.00	$86,178,000	$136,178,000	$60.05 (+58%)
All others	$38.00	$184,822,000	$234,822,000	$48.28 (+27%)

Table 11– Surrey Frequent Transit Network - Comparing a property tax increase with and without an area benefiting tax

Municipality	2010 Residential Property Tax Rate per $100,000	TransLink Property Tax Revenue-2010	2010 Revenue + $100,000,000	New Tax Rate
Scenario 1 – Evenly Shared				
Entire Region	$38.00	$271,000,000	$371,000,000	$52.00 (+36%)
Scenario 2 - 50% of new revenue coming from area benefiting; 50% from all others				
Surrey	$38.00	$34,146,000	$84,146,000	$93.60 (+146%)
All others	$38.00	$236,854,000	$286,854,000	($46.00) (+21%)

Tables 9 – 11 show an important aspect of an area benefiting tax: when the benefiting area takes on a fixed proportion of costs, the impact on itself and other municipalities varies as a function of the benefiting area's proportion of total regional property values. Areas with higher property values (like Vancouver in the examples above) are more able to reduce the impact on the rest of the region for their cost of the project. From the three scenarios (Tables 9 – 11) we can compare the effects of each benefiting area by comparing the ratio of the percentage increase in tax rate for the benefiting area and the resulting smaller increase in other regions compared to the case where the area benefiting tax was not applied. For example, in Table 10, Vancouver accepting a 58% increase would reduce the impact on the others by 25% (a 27% increase, rather then a 36% increase for everyone if there was no area benefiting tax), this is a ratio of 2.32:1 and is the lowest of such ratios derived from the other area benefiting scenarios. Because the Evergreen Line example had the smallest benefiting area (in terms of proportional share of total regional property values) and so had the highest ratio, or the least efficiency at reducing others taxes by accepting costs: a 261% increase only reduced the impact on the others by 41%, a ratio of 5.67:1.

5.7 Policy Option 3: Tax Increment Financing

Tax increment financing is similar to the area-benefiting tax in that a particular area is expected to accrue benefits from public investment in transit infrastructure and redevelopment. But rather than decide on the amount upfront, the agreement concerns the diversion of increased taxes to fund the project (or a portion of it) – dependent on actual increases in property values to pay for the area-benefiting tax.

In the context of Metro Vancouver and transportation property tax, this would amount to a two-tiered tax rate for a benefiting area. Property values in a given area prior to investment are taxed at the current tax rate, and any incremental growth in property values are taxed a higher rate.

Use of the technique occurs in large-scale projects extending well beyond the provision of transit. In the United States, the process works by a public-sector agency issuing a bond to build infrastructure (including public transit) that encourages private and other development take place within a given area. As property values rise, the increment of value created is used to repay the initial development bonds. (GAO, 2010) For instance, a project proposed in Atlanta, the Atlanta Beltline, plans to use tax-increment financing to pay for 61% of the costs of building the thirty-five kilometre streetcar or light-rail and the associated 1,300 acres of parks, for a total of $1.6 billion dollars. Other tax increment schemes use pay back bonds for schools, roads, and other infrastructure. (GOA, 2010) This planned diversion of property tax does have an opportunity cost, i.e. the tax revenue could be put to other uses, and because of this, it can be difficult to implement over a large geographic area (CTOD).

To consider how this tool may function in Metro Vancouver consider first the UBC line expansion scenario. Imagine that this line increased transit values everywhere it serviced from their current levels to the maximum that currently exists system wide (TRANSIT=55). From the regressions, we see that moving from the mean amount of transit in Vancouver East to the maximum would yield about a 15% increase in property values. In Vancouver West (notwithstanding the statistical insignificance) a move from mean TRANSIT value (23 opportunities to access the system per 100 people from a given census tract) to the maximum TRANSIT value in the sample (55 'opportunities') would, according to the regression, raise property values by 2% increase, despite more a doubling of opportunities. This in no way reflects the actual nature of the increases that would arise from the UBC line, but merely shows the maximum values might change based on the current characteristics of transit-property value relationship as revealed with the regression.

Assuming changes in property values are as the regression would predict, could we rely on tax-increment financing to 'capture' a significant portion of project costs? For the UBC expansion scenario suppose property values and therefore tax revenue went up according to the regression estimates by an average of 7-10% (15% in the east and 2% in the west from above). Then what would the incremental tax rate need to be in order to raise a significant portion of the $100,000,000 outlined as required yearly revenue for the project? Put differently, what is total increase in property values we would expect to witness according to the regression, and what would the tax rate on that increment of value need to be set at in order to recover a significant portion of project costs. I cannot at this time calculate the total current residential property values for some hypothetical benefiting area around the UBC/Broadway corridor, and so I use an admittedly crude estimation that assumes that 10% of total residential property value in the city falls within the area that will accrue benefit. I think this is extremely generous and the actual value would be much lower.

Table 12 – Tax Increment Financing for UBC line

	Current Property Values (10% of total 2010 Vancouver property assessment roll)	Expected New value (Area total*10%)	Secondary Tax Rate in order to raise $50,000,000 (1/2 of yearly required revenue)
Benefiting Area – UBC Line	$18.8 Billion	$1.8 Billion	$2777 per $100,000 assessed value 73X the status quo tax rate

Table 12 shows that if the estimated size of the benefit and benefiting area are even close to accurate, this would be an impossible policy to implement. An announcement that within the given area (presumably an area where development is desired, given the investment of infrastructure and the wants of transit-oriented planning) the tax rate on any additional property value would be so high compared to the existing rate may actually act to drive demand downwards to the point whereby the entire policy collapses. The fact is that while the UBC line is very much anticipated in the region, it may not have a large impact on residential property values because of the already high property values and transit availability. The majority of what will be the UBC line is currently the province's busiest bus route, so it is not a transit-desert by any means.

In Surrey though, this could be a different story, and I admit, the calculations I use below are very generous in terms of the increases likely from the Surrey expansion scenario. In Table 13, I suppose that full ½ of the current residential property values in the city lie within an area that will benefit from the transit expansion. I further assume that this entire area would accrue value at the marginal rate the regression calculated for Vancouver-East – supposing that the Surrey Rapid Transit Network full pushes the benefiting area above the 'threshold' and achieves a maximum (as shown by the regression) growth of 40% in property values.

Table 13 – Tax Increment Financing For Surrey Rapid Transit Network

	Current Property Values (50% of total 2010 Surrey property assessment roll)	Expected New value (Area total*40%)	Secondary Tax Rate in order to raise $50,000,000 (1/2 of yearly required revenue)
Benefiting Area	$37.4 Billion	$14.9 Billion	.$334 per $100,000 assessed value 9X the status quo rate

5.8 Summary of Analysis

I analyzed the three options (Land Value Tax, Area-Benefiting Tax, and Tax-Increment Financing) to reveal their strengths and weakness with regards to their ability to raise revenue and to shift a portion of the responsibility for new costs from the entire region to the benefiting areas. I wanted to see if there were reasons why they would be particularly difficult to implement administratively, or if they created significant negative consequences, especially to vertical equity between people of different economic status. As evident in the previous section, they were not each analysed against the same criteria in an organized manner, but rather, each was explored for its advantages and disadvantages as an initial step towards designing value capture based tools for use in Metro Vancouver.

Table 14 compiles the relevant advantages and disadvantages revealed through the analysis above for each of the options. The land-value tax is complex administratively and raises significant equity issues, so I thus rule it out of consideration. The other two options (an area benefiting tax & tax-increment financing) have advantages in opposing situations. Where land values are relatively high and some adequate level of transit is already established, investment in transit may be highly valued, but that value may not be capitalized in property values. In this case an area-benefiting tax can work well. In areas where transit investment is likely to bring the area over the transit threshold and the benefits will be capitalized in increased property values, then tax-increment financing is an innovative way to capture surplus rents accruing to private land owners – given the taxing authority has a high level of certainty in the expected change in values due to the project. Both of these tools could prove useful for TransLink; however one needs a greater understanding of how transit and property values change with each other over time and across the region.

As a final note, each option would require changes to how TransLink is permitted to increase property tax revenues. As noted earlier, the *SCBCTA Act* allows for a 3% increase in property tax revenues per annum. To put these property tax based value capture mechanisms to best use, TransLink would need greater flexibility in terms of from which municipality increased revenues will come and the annual limits allowed under different circumstance (e.g. for tax increment financing, the revenue would need to be captured as it was created, which may not follow the 3% per year limit).

Table 14 – Advantages and Disadvantages of Policy Options

Land Value Tax	
Advantage	• Don't need to define the benefiting area • Makes intuitive sense because land values, and not improvement values, change with provision of services • Would naturally increase revenue from areas where the real growth in land values was higher then the growth in improvement value. Areas of relative low value in the region will grow faster then areas of already high value
Disadvantage	• Creates significant vertical equity concerns with regards to income class, by shifting some share of tax burden from those with relatively expensive houses to those with relatively inexpensive houses • Property values may change for any sort of reason throughout the region irrespective of any changes in Transit • Would create very erratic changes in taxes for many rate-payers, so would need to be phased in very slowly, and the administrative burden would be considerable
Area Benefiting Tax	
Advantage	• Relatively easy to implement • Relative certainty with regards to revenue expectation • Works well in an area where land values and/or transit service is uniform, because these areas are unlikely to change much in value regardless of transit expansion • Works best applied to a relatively small benefiting area
Disadvantage	• Defining the area could be difficult • If the area benefiting is small, but the cost of project high, this has little impact on the general increase even if benefiting area pays a substantial portion
Tax-Increment	
Advantage	• Based directly on real increases – pure value capture
Disadvantage	• The uncertainty present creates considerable financial risk, because if growth rates are not as high as expected the revenues will be accordingly reduced • Because the marginal effect of transit access upgrades in areas with high property values and pre-existing access is lower than areas with low land values and little transit, this tool would not work well in an area with already high property values

6: Findings, Recommendations, and Caveats

This study may serve as a pilot for the analysis of the relationship between the value of residential property and access to transportation. Access to data is limited by scope, but the study provides some insights valuable to transportation policy. My analysis derived from the hedonic study of the houses sold in portions of Vancouver and Surrey in 2010 and the assessment of alternatives to the property tax, lead me to the following conclusions:

- Assessed property values in Metro Vancouver reflect transit access under certain circumstances; however the effect is inconsistent and subject to many factors, so there is no system-wide variation in tax obligation due to access.
- The spectrum of transit-effects can be: (1) a negative or absent relationship, such as in Surrey where the disparate nature of the city and the low transit levels mean that people do not place a high economic value on living near transit. (2) The mid point of the spectrum, where many areas have transit well above the threshold but many others may fall below, and so the premium on having access is high, such as in Vancouver East. (3) The extreme stage, exhibited by Vancouver West, where the overall level is well above the threshold and so the marginal effect normalizes across the area, reducing the premium of any one spot versus another with regards to transit access. This area contains house prices so high that the modest effect of transit is subsumed by the total value and the elasticity of price with regards to all service attributes is weakened.
- When the transit-property value relationship is active (step '2' in the point above), considerable surplus rents may accrue to residential property owners.

- Because of the city's relative share of total regional property values, the transit authority could introduce a variable tax rate and remain revenue neutral even if Vancouver alone paid for the tax decrease in all other municipalities.
- Political feasibility or public acceptance of an agreement to increase some municipalities' taxes in order to reduce the tax rate for others would be increased if a simultaneous agreement set to have municipalities increase their proportion of the total revenues as their systems improve.
- Tax increment and area benefiting taxes (value capture mechanisms) could be a useful revenue stream for TransLink. These taxes require more analysis to help incorporate and understand the spectrum of transit-access property-value effects.

More Research Needed:

- The relationship between transit-access and property values needs to be much better understood for effective use of value capture mechanisms — with particular attention to time series and the interrelationship with commercial property value growth.
- My study uses residential property in the study and analysis. Residential property contributes approximately half of TransLink's total property tax revenue, so a fulsome approach would need to consider other forms of property as well.
- Studies in the literature suggest even higher marginal effects for condominiums and office/commercial buildings than typically seen among detached single family dwellings, and with the focus of increasing density (by building condominiums and commercial space) around transit lines and hubs, understanding the effect of transit on these types of properties (and how to capture value from them) would be very useful.
- Some attempt to fully quantify the costs and benefits for various regions arising from transit would be interesting. Basing it on access as I have is extremely narrow, and misses

the various other benefits accruing to the region. Given complete information, municipalities could be responsible for a proportion of costs respective to their share of total benefits accruing from public transportation across the entire region.

Appendices

Appendix I - Regression Output Tables

Table1 **-Dependent Variable: Assessed Value (Level in Spec#1 Logged in 2&3)(2010)**

Variable	**1**	**2**	**3**
TRANSIT	4814.36*** (5.753)	0.0023*** (3.610)	
Log TRANSIT			0.032*** (4.302)
AGE	-3420.90 (-10.537)	-0.0031*** (-12.706)	
Log AGE			-0.110*** (-19.585)
BED	-55809.14*** (-10.888)	-0.0335*** (-8.552)	
Log BED			-0.173*** (-9.037)
BATH	53516.51*** (7.441)	0.0549*** (9.987)	
Log BATH			0.107*** (6.399)
SQFT	131.718*** (12.511)	0.0001*** (17.342)	
Log SQFT			0.402*** (17.92)
LTSZ	35.971*** (11.445)	2.64E-05*** (10.976)	
Log LTSZ			0.316*** (20.650)
EAST	589111*** (29.742)	0.708*** (46.757)	0.764*** (51.583)
WEST	658979*** (31.96)	0.759*** (48.185)	0.818*** (53.166)
CTINC	7.497*** (19.444)	7.21E-06*** (24.44)	
Log CTINC			0.499*** (25.492)
DCBD	-20.873*** (-7.790)	-1.47E-05*** (-7.172)	
Log DCBD			-0.0544*** (-5.675)
C	-358916*** (-9.054)	12.154*** (401.03)	2.489*** (11.842)
#of OBS	1515	1515	1512
Adj R2	0.802	0.8860	0.900
Durban-Watson	2.004	1.977	1.989
F-Stat	617.14	1183.129	1390.262
White Test NR2	484.54	330.92	270.35

***Table 2*: Dependent Variable: LOG of Assessed Value (2010)**

Variable	**4**	**5**	**6**
LogTRANSIT/100capita			0.032*** (4.302)
Log TRANSIT/KM2		0.021*** (3.691)	
Log TRANSIT UNWEIGHTED	7.11E-05*** (5.728)		
Log AGE	-0.111*** (19.612)	-0.111*** (-19.55)	-0.110*** (-19.585)
Log BED	-0.179*** (-9.942(	-0.180*** (-9.902)	-0.173*** (-9.037)
Log BATH	0.108*** (6.216)	0.108*** (6.142)	0.107*** (6.399)
Log SQFT	0.398*** (17.605)	0.400*** (17.515)	0.402*** (17.92)
Log LTSZ	0.316*** (21.090)	0.318*** (21.092)	0.316*** (20.650)
EAST	0.744*** (48.454)	0.762*** (47.862)	0.764*** (51.583)
WEST	0.810*** (52.901)	0.813*** (46.870)	0.818*** (53.166)
Log CTINC	0.492*** (24.981)	0.524*** (25.719)	0.499*** (25.492)
Log DCBD	-0.055*** (-5.862)	-0.059*** (-6.260)	0.0544*** (-5.675)
C	2.630*** (11.848)	2.200*** (8.822)	2.489*** (11.842)
#of OBS	1512	1512	1512
Adj R2	0.900	0.898	0.900
Durban-Watson	2.001	2.085	1.989
F-Stat	1375.41	1492.60	1390.262
White Test NR2	286.67	266.31	270.35

Appendix II. Satisfying the classical assumptions of OLS

In order to consider Ordinary Least Squares (OLS) to be the best available estimator, a number of assumptions regarding the data set and the behaviour of the stochastic error term must be met. Each of these 'Classical Assumptions' is addressed below.

I – "The regression model is linear, is correctly specified, and has an additive error term."

The independent variables were chosen from the literature, as was the basic specification; error term present.

II –"The error term has a zero population mean."

The mean value for the residual is -2.58e-15; very close to zero.

III – "All explanatory variables are uncorrelated with the error term."

Correlation	RESID1
RESID1	1.000000
_BATH	0.010797
_BED	-0.026216
AGE	2.21E-14
CBD	0.049857
CTINC	-0.007198
MUN	3.11E-14
LTSZ	1.23E-13
OP100	-0.010627
SQFT	-3.16E-14

IV – "Observations of the error term are uncorrelated with each other (no serial correlations)."

There is no reason why, once placed in random order, the error (between the actual value of the case and the predicted by the formula value) of one house would influence the next. This is verified with the use of the Durban-Watson test. The final regression had a d-stat of 2.005, which indicates no reason to suspect serial correlation in the data set.

V – *"*The error term has a constant variance (no heteroskedasticity)"

As discussed in the body of this paper, the White test indicated heteroskedasticity. I attempted to correct for this, albeit unsuccessfully. The final results rely on Eview's 'Heteroskedasticity Consistent Standard Errors'. As a reminder, heteroskedasticity can bias the size of the standard errors (and thus the t-test) but not the coefficients.

VI – *"*No explanatory variable is a perfect linear function of any other explanatory variable(s) (no perfect multicolinearity*)"*

	BED	**BATH**	**AGE**	**SQFT**	**LTSZ**	**CTINC**	**TRANSIT**	**CBD**
BED	*1*							
BATH	***0.659***	**1**						
AGE	-0.375	-0.556	**1**					
SQFT	***0.615***	**0.773**	-0.360	**1**				
LTSZ	0.133	0.168	-0.083	0.444	**1**			
CTINC	-0.1206	0.096	0.087	0.240	0.149	**1**		
TRANSIT	-0.093	0.001	0.309	0.053	-0.061	0.285	**1**	
CBD	-0.018	0.064	-0.186	-0.021	-0.207	0.114	0.153	1

The correlations above show that the closest relationship is between the variables SQFT, BED, and BATH. Clearly the number of bedrooms and bathrooms often affects the size of a house, so this is expected.

VII – “The error term is normally distributed.”

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