Transit and Land Value Uplift: An Introduction

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1 Introduction

Public transit infrastructure investment, particularly rail infrastructure, is widely expected to have an influence on residential and commercial property values expressed through sales price and rents. The strength of the relationship between transit and land value, the mitigating factors and supporting conditions have been the subject of a wide body of literature in the transportation, planning and economic academic literature for decades. Land value uplift is expected as the travel time-savings provided by transport infrastructure are capitalized into the land surrounding transport nodes. Further, land value uplift may be found from the knock-on effects of a transit node, such as a concentration of shops around a rail station, redesign of the area around the transit node and development supportive policies. As promoters of public transit look to expand beyond traditional funding sources land value capture (LVC) mechanisms are attracting attention. The basic concept of LVC is to use taxation mechanisms and/or public private partnerships based on the land value uplift associated with transit to pay for the infrastructure that created the value.This document provides an introduction to the relationship between transit, land value and land value capture.

The literature exploring the relationship between land value and transport infrastructure, and rail public transit infrastructure in particular, is large. This is illustrated by the growing body of review articles and meta-analyses on the topic (Cervero and Duncan 2002; Smith and Gihring 2006; Debrezion, Pels, and Rietveld 2007; Bartholomew and Ewing 2011; Banister and Thurstain-Goodwin 2011; Mohammad et al. 2013). Even in the 1980's the body of literature exploring this topic was considered vast (Bajic 1983). In addition to the review articles referenced above, McIntosh and colleagues include a detailed summary table by mode of land value studies around the world for different transit modes from BRT to commuter rail and makes a valuable summary reference, despite not being formally a review paper (McIntosh, Trubka, and Newman 2014). The large body of literature, however, has not led to agreement on the relationship between provision of public transit and land value uplift. The findings range from a 19% decrease up to a 120% increase in land value (Bowes and Ihlanfeldt 2001; Cervero and Duncan 2002). The findings vary with the methods used, the type of infrastructure considered, the location studied and the outside factors considered. This summary explores the observed changes in the land value, the approaches used to calculated land value uplift and mitigating factors effecting capitalization of transit into land values discussed in the literature. The body of literature surrounding land value capture and transit is smaller but growing as more cities consider LVC to find their transit priorities.

This summary does not attempt to provide a comprehensive overview of the literature in this field. Focus has been placed on literature published since 2000, research that explores locations relevant to the Toronto context – namely those in North America, the United Kingdom and Australia – and seminal, widely referenced papers in the field. Older literature, and that from countries with very different cultural contexts were thought to be of reduced value for informing a Toronto-based model. For more detail we recommend three papers which provide high level but detailed summaries of the state of the art in transit and land value: (1) Debrezion, Pels, and Rietveld 2007, (2) Bartholomew and Ewing 2011 and (3) Mohammad et al. 2013. For more on LVC, we suggested Medda 2012 as a starting point.

The structure of this summary is as follows: Section 2 provides a summary of recent findings in the transit-land value literature, an introduction to the methods used in such assessments, and a discussion of the relationship between neighbourhood design and transit's impact on land value. Section 3 provides a high level summary of land value capture mechanisms and their use in transit development. Section 4 identifies outstanding questions that will inform modelling and estimates of the interactions between transit infrastructure provision, land value uplift and land value capture in the GTHA.

2 Transit and Land Value: Summary of Findings

The majority of papers that assess the relationship between rail transit and land value find an increase in land value associated with being near a rail station. TABLE 1 summarizes the findings of 17 such papers. Most of the listed papers were published this millennium, with the exception of work by Dewees in 1976 and Bajic in 1983, included since they are Toronto-based. The findings range significantly from place to place. Hess and Almeida (2007) and Bowes and Ihlanfeldt (2001) found that the provision of rail in low-income neighbourhoods lowered the value of housing. In both LA (residential) and in Chicago (industrial) being close to rail had no effect on land values. The majority of the reviewed papers, however, did find a positive effect of rail on land value. In a 2007 meta-analysis, Debrezion and colleagues found that on average the price of housing near rail increased by 4.3% and by 16.4% for commercial property. Work carried out since in Charlotte, NC, Hamburg, Germany and Montreal, QC has found similar scale impacts, with a 40% increase in Perth Australia an outlier. The different ways findings are presented in the literature – as percent increases, as change in value with changing distance, as monetary value changes – make comparison difficult between some studies. The literature does highlight that commercial values tend to go up more than residential ones, condominiums more than single-family homes and land near heavy rail more than light rail.

The four studies reviewed in the Toronto area found mixed results. Dewees (1976) and Bajic (1983) found increased housing values associated with proximity to the TTC Subway. Haider and Miller (2000), however, found minimal explanatory impact of including proximity to metro as a factor in their land value model. Higgins and Kanaroglou found minimal impacts and a possible disamenity of transit accessibility when separated from the effects of neighbourhood design and characteristics. They found that transit-oriented design had a significant impact on land value and that for single family homes preferences for a more suburban character may drive value (Higgins and Kanaroglou 2015). In Ottawa, the other Ontario example, while overall the influence of light rail of land value was considered positive, the impact varied from positive to negative in different areas along the route (Hewitt and Hewitt 2012).

The high level summaries in TABLE 1 obscure the variations in land value impacts observed with distance from the studied transit stations, neighbourhood income and distance from the central business district (CBD). Radial distance from a station, distance from the CBD and local socio-economic factors all have strong influences on land value effects.

Areas within 200 m of a station are often unchanged from areas more than 800 m away. In a meta-analysis the largest impacts on land value were found to be between 500 and 800 m from stations (Mohammad et al. 2013). The lack of uplift or even decreases in value found directly adjacent to rail stations is due to the disamenities associated with rail lines and stations. These include noise and crime, and have a particularly strong impact at park and ride stations where the parking-lot itself is associated with land value suppression (Bowes and Ihlanfeldt 2001; Bartholomew and Ewing 2011; Mohammad et al. 2013). Neighbourhood income is similarly related to value uplift. In US studies, higher-income neighbourhoods saw larger value increases. This is surprising given the expectation that lower-income people, with commensurate less access to automobiles, would place more value on public transit access (Hess and Almeida 2007; Bowes and Ihlanfeldt 2001). In Buffalo, high income neighbourhoods with rail saw a change in housing value 41% points larger than low income neighbourhoods with rail (Hess and Almeida 2007). By contrast research in the UK found the opposite, with poorer neighbourhoods seeing a land value benefit five times greater than average (Du and Mulley 2012).

Distance from the CBD was also a strong influence on the impact of rail in most cases in which it was examined. In general, rail stations had more impact with increasing distance from the CBD. This finding was consistent with expectations as the advantages of increased travel speeds are larger when the travel distance is longer (Cervero and Duncan 2002; Bartholomew and Ewing 2011; Dubé, Thériault, and Des Rosiers 2013). Increasing value with increasing distance from the CBD has it limits, for commuter rail in Montreal the largest increase in land value was observed within 2 driving minutes of the metro, 10 to 20 km from the CDB. Below 10 km and above 20 km the impact decreased (Dubé, Thériault, and Des Rosiers 2013).

TABLE 1: Land Value Uplift: Examples from the Literature

Year	Location	Source	Infrastructure	Infrastructure Type	Land Use	Change in Land Value	Assessment Method
1976	Toronto, Ontario	(Dewees 1976)	Bloor-Danforth Subway replacing streetcar	Metro Rail	Residential	50% increase in slope of property values parallel to Bloor. No change in slope along Bloor.	Before and after multivariate hedonic regression
1983	Toronto, Ontario	(Bajic 1983)	Spadina Subway Extension	Metro Rail	Residential	Average house near the subway increased by $2,237	Binary logit model
2000	Boston, Atlanta, Chicago, Portland and Washington D.C., USA	(Baum-Snow and Kahn 2000)	Metro in Boston, Atlanta, Chicago, Portland and Washington, D.C.	Metro rail	Residential	A decrease in distance to the nearest metro from 3 km to 1 km increased rents by $19/month and housing values by $4972	Time series hedonic model
2000	Toronto, Ontario	(Haider and Miller 2000)	TTC Subway	Metro Rail	Residential	Property values higher near subway stations but including proximity to subway variable didn't improve the explanatory power of the model	Spatial Autoregressive Models
2001	Atlanta	(Bowes and Ihlanfeldt 2001)	MARTA rail stations	Metro Rail	Residential	Up to 19% decrease in land value within 1/4 mile for single-family homes. Biggest improvement in land value at 1/4 to 1/2 mile from station, far from the CBD, with high income	Hedonic price model plus regressions for crime and retail impact
2002	Santa Clara, California	(Cervero and Duncan 2002)	Caltrain and Santa Clara County LRT	Commuter Rail and LRT	Commercial	120% increase within 1/4 mile of commuter rail; 23% increases within 1/4 of LRT.	Multivariate hedonic regression
2005	London, UK	(Gibbons and Machin 2005)	Jubilee Line Extension and Dockland Light Railway	Metro Rail and LRT	Residential	9.3% increase near rail stations	Difference in Difference and Quasi-experimental before-after analysis
2007	Meta analysis	(Debrezion, Pels, and Rietveld 2007)	Meta analysis	Metro rail, commuter rail, LRT and BRT	Residential and Commercial	4.2% premium on residences in railway zone; 16.4% premium for commercial property	Regression based meta-analysis
2007	Buffalo, New York	(Hess and Almeida 2007)	Buffalo Metro Rail	LRT	Residential	$1300 to $3000 USD increase in house value within 1/2 miles of station. Negative impacts in low income neighbourhoods	Multivariate hedonic regression
2009	Los Angeles, California	(Redfearn 2009)	Los Angeles Light Rail	LRT	Residential	No effect	Locally Weighted Regression
2011	Charlotte, NC	(Billings 2011)	South Line LRT	LRT	Residential	Hedonic: 4.0% increase in single family home prices within 1 mile. 11.3% increase in condo prices within 1 mile or LRT, 13.4% within 1/2 mile. Repeat Sales: 4.0 to 10.6% increase for single family homes. 9.0 to 30.2% for condominiums.	Hedonic regression and repeat sales analysis
2012	Hamburg, Germany	(Brandt and Maennig 2012)	Hamburg railway network.	Commuter Rail and Metro Rail	Residential, condos	Maximum premium of 4.6% found 230-750 m from rail station	Hedonic regression model
2012	Ottawa, Ontario	(Hewitt and Hewitt 2012)	O - Train	LRT	Residential	Maximum benefit of $12.06 to $42.99 per meter proximity	GWMR Model
2013	Montreal, Quebec	(Dubé, Thériault, and Des Rosiers 2013)	South Shore CRT	Commuter Rail	Residential	11% increase in direct vicinity of station; 2.6% increase in housing values in the entire South Shore	Difference in difference hedonic model
2014	Perth, Western Australia	(McIntosh, Trubka, and Newman 2014)	Perth Rail Network	Metro Rail	Residential	Land value increase up to 40%	Cross-sectional and hedonic regression models
2014	Montreal, Quebec	(Dubé et al. 2014)	North Shore CRT	Commuter Rail	Residential	5.2% increase for houses nearest the station (0 to 500 m)	Spatial Difference-in-Difference Hedonic Model
2016	Chicago, Illinois	(Clark and Pennington-Cross 2016)	Metra Rail	Commuter Rail	Industrial	No effect	Multivariate hedonic regression
2016	Toronto, Ontario	(Higgins and Kanaroglou 2015)	TTC	Metro Rail	Residential	Including TOD, up to 2!% increase. No effect or dissamenity from transit access alone.	Hedonic price modelling

2.1 Calculation methods

The most common method used to assess the observed relationship between transit and land value is multivariate hedonic price modeling. The hedonic method is based on the understanding that the value of land and buildings is based on many factors, including those intrinsic to the property (e.g. size, number of bedrooms, number of bathrooms) and extrinsic factors related to where it is located (e.g. neighbourhood characteristics, the local economy, the view) (Rosen 1974; Bartholomew and Ewing 2011). Hedonic modeling is a method for assessing revealed preference (RP). Generally, hedonic price models take the form:

$$P_i = f(T, N, L, C)$$

Where:

P_i is the estimated price

T measures the proximity to transport facilities

N expresses neighbourhood characteristics

L is a measure of location and regional accessibility attributes

C is a control for fixed variable effects (Cervero and Duncan 2002).

While hedonic models are the most common method and continue to be used, there is growing criticism that they conflate the effects of different externalities. The most common hedonic price modelling approach is to perform regressions for a single year cross-sectional analysis; others have modified the approach to include multi-year panel data, quasi-experimental analysis and local spatial effects. In a cross-sectional analysis it may not be possible to separated the change in value associated with rail from other aspects of the neighbourhood such as roadway noise, crime or retail amenities. A common extension is to use hedonic modeling in more than one time period, and/or to examine and area before and after opening of public transit. Dewees (1976) and Baum-Snow and Kahn (2000) took advantages of natural experiments to examine the change associated with the opening of a new rail by doing before and after analyses (Dewees 1976; Baum-Snow and Kahn 2000). Mcintosh et al. (2014) highlight the need for time series data, in their work a single cross-sectional analysis would have indicated no-effect or a depression of value around rail stations where the time series data indicated large gains in value associated with rail. This was due to the co-locating of the studied rail line with a highway which had a strong negative impacts on nearby land values (McIntosh, Trubka, and Newman 2014). Gibbons and Machin (2005) apply a difference and difference hedonic method to areas before and after a change in transport policy (Gibbons and Machin 2005). A similar approach is also adopted by Dube et al in their work around Montreal, QC (Dubé, Thériault, and Des Rosiers 2013; Dubé et al. 2014). Redfearn, 2009, argues that the hedonic model fails to capture changes in housing value with time and location and proposes that the large variations in the literature result from changes in the structure of hedonic values used. He proposes Locally Weighted Regression (LWR) as an improved method, where a sample of close observations only are used to generate the control estimates of price (Redfearn 2009). While Redfearn proposes that the different assessments of the capitalization of rail into land value are due to flaws in application of hedonic modelling, it seems likely that they are in a large part due to the different amounts of accessibility provided by different rail systems and the differing value people assign to rail accessibility in different times and places.

2.2 Neighbourhood form and its relationship with rail and value

The type of land use and urban form near a rail station has important implications on the observed land values. For instance, in places where the neighbourhood form near the station is pedestrian friendly, larger increases in land value are seen near the station. Where large parking lots provide park and ride facilities but limit pedestrian accessibility, the value of land adjacent to the station is suppressed but the value of land within near driving distance may increase (Billings 2011). Transit oriented rather than transit adjacent land uses are critical to maximize land vale uplift (Bartholomew and Ewing 2011). In Hong Kong, stations with TOD developments saw increases in land value of 30% compared to non-TOD stations (Cervero and Murakami 2009).

The impact of being near other types of transit infrastructure, like highways can also have an strong impact on land value (Seo, Golub, and Kuby 2014; McIntosh, Trubka, and Newman 2014). The suppression impacts of road infrastructure on land value near transit manifests in a number of ways: (i) the noise and pollution associated with roads can extend to the rail catchment area if they are collocated depressing land value, and (ii) people appear to value rail less where there are other transport options (Mohammad et al. 2013).

There are also negative potentials associated with new rail and increased land value through its relationship with neighbourhood change. In both Montreal and Toronto being close to rail transit is associated with neighbourhood gentrification (Grube-Cavers and Patterson 2014). Transit accessibility and TOD design are very popular with higher income earners. This can lead to the pushing out of lower income and or long-term residents as transit brings redevelopment to an area. In a study of business perceptions of transit, lower sales companies and those with immigrant clientele had lower perceptions of the value of transit. Similarly older businesses were more wary of rail, likely with reason given the indications of higher rents near rail stations (Fan and Guthrie 2013). In a holistic, or triple bottom, line assessment of the relationship between rail and land value the negative impacts of neighbourhood change should be considered.

3 Land Value Capture

Due to the relationship between new transit infrastructure, increased accessibility and associated increases in land value, interest has been growing in the concept of land value capture (LVC) (Levinson and Istrate 2011; Medda 2012).

Functionally, this means the use of taxation or the charging of fees to return some of the benefit associated with the new transit infrastructure to the government, thereby providing financing for the project and supporting future infrastructure expansion. Medda (2012) highlights three general types of LVC:

1) Betterment tax;
2) Accessibility increment contribution (AIC), and;
3) Joint development mechanism.

Betterment tax is a direct levee on the beneficiaries of the amenities provided by a new transit project (not just users). Since they are targeted at those who benefit, betterment taxes are seen as equitable and easy to understand. However, they can be difficult to establish, as accurate assessments of who is benefiting from the new infrastructure and how much they are each benefiting are needed. AIC is based on the assumption that the public investment will encourage growth in an area. The financial impacts of this growth can then be captured and used locally. The most well known AIC is tax increment financing (TIF) which captures future revenue from growth with no change in the existing tax level. TIF is often criticized for diverting tax income away for existing needs (like schools) to local infrastructure. In a joint development project the public sector encourages private development near transit stations that will share construction costs or provide leasing income with an aim to mutual private and public benefit and does not require a taxation regime (Medda 2012).

The choice between LVC mechanisms is very dependant on place and time with betterment taxes and AICs being best suited to places with robust demand for development and increasing land values (Medda 2012; Zhao, Das, and Larson 2011). The decision to use an LVC must depend on balancing the political viability, administrative complexity, the equity of a proposed scheme, and the capital, operation and other funding needs of the project in question (Levinson and Istrate 2011).

LVC is not currently widely used in Canada to fund transit infrastructure but it has been used in the past extending back to construction of the railway (National Bank of Canada 2014). In its 2013 funding strategy Metrolinx, the regional transit body for the Greater Toronto-Hamilton Area (GTHA), suggested a $20 million contribution from LVC, however these strategies have yet to be deployed (Metrolinx 2013). In the 1990s a development charge, a type of LVC, was used in North York (now part of the City of Toronto), Ontario to save the Sheppard Subway from cancellation (Swainson 1996). A version of LVC is being used in London to fund part of the construction costs of Crossrail as a type of betterment tax on all businesses properties. However, in contrast to the concept that LVC tools should be equitable the Business Rate Supplement in London is applied equally across the city without accounting for the areas most likely to benefit from the Crossrail project (Roukouni and Medda 2012). A similar universal tax is being used in Toronto to fund part of the planned Scarborough Subway.

The amount of money raised from an LVC depends on the type used, how it is structured and external factors influencing the real estate market. In an examination of joint development projects in the U.S.A, Mather and Smith (2013) found that the amount and stability of revenue varied widely depending on the real estate market and the type of agreement established (Mathur and Smith 2013). Also of concern is the way an LVC can negatively influence development, for example by encouraging developers to site their projects just outside the LVC boundary. Modelling the income generating potential of LVC in Toronto will require an estimation of these negative incentives.

4 More questions

It appears from the literature that, on average, land values are increased by the provision of rapid transit. This is especially the case when land use planning and transportation planning are coordinated and transit oriented development promoted. Successful implementation of LVC requires that the land around metro stations actually goes up and can be accurately estimated in advance, especially for betterment tax and AIC mechanisms. For application in the GTHA context there are a number of outstanding questions not sufficiently addressed in the literature, these include:

1) What is the impact of current urbanization trends on the relationship between transport infrastructure and land use? A 2014 survey of housing preferences in the GTA found that 81% of people would prefer to live in a transit oriented pedestrian friendly area, if they could afford it. In addition 42% of people would choose a smaller house or condo to live where it is possible to commute by transit, up from 39% two years earlier (Pembina Institute 2014). Much of the literature on the relationship between transit and land use is decades old. Even the recent literature listed in TABLE 1 often used data from the 1990s or earlier. Given the current stated preferences for transit-oriented living, does the older literature reflect current values and willingness to pay?
2) What is the impact of station supply on land value? Toronto is a weak rail city with limited rail stops (Kenworthy 2008) and, as mentioned above, a large proportion of the population that wants to live near rapid transit. The transit-land value literature includes cities with varying levels of rail supply. The literature has not satisfactorily addressed the relationship between station supply and land value. On one hand, a network with more stations would provide greater accessibility and connections to more locations that could increase land value. On the other, more stations mean there are more options for living and working near transit, a larger supply, which could decrease the premium of land near stations.
3) The literature discussed the externalities that impacted the realization of land value (e.g. neighbourhood income, crime, retail, proximity to other forms of transport) but did not identify methods for siting new stations to maximize land value uplift. Given the long-term interest in using land value capture to fund transit expansion in the GTHA this seems an important area of research. The literature on transit stations and density, which is

somewhat analogous to land value, identifies factors that effect densification around stations like, large plots of land available for redevelopment, government provision of anchor tenants and supportive public policy to drive development to the stations (R. Knight and Trygg 1977; R. L. Knight 1980). Are these the same factors that influence potential land value uplift? What are the measurable advance factors that will determine the realization of land value uplift around a station?

4) How sensitive are GTHA developers to the extra costs associated with LVC mechanisms, would it discourage concentrated development around stations? Does this vary by location?

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