UNBUNDLING THE HEDONIC PRICE EFFECTS OF RAPID TRANSIT AND TRANSIT-ORIENTED DEVELOPMENT IN TORONTO

Christopher D Higgins, McMaster Institute for Transportation and Logistics
Pavlos S Kanaroglou, McMaster Institute for Transportation and Logistics

Introduction

Determining the amount of land value uplift (LVU) produced by rapid transit infrastructure is of great importance to planners and policymakers. In the most basic sense, LVU acts as a proxy that provides tangible evidence of a rapid transit project's larger benefits to society. While there can be many such benefits, we focus here on two primary ones: an improvement in transportation accessibility and changes in land use around transit stations. There are clear rationales for expecting such LVU impacts. From accessibility, the standard urban model of Alonso (1964), Muth (1969), and Mills (1972), or the AMM model, postulates that the spatial distribution of transportation costs in terms of time, money, or even stress, are primary drivers of differences in land values over space. If a rapid transit facility can offer an improvement in accessibility and reduction in transportation costs, it stands to reason that land values around stations should increase. Because most transit trips begin and end on foot, the spatial extent of LVU should peak at stations and generally dissipate over a short distance, typically operationalized as a 10-minute walk from a station or about 800 metres (Guerra et al., 2013).

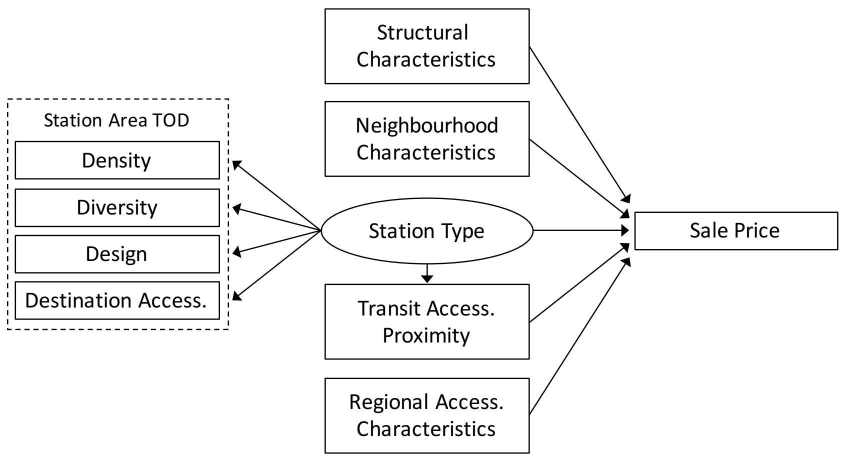
For land use, the trend towards coordinated land use and transportation planning for many rapid transit projects can result in additional price effects from transit-oriented development (TOD), which generally refers to high-density, mixed-use, amenity-rich, and pedestrian-friendly development around rapid transit stations. In terms of LVU, the type of lifestyle offered through TOD implementations is said to be particularly valued by specific cohorts of the population, namely young professionals, empty-nesters, and recent immigrants (Cervero et al., 2004; Dittmar et al., 2004), especially in the age of the 'consumer city' detailed by Glaeser et al. (2001). Indeed, previous literature has demonstrated positive land value changes associated with aspects of TOD (Bartholomew & Ewing, 2011). In many ways this phenomenon relates to Tiebout's (1956) theory of sorting, wherein individuals self-select their location based on the best fit between local characteristics and individual preferences.

Taken together, this essentially means that that transit accessibility and TOD result in a bundle of goods around transit stations, one that is simultaneous and potentially self-reinforcing. Using the example of the Yonge-University-Spadina (Line 1) and Sheppard (Line 4) heavy rail transit (HRT) lines in the City of Toronto, we utilize spatial hedonic regression to isolate the effects of transit and TOD on single-detached home values. To overcome the issue of heterogeneity in implementations of station area TOD the present research adopts the TOD typology method proposed by Higgins and Kanaroglou (2016) to segment and control for different TOD contexts directly. Results show significant LVU effects for transit and TOD, though as hypothesized, these effects vary by the type of station area TOD. This suggests that transit access and TOD create different bundles of local goods and that individual sorting is at least partly responsible for the increases in land value seen within them.

Modelling Approach

We adopt the model structure depicted in Figure 1. Here, independent variables reflecting structural, neighbourhood, and location characteristics are regressed on the dependent variable of sale price to control for their effects. To reveal the capitalization of transit access and TOD into land values, we adopt a twostage approach with three measures. First, like other models in this research area we operationalize transit accessibility as a parcel's proximity to a transit station and model this effect directly.

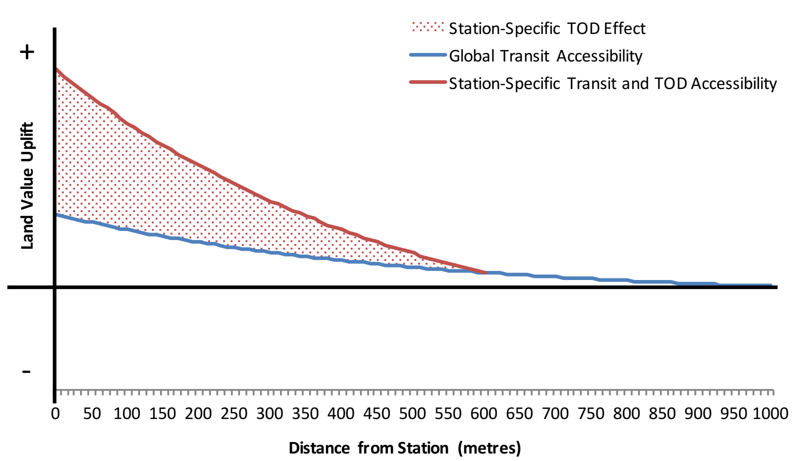
Figure 1. Model Structure



However, we break with previous studies by including a second key variable that controls for the LVU effects of heterogeneous station area TOD contexts. Using the latent class analysis method proposed in Higgins and Kanaroglou (2016), we incorporate a measurement model that distils several attributes of station area TOD into a latent categorical variable that corresponds to more homogeneous station types. From this, the categorical variable for each station type enters the model directly to isolate the value placed on different bundles of TOD characteristics.

Furthermore, if implementations of TOD radiate outwards from the transit station, it is reasonable to assume that a home's proximity to TOD is also important. Here our third key variable consists of an interaction effect between station proximity and station area TOD that should account for any such additional synergies or multiplier effects between station-specific transit accessibility and proximity to any TOD amenities.

Figure 2. Expected Relationship between Land Values and Transit and TOD



Together the three variables account for basic levels of accessibility common to all station types, a TOD effect specific to each station type, and any additional synergies that result from proximity to different bundles of transit and TOD. The combined end result is theorized to resemble that in Figure 2, where the measure of global transit accessibility produces a negative non-linear relationship wherein land values decrease the further a home is away from a station. A station-specific TOD effect should represent the more localized value placed on a location within walking distance of different packages of TOD characteristics over and above base transit accessibility. Finally, the interaction effect measures the rate at which this additional localized TOD effect decays over space as distance from the station increases.

Sample and Study Area

The study area consists of two intersecting HRT lines in the City of Toronto (Figure 3). The sample consists of homes located within 1 kilometre of these lines. Real estate transaction data for single-detached homes within the study area have been obtained over two time periods: 2001 to 2003, and 2010 to 2014.

Figure 3. Study Area and Sale Transactions by Station Type (2010-2014 Sample)

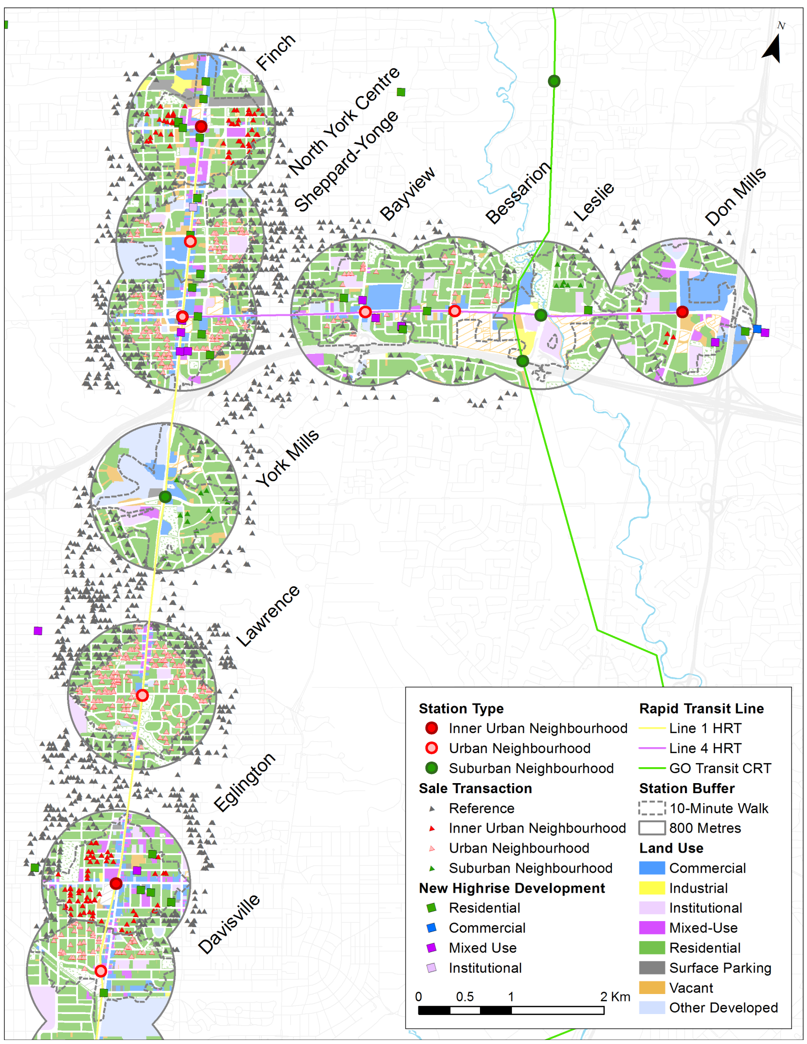


Table 1. Spatial Hedonic Model Results

Variable	Model 1c: 2001-2003 Coefficient	Model 2c: 2010-2014 Coefficient
Transit Proximity and TOD		
Station Distance	0.000072 **	0.000097 ***
10-Minute Walk (0-1)	-	-
10-Min. Walk * Station Dist.	-	-
Urban Mixed-Use Core (0-1)	-	0.010617
Urb Mix-Use Core * Stn Dist.	-	0.000108
Inner Urban Nhbd. (0-1)	0.188513 **	0.176733 **
Inner Urban * Station Dist.	-0.000284 **	-0.000317 **
Urban Nhbd. (0-1)	0.153191 ***	0.196407 ***
Urban Nhbd. * Station Dist.	-0.000249 ***	-0.000267 ***
Suburban Nhbd. (0-1)	0.402231 **	0.040151
Suburb. Nhbd. * Station Dist.	-0.000777 ***	-0.000118
GO Suburb. Nhbd. (0-1)	0.151021	-0.899142 *
GO Sub. Nhbd. * Stn. Dist.	-0.000396	0.001516
Structural Characteristics		
Structure Age	-0.003385 ***	-0.008719 ***
Structure Age^2	0.000039 ***	0.000080 ***
Lot Area	0.000124 ***	0.000110 ***
Floor Area	0.000184 ***	0.000140 ***
Finished Basement Area	-0.000031 **	0.000058 ***
No. Bedrooms	0.007485	-0.012618
No. Full Baths	0.054767 ***	0.015519 *
No. Half Baths	0.061186 ***	0.037709 ***
Attached Garage (0-1)	-0.015296	0.017705
Detached Garage (0-1)	0.015117	0.031987 **
Air Conditioning (0-1)	-	0.002126
Heat – Forced Air (0-1)	-0.021347 **	-0.009125
Pool (0-1)	0.035675 **	0.078911 ***
Median Household Income	0.000001 ***	0.000001 ***
Distance to nearest School	0.000041 *	0.000011
Distance to nearest Park	0.000086 **	-0.000026
Within 100m Hwy. (0-1)	-0.191130 ***	-0.196924 **
Regional Accessibility		
Emp. Interaction Potential	0.008419 **	0.006119
Time of Sale		
Omitted for Brevity		
Constant	7.097689 ***	7.612338 ***
W_lnSalePrice	0.399641 ***	0.438847 ***
Lambda	0.130841 ***	0.000426
N	2,938	1,982
Pseudo-R^2	0.758	0.727

Model Results

Model results are reported in Table 1 for two sets of models. Model 1 corresponds to the early sample of sales that occurred between 2001 and 2003, while Model 2 corresponds to the most recent cross section of transactions that occurred between 2010 and 2014. we can see that there are indeed heterogeneous station proximity and station type effects informing land values within *Inner Urban Neighbourhood* and *Urban Neighbourhood* stations (Figure 4). Results for the earlier time period show consistently positive relationships between station types and station-specific transit access and TOD proximity effects. Compared to the reference group of homes outside a 10-minte walk, a location within an *Inner Urban Neighbourhood* station exhibits LVU of up to approximately 20%, decreasing at a rate of 0.028% every metre. But unlike the recent cross section, results for *Inner Urban Neighbourhood* and *Suburban Neighbourhood* stations are also significant. In the former, For *Urban Neighbourhood* stations, homes are worth up to approximately 17 percent, decreasing 0.025% every metre. Finally, the model estimates that homes located next to *Suburban Neighbourhood* stations are valued at approximately 50% more than the reference group, decreasing rapidly by 0.078% every metre farther away from the station access point.

For the later cross section, the coefficient on the dummy variable corresponding to whether a single-detached home is located within a 10-minute walk of an *Inner Urban Neighbourhood* station indicates that these homes sold at a premium of 19% compared to the reference group, all else being equal. Likewise, a location in an *Urban Neighbourhood* corresponds to an increase of up to 21% increase in value compared to the reference group. After achieving these maximum values, the rate of LVU decreases by approximately 3% every 100 metres farther from a station. However, in contrast to the earlier cross section, results for *Suburban Neighbourhood* stations are insignificant. Furthermore, no statistically significant effect could be detected for the *Urban Mixed-Use Core* station, indicating no additional capitalization of station proximity into home values around Eglinton station.

Conclusion

Given the shift towards integrated transportation and land use planning for rapid transit, it seems plausible that both rapid transit and associated TOD land use planning can result in significant price premiums for locations around stations. Until now research into rapid transit's LVU effects has largely considered this bundle of goods as a whole, which has lead to omitted variables and left potentially interesting information unobserved. Furthermore, working only through the lens of the AMM model, any LVU effects from TOD that are captured by proximity may be misvalued evidence of transit accessibility.

In response to these shortcomings in the previous literature, we explicitly recognize the potential for LVU effects from both transit accessibility and TOD, and have sought to unbundle the simultaneous and potentially self-reinforcing price effects of each. The TOD typology delineates more homogeneous station areas in terms of their TOD inputs, and controlling for these factors directly enables greater precision in terms of isolating any transit access effects common to all stations and any additional multiplier effects that accrue from station-specific TOD proximity.

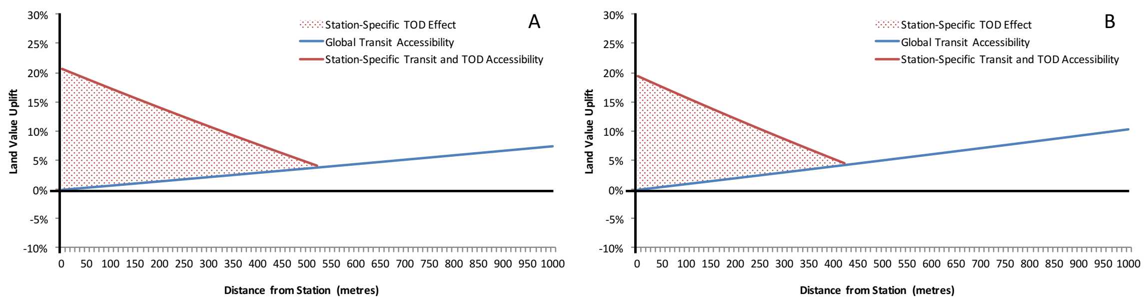
Model results reveal strong and statistically significant LVU effects for a location within specific types of TOD submarkets. Such results also suggest that individual preferences may indeed be guiding locational decisions wherein some homebuyers are outbidding others for locations rich in characteristics associated with particular implementations of TOD. That said, the model reported a global transit accessibility effect that was opposite than theorized, indicating a general disamenity for proximity to HRT stations in the sample. In this sense, if transit and TOD are in fact being unbundled by the modeling approach, it seems as though preferences for locations in different TOD submarkets may outweigh any basic considerations of transit accessibility. Still, transit and TOD may continue to be a localized and self-reinforcing bundle of goods, at least in some stations.

As such, our attempts to unbundle the LVU effects of transit and TOD have resulted in more questions for future research. Further study will be needed to analyze the capitalization of transit and TOD into different housing types and examine the heterogeneous individual preferences that inform spatial sorting decisions.

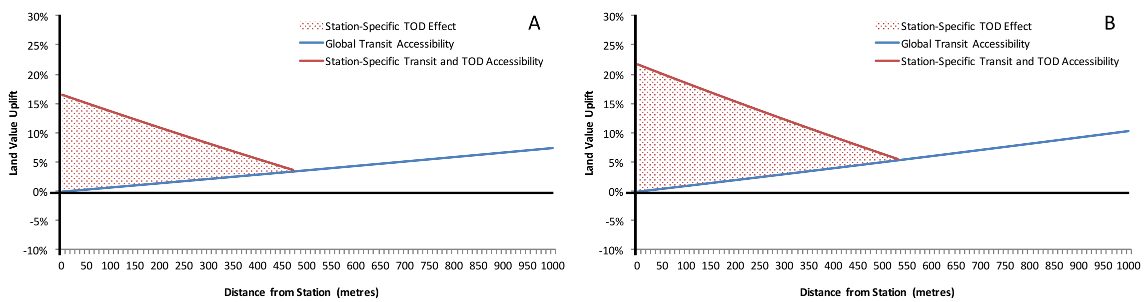
Furthermore, if possible, more precise measures of transport costs and accessibility should be used instead of proximity to offer greater insight into the separate LVU effects transit and TOD.

Figure 4. Land Value Uplift by Station Type

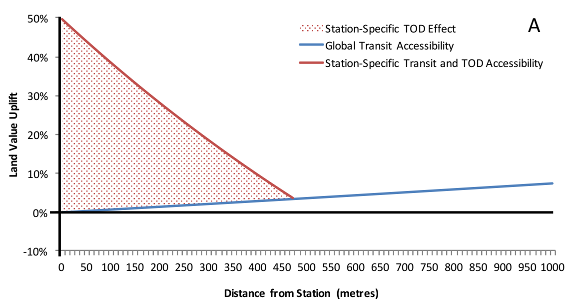
Inner Urban Neighbourhood HRT Stations: Model 1 (A) and 2 (B)



Urban Neighbourhood HRT Stations: Model 1 (A) and 2 (B)



Suburban Neighbourhood HRT Stations: Model 1 (A)



not significant

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