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Sizing up transport poverty: A national scale accounting of low-income households suffering from inaccessibility in Canada, and what to do about it

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1 **Sizing up transport poverty: a national scale accounting of low-income**
2 **households suffering from inaccessibility in Canada, and what to do about**
3 **it**

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13 **Abstract**

14 Millions of Canadians rely on public transportation to conduct daily activities and partici-
15 pate in the labour force. However, many low-income households are disadvantaged because
16 existing public transit service does not provide them with sufficient access to destinations.
17 Limited transit options, compounded with socioeconomic disadvantage, can result in trans-
18 port poverty, preventing travel to important destinations, like employment opportunities.
19 Given the growing gentrification of Canadian downtowns and the dispersion of poverty into
20 Canadian suburbs, the time is right for a national accounting of those living in transport
21 poverty, and the development of a national transport and land use strategy for alleviating
22 the risks of accessibility deprivation. Accordingly, in this paper we measure and analyze
23 vertical inequalities in access to employment in Canadian cities in order to estimate how
24 many, where, and to what extent, Canadians are at risk of transport poverty. We make use
25 of open transit network data and cutting edge accessibility measurement methods to gen-
26 erate comparative scores suitable for a national-scale analysis. We find that in aggregate,
27 lower income neighbourhoods tend to have better levels of transit accessibility. But despite
28 this overall positive outlook, there are still nearly one million low-income individuals living
29 in urban areas with low transit accessibility. We summarize our findings by generating de-
30 scriptive typologies for areas vulnerable to transport poverty which are then used to develop
31 and recommend planning strategies to reduce inequalities.

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20 this overall positive outlook, there are still nearly one million low-income individuals
21 living in urban areas with low transit accessibility. We summarize our findings by
22 generating descriptive typologies for areas vulnerable to transport poverty which are
23 then used to develop and recommend planning strategies to reduce inequalities.

24 **Keywords**

25 transport poverty, accessibility, inequalities, Canada

1 Introduction

2 Public transit is paramount in providing many urban residents around the world with
3 the ability to travel to daily activities and participate in the labour force. Especially
4 within lower income groups, transit is often the only means for accomplishing indepen-
5 dent travel. Despite this reliance, many neighbourhoods are disadvantaged because
6 public transit does not provide all places with sufficient access to destinations, like
7 employment opportunities. Poor transit accessibility, combined with other forms of
8 social and economic disadvantage (e.g. poor health, not being able to afford a car,
9 etc.), can result in transport poverty (Casas, 2007; Preston & Rajé, 2007; Lucas,
10 2012). This can limit people in their ability to find employment opportunities and
11 participate in the labour force. In Canada, governments are currently investing bil-
12 lions of dollars in public transport with very little guidance on whether and how this
13 infrastructure can be used to achieve a higher degree of transport justice in Canadian
14 cities. Social equity and inclusion are part of provincial and municipal policy goals
15 across the country (Government of Canada, 2017), but to date there has been no
16 attempt to understand the scale of transport poverty at a national scale. To address
17 this knowledge shortcoming, the objectives of this paper are threefold:

- 18 1. Measure transit access to employment for Canada's eight largest cities to analyze
19 inequalities in accessibility with respect to socioeconomic status (SES).
- 20 2. Estimate where and to what extent Canadians are at risk of transport poverty.
- 21 3. Generate neighbourhood-level typologies for areas vulnerable to transport poverty
22 in order to recommend urban planning strategies aimed at reducing risks of
23 transport-related exclusion.

24 Our findings show that low SES residents are generally more centrally located
25 and have relatively higher levels of transit accessibility. Despite this positive outlook
26 in aggregate, there are still a substantial number of low SES Canadians who are living
27 in areas with low transit accessibility. We estimate the number of Canadians at risk
28 of transport poverty by counting low income or otherwise vulnerable residents who
29 are living in the lowest areas of transit accessibility. We find that within Canada's
30 eight largest cities, 5% of the total population are living in low income households
31 which are also situated in areas with low transit accessibility. This totals to nearly
32 one million people who are at risk of transport poverty nation-wide.

33 Through a cluster analysis approach, we generate descriptive typologies of trans-
34 port poor neighbourhoods. We find that transport poverty is most apparent in very
35 dense, low-income, tower-neighbourhoods located off of the main axes of transit sup-
36 ply, or wherever low income populations live in low-density suburban urban forms
37 across the nation. We use these findings to recommend policy and urban planning
38 strategies directed towards improving transit accessibility and reducing risks of trans-

1 port poverty in Canadian cities. Policy recommendations include focusing future tran-
2 sit investments in areas which have high concentrations of low income households and
3 low levels of transit accessibility, intensification and diversity of land-use to increase
4 accessibility and reduce commute distances, as well as a consideration of subsidizing
5 ride-sharing or implementing demand-responsive transit in low density areas.

6 This is the first time, from our knowledge, that an accounting of transport
7 poverty has been conducted at a national scale anywhere in the world. And since con-
8 cerns of transport poverty are escalating internationally, the methodologies described
9 in this paper can inform studies in other countries as well. The policy recommenda-
10 tions in this paper can also provide guidance for urban areas outside of Canada since
11 Canadian cities are quite similar in terms of urban form and transportation issues to
12 some cities in the United States, Australia, and Europe.

13 **2 Background**

14 **2.1 Inequalities in Transport Accessibility**

15 A primary function of an urban transport system is to provide people the opportunity
16 to participate in daily activities, social interactions, and access to destinations neces-
17 sary for their well-being. The concept of accessibility is commonly used to assess the
18 distribution of benefits of urban transport systems. Accessibility can be understood
19 as the ease of reaching destinations (Hansen, 1959) and is increasingly being used to
20 evaluate transport plans and land use policy (Papa et al., 2014; Merlin et al., 2018).
21 In modern cities, greater levels of accessibility have been significantly associated with
22 shorter commuting times (Kawabata & Shen, 2007; Hu, 2015), increased employment
23 rates (Sanchez, 1999; Merlin & Hu, 2017), greater levels of activity participation
24 (Paez et al., 2009; Cordera et al., 2017), and it can foster social inclusion and reduce
25 social isolation (Garrett & Taylor, 1999; Lucas, 2012).

26 The distribution of land-use and transportation networks in cities is never spa-
27 tially uniform. Therefore, access to destinations is never equal among urban popula-
28 tions. While some inequality is inevitable, particularly low levels of accessibility can
29 potentially result in transport poverty. Transport poverty occurs when transport dis-
30 advantage (not having access to a car, poor public transit options, etc.) compounds
31 with other forms of potential social disadvantage (unemployment or low income, dis-
32 ability or poor health, etc.) (Lucas, 2012). Transport poverty is the compounded
33 lack of ability to travel to important destinations and activities. This can result in
34 an increased generalized cost of reaching destinations, suppression of activity partic-
35 ipation, and, in the worst cases, can result in the perpetuation of social exclusion
36 (Casas, 2007; Preston & Rajé, 2007; Pereira et al., 2017).

1 From a justice perspective, the normative argument for reducing inequalities is
2 often framed through a moral lens of social equity. At a basic level, social equity
3 refers to the fairness with which impacts (i.e. benefits and costs) are distributed.
4 For transport policy, social equity is usually framed towards providing equality of
5 opportunity (e.g. to access destinations) rather than of outcome (Litman, 2003).
6 Recent approaches for investigating social equity in transport have included drawing
7 upon Walzer's *Spheres of Justice* (Walzer, 1983) and Rawls' *A Theory of Justice*
8 (Rawls, 1971) to advocate for increasing the average accessibility in a region while at
9 the same time reducing the gap between the highest and lowest levels of accessibility
10 (Martens, Golub, & Robinson, 2012; Martens, 2016; Pereira et al., 2017).

11 Assessing the equity of transport systems is often approached by framing eq-
12 uity in terms of horizontal or vertical dimensions (Litman, 2002; Delbosc & Currie,
13 2011; Pereira et al., 2017). Horizontal equity is concerned with the distribution of
14 a resource, like transit provision, equally amongst the overall population. Vertical
15 equity pertains to the distribution of a resource with focus towards specific groups,
16 often those who are more vulnerable to social or economic exclusion. As it pertains to
17 transportation, vertical equity is often studied in relation to income and social class
18 (Litman, 2002; Welch & Mishra, 2013). In other words, vertical equity is focused on
19 analyzing the compounding factors that can result in transport poverty. There have
20 been a plethora of studies which have measured inequalities in accessibility among
21 the overall population and comparing with various subgroups, who are potentially
22 more vulnerable to experiencing transport poverty. Some studies have found differing
23 levels of accessibility for minority groups (Parks, 2004; Klein et al., 2018), recent
24 immigrants (Blumenberg, 2008; Farber et al., 2018), single-parent families (Páez et
25 al., 2013), by age cohorts (Delbosc & Currie, 2011; Barnes et al., 2016), by gender
26 (Hanson & Pratt, 1995; Klein et al., 2018), or by wages and income levels (Delbosc &
27 Currie, 2011; Fan et al., 2012). Other studies have generated combined measures of
28 socio-economic disadvantage at a neighbourhood level to compare with accessibility
29 measures to highlight where gaps in transit accessibility align with social need (Foth
30 et al., 2013; Fransen et al., 2015). Research has also shown that the travel modes
31 available to an individual makes a substantial difference in terms of access to desti-
32 nations, particularly the disparity between transit riders and those who have regular
33 use of a private vehicle (Benenson et al., 2011; Golub & Martens, 2014; Benenson et
34 al., 2017). There have been a number of academic reviews which have discussed how
35 social equity, and in particular improving people's access to destinations, should be
36 further incorporated into transportation plans and policy to reduce inequalities and
37 foster social and economic inclusion (Wee & Geurs, 2011; Karner & Niemeier, 2013;
38 Manaugh et al., 2015; Pereira et al., 2017).

39 Access to employment opportunities in particular has been a key indicator for
40 evaluating the performance and social outcomes of a city's transport network (Shen,
41 1998; El-Geneidy & Levinson, 2006; Bania et al., 2008). Employment is paramount

1 to preventing social exclusion as it provides the financial ability to support other as-
2 pects of life. The ability to obtain and retain employment can depend on a number
3 of factors like education, social network, and size and proximity to the labour mar-
4 ket. Difficulties in finding employment can be compounded if local transit service is
5 ineffective in providing access to destinations in a reasonable amount of time (Kain,
6 1992). Some recent studies have examined how lower levels of transit accessibility
7 can negatively affect employment outcomes (Sanchez, 1999; Allard & Danziger, 2002;
8 Merlin & Hu, 2017). In a survey in the UK, two out of five unemployed citizens
9 link difficulties in finding employment with the inability to use a car and insufficient
10 public transit options (Social Exclusion Unit, 2003). Other studies have not found
11 a significant relationship with job access and employment outcomes. For example,
12 Sanchez, Shen, and Peng (2004) found no association between transit access and
13 employment status of welfare recipients in six American cities. Access to employ-
14 ment by transit is also associated with transit mode share (Owen & Levinson, 2015;
15 Boisjoly & El-Geneidy, 2016), indicating that if transit accessibility is improved for
16 an area, then it could encourage a mode shift away from private vehicles and have
17 other environmental and economic benefits like reducing congestion and emissions.
18 Jobs accessibility is also a good proxy for access to other types of destinations as the
19 location of jobs are highly correlated with other key activity destinations like shops,
20 services, and recreation.

21 **2.2 Accessibility Research within the Canadian Context**

22 In recent decades, Canada has witnessed a rise in socioeconomic inequalities, and
23 concentrations of poverty, both at a regional level (Breau, 2015) and within cities
24 (Hulchanski et al., 2010; Walks & Twigge-Molecey, 2013; Breau et al., 2018). Along
25 with this growth in poverty, evidence has indicated that poverty distributions have
26 become more suburbanized; increased costs of housing in city centres have pushed
27 lower-income residents to more affordable, but less accessible areas (Ades et al., 2012,
28 2016).

29 Moreover, several Canadian research projects have found that people living in
30 areas with low accessibility have significantly lower activity participation rates, partic-
31 ularly for those who are socially disadvantaged in other ways. For example, McCray
32 and Brais (2007) examined how transportation factors limit the daily activity pat-
33 terns of low income women in Quebec City. Spinney et al. (2009) showed there is
34 significant association between transport mobility benefits and quality of life for el-
35 derly Canadians. Allen and Farber (2018) analyzed how low accessibility limits the
36 on-campus participation of University students. A series of papers from the same re-
37 search effort used large-scale travel surveys and spatial econometric models of travel
38 behaviour to identify how the disparities in accessibility among low income, elderly,
39 and single-parent families dissuaded participation in daily activities (Paez et al., 2009;

1 Roorda et al., 2010; Páez et al., 2013). Many suburban low-SES households currently
2 have a vehicle which they rely on for daily travel. However, they may still be at risk of
3 transport poverty as they are more sensitive to increasing costs of driving (fuel costs,
4 paying interest on car loans, etc.) which increase the likelihood of not being able
5 to afford a vehicle in the future, meaning they would become reliant on insufficient
6 transit service (Mattioli et al., 2018; Walks, 2018).

7 The Canadian government is currently investing billions of dollars on transit in
8 aims to relieve congestion, reduce travel times, and increase accessibility. The 2016
9 federal budget pledged \$3.4 billion towards transit investment over the subsequent
10 three years, and in 2017 the Canadian government announced it will invest \$20.1 bil-
11 lion over the next decade in public transit through bilateral agreements with provinces
12 (Government of Canada, 2017). Provincial and municipal governments are also in-
13 vesting substantially in transit infrastructure projects. Even though social equity and
14 inclusion are increasingly a part of policy goals in regions across the country, as well as
15 at a national level (Government of Canada, 2017), there is little coordination or guid-
16 ance as to whether or how these goals can be addressed through investments in public
17 transit infrastructure. We argue that by accounting for the number of transport-poor
18 people across the nation in this paper, we can shed light on the importance for the
19 development of national, provincial, and municipal policy strategies that can be used
20 to steer transport investments in a socially progressive manner.

21 There has been some previous research in analyzing transit access to employment
22 in Canadian cities, primarily focused in Montreal and Toronto. These existing stud-
23 ies have involved analyzing inequalities in accessibility comparing with socioeconomic
24 status (Páez et al., 2013; Foth et al., 2013; El-Geneidy et al., 2016), incorporating
25 fare costs into accessibility measures (El Geneidy et al., 2016), comparing transit
26 accessibility before and after long-term changes in transportation infrastructure and
27 land use patterns (Foth et al., 2013; Farber & Grandez, 2017), or examining daily
28 fluctuations in accessibility (Boisjoly & El-Geneidy, 2016; El-Geneidy et al., 2016;
29 Wessel, Allen, & Farber, 2017). Overall, this existing work has indicated that lower
30 income neighbourhoods generally have better transit access to jobs than the overall
31 population. Correlation results are however most likely skewed by the large num-
32 ber of affluent suburban neighbourhoods with poor transit accessibility. Despite this
33 positive outlook in aggregate, there are still potentially large numbers of low income
34 suburban households lacking sufficient access to employment that are not being ac-
35 counted for. A report on social inclusion in transport planning in Canada estimated
36 that a third or more of households in Canada have at least one member who is trans-
37 port disadvantaged (Litman, 2003). And while ample research has linked transport
38 disadvantage with activity participation and well-being (Spinney et al., 2009; Paez
39 et al., 2009), there is little existing detailed knowledge on the scope of the national
40 transport poverty problem, and how it is distributed within and between Canadian
41 cities. This means that existing policy does not have a clear understanding of how

1 to funnel transit investment into projects that reduce inequalities in transit accessi-
 2 bility. The following sections detail analyzing inequalities in transit accessibility and
 3 quantifying the extent of transport poverty in Canada's eight largest cities.

4 **3 Study Regions & Data**

5 This study looks at the eight most populous metropolitan regions in Canada. Addi-
 6 tively, these have been referred to as urban megaregions (Simmons & Bourne, 2013).
 7 For our study, we use household demographic and employment data from the 2016
 8 Canadian census. From the 2016 Canadian census, 58% of Canadians live in the
 9 eight study regions. The boundaries of these regions for our study are composed
 10 from Census Metropolitan Areas (CMA). CMAs are agglomerations of municipalities
 11 which pertain to urban areas with a population of over 100,000 where at least 50% of
 12 the employed labour force works in the region's core (Statistics Canada, 2016a). For
 13 our study, any adjacent CMAs are merged due to the commuting flow and transit
 14 agencies that link adjacent regions together. See Table 1 for summary statistics of
 15 each urban region.

16 For our analysis, we use a measure of competitive access to employment. Com-
 17 petitive measures of access to employment allow for comparing between regions by
 18 accounting for competition both among the labour force for jobs as well as competi-
 19 tion among employers for employees (Geurs & van Eck, 2003; Merlin & Hu, 2017).
 20 These measures were computed at the census Dissemination Area (DA) level using
 21 2016 census demographic and employment data (Statistics Canada, 2016b). DAs are
 22 the smallest geography in which demographic and socio-economic data are released
 23 for the Canadian census. Competitive access to employment measures were calculated
 24 as follows.

$$A_{i,T} = k|120|^{-1} \sum_{\tau \in M} \sum_{j=1}^J \frac{O_j f(t_{i,j,\tau}) f(t_{i,j,\tau})}{L_j} \quad (1)$$

$$A_{i,D} = k \sum_{j=1}^J \frac{O_j f(t_{i,j,d}) f(t_{i,j,d})}{L_j} \quad (2)$$

$$L_j = |120|^{-1} \sum_{\tau \in M} \sum_{i=1}^I \frac{\alpha_{i,T} P_i f(t_{i,j,\tau})}{A_{i,T}} + \sum_{i=1}^I \frac{\alpha_{i,D} P_i f(t_{i,j,d})}{A_{i,D}} \quad (3)$$

25 $A_{i,T}$ is the measure of location i 's access to employment by transit, and $A_{i,D}$ is
 26 a measure of access to employment by driving. O_j is the number of jobs at j . L_j
 27 is a measure of access to the labour force from work location j (i.e. the number of

1 workers in the catchment area of a place of employment). P_i is the size of the labour
 2 force at i . $t_{i,j,d}$ and $t_{i,j,\tau}$ are travel times by driving and transit during the morning
 3 commute period. Travel times were computed using OpenStreetMap and GTFS data.
 4 As in other studies (Owen & Levinson, 2015; Farber & Fu, 2017), travel times by
 5 transit were computed for every minute, τ , during the morning commute period M
 6 (7:00am to 8:59am), and then averaged to account for fluctuating transit schedules.
 7 The impedance functions for transit and driving, $f(t_{i,j,\tau})$ and $f(t_{i,j,d})$, use an inverse-
 8 power decay function parametrized such that a 30 minute commute returns a value
 9 of 0.5, and with a maximum value of 1 (at $t_{i,j} = 0$). 30 minutes is approximately the
 10 average commute duration across all eight regions (Statistics Canada, 2016b). The
 11 two $f(t)$ terms in A_i permit accurate comparison between cities which have differing
 12 transport networks and sub-optimal distributions of opportunities (Delamater, 2013).
 13 $\alpha_{i,D}$ is the commute mode share ratio of workers at location i who travel to work via
 14 private vehicle. $\alpha_{i,T}$ is the mode share ratio by transit and walking. The mode share
 15 for transit for our study is assumed as the total non-driving commuting population
 16 ($\alpha_{i,T} = 1 - \alpha_{i,D}$), and therefore also includes the small percent of those who take
 17 active modes (bike or walk). This assumes that those who bike or walk to work are
 18 also able to commute to work by transit, but not by car. The resulting values of $A_{i,T}$
 19 and $A_{i,D}$ are scaled (via the parameter k) from 0 to 1 to provide easier interpretation,
 20 where 0 is no access and 1 is the maximum level of access to employment observed
 21 for any travel mode across Canada (URL blinded for review).

22 Accessibility was computed for access to all jobs in each region as well as access
 23 to jobs by different income levels in order to examine if there is a greater mismatch
 24 between low-income workers and low-income jobs. When computing access to jobs
 25 stratified by income level, O_j and P_i pertain to jobs and the labour force within the
 26 specified income range. The income ranges are split at \$10,000 intervals of yearly
 27 after-tax individual income (Statistics Canada, 2016a).

28 There are two potential limitations regarding the accessibility measures used in
 29 this study. One is that the spatial distribution of actual jobs seekers and job openings
 30 could vary from the overall population and employment surfaces (Fransen et al., 2018).
 31 However, we only had available data for the overall labour force and the total amount
 32 of employment in these regions. From our knowledge, comprehensive data for job
 33 seekers and openings does not exist Canada-wide. Another limitation is that we do
 34 not consider the monetary cost of travel. Some transit agencies have greater fares than
 35 others which could deter travel, particularly for lower income groups and trips that
 36 involve travelling with more than one transit agency. El Geneidy et al. (2016) showed
 37 how this could impact accessibility measurements in Montreal. Toronto is similar in
 38 that there are multiple transit agencies each with their own fare structure.

39 For the subsequent analysis, we only include people living in areas with a popu-
 40 lation density greater than 200 people/km². Areas under this threshold are omitted
 41 from analysis as they typically pertain to rural or large industrial areas in our regions

1 of study, typically areas without transit supply. Leaving these areas in our analysis
 2 would skew our results since some municipalities have more rural areas than others,
 3 depending on how the municipalities and CMAs are delineated. 200 people/km² is
 4 the same urban-rural threshold used by Delbosc and Currie (2011) in measuring tran-
 5 sit equity in Melbourne, Australia, a city with similar urban form characteristics to
 6 Canadian cities.

Table 1: Summary statistics by urban region

	Population	Jobs	Transit Mode Share [†]	Mean Trip Time*		Mean Access to Jobs [§]	
				Transit	Car	Transit	Car
Toronto	8,335,444	3,462,100	18.4%	49.2	29.0	0.09	0.38
Montreal	4,098,927	1,756,640	22.2%	44.4	26.8	0.10	0.42
Vancouver	2,745,461	1,091,405	18.7%	43.8	27.2	0.14	0.38
Calgary	1,392,609	587,280	15.9%	41.6	24.1	0.08	0.40
Ottawa	1,323,783	595,950	20.1%	42.2	24.7	0.12	0.52
Edmonton	1,321,426	553,640	11.3%	40.2	24.2	0.07	0.40
Quebec City	800,296	375,720	11.3%	35.1	21.2	0.10	0.54
Winnipeg	778,489	344,320	13.4%	35.7	22.6	0.13	0.54

[†] Percent of work commute trips by transit

* Mean one-way commute time for journey to work trips (in minutes)

[§] Access to all jobs using equations (1-3), scaled from 0 (lowest) to 1 (highest)

7 4 Analyzing Inequalities in Access to Employment

8 In this section, we analyze the association between SES with transit access to employ-
 9 ment using simple correlation measures. For indicators of SES, we use four income-
 10 related categories from the census; unemployment rate (UR), the log of median after-
 11 tax household income (ln MHI), and two variables of low income status tabulated by
 12 Statistics Canada, the low income measure (LIM) and the low income cut-off (LICO).
 13 The LIM is a count of households below the low-income line. This line is set at half
 14 the median household income and adjusted by the square root of the number of per-
 15 sons living in the household. This has the effect of raising the low income line for
 16 households with more people, but at a diminishing rate of increase (Statistics Canada,
 17 2016a). Alternatively, the LICO pertains to households which are estimated to spend
 18 more than 20% of their income on basic necessities (e.g. food, shelter, and clothing),
 19 relative to an average family. The LICO controls for regional variations as well as
 20 household size to account for differing costs of living. These four income categories
 21 are highly correlated. To examine their compounded effect, we also generate a com-
 22 bined measure of neighbourhood SES, weighting the four variables equally. This is

1 generated as follows, where \hat{I} pertains to the standardized score of each of the four
2 measures.

$$I_{\mu} = 0.25\hat{I}_{\ln MHI} - 0.25\hat{I}_{UR} - 0.25\hat{I}_{LIM} - 0.25\hat{I}_{LICO} \quad (4)$$

3 The lower the I_{μ} , the lower the SES of the DA.

4 We then generate Pearson correlation coefficients between these income variables
5 and transit access to jobs. We conduct this analysis in terms of access to all jobs as well
6 as access to jobs stratified by different by income levels. Table 2 shows correlation for
7 access to all jobs as well as access to low-income jobs. Access to all jobs and access
8 to low-income jobs produces similar correlation coefficients with measures of SES.
9 Similar results were also found for other income brackets, but this is not presented in
10 the table for the sake of brevity.

Table 2: Correlation coefficients between transit access to jobs and income-related variables

	Access to all jobs					Access to low-income jobs (<\$20k/year)				
	\hat{I}_{LICO}	\hat{I}_{LIM}	\hat{I}_{UR}	$\hat{I}_{\ln MHI}$	\hat{I}_{μ}	\hat{I}_{LICO}	\hat{I}_{LIM}	\hat{I}_{UR}	$\hat{I}_{\ln MHI}$	\hat{I}_{μ}
Toronto	0.43	0.32	0.04	-0.29	-0.32	0.41	0.33	0.05	-0.33	-0.33
Montreal	0.66	0.68	0.27	-0.48	-0.56	0.66	0.58	0.27	-0.49	-0.56
Vancouver	0.48	0.35	0.01	-0.38	-0.38	0.48	0.36	0.01	-0.40	-0.40
Calgary	0.45	0.38	-0.01	-0.36	-0.32	0.43	0.35	-0.02	-0.34	-0.29
Ottawa	0.53	0.43	0.20	-0.38	-0.44	0.52	0.42	0.20	-0.37	-0.43
Edmonton	0.58	0.46	0.09	-0.53	-0.48	0.58	0.46	0.09	-0.53	-0.48
Quebec City	0.66	0.61	0.28	-0.57	-0.62	0.66	0.61	0.28	-0.57	-0.62
Winnipeg	0.59	0.58	0.28	-0.64	-0.59	0.58	0.56	0.27	-0.63	-0.58
All	0.51	0.42	0.08	-0.37	-0.41	0.50	0.42	0.08	-0.39	-0.41

11 Median household income, as well as the two low-income prevalence categories
12 (LIM and LICO), are significantly correlated with transit accessibility in each of the
13 eight regions. This is the same overall relationship as in previous research in Toronto,
14 which found that neighbourhoods of lower socioeconomic status tend to have better
15 transit accessibility (Foth et al., 2013; El-Geneidy et al., 2016). Table 2 indicates that
16 this relationship is similar, and even accentuated, in cities across the nation. Comparing
17 between cities, we observe that transit access in Toronto and Calgary have the
18 weakest association with income categories, while Montreal, Winnipeg, and Quebec
19 City have the strongest association. We also observe that unemployment is less associated
20 with transit accessibility compared to the other income measures. Toronto,
21 Vancouver, and Calgary do not have a strong relationship between unemployment

1 and transit accessibility, while in the other cities, unemployed people are more likely
2 to be in areas with good transit accessibility.

3 Overall, these results show that transit accessibility is vertically equitable in all
4 of the cities included in our analysis. Transit is serving low-income residents, those
5 who theoretically have a greater need, with higher levels of accessibility compared to
6 high income residents. This could be due to a number of factors. One is that transit
7 is being directly or indirectly planned to serve lower income residents. Lower-income
8 households live in smaller units with higher levels of population density, and transit
9 is usually more efficient in more intensely developed neighbourhoods. Second, there
10 may be preference-selection effects. People living near transit may be satisfied with
11 lower incomes relative to housing costs as they will not need to pay for a private
12 vehicle, and wealthier households who have no intention to use transit choose to live
13 in larger lots at greater distances to employment. Lower-income households without
14 cars are more likely move to areas with higher levels of transit service (Glaeser et al.,
15 2008). Third, there are historical factors which have led to concentrations of lower SES
16 populations in older downtown housing stocks which have either experienced decay or
17 were redeveloped into low-income apartment complexes in the post-war period.

18 **5 Estimating the Extent of Transport Poverty**

19 Despite the overall positive outlook seen in the above correlation analyses, there are
20 still a large number of low SES neighbourhoods with low transit accessibility, and
21 the situation of these people need to be accounted for. Also, the previous analysis
22 correlates at a neighbourhood level, but does not take into consideration the income
23 distributions within each areal unit. This potentially obfuscates low-income house-
24 holds at risk of transport poverty in neighbourhoods which have higher levels of SES
25 on average.

26 To estimate the extent of transport poverty in Canada, we tabulate the number
27 of low-income or otherwise vulnerable populations in areas of low transit accessibil-
28 ity. We first tabulate counts living in the lowest deciles of transit access to jobs for
29 each region. Tabulating by deciles provides a simple interpretation like "there are X
30 number of people living in the lowest 10% of transit accessibility for each region".
31 However, this does not provide an adequate comparison between regions (there will
32 always be a lowest 10%, even in a relatively high-access city). Accordingly, we also
33 tabulate populations under certain thresholds of transit accessibility. Specifically, we
34 count the populations in areas where transit accessibility is less than 0.1 and where it
35 is less than 0.05 (on the scale of competitive accessibility where 0 is the minimum and
36 1 is the maximum observed for anyone across these eight Canadian regions). This
37 allows for interpretation in the form of "there are X number of people living in areas
38 of low and extremely low levels of nationally comparative transit accessibility".

1 These categories of low transit accessibility are cross-tabulated with four socioe-
2 conomic variables which are likely to compound with low transit accessibility and
3 result in transport poverty. Firstly, we tabulate using two measures specified by
4 Statistics Canada (2016), the low income cut-off (LICO) and the low income measure
5 (LIM). These groups are more likely to face financial constraints, like not being able
6 to afford a private vehicle, and are more likely to rely on transit. If transit accessibil-
7 ity is relatively low, it could increase the risk of transport poverty (Lucas, 2012). As
8 well, we sum cross-tabulations by two other measures of socio-economic status which
9 could compound with transport disadvantage and result in transport poverty. One is
10 recent immigrant status (immigrated between 2011 and 2016) as recent immigrants
11 are more likely to rely on transit due to the time-intensive process of obtaining a
12 driving license, the cost of a vehicle, and potential language barriers (Lo, Shalaby, &
13 Alshalalfah, 2011; Farber et al., 2018). Recent immigrants are also more likely to be
14 in search of employment. Lastly we tabulate by the number of individuals who are
15 unemployed, since previous research has linked difficulties of unemployed individuals
16 in finding work with the inability to use a car and insufficient public transit options
17 (Social Exclusion Unit, 2003; Merlin & Hu, 2017). These cross-tabulations are shown
18 in Tables 3 and 4.

19 The results indicate that even though low SES residents are more likely to be
20 in areas of higher transit accessibility, there are still a large number living in areas
21 of low transit accessibility. These people may be a small percentage of the overall
22 population, or even just a modest share of low-income people overall, but given the
23 sizes of the populations under investigation, the overall number of people at risk
24 of transport poverty is quite substantial. Calgary, Edmonton, and Toronto have
25 particularly large counts of low-income, unemployed, and recent immigrants in areas
26 of low transit accessibility relative to their totals, while in Quebec City, Winnipeg, and
27 Ottawa, relatively fewer vulnerable populations are living in areas with low transit
28 accessibility. Tabulating by deciles (Table 3) produces lower counts than by low
29 transit accessibility (Table 4) due to how low accessibility was defined. We also
30 looked at cross-tabs of counts by deciles of access to low-income jobs instead of access
31 to all jobs. Percent difference between cells of the table for access to all jobs compared
32 to low-income jobs did not exceed 8%, with a mean percent difference of only 2%.
33 This is not presented due to similarity in results.

Table 3: Counts of all low-income residents, unemployed, and recent immigrants (2011-2016) in the lowest decile and lowest quintile of transit accessibility by region

		LIM	LICO	Unem.	Rec.Im.	Labour Force	Total Pop.
Toronto	10%	60,000	35,000	25,000	21,000	435,000	787,000
	20%	131,000	86,000	53,000	50,000	863,000	1,572,000
	Total	1,173,000	922,000	328,000	399,000	4,317,000	7,963,000
Montreal	10%	27,000	14,000	12,000	2,000	216,000	380,000
	20%	51,000	29,000	23,000	6,000	420,000	746,000
	Total	598,000	472,000	158,000	178,000	2,092,000	3,925,000
Vancouver	10%	27,000	20,000	7,000	7,000	145,000	273,000
	20%	54,000	40,000	15,000	16,000	287,000	537,000
	Total	422,000	349,000	86,000	148,000	1,440,000	2,637,000
Calgary	10%	8,000	5,000	7,000	7,000	80,000	138,000
	20%	15,000	11,000	14,000	17,000	158,000	269,000
	Total	118,000	108,000	74,000	92,000	789,000	1,343,000
Ottawa	10%	8,000	4,000	3,000	1,000	64,360	117,479
	20%	15,000	9,000	7,000	3,000	128,000	229,000
	Total	148,000	125,000	46,000	37,000	639,000	1,169,000
Edmonton	10%	7,000	4,000	6,000	3,000	73,000	128,000
	20%	13,000	8,000	11,000	8,000	134,000	242,000
	Total	112,000	99,000	59,000	77,000	692,000	1,203,000
Quebec City	10%	4,000	2,000	1,000	500	40,000	70,000
	20%	6,000	4,000	3,000	500	78,000	135,000
	Total	75,000	62,000	18,000	13,000	388,000	712,000
Winnipeg	10%	6,000	5,000	2,000	4,000	39,000	69,000
	20%	10,000	8,000	4,000	7,000	77,000	136,000
	Total	109,000	91,000	25,000	52,000	387,000	712,000
All	10%	147,000	89,000	64,000	45,000	1,092,000	1,963,000
	20%	296,000	197,000	129,000	107,000	2,151,000	3,866,000
	Total	2,755,000	2,228,000	794,000	996,000	10,744,000	19,663,000

Table 4: Counts of all low-income residents, unemployed, and recent immigrants (2011-2016) in areas of low (<0.1) and extremely low (<0.05) transit accessibility

	$A_{i,T}$	LIM	LICO	Unem	Rec.Imm.	Labour Force	Total Pop.
Toronto	<0.05	330,000	234,000	129,000	121,000	1,856,000	3,406,000
	<0.1	638,000	472,000	212,000	225,000	2,867,000	5,330,000
	Total	1,173,000	922,000	328,000	399,000	4,317,000	7,963,000
Montreal	<0.05	136,000	87,000	53,000	23,000	913,000	1,658,000
	<0.1	242,000	168,000	82,000	55,000	1,274,000	2,374,000
	Total	598,000	472,000	158,000	178,000	2,092,000	3,925,000
Vancouver	<0.05	115,000	86,000	30,000	39,000	534,000	1,014,000
	<0.1	199,000	152,000	47,000	72,000	798,000	1,510,000
	Total	422,000	349,000	86,000	148,000	1,440,000	2,637,000
Calgary	<0.05	39,000	33,000	32,000	40,000	354,000	609,000
	<0.1	74,000	66,000	53,000	66,000	564,000	979,000
	Total	118,000	108,000	74,000	92,000	789,000	1,343,000
Ottawa	<0.05	18,000	11,000	9,000	4,000	154,000	274,000
	<0.1	45,000	32,000	20,000	13,000	341,000	613,000
	Total	148,000	125,000	46,000	37,000	639,000	1,169,000
Edmonton	<0.05	38,000	30,000	28,000	32,000	356,000	614,000
	<0.1	69,000	58,000	43,000	53,000	523,000	916,000
	Total	112,000	99,000	59,000	77,000	692,000	1,203,000
Quebec City	<0.05	10,000	6,000	4,000	1,000	119,000	206,000
	<0.1	24,000	17,000	9,000	3,000	228,000	405,000
	Total	75,000	62,000	18,000	13,000	388,000	712,000
Winnipeg	<0.05	7,000	6,000	2,000	4,000	46,000	82,000
	<0.1	25,000	20,000	8,000	15,000	155,000	279,000
	Total	109,000	91,000	25,000	52,000	387,000	712,000
All	<0.05	692,000	492,000	287,000	265,000	4,338,000	7,864,000
	<0.1	1,315,000	985,000	475,000	502,000	6,749,000	12,406,000
	Total	2,755,000	2,228,000	794,000	996,000	10,744,000	19,663,000

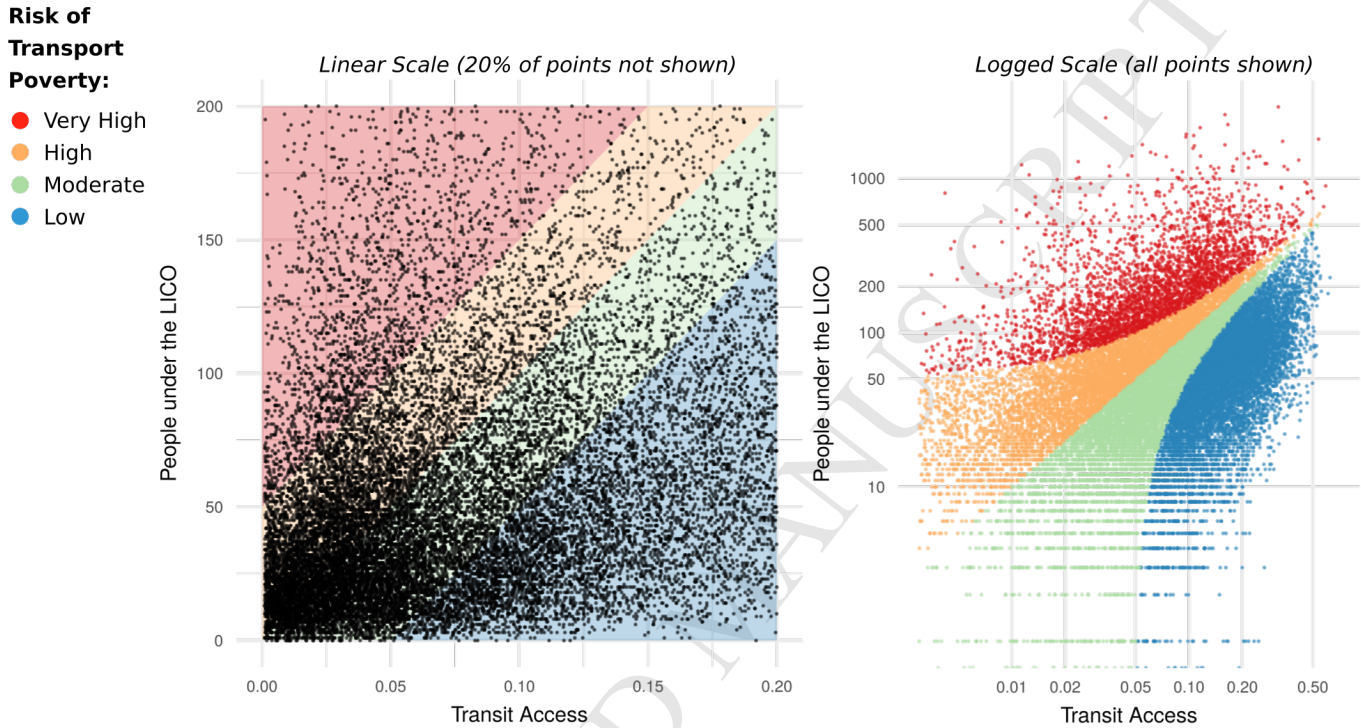
1 6 Creating a Typology of Transport Poor Neigh- 2 bourhoods in Canada

3 We now analyze the characteristics of areas that are at risk of transport poverty in
4 order to support discussion and policy recommendations. We first classify Dissemina-
5 tion Areas (DA) in terms of their risk of experiencing transport poverty. Theoretically,
6 transport poverty is more likely to occur where there is low transit accessibility and
7 lower levels of SES. For the scope of this paper, we simplify to assume that areas
8 at risk of transport poverty are those with low transit access to employment, and
9 have high counts of people living under the regionally adjusted low-income cut-off
10 (LICO). We use the compounding effect of these two variables to classify DAs into
11 four categories of risk of transport poverty (low, moderate, high, and very high). The
12 classification was based on the assumption that both transit accessibility and preva-
13 lence of low-income residents contribute linearly to the risk of transport poverty.
14 This relationship is visualized Figure 1 in a linear plot and log-log plot. Overall, 12%
15 of DAs are classified as very high risk and 23% as high risk of transport poverty.
16 Toronto and Vancouver have the greatest percent of their DAs at high risk of trans-
17 port poverty, and the smaller cities of Winnipeg and Quebec have the lowest (see
18 Table 5). Toronto and Vancouver are also the two cities which have been reported
19 on the most in terms of experiencing rising housing costs and sub-urbanization of
20 poverty (Ades et al., 2012, 2016).

Table 5: Percent of DAs classified by risk of experiencing transport poverty in each region

	Low	Moderate	High	Very High
Toronto	30.0%	31.0%	24.0%	15.1%
Montreal	30.5%	32.1%	26.9%	10.5%
Vancouver	35.9%	20.7%	27.7%	15.8%
Calgary	35.6%	34.3%	19.9%	10.2%
Ottawa	53.6%	24.2%	13.5%	8.7%
Edmonton	29.9%	35.0%	24.0%	11.1%
Quebec City	49.6%	34.4%	13.8%	2.1%
Winnipeg	62.4%	22.0%	8.9%	6.7%
All	34.8%	29.6%	23.2%	12.4%

Figure 1: Classifying DAs in terms of risk of experiencing transport poverty (each dot in the plots represents a DA)



1 Lastly, we conduct a k -means cluster analysis of zones at risk of transport poverty
 2 in order to generate a typology that can be used for policy recommendations. Specifi-
 3 cally we cluster on DAs that we classified as high or very high risk of transport poverty.
 4 We cluster these DAs using seven relevant variables; access to jobs by transit, access to
 5 jobs by car, population density, percent of population living in apartments, number of
 6 residents in low-income households, percent of residents living in new housing stock
 7 (built since 2000), and the percent who have moved recently (from 2011 to 2016).
 8 The resulting number of clusters ($k = 2$) was determined by generating a Scree plot,
 9 and then selecting the k where the graph provides the greatest change in slope. The
 10 means of the variables selected in the cluster analysis for the two resulting groups are
 11 displayed in Table 6. Table 6 also shows the number of DAs in each category, and
 12 the number of DAs that were previously categorized as being high or very high risk
 13 of transport poverty. There is a greater proportion of DAs that have a very high risk
 14 of transport poverty in the first group, which also has greater population density and
 15 high percent of people living in apartments.

Table 6: Cluster analysis results of DAs at risk of transport poverty

mean	Group A	Group B
Auto Access	0.481	0.235
Transit Access	0.117	0.032
Population Density (ppl/km ²)	8,281	3,287
People under the LICO	257	74
Percent living in apartments	74%	14%
Percent moved 2011-2016	51.8%	36.3%
Percent in dwellings built since 2000	16.3%	26.3%
n DAs	2,252	7,239
n Very high risk of transport poverty	1,388	1,750
n High risk of transport poverty	864	5,489

1 We can summarize by saying that there are two main typologies of areas in
 2 which people are at a high risk of experiencing transport poverty. One are areas with
 3 high population density, primarily people living in older apartments, with very high
 4 concentrations of low income residents, who were more likely to have moved recently,
 5 and who have average levels of transit access to employment (Group A). The second
 6 (Group B) are more peripheral, typical suburban single family housing, low density
 7 neighbourhoods, with extremely low levels of transit accessibility, have a wider gap
 8 between the relative level of transit accessibility to auto accessibility, more likely to
 9 be living in newer housing stock, but have fewer low income residents. Put simply,
 10 transport poverty is most apparent in very dense, low-income, tower-neighbourhoods
 11 located off of the main axes of transit supply, or wherever low income populations
 12 live in low-density suburban urban forms across the nation.

13 7 Policy Recommendations

14 Our research shows that while there are not systemic vertical inequalities in transit
 15 accessibility, there are still a substantial number of low-income Canadians living in
 16 areas of low transit accessibility. We estimate that 40% of all low-income residents
 17 in these cities are at risk of transport poverty, 5% of the overall population, and
 18 nearly one million people in total. The literature explains that the compounding
 19 effects of low transit accessibility and low SES increase the risks of transport poverty,
 20 potentially limiting people in their ability to travel to and participate in daily activi-
 21 ties, including finding and retaining employment (Preston & Rajé, 2007; Paez et al.,
 22 2009; Lucas, 2012). Investing in public transport to improve accessibility, particu-

1 larly focused towards those at risk of transport poverty, has the potential to reduce
2 inequalities, limit barriers to activity participation, and foster social and economic
3 inclusion.

4 This leads to the broad conclusion that transport policy in Canadian cities should
5 focus towards improving transit service to low accessibility neighbourhoods, with par-
6 ticular focus towards those neighbourhoods with more low-income households since
7 they are more likely to be reliant on transit. Unfortunately, there is only a limited
8 amount of funds and resources available for improving public transportation in Cana-
9 dian cities. Certainly, this points towards advocating for increasing public funding
10 for public transit service, either through raising taxes (e.g. like gas taxes or conges-
11 tion charges) or re-allocation of government spending from other infrastructure (e.g.
12 shift spending from highways to transit). However, it would be quixotic to think
13 that there will be a sufficient amount of funds for desirable levels of public transit
14 provision in urban areas across Canada in the near future. The prevailing challenge of
15 urban transportation planning is deciding how to allocate scarce funds and resources
16 to where they are to be the most effective.

17 The previous section indicates that there are two types of areas at risk of trans-
18 port poverty. The first group have high levels of population density (e.g in apartment
19 towers) and high concentration of low income residents. These are usually located in
20 the "inner-suburbs" of urban areas, and typically already have some transit service in
21 place, but the existing service is low relative to the socioeconomic status and density
22 of residents. Due to greater density, improving transit accessibility in these areas
23 would be the most effective in reducing risks of transport poverty for a large group
24 of people. Indeed, those areas with particularly high concentrations would be ideal
25 candidates for new rapid or regional transit stations. However, this would only be
26 realistic solution in a few locations given the high capital costs of such infrastructure.
27 For most areas, more cost effective solutions should be considered for upgrading exist-
28 ing service. One would be increased frequency on existing bus routes by adding more
29 vehicles to limit wait times, particularly for routes with large headways. Travel times
30 could also be reduced by implementing express lines which make fewer intermittent
31 stops. Another cost-effective solution would be to alter the design of roads to incor-
32 porate dedicated bus lanes (i.e. BRT), to depose delay caused by auto congestion.
33 The majority of suburban arterial roads in Canada have ample room to implement
34 dedicated bus lanes, a convenience of the unbridled auto-oriented planning of the
35 previous decades. Planning new routes, or upgrading existing routes, should not be
36 offset by reducing or re-routing other existing bus routes relied upon by lower-income
37 residents, which has unfortunately been the case in American cities like Los Angeles
38 (Grengs, 2002) and Salt Lake City (Farber & Fu, 2017).

39 Improving transit accessibility in lower density, single-family housing areas is a
40 greater challenge given the greater dispersment of individuals. In these regions, many
41 transit agencies opt for coverage rather than directness in their design of suburban

1 transit routes. It may be possible that faster, more direct, routes in some instances
2 will have a greater potential in providing greater accessibility, depending on the spa-
3 tial distribution of transit need in the region (Walker, 2012). Transit networks should
4 also focus on providing better links to suburban employment locations. Many subur-
5 ban employment areas currently have sparse transit service, despite recent growth in
6 employment numbers and suburb-to-suburb commuting (Blais, 2015).

7 Another potential solution, or as an augmentation to other solutions, is to pro-
8 vide subsidies for ride-sharing or implement demand responsive transit services. This
9 could be beneficial in lower-density suburban areas, where implementing traditional
10 fixed-route transit service has substantial monetary costs, or in areas where there is a
11 last mile problem. A few regions have begun to experiment with this type of service.
12 For example, the growing town of Innisfil (north of Toronto), recently partnered with
13 Uber to subsidize an on-demand ride-sharing service, as a more economical alternative
14 to developing traditional, fixed-route, transit service (Town of Innisfil, 2017). While
15 this may be a solution for alleviating transport poverty in areas with less demand, it
16 may not be applicable in urban areas where there is already heavy congestion or a
17 greater need for adding higher capacity transit (Mageean & Nelson, 2003). Evaluating
18 the success of such projects however will provide useful knowledge on how and where
19 demand responsive transit could be implemented elsewhere in Canada, and whether
20 it can be appropriately scaled if demand for transit increases.

21 In conjunction to the aforementioned recommendations for transit improvement,
22 municipalities and regional planners should also enforce land use policies which re-
23 strict urban sprawl and zone for urban intensification and mixed-use development,
24 in order to help reduce commute times and auto-dependency. This should include
25 planning any future development of housing for low-income residents and recent immi-
26 grants to be in areas with high transit accessibility. This should also include focusing
27 some employment growth in areas which have existing transit service, but have low ac-
28 cessibility metrics due to a local absence of jobs - areas where there are an abundance
29 of labourers who currently have to travel further to find employment. These ideas of
30 "smart growth" and denser, transit-oriented development, are often cited by urban
31 planners to reduce congestion and environmental impacts (Bernick & Cervero, 1997).
32 This sphere of development strategies can also reduce risks of transport poverty by
33 providing more nearby opportunities.

34 Lastly, it is possible that in the long term, providing better transit accessibility
35 to a neighbourhood could increase demand and costs for housing. This would likely
36 first affect low-income people in these areas for whom transit is the only option for
37 daily travel. Rising costs could then result in displacement to less accessible areas.
38 This indicates the importance of policy directed towards maintaining stability and
39 affordability of housing costs, in order to break any cycles of displacement. This also
40 shows the importance of ensuring minimum standards of accessibility across an entire
41 region, given uncertainties of housing markets and living costs in the future.

1 8 Conclusion

2 In this study, we examined inequalities in transit access to employment for eight
3 Canadian metropolitan regions. We find that neighbourhoods of lower SES, on aver-
4 age, have higher levels of transit access to employment than the overall population.
5 These trends are similar across all eight cities, but are less apparent in the larger
6 cities of Toronto and Vancouver, which have faced more gentrification and dispersion
7 of poorer populations into suburban areas. Despite an overall positive outlook, there
8 are still many households at risk of experiencing transport poverty. We estimate that
9 there are nearly one million urban Canadians living in low-income households who are
10 also living in areas of low transit accessibility. This accounts to 5% of the population
11 in these regions.

12 Recommendations to reduce inequalities in transit accessibility and limit risks
13 of transport poverty include focusing future transit investments in areas which have
14 high concentrations of low-income households and low levels of transit accessibility,
15 upgrading bus levels of service, intensification and diversity of land-use to increase
16 accessibility and reduce commute distances, as well as a consideration of subsidizing
17 ride-sharing or implementing demand-responsive transit in areas of low density. Doing
18 so could help reduce the risks of transport poverty and social exclusion. Given recent
19 and likely continuing growth of poverty in the suburbs, it is imperative that these
20 regions have adequate transit service, not only to find employment opportunities, but
21 to participate in other daily activities constituting a high quality of life.

22 This study used access to employment as a proxy measure for the distribution of
23 transit benefits across multiple regions. We do not contend that this research shows
24 a direct link between transport investments and employment outcomes, as this is
25 dependent on many other factors such as education, social networks, skill develop-
26 ment, and other services aimed at reducing barriers to employment. Future research
27 that explores the impacts of jobs accessibility on employment outcomes could adopt
28 the accessibility measures in this study, but should additionally focus on matching
29 the skills of unemployed jobs seekers with available job openings during accessibility
30 calculations, rather than analyzing the locations of the overall labour force and em-
31 ployment. However, from our knowledge, comprehensive data for job seekers and job
32 openings does not exist Canada-wide. This highlights that the Canadian transport
33 policy sector needs to advocate to make detailed employment data available to re-
34 searchers in order to advance analysis beyond existing studies which rely on aggregate
35 census data. If available, this additional information, along with greater considera-
36 tion for travel costs and reduced willingness to travel for lower SES households, would
37 provide a deeper understanding of the who and where of transport poverty in Canada,
38 and be more effective at aiding policy aimed at poverty reduction.

39 While applied to Canadian cities, this paper adds to the literature by detailing

1 a methodology for accounting for transport poverty. From our knowledge, a large-
2 scale, multi-city accounting of transport poverty has not been conducted anywhere
3 in the world. We also outlined a novel method for generating descriptive typologies
4 of transport poor neighbourhoods that can directly inform policy recommendations.
5 The methods detailed on accounting for transport poverty and describing transport
6 poor neighbourhoods could be similarly be applied elsewhere. This is highly relevant
7 as concern regarding transport poverty is escalating in regions around the world.
8 Moreover, the policy discussion provided in our paper is applicable to other regions,
9 particularly for urban areas in the United States, Australia, and Europe which have
10 similar transport and land use patterns as Canadian cities.

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1 **Sizing up transport poverty: a national scale accounting of**
2 **low-income households suffering from inaccessibility in Canada,**
3 **and what to do about it**

4 **Highlights:**

- 5 • We measure transit access to employment for Canada's eight largest cities.
6 • We estimate where and to what extent Canadians are at risk of transport poverty.
7 • Findings show low SES residents generally live in more accessible areas.
8 • However, there are still nearly one million residents at risk of transport poverty.
9 • A neighbourhood-scale cluster analysis is used to inform policy recommendations.