Suburbanization of Transport Poverty in Toronto

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Introduction:

Many cities have undergone spatial re-distributions of low socio-economic status (SES) populations from central to suburban neighborhoods over the past several decades.

A potential negative impact of these trends is that low-SES groups are concentrating in more automobile oriented areas and thus resulting in increased barriers to daily travel and activity participation, particularly for those who are unable to afford a private vehicle.

Accordingly, the objective of this paper is to analyze the links between increasing socio-spatial inequalities, transport disadvantage, and adverse travel behaviour outcomes over time - in order to assess whether risks of transport poverty (*see right*) are growing in the suburbs.

This is examined via a spatio-temporal analysis for the Toronto region through six periods of the quinquennial Canadian census and a regional travel survey (from 1991 to 2016) in order to describe neighborhood-level changes in SES *vis-à-vis* changes in transport disadvantage and travel behaviour outcomes

Data Sources:

1) Canadian census from 1991 to 2016

2) Transportation Tomorrow Survey (TTS) from 1991 to 2016

3) Estimated zone-to-zone travel times by transit from 1991 to 2016

All data were aggregated to 2016 census tracts via population-weighted areal interpolation

Measuring neighbourhood SES:

We generate a single indicator of SES at a neighbourhood-level via a Principal Component Analysis.
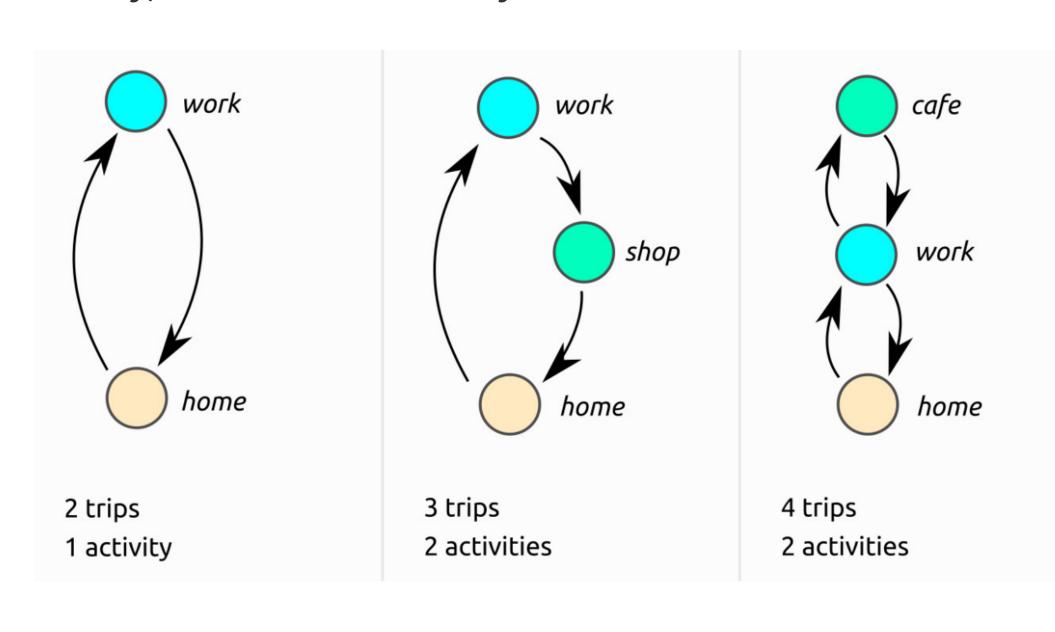
$$SES_{i,\gamma} = \sum_x w_x Z_{x,i,\gamma}$$

	w_x	$corr(SES_{i,\gamma}, Z_{x,i,\gamma})$
Logged average household income (in 2016 CAD)	0.43	0.87
% who live in low income households	-0.45	-0.92
% who have housing cost 30% or more of their income	-0.33	-0.67
% of dwellings that need major repairs	-0.28	-0.57
% of families that are single-parent families	-0.38	-0.77
% who immigrated internationally in the past 5 years	-0.30	-0.62
% who do not have a high school diploma	-0.21	-0.43
% who are unemployed	-0.39	-0.79

Measuring activity participation:

Activity participation can be used to assess whether residents are experiencing barriers to daily travel.

We measure activity participation as the neighborhood average of the number out-of-home activities people travel to over the course of a day, based on travel survey data.
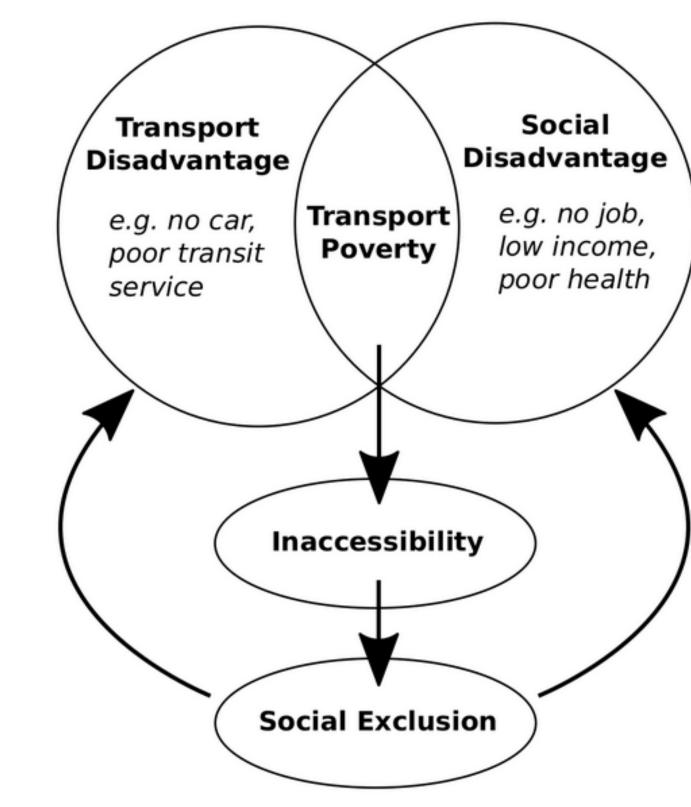

2 trips
1 activity

3 trips
2 activities

4 trips
2 activities

Analysis & Results:

Summary statistics:

	1991	1996	2001	2006	2011	2016
Population (millions)	3.84	4.19	4.50	5.02	5.49	5.82
Dwellings (millions)	1.35	1.46	1.60	1.77	1.96	2.10
Jobs (millions)	1.87	1.96	2.22	2.28	2.50	2.60
Built Up Area (km^2)	1,700	1,900	2,100	2,200	2,200	2,300

	1991	1996	2001	2006	2011	2016
% of households without cars	15.0%	18.0%	16.7%	16.6%	14.1%	17.3%
Mean transit accessibility ($A_{i,\lambda}$)	0.33	0.35	0.37	0.37	0.39	0.37
Mean one-way commute duration (min)	31.0	29.8	31.4	32.0	32.3	33.2
Mean activities per day	1.39	1.32	1.37	1.31	1.30	1.20

Conceptual diagram of transport poverty (adapted from Lucas 2012)

Transport Disadvantage
e.g. no car, poor transit service

Social Disadvantage
e.g. no job, low income, poor health

Transport Poverty

Inaccessibility

Social Exclusion

Assessing auto availability:

Via the neighborhood average of the number of households that do not have private cars.

Measuring transit accessibility:

Measuring accessibility to non-work activity destinations:

$$A_{i,D,\lambda} = \sum_{j \in J} D_j f(t_{i,j,\lambda})$$

Measuring accessibility to employment:

$$A_{i,E,\lambda} = \sum_{j \in J} \frac{E_j f(t_{i,j,\lambda})}{L_{j,P}}$$

$$L_{j,P} = \sum_{\lambda \in \Lambda} \sum_{i \in I} \frac{\alpha_{\lambda,i} P_i f(t_{i,j,\lambda})}{A_{i,E,\lambda}}$$

A combined accessibility metric:

$$A_{i,\lambda} = \frac{0.5 A_{i,E,\lambda}}{\max(A_{i,E,\lambda})} + \frac{0.5 A_{i,D,\lambda}}{\max(A_{i,D,\lambda})}$$
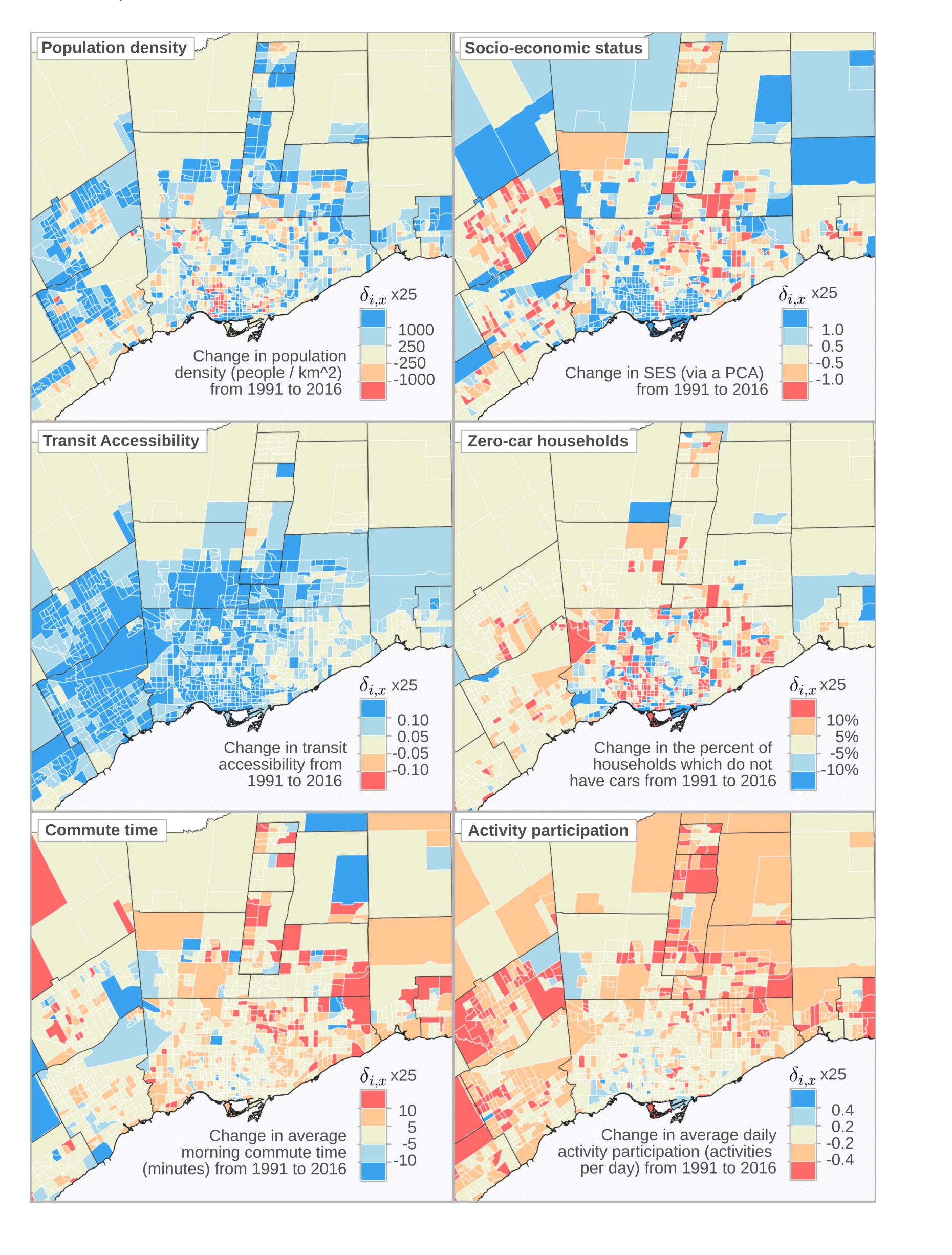
Measuring commute times:

One-way historical trip times for journey-to-work trips, averaged for all workers in a neighbourhood who reported travelling to work on the day of the travel survey.

Spatio-temporal mapping:

We map the rate of change of variables pertaining to transport disadvantage, travel behaviour, and SES to find where these are improving or declining within the region.

Rates of change were determined via neighbourhood-specific bi-variate regression models with the year as the independent variable.

Population density

$\delta_{i,x}$ x25
1000
250
-250
-1000

Change in population density (people / km^2) from 1991 to 2016

Socio-economic status

$\delta_{i,x}$ x25
1.0
0.5
-0.5
-1.0

Change in SES (via a PCA) from 1991 to 2016

Transit Accessibility

$\delta_{i,\lambda}$ x25
0.10
0.05
-0.05
-0.10

Change in transit accessibility from 1991 to 2016

Zero-car households

$\delta_{i,x}$ x25
10%
5%
-5%
-10%

Change in the percent of households which do not have cars from 1991 to 2016

Commute time

$\delta_{i,x}$ x25
10
5
-5
-10

Change in average morning commute time (minutes) from 1991 to 2016

Activity participation

$\delta_{i,x}$ x25
0.4
0.2
-0.2
-0.4

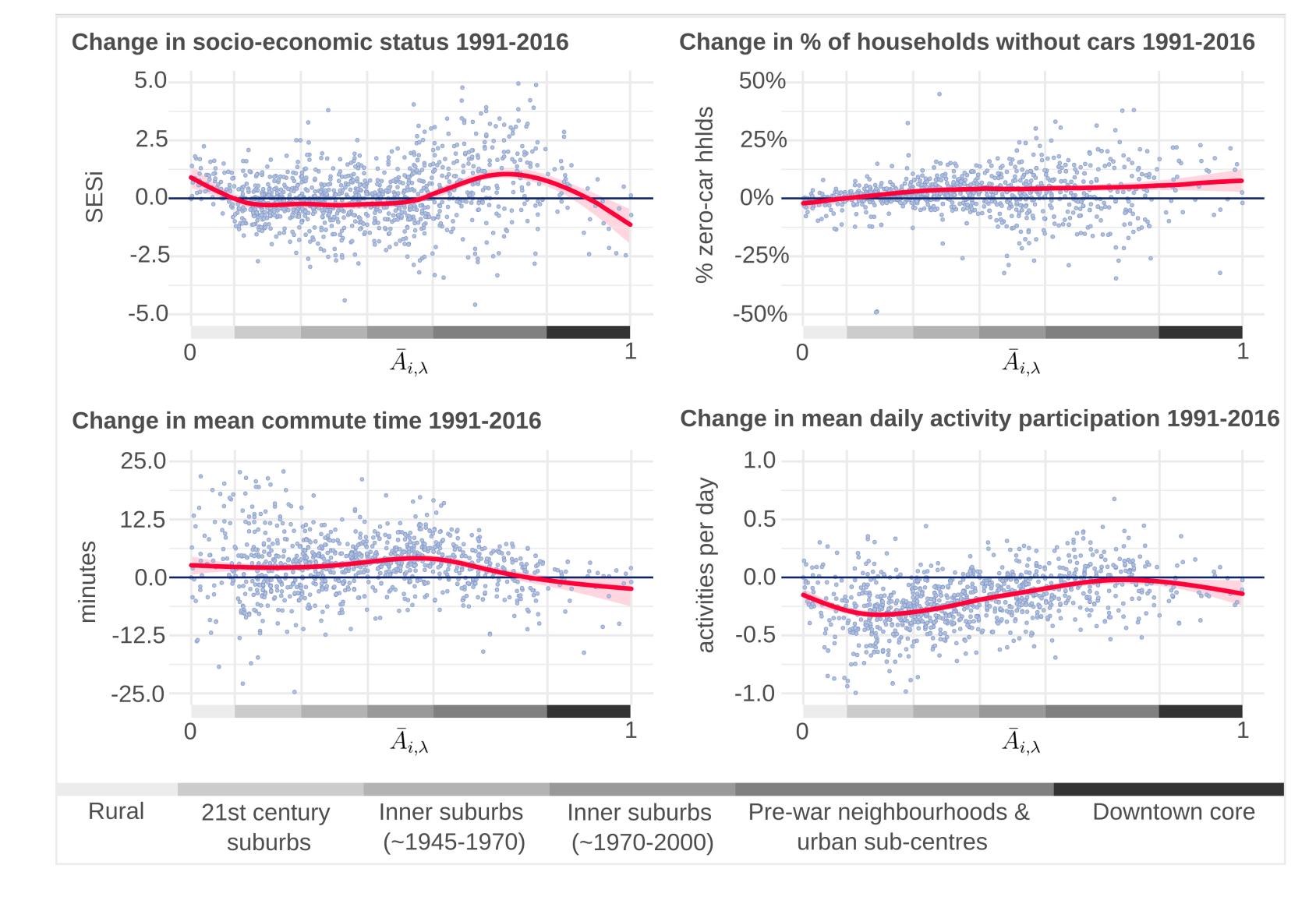Change in average daily activity participation (activities per day) from 1991 to 2016

Tracking change by type of urban form:

We examine whether neighborhoods with increasing social and transport disadvantage are located more in suburban areas compared to central areas.

We first create an index suburban a neighbourhood is based on its level of transit accessibility.
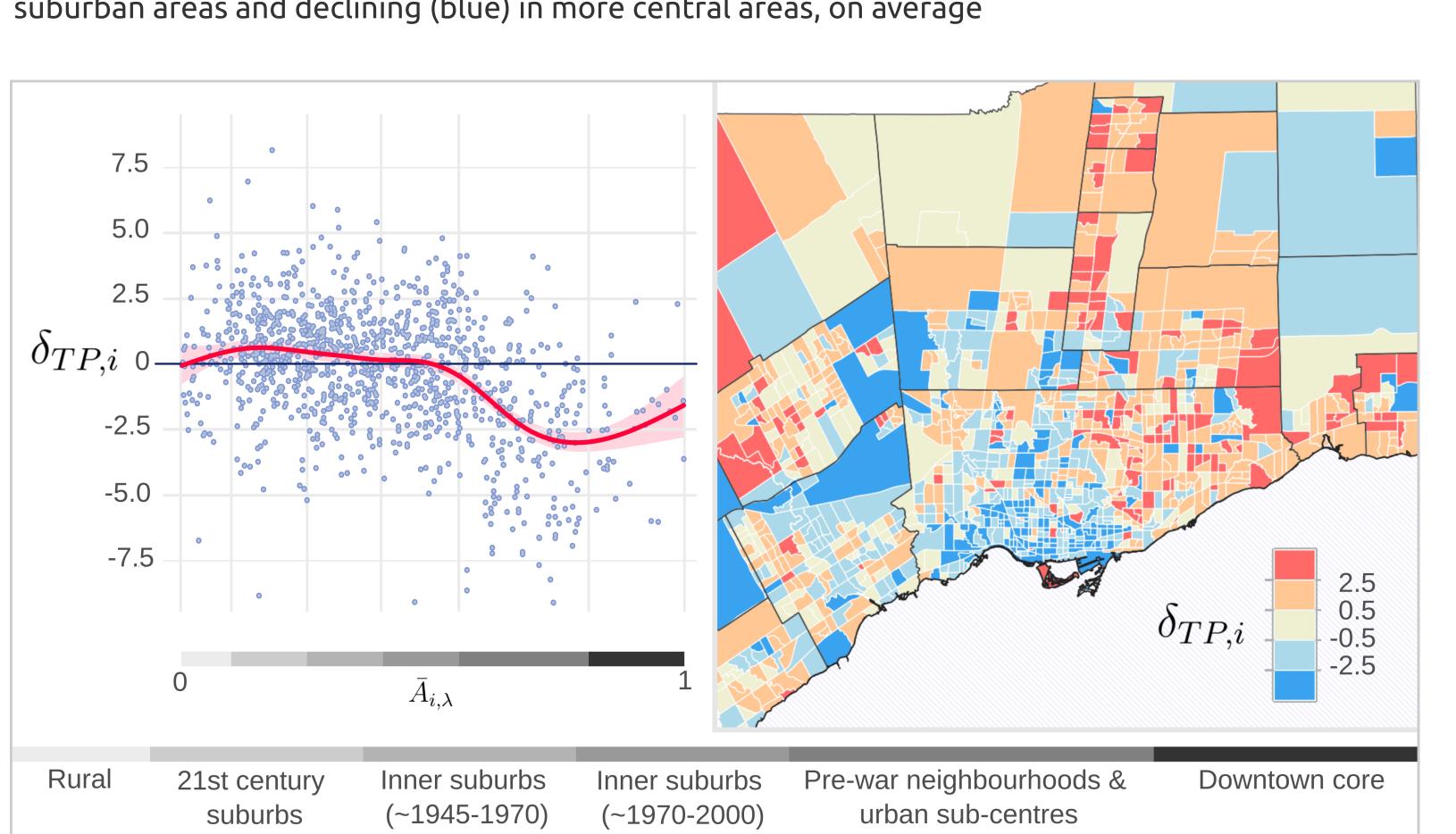
We then plot how changes in social and transport disadvantage are related to this accessibility-based level of suburbanization. Each dot in these plots is a neighbourhood, and the curves were fit via a generalized additive model based on regression splines.

Change in socio-economic status 1991-2016

Change in % of households without cars 1991-2016

Change in mean commute time 1991-2016

Change in mean daily activity participation 1991-2016

Rural | 21st century suburbs | Inner suburbs (~1945-1970) | Inner suburbs (~1970-2000) | Pre-war neighbourhoods & urban sub-centres | Downtown core

We then combine each indicator into a single index of transport poverty via summing their standard scores:

$$\delta_{TP,i} = \sum_x \frac{\delta_{x,i} - \mu_{\delta_x}}{\sigma_{\delta_x}}$$

The result is plotted and mapped below, showing that transport poverty is growing (red) slightly in suburban areas and declining (blue) in more central areas, on average

$\delta_{TP,i}$

$\delta_{TP,i}$
2.5
0.5
-0.5
-2.5

Rural | 21st century suburbs | Inner suburbs (~1945-1970) | Inner suburbs (~1970-2000) | Pre-war neighbourhoods & urban sub-centres | Downtown core

Spatio-temporal models

We estimate the multivariate effects of changes of social and transport disadvantage on changes in adverse travel behaviour outcomes: increasing commute times and declining activity participation rates.

Specifically, we use spatial lag model to also account for residual spatial auto-correlation.

$$Y = \rho WY + \Theta X + \epsilon$$

ρWY is the spatially lagged component, X are independent variables, and Θ are coefficients.

The commute time model indicates that increases in transit accessibility and car ownership are linked to reduced commute times, indicating a strong relation to transport disadvantage, overall. Change in SES over time, however, is not found to have a significant association with changing commute times, after controlling for other variables.

For the activity participation models, we find that growing social and transport disadvantages are both related to declining participation rates over time. This shows the resources people have declines over time, the less likely they are able to travel to and participate in daily activities.

	Change in activity participation		Change in commute time	
n	1133		1133	
pseudo-R2	0.26		0.16	
	Coefficient	*p*-value	Coefficient	*p*-value
α	-0.004	0.000	0.145	0.000
ρ	0.400	0.000	0.388	0.000
Change in population (1000s)	-0.019	0.000	0.091	0.142
Change in SES_i	0.019	0.000	-0.159	0.235
Change in $A_{i,\lambda}$	0.281	0.003	-16.250	0.000
Change in % zero-car households	-0.002	0.002	0.044	0.013
Change in % elderly (65+)	-0.003	0.003	-0.111	0.000

Conclusions:

Findings show that many suburban areas in Toronto are not only declining in socioeconomic status, but are also suffering from increased barriers to daily travel evidenced by longer commute times and decreasing activity participation rates, relative to central neighborhoods.

Future work could look at other components of urban form (local walkability metrics, access to green space, etc.) and individual effects (rather than only looking at neighbourhoods). However, travel survey and census data in Toronto is not currently longitudinal at the individual level.

Policy to reduce these continued effects in the suburbs should have a two-pronged approach. The first is to curb the growth of suburban poverty through focusing on increasing the supply of affordable housing in areas with high transit accessibility, having strong rent controls, and preventing forced eviction and displacement from central to suburban neighborhoods. The second is to upgrade suburban environments through transport planning and urban design strategies that improve transit accessibility and walkability (i.e. improving accessibility at both neighborhood and regional scales).

These are not new ideas. Many of them have been advocated for previously in terms of reducing the negative population health and environmental impacts associated with auto-oriented environments. Our research provides one more important piece of evidence showing that such strategies would also be progressive options in reducing barriers to daily travel and transport-related social exclusion.