RESOLVING THE ACCESSIBILITY DILEMMA
Comparing cumulative and gravity−based measures of accessibility in eight Canadian cities

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INTRODUCTION

- Accessibility is a comprehensive measure of transport and land-use systems performance.

- Only a few cities worldwide use accessibility in practice because it requires data and technical competence.

- Cumulative accessibility does not require a lot of data and it is easy to communicate while gravity-based accessibility is theoretically sound.

- Can we prove that cumulative accessibility is as reliable as gravity-based measures?
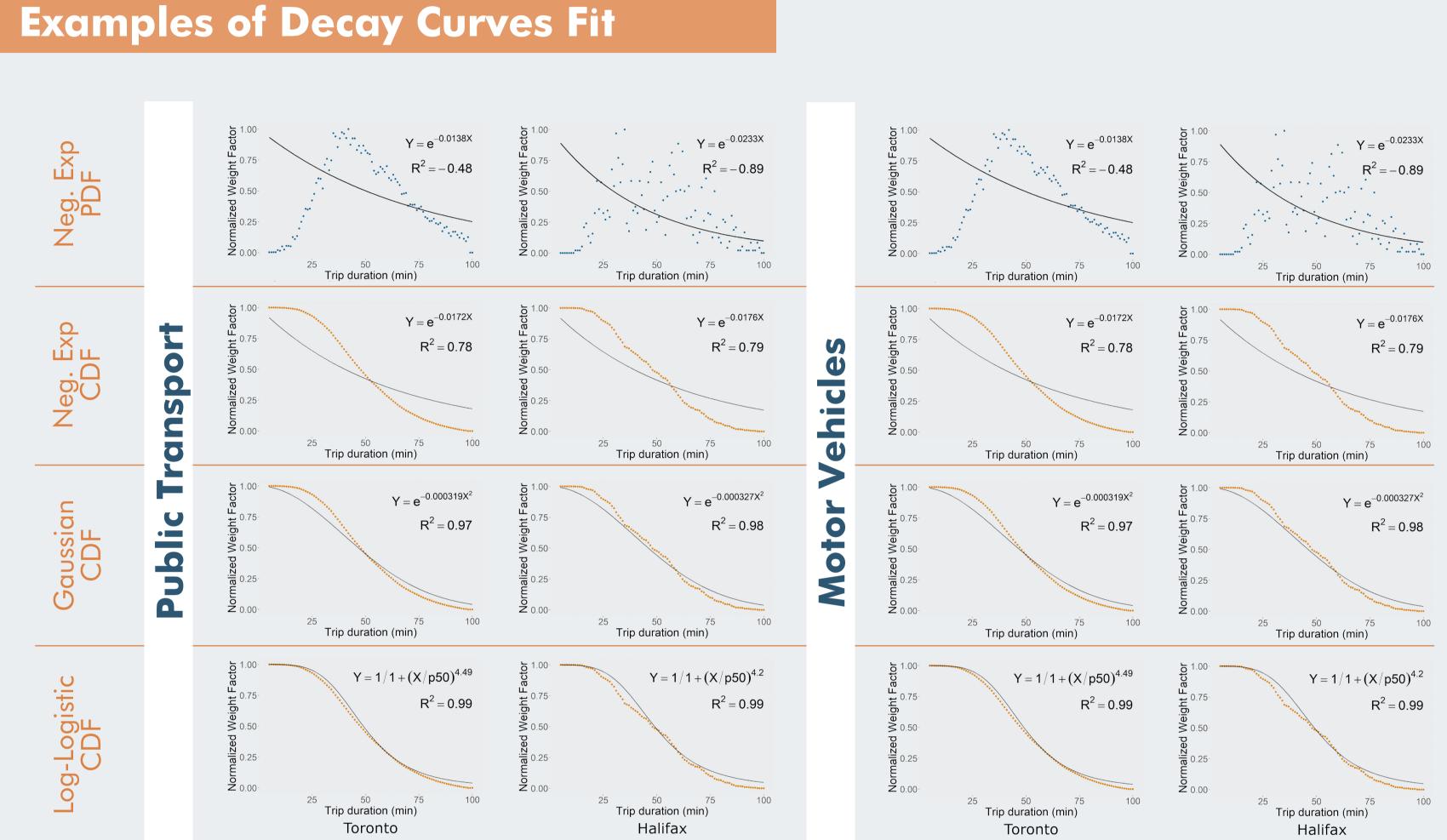
METHODS

- Estimated a cumulative and 4 gravity-based accessibility metrics to jobs in 8 Canadian metropolitan areas for public transport and motor vehicles.

- Number of jobs - selected measure of Census Tract's attractiveness.

- Data:
  - Public transport schedules in the General Transit Feed Specification (GTFS) format for 2016;
  - 2017 Google API motor vehicles travel times, adjusted for parking (+5 minutes on average);
  - Jobs data from Statistics Canada (2016 Census).

- Calculated transit travel times between the centroids of each Census Tract in each region using r5r package in R.

- Used non-linear least square methods to compute gravity-based accessibility using 4 functional forms: Negative Exponential (both for decay-probability density function (PDF) and decay-cumulative density function (CDF)), Gaussian, and Log-Logistic decay-cumulative density functions.

- Tested cumulative and gravity-based accessibility metrics using Pearson correlation.

- Equity focus: repeated analysis for all jobs, low-wage jobs, and non-low-wage jobs for all 8 metropolitan areas.

ANALYSIS/RESULTS

Examples of Decay Curves Fit

Calculated weights, commute−time decay curves and parameters for Toronto and Halifax
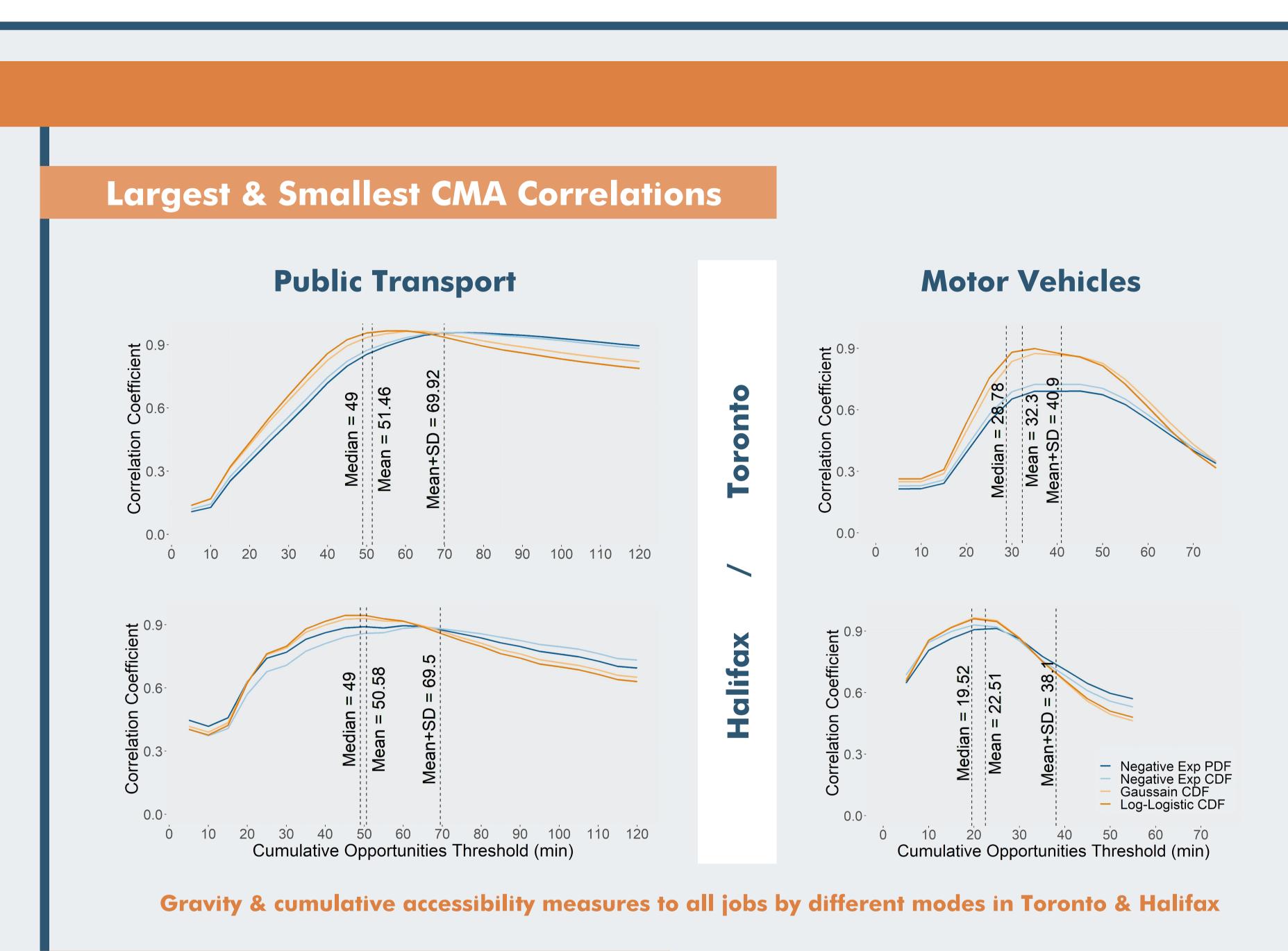
Decay Function Parameters & R^2

Region	Mode	Neg Exp PDF		Neg Exp CDF		Gaussian CDF		Log-Logistic CDF	
		β	R^2	β	R^2	β	R^2	β	R^2
Toronto	Transit	-0.0138	-0.48	-0.0172	0.78	-0.0003	0.97	4.4856	0.99
	Motor Vehicles	-0.0287	0.2	-0.0326	0.82	-0.0009	0.98	4.8662	0.99
Montreal	Transit	-0.015	-0.41	-0.0181	0.79	-0.0004	0.98	4.1168	0.99
	Motor Vehicles	-0.0294	0.39	-0.0372	0.84	-0.0012	0.98	4.5590	0.99
Vancouver	Transit	-0.0165	-0.37	-0.0190	0.81	-0.0004	0.98	4.1339	0.99
	Motor Vehicles	-0.0269	0.44	-0.0365	0.85	-0.0012	0.99	4.0718	0.99
Edmonton	Transit	-0.0193	-1.03	-0.0158	0.75	-0.0003	0.96	5.0643	0.99
	Motor Vehicles	-0.0324	0.46	-0.0417	0.85	-0.0015	0.99	4.4193	0.99
Quebec City	Transit	-0.0137	-0.44	-0.0174	0.80	-0.0003	0.98	4.1947	0.99
	Motor Vehicles	-0.0443	0.46	-0.0483	0.85	-0.0021	0.98	4.3722	0.99
Winnipeg	Transit	-0.0238	-0.74	-0.0194	0.78	-0.0004	0.97	4.6869	0.99
	Motor Vehicles	-0.0332	0.54	-0.0447	0.86	-0.0017	0.99	4.2937	0.99
London	Transit	-0.0263	-0.88	-0.0184	0.78	-0.0004	0.97	4.6801	0.99
	Motor Vehicles	-0.0434	0.46	-0.0480	0.46	-0.0020	0.99	4.4211	0.99
Halifax	Transit	-0.0232	-0.89	-0.0176	0.79	-0.0003	0.98	4.2019	0.99
	Motor Vehicles	-0.0380	0.83	-0.0467	0.93	-0.0020	0.99	3.0633	0.99
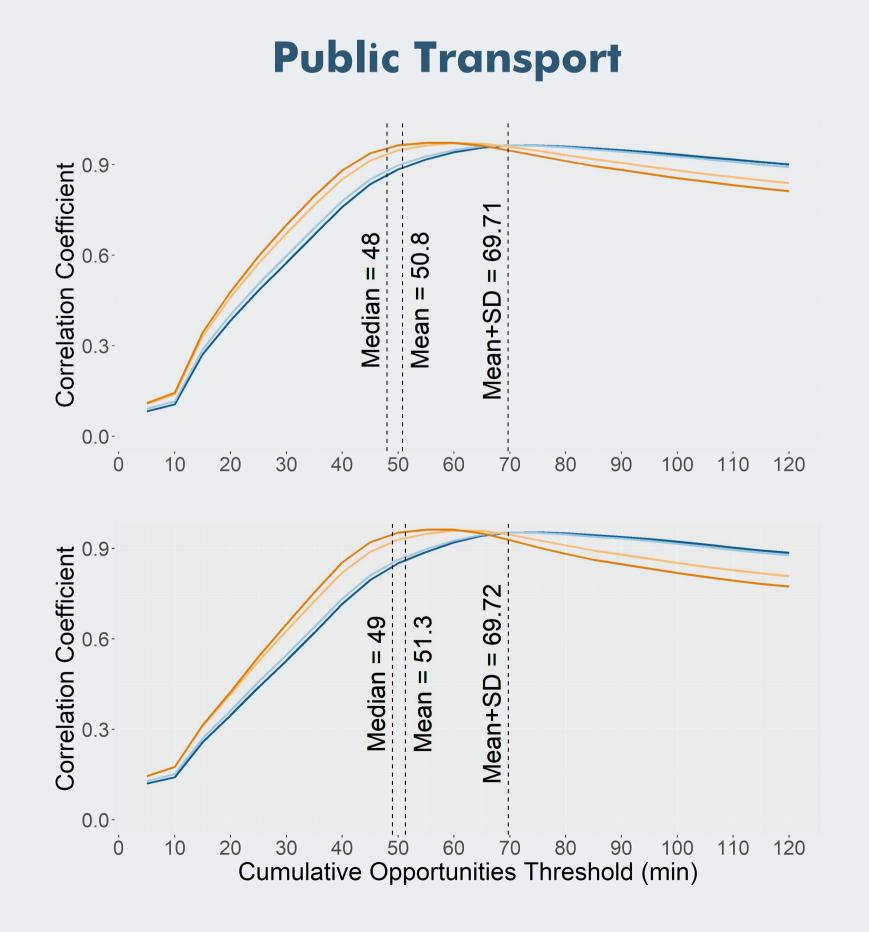
Estimated distance decay function parameters & R^2 values for all 8 studied regions

Largest & Smallest CMA Correlations

Gravity & cumulative accessibility measures to all jobs by different modes in Toronto & Halifax
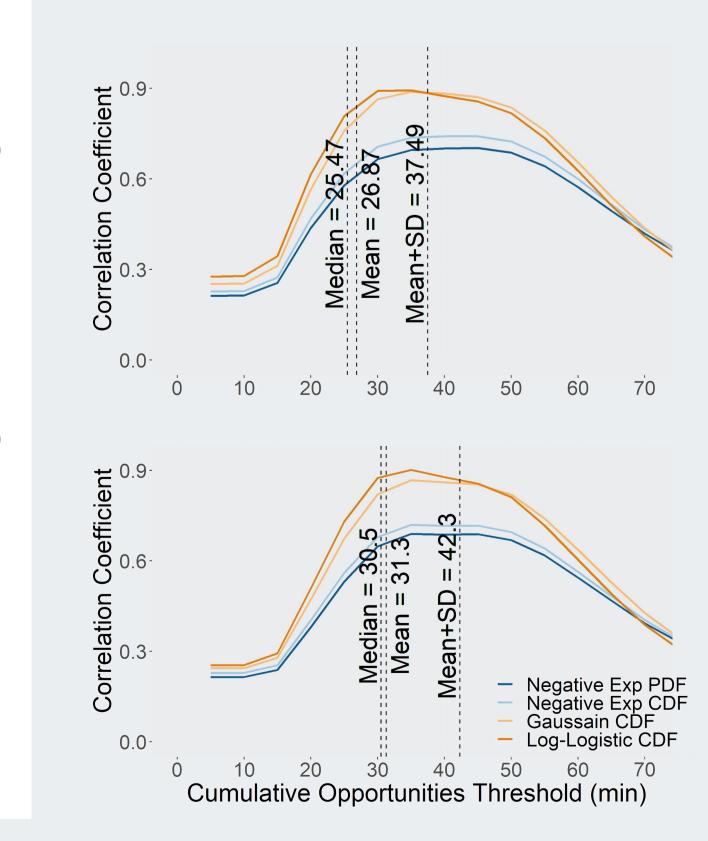
Equity Analysis for Toronto

Gravity & cumulative accessibility measures to low−wage and non−low−wage jobs by different modes for the largest and the smallest regions in the study

CONCLUSION

- Overall, for both modes, correlation coefficient is consistently above 0.90 when the commute time threshold approximates the regional mean travel time value and when gravity measures are estimated using a Log-logistic or a Gaussian decay function.

- Accessibility by transit analysis reveals the correlation coefficient that hovers around 0.95 at a mean regional commute time in Winnipeg and London, and approximately 0.90 in Toronto, Vancouver, and Edmonton, with other regions' coefficients being somewhere in between.

- Job-accessibility by motor vehicle correlation coefficients hover around 0.95 in Montreal, Quebec City, Winnipeg, and London, and approximately 0.90 in Toronto, Vancouver, and Edmonton, with other regions' coefficients being somewhere in between.

- The findings are also robust to income class, tested by comparing outcomes from low and non-low-wage jobs accessibility.

- Cumulative measure can substitute more complex gravity-based measures when evaluating transport and land use interactions in North American cities at a mean travel time, as well as to advance the equitable distribution of transport system benefits.

- Future research should investigate if findings are generalizable to active transportation modes, travel behavior for discretionary trip purposes, and other population groups segmentation variables such as gender and age.

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