What's a City Got to Do? Setting Minimum Transit-Based Jobs Accessibility to Enhance Travel Time Equity and Public Transport Mode Share in Canadian Cities

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1. INTRODUCTION

Recent years have seen transport planning focusing more on advancing social and sustainability goals (Manaugh et al., 2015). Transport plans document a region or city's long-term transport goals, and often define cities' aim to increase sustainable mode use (public transport (PT), walking, cycling) and decrease personal car use. These goals can also be set with hopes of increasing people's quality of life through the means of transport. To ensure these targets are reached, performance-based measures are increasingly becoming incorporated in transport plans worldwide (International Associate of Public Transport, 2010).

Accessibility, or the ease of reaching destinations, is a performance-based measure that accounts for land use, transport mode, time, and individual characteristics of a traveler, and gives policymakers a better idea of how adequately cities provide their residents access to services and opportunities (Geurs & van Wee, 2004; Hansen, 1959). A shift from planning for mobility (a measure of transportation system throughput) to planning for accessibility is necessary (Levinson, 2019). There are various approaches to assessing accessibility, including the use of cumulative, gravity, and utility-based measures (El-Geneidy & Levinson, 2006; Handy & Neimeier, 1997). The cumulative accessibility measure is the most straightforward among those, as it corresponds to the number of opportunities that can be reached in a certain time threshold (El-Geneidy & Levinson, 2022). Moreover, the cumulative opportunity measure was found to be as reliable as more complex (Kapatsila et al., 2023).

Cities are applying accessibility measures to advance their sustainability goals (Handy, 2020). Research has proven that higher levels of accessibility led to shorter commute times (Levinson, 1998), increased land values (Martínez & Viegas, 2009), and decreased risk of social exclusion (Lucas, 2012). Moreover, accessibility can potentially affect transport mode choices, as evidenced by an increased public transport mode share and a decrease in private-vehicle travel distance for the areas with enhanced transit accessibility (Cui & El-Geneidy, 2019). This, however, requires further research, especially accounting for who uses PT and destinations needing to be accessed. As it accounts for individual characteristics, location-based accessibility could help better understand the impact of land use and the transport network on different populations, such as vulnerable groups (Deboosere & El-Geneidy, 2018). Moreover, smaller cities tend to select accessibility goals or PT mode share goals based on general thresholds that aren't necessarily suitable for the region (G. Boisjoly & A. El-Geneidy, 2016). As such, there is a gap in understanding how accessibility can be meaningfully used to increase the use of more sustainable transport modes like PT.

To guide communities in their aspirations to increase sustainable mode use this study identifies the minimum levels of accessibility needed to improve travel-time equity and achieve the targeted PT mode shares in eight major Canadian Metropolitan Areas (CMA). The knowledge is generated through the exploration of the relationships between the level of accessibility, mean travel time by PT, and the existing as well as desired PT mode share for all and low-income groups. This last step of the analysis is particularly important, as income-disparity in transit ridership is well-documented (Giuliano, 2005; Taylor et al., 2009), emphasizing the necessity for planners and policymakers to account for this inequality when developing interventions aimed at increasing PT mode share. The findings of this quantitative assessment can help policymakers and planners to better understand the opportunities and limitations for accessibility measures to guide and achieve an increase in sustainable transport mode share.

2. METHODS

This study pertains to eight major Canadian CMAs located across the country with varying populations, areas, geographies, and PT networks, including Toronto, Montréal, Vancouver, Edmonton, Québec City, Winnipeg, London, and Halifax. Moreover, to study the differences between the core city, which generally has better transit accessibility and PT use, and the rest of the CMA, we explore these regions separately for each of the eight study areas. Since official city delineations were not available for Halifax, census tracts (CTs) near the centre of the CMA and of PT service were chosen as proxy.

The mean values for the various input variables, as well as the population and density values, are presented in Table 1 for the eight metropolitan regions. The targeted PT (PT) mode share, found in the regions' respective transport plans, are also included.

TABLE 1 Summary of descriptive statistics of the eight studied regions

	Vancouver	Edmonton	Winnipeg	London	Toronto	Montréal	Québec City	Halifax[2]
Population								
CMA	2.46 million	1.32 million	778,489	494,069	5.93 million	4.10 million	800,296	403,390
City	631,486	932,546	705,244	383,822	2.62 million	1.70 million	531,902	279,313
Density (pop/km^2)								
CMA	854.6	140.0	146.7	185.6	1,003.8	890.2	234.8	73.4
City	5,492.6	1,360.9	1,518.8	913.1	4,334.4	4,662.1	1,173.2	335.9
Public transport share (%)	20.4	11.3	13.6	7.2	24.3	22.3	11.1	11.8
Car share (%)[1]	69.3	82.6	79.1	85.1	68	69.7	80.4	77.7
Target public transport share (%)	34	35	15	20	26.3	35	26	16+
Travel times (for public transport)								
Mean travel time for all jobs (minutes)	48	54	47	49	51	49	51	51
Mean travel time for low-wage jobs (minutes)	47	54	47	50	51	47	55	49
Mean travel time for non-low-wage jobs (minutes)	49	55	47	47	51	51	47	53
Accessibility								
Total jobs at mean PT travel time (thousands of jobs)	136.5	93.3	88.3	50.2	238.4	288.0	94.6	50.6
Low-wage jobs at low-wage mean PT travel time (thousands of jobs)	48.6	34.1	27.6	18.0	67.3	83.5	36.0	15.2
Non-low-wage jobs at non-low-wage mean PT travel time (thousands of jobs)	109.7	61.1	58.6	29.1	162.9	204.0	51.1	35.7

*Unless otherwise specified, all the numbers refer to the CMA

[1] Solo and car passenger combined

[2] The city refers to Halifax, Dartmouth and Bedford, which were chosen due to their proximity to the city centre and the public transport network

Cumulative-opportunity measures were used in this study to calculate job accessibility in the eight regions. This method estimates the number of job opportunities reachable from a given point at a fixed travel time using census data pertaining to jobs available in each CT and the travel time between the centroids of said CTs.

We obtained data from the Statistics Canada 2016 Commuting Flow tables and archived records from General Transit Feed Specification (GTFS) for each region. The Commuting Flow tables contain information on the number of workers commuting between their home and work CTs, the mode of transport used for the trip, and the commuter's income bracket. This information also allows for the calculation of the PT mode share of the CT, with modes included being bus, subway, elevated and light rail, streetcar, commuter train, and passenger ferry. The number of jobs available in each CT was approximated by the number of commuters working in that CT. The main limitation of using the Flow tables is that the data can be suppressed to ensure confidentiality, leading to inconsistencies in areas with very few commuters. The spatial distribution of the jobs is not available through the Flows, so all jobs were assumed to be located at the centroid of their CT. Using the approach for larger CTs (e.g., suburban) may result in less precise travel times, which could impact the observed accessibility levels in those areas.

As different income groups typically use PT at varying frequencies, a deeper equity analysis was deemed important for the study. The income threshold considered for the low-income group as 30% of the median income in the region (Deboosere & El-Geneidy, 2018) translates into a $30,000 CAD threshold for all studied regions except for Edmonton, where it is estimated as a $40,000 CAD threshold. The non-low-income group includes jobs of commuters with the income above that threshold.

In order to estimate PT travel times, GTFS data for each region from Fall 2016, the specific date depending on the data availability, is used. This data is processed in the *R* statistical software using the *r5r* package (Pereira et al., 2021). The package generates the transit-travel-time estimates between the CT centroids in the various CMAs, including the in-vehicle travel time, access, egress, waiting, and transferring time. The 8-9 AM period on a regular weekday was selected based on previous studies (Geneviève Boisjoly & Ahmed El-Geneidy, 2016).

Since the cumulative-opportunity measure of accessibility is time-based, it is important to use the appropriate time threshold when studying the impact of land use and transport network on different populations. Given the regional scale of the study, we chose to use the mean travel time for the entire region as the travel-time threshold for accessibility to all jobs, as well as the respective mean travel time for low-income and non-low-income groups in the equity part of the analysis. These mean travel times can be found in Table 1.

Cumulative accessibility measures were calculated as follows:

$$A_{jobs,i} = \frac{1}{\sum_{j=1}^{J} E_j} \sum_{j=1}^{J} E_j f(t_{ij}) \; where \; f(t_{ij}) = \begin{cases} 1, & t_{ij} \leq t_{mean} \\ 0, & t_{ij} > t_{mean} \end{cases}$$

Where:

$A_{jobs,i}$ = accessibility to jobs from origin CT *i*

$\sum_{j=1}^{J} E_j$ = total number of jobs in the metropolitan region

E_j = number of jobs in destination CT *j*

$f(t_{ij})$ = a dichotomous function to determine whether jobs in CT *j* are reachable by CT *i*

t_{ij} = commute travel time by PT between 8 and 9 am between CTs *i* and *j*
t_{mean} = mean commute travel time being used as the travel time threshold

The relationships between the mean travel times and accessibility, as well as mode share and accessibility at the mean travel time, were assumed to be non-linear following the findings of the previous studies (Cui et al., 2020; Deboosere & El-Geneidy, 2018). In practice this means the addition of a squared term for the time and mode share to the respective regressions. The estimated mean travel time and accessibility model is formulated as follows:

$$A_{jobs,i} = \beta_0 + \beta_1 X_i + \beta_2 X_i^2$$

Where:
$A_{jobs,i}$ = accessibility to jobs from origin census tract *i* at the mean travel time
X_i = mean travel time for PT commuters or PT mode share of commuters (depending on the model) leaving CT i
β_0,β_1,β_2 = parameters to be estimated

Separate estimates are generated for each metropolitan region for all, low-income, and non-low-income jobs, using its corresponding mean travel time as the threshold to calculate job accessibility.

3. RESULTS

3.1 Descriptive Statistics

As shown in Table 1, the three most populous regions, Toronto, Montréal, and Vancouver, are also the densest, especially in their urban core, and they report the highest PT mode share. According to their transport plans, their target PT mode share varies between 26.3% for Toronto to 35% and 34% for Montréal and Vancouver respectively (Autorité régionale de transport métropolitain, 2021; Metrolinx, 2008; Translink, 2022). Since Vancouver and Edmonton's transport plans had only a combined PT, walking and cycling share (City of Edmonton, 2020; Translink, 2022), a PT share was estimated using the ratios of sustainable mode use recorded in the 2016 Census and this amalgamated goal.

Edmonton, Winnipeg and Québec City, mid-sized CMAs, have a much lower PT share. The City of Edmonton is aiming for a 35% public transport mode share, the same as Montréal, whereas Winnipeg and Québec City aim lower at 15% and 26% respectively (City of Edmonton, 2020; City of Winnipeg, 2020; Ville de Québec, 2010). At the same time, the three mid-size cities have similar levels of accessibility.

Finally, the two smallest cities, London and Halifax, have very low densities compared to other regions. Interestingly, Halifax has a relatively high PT mode share, 11.8%, compared to London's, which stands at 7.2%. London is targeting a 20% PT mode share whereas Halifax is aiming for 16% (City of London & AECOM, 2013; McPhail Transportation Planning Services Ltd. & Halifax, 2017). The levels of job accessibility at the respective mean PT travel time are similar for both CMAs.

3.2 General Accessibility

Reasonable Travel Time and Accessibility

Figure 1 shows the relationship between cumulative accessibility in each region by PT at the CT level and estimated mean travel time of commuters residing in these CTs. The travel time threshold used for generating the cumulative opportunities in each region is set to the mean travel time by PT in the entire region. A target travel time of 60 minutes was assumed as a reasonable goal for the eight regions following the findings of the studies on the subject (Milakis et al., 2015).

Toronto, Montréal, and Vancouver show a relatively high level of PT accessibility, especially within the main city limits. Since these regions have the most developed and well-used PT networks among the eight studied CMAs, these observed levels can be expected.

Toronto shows an enormous disparity in the number of transit-accessible jobs among CTs, some having access to more than the 800,000 jobs with a mean travel time below 60 minutes, whereas others can barely access any employment opportunities in the region by transit. Given the observed trends, the average accessibility of jobs in Toronto CMA would have to be around 780,000 jobs for the majority of CTs to have a reasonable travel time of 60 minutes by PT.

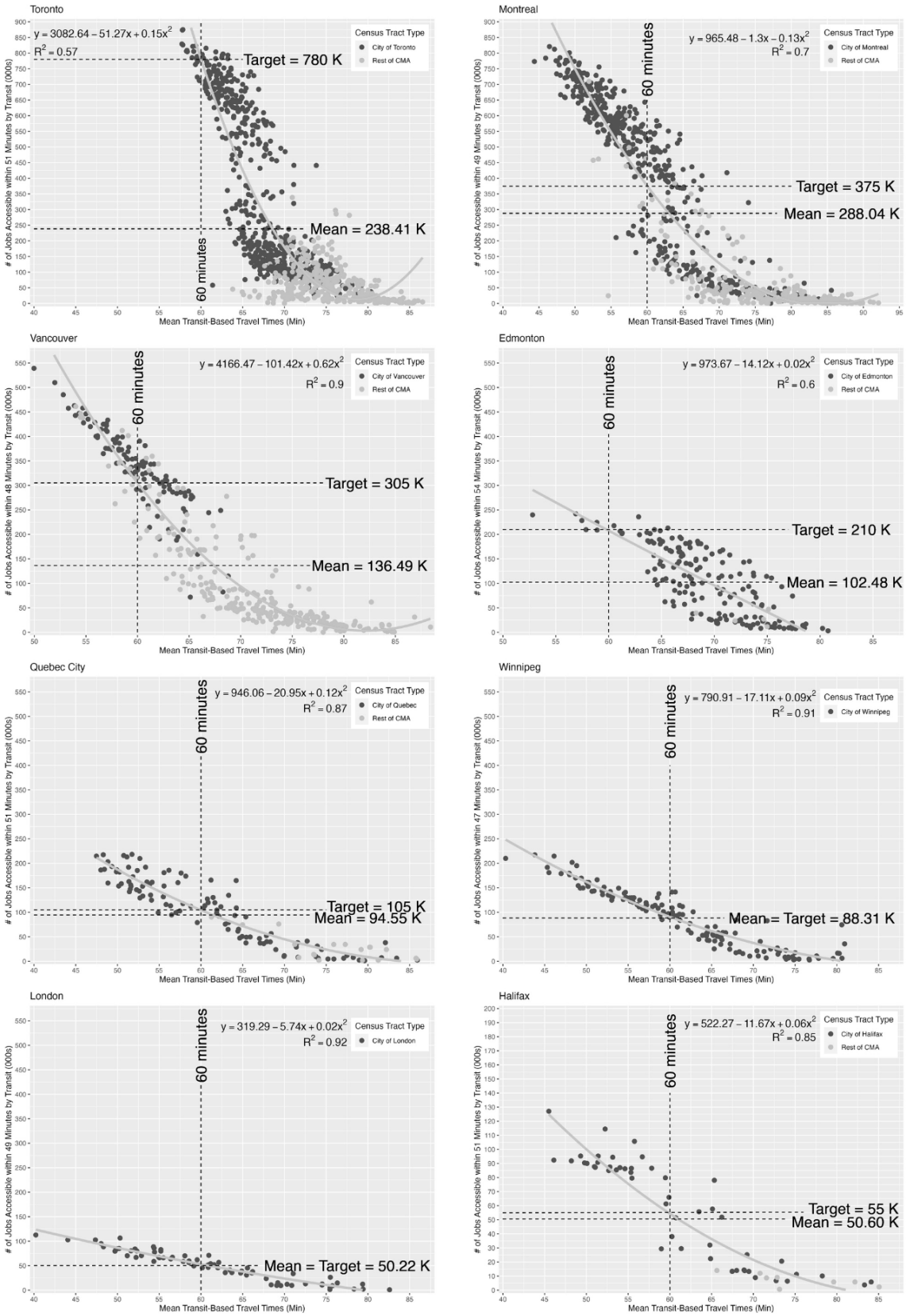

Figure 1 The relationship between mean transit travel times and mean employment accessibility at the census tract level

For Montréal, a significant portion of the city CTs can already be found below the 60-minute travel-time target of 375,000 jobs. Interestingly, we can observe two categories of CTs, similar to Toronto's. We believe this to be a clear distinction between the accessibility levels and transit service available to mature and activity-rich urban cores, and to other more suburban parts of the region.

On average, the CTs in the City of Vancouver have very high PT accessibility and their mean travel times are lower or revolve around 60 minutes already. However, in the rest of the CMA, baring a few exceptions, the mean travel times by PT are much higher, though fewer jobs can be accessed from those CTs. Based on the observed trend for the Vancouver CMA, to move more CTs to the mean travel time of 60 minutes by PT, the average number of accessible jobs must be more than doubled, to reach the target of 305,000 accessible jobs.

The three mid-sized regions (Edmonton, Winnipeg, and Québec City), with their lower population density and less-developed PT network, yield very similar results. In Edmonton CMA, the mean PT travel times are high, and the mean number of jobs accessible at 54 minutes or less is 93,310. For a targeted mean PT time of 60 minutes, the number of jobs needed would be 235,000, which is higher than the current mean in Toronto, a city with more than four times its population. In Winnipeg CMA, the relationship between the mean PT travel times and number of accessible jobs is more linear than in the cities discussed above, with CTs that have shorter PT travel times having transit access to more jobs. Since the mean number of jobs should already theoretically correspond to the 60-minute mean travel time, the transit network needs to better serve the rest of the CMA and allow them to get to their destinations more quickly. Finally, in Québec City, there is more variation in the number of jobs accessible by PT within the mean transit-based travel time of 51 minutes, especially in the city itself. This is mostly observed in the CTs that have a higher number of accessible jobs and shorter mean PT travel times.

The two smallest metropolitan areas, London, and Halifax, display trends similar to the larger CMAs. In London, similarly to Winnipeg, the more jobs are accessible by PT at the mean PT travel time of 49 minutes, the shorter the mean transit-based travel time is for the CTs. In the Halifax CMA, much like in Québec City, the targeted number of accessible jobs by PT at the mean travel (55,000) is not far from the existing mean of accessible jobs (50,600).

Based on the observed trends it is obvious that smaller regions in Canada are far closer to or already at the mean level of employment accessibility by PT within the reasonable travel time, especially when compared to the largest CMAs. The average level of accessibility needs to be radically improved to move travel times by transit for the majority of CTs to a 60-minute mark for the medium and large CMAs, especially in the more suburban parts of the CMA. On the other hand, some regions like Toronto and Montréal have a clear division between the CTs with exceptionally high levels of accessibility and low travel times, and the parts of CMAs where accessibility by PT is below the regional average but has higher travel times.

Accessibility and Mode Share

Figure 2 plots transit-based job accessibility as it relates to the PT mode share. For each region the observed and desired PT mode shares were plotted, though it is important to note that the year chosen to reach this goal depends on the region, and how each region plans to ensure the goals are met differs.

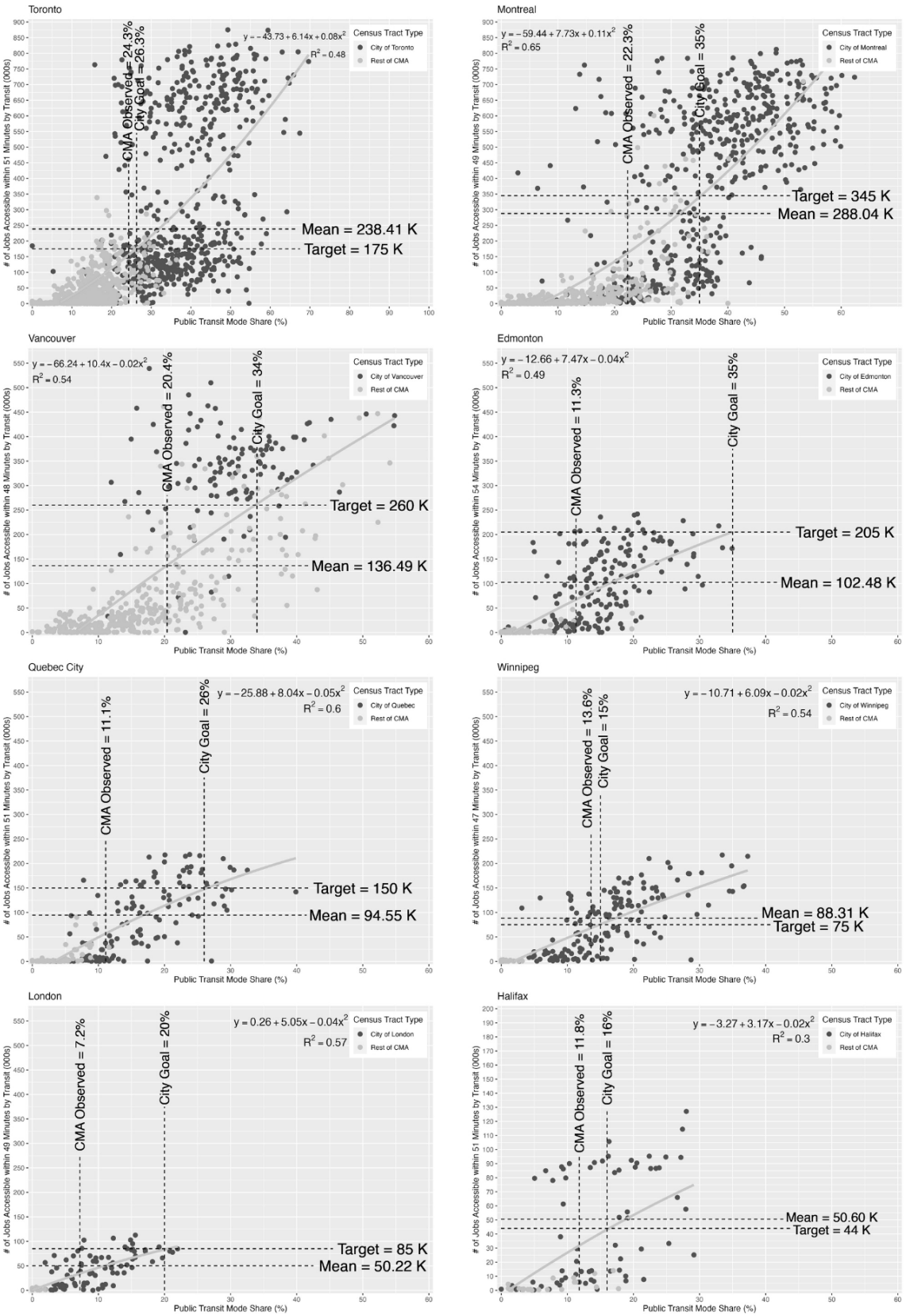

Figure 2 The relationship between public transport mode share and mean employment accessibility at the census tract level

For Toronto, which set a very conservative PT mode share goal of 26.3%, the vast majority of the city CTs are already well above this target, whether or not it corresponds to a high level of accessibility. The rest of the CMA remains underserved, having relatively low numbers of transit-accessible jobs, and low PT mode shares.

To hit the more ambitious PT mode share goal of 35% in Montréal, the average level of 345,000 accessible jobs must be achieved. Increasing the number of jobs might prove to be more beneficial to CTs that have fewer jobs accessible, meaning predominantly for the rest of the CMA, whereas the CTs above the targeted number of jobs already have a high PT mode share.

On the other hand, the majority of the CTs in the City of Vancouver already have transit access to jobs well above the regional mean, and as a result PT mode share for the city CTs is already around its intended 34% share goal. At the same time, most of the CTs in the rest of the Vancouver CMA have poor transit accessibility at the mean travel time and significantly lower PT mode share.

For the mid-size CMAs, the relative feasibility of the PT mode share goals varies. Edmonton set an ambitious goal of 35%, meaning it would have to double the current number of transit accessible jobs to achieve it. Moreover, currently in the city CTs, a higher number of accessible jobs does not necessarily result in higher PT mode share. The rest of the CMA has almost no PT accessible jobs and the PT mode share remains very low.

The City of Winnipeg stands at the other end of the goal-setting spectrum. Having set a transit share goal of 15%, it already provides enough jobs accessible in 47 minutes to theoretically hit this target (75,000 jobs). Moreover, many CTs' PT mode share is already higher than the goal. Finally, of the three mid-sized CMAs in this study, Québec City is somewhere in the middle, with a PT mode share goal of 26%. Our model suggests that a mean accessibility of 150,000 jobs reachable by 51 minutes by transit would be needed.

In London, similarly to Edmonton, the PT mode share goal of 20% is higher than the observed share in any CT in the region. However, the higher number of jobs accessible within 49 minutes by PT seems to be related to a higher mode share. The transit mode share and job accessibility in the rest of the CMA is almost non-existent which represents the reality of the extent of the transit service. Like the Edmonton CMA, the introduction of a regional PT system is instrumental for the achievement of the transit mode share goal.

Halifax set a public-transport-share goal of 16%. There, many CTs already have a higher PT mode share than the target. Like in the case of Québec City, the PT mode share is quite high in the rest of the CMA compared to regions of similar size and transit provision.

This section of the analysis has shown that Canadian communities that have set more ambitious PT mode share goals are in need of a significant increase of average job accessibility at the mean travel time. Nevertheless, the target number of jobs allowing the CMAs to reach their transit mode share goal is usually lower than the one needed for the 60-minute time travel goal, which means that dedicated efforts would have to be made towards hitting both targets in order to see significant improvement in PT use.

3.3 Equity Analysis of Accessibility and Public Transport Mode Share

The introduction to this chapter highlighted the difference in the use of PT across various income groups. To understand what this means for mode share goal setting, we replicated the analysis for low and non-low-income jobs. This effort is necessary to ensure that the benefits that

arise from additional investments are equitably distributed, as well as groups that currently use PT less are prioritized when transit promotion policies are developed.

We analyzed all eight CMAs, however, for the purpose of brevity, results are reported for one of the large, mid-sized, and small regions, as the trends are generalizable. The findings are presented in Figure 3.

In Toronto, the number of jobs that would allow the target PT mode share to be possible has been surpassed for both low and non-low-income jobs. Most of the city CTs report shares above the targeted 26.3%, though fewer low-income jobs are accessible at the mean PT travel time when compared to the non-low-income ones. The latter group enjoys a far greater access to employment opportunities, though their average mode share is visibly lower than for the low-income employment.

The differences between the two income groups are also significant in Winnipeg. Non-low-wage workers enjoy a far greater level of employment accessibility by transit, though CTs with low-wage workers have a significantly higher share of PT users. Lastly, the same trend holds truth for the smallest CMA in this sample – Halifax. However, given the relatively unambitious PT mode share goals these communities have, even small improvements to accessibility may bring these communities to the desired levels.

Overall, this section confirms that low-income commuters use PT at a far greater rate compared to non-low-income ones, despite the lower level of accessibility offered. This suggests that a dedicated effort needs to be made to allow for low-income workers to enjoy the same level of transit accessibility as the more advantaged income group has. On the other hand, it is also evident that the effect of accessibility on mode share has its limits, and for non-low-income workers, other policies should be considered to facilitate their uptake of PT.

4. CONCLUSION

This study offers an evidenced-based methodology to setting the level of accessibility necessary to achieve regions' goals in terms of reasonable travel times and PT mode share as they plan for the more sustainable future. The results show that the required level of transit-based accessibility is context-specific and depends on the size, density, built environment, and spatial structure of respective regions, as well as the level of ambition that their goals represent.

Generally speaking, for many regions with relatively modest PT mode share goals, the improvements in accessibility would require moderate efforts. However, to provide more residents with the reasonable travel times of under an hour, or under the current average travel time, the increase in transit accessibility would have to be more dramatic.

We have found that fewer low-income jobs were accessible at the corresponding mean travel times, though the PT shares in these CTs were much higher than for the non-low-income group. Improving PT service would greatly improve low-income PT users' travel experiences. This study demonstrates how important it is to use region and group-dependent thresholds in assessing the benefits of accessibility and the importance of accounting for these differences when developing policies aimed at achieving an increase in the use of sustainable transport modes. At the same time, it all also highlights the limits of accessibility to deliver the desired increase in PT use, and the necessity to consider other policies, especially those that target non-low-income individuals.

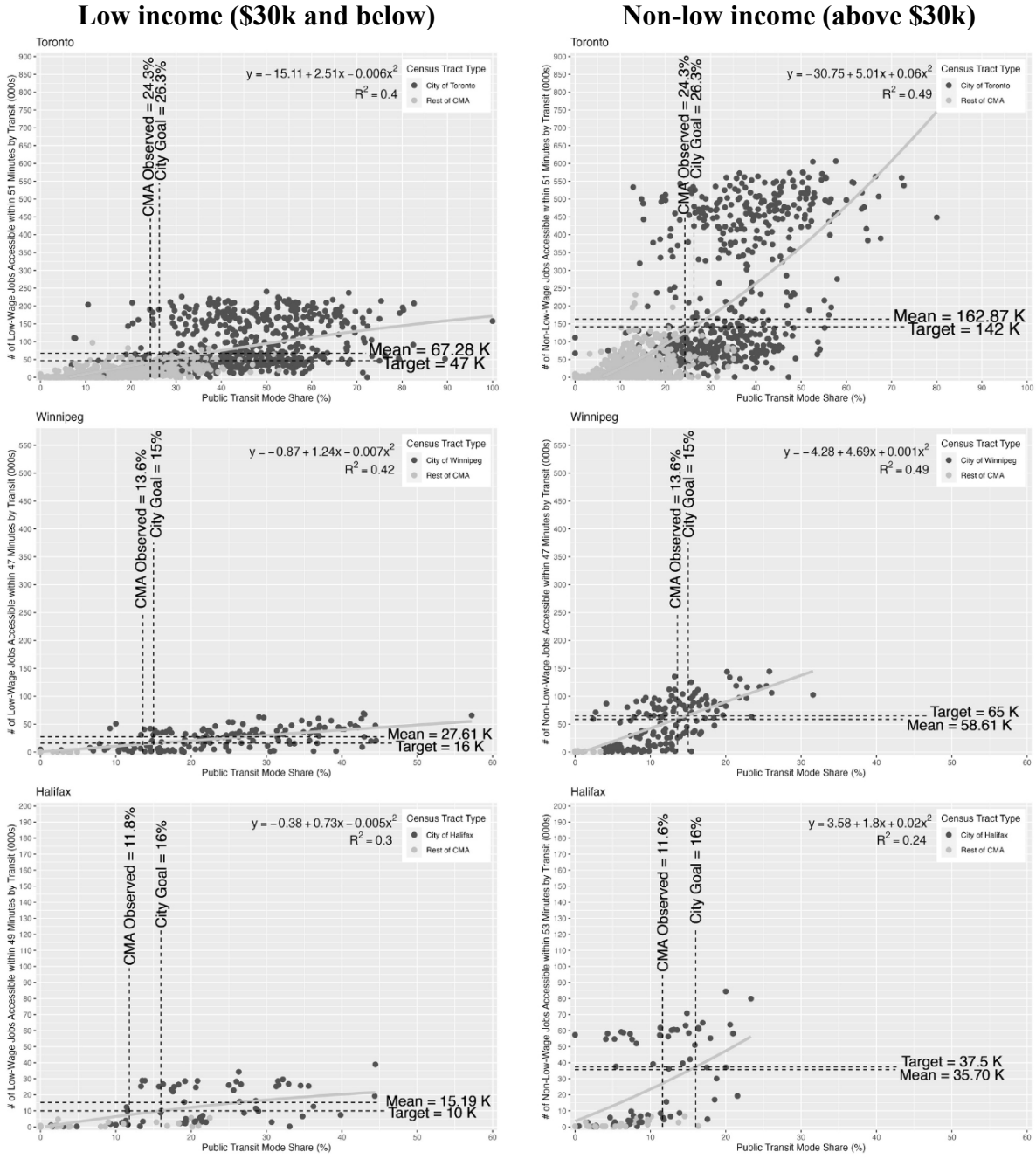

Figure 3 The relationship between public transport mode share and mean employment accessibility at the census tract level for low and non-low-wage jobs

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REFERENCES

Autorité régionale de transport métropolitain. (2021). *Plan Stratégique de Développement du Transport Collectif*. https://www.artm.quebec/wp-content/uploads/2021/04/PSD_adopt%C3%A9_R0A_2021-04-162.pdf

Boisjoly, G., & El-Geneidy, A. (2016). Daily fluctuations in transit and job availability: A comparative assessment of time-sensitive accessibility measures. *Journal of Transport Geography*, *52*, 73-81. https://doi.org/10.1016/j.jtrangeo.2016.03.004

Boisjoly, G., & El-Geneidy, A. (2016). *Measuring performance: Accessibility metrics in metropolitan regions around the World.* . Brookings Institution.

City of Edmonton. (2020). *Edmonton City Plan*. https://www.edmonton.ca/city_government/city_vision_and_strategic_plan/city-plan

City of London, & AECOM. (2013). *A New Mobility Transportation Master Plan for London - 2030 Transportation Master Plan: SmartMoves*. https://london.ca/sites/default/files/2020-11/TMP%20Accessible.pdf

City of Winnipeg. (2020). *Winnipeg's Climate Action Plan*. https://winnipeg.ca/sustainability/PublicEngagement/ClimateActionPlan/pdfs/WinnipegsClimateActionPlan.pdf

Cui, B., Boisjoly, G., Miranda-Moreno, L., & El-Geneidy, A. (2020). Accessibility matters: Exploring the determinants of public transport mode share across income groups in Canadian cities. *Transportation Research Part D: Transport and Environment*, *80*, 102276. https://doi.org/10.1016/j.trd.2020.102276

Cui, B., & El-Geneidy, A. (2019). Accessibility, equity, and mode share: a comparative analysis across 11 Canadian metropolitan areas *Transport Findings*. https://doi.org/10.32866/7400

Deboosere, R., & El-Geneidy, A. (2018). Evaluating equity and accessibility to jobs by public transport across Canada. *Journal of Transport Geography*, *73*, 54-63. https://doi.org/10.1016/j.jtrangeo.2018.10.006

El-Geneidy, A., & Levinson, D. (2006). *Access to destinations: Development of accessibility measures* (1). (Access to Destinations Study, Issue. https://hdl.handle.net/11299/638

El-Geneidy, A., & Levinson, D. (2022). Making accessibility work in practice. *Transport Reviews*, *42*(2), 129-133. https://doi.org/10.1080/01441647.2021.1975954

Geurs, K., & van Wee, B. (2004). Accessibility evaluation of land-use and transport strategies: review and research directions. *Journal of Transport Geography*, *12*(2), 127-140. https://doi.org/10.1016/j.jtrangeo.2003.10.005

Giuliano, G. (2005). Low Income, Public Transit, and Mobility. *Transportation Research Record*, *1927*(1), 63-70. https://doi.org/10.1177/0361198105192700108

Handy, S. (2020). Is accessibility an idea whose time has finally come? *Transportation Research Part D: Transport and Environment*, *83*(102319). https://doi.org/10.1016/j.trd.2020.102319

Handy, S., & Neimeier, D. (1997). Measuring accessibility: an exploration of issues and alternatives. *Environment and Planning A: Economy and Space*, *29*(7), 1175-1194. https://doi.org/10.1068/a291175

Hansen, W. (1959). How accessibility shapes land use. *Journal of the American Institute of Planners*, *25*(2), 73-76.

International Associate of Public Transport. (2010). *Public transport: the smart green solution*. http://www.uitp.org/

Kapatsila, B., Palacios, M., Grisé, E., & El-Geneidy, A. (2023). Resolving the accessibility dilemma: Comparing cumulative and gravity-based measures of accessibility in eight Canadian cities. *Journal of Transport Geography*, *107*, 103530. https://doi.org/10.1016/j.jtrangeo.2023.103530

Levinson, D. M. (1998). Accessibility and the journey to work. *Journal of Transport Geography*, *6*(1), 11-21. https://doi.org/10.1016/S0966-6923(97)00036-7

Levinson, D. M. (2019). *The 30-minute city: designing for access*. Network Design Lab.

Lucas, K. (2012). Transport and social exclusion: Where are we now? *Transport Policy*, *20*, 105-113. https://doi.org/10.1016/j.tranpol.2012.01.013

Manaugh, K., Badami, M., & El-Geneidy, A. (2015). Integrating social equity into urban transportation planning: A critical evaluation of equity objectives and measures in transportation plans in North America. *Transport Policy*, *37*, 167-176. https://doi.org/10.1016/j.tranpol.2014.09.013

Martínez, M., & Viegas, J. M. (2009). Effects of Transportation Accessibility on Residential Property Values: Hedonic Price Model in the Lisbon, Portugal, Metropolitan Area. *Transportation Research Record*, *2115*(1), 127-137. https://doi.org/10.3141/2115-16

McPhail Transportation Planning Services Ltd., & Halifax, C. o. (2017). *Integrated Mobility Plan*. https://www.halifax.ca/sites/default/files/documents/about-the-city/regional-community-planning/IMP_report_171220-WEB.pdf

Metrolinx. (2008). *The Big Move - Transforming Transportation in the Greater Toronto and Hamilton Area*. https://www.metrolinx.com/thebigmove/Docs/big_move/TheBigMove_020109.pdf

Milakis, D., Cervero, R., Wee, B., & Maat, K. (2015). Do people consider an acceptable travel time? Evidence from Berkeley, CA. *Journal of Transport Geography*, *44*. https://doi.org/10.1016/j.jtrangeo.2015.03.008

Pereira, R., Saraiva, M., Herszenhut, D., Kaue Vieira Braga, C., & Wigginton Conway, M. (2021). r5r: Rapid Realistic Routing on Multimodal Transport Networks with R5 in R. *Transport Findings*. https://doi.org/10.32866/001c.21262

Taylor, B., Miller, D., Iseki, H., & Fink, C. (2009). Nature and/or nurture? Analyzing the determinants of transit ridership across US urbanized areas. *Transportation Research Part A: Policy and Practice*, *43*(1), 60-77. https://doi.org/10.1016/j.tra.2008.06.007

Translink. (2022). *Transport 2050 Regional Transportation Strategy*. https://www.translink.ca/plans-and-projects/strategies-plans-and-guidelines/transit-and-transportation-planning/transport-2050

Ville de Québec. (2010). *Plan de mobilité durable - Pour vivre et se déplacer*. https://www.ville.quebec.qc.ca/apropos/planification-orientations/transport/docs/PlanMobiliteDurable.pdf