Determinants of Mode Share over Time

How Changing Transport System Affects Transit Use in Toronto, Ontario, Canada

Nicole Foth, Kevin Manaugh, and Ahmed M. El-Geneidy

Increasing public transit ridership is a goal for most transit agencies and plays a central role in many recent regional transportation plans. Therefore, a comprehensive understanding of the determinants of mode choice and their effects over time is important. This study sought to understand how accessibility to employment by public transit changes over time, and how this accessibility explains changes in transit use. With the use of linear regression analysis, the authors explored the influence of job accessibility, transport infrastructure, and social disadvantage on transit mode share for three job categories in Toronto, Ontario, Canada, in 2 years, 1996 and 2006. New transit infrastructure did not necessarily attract more transit commuters but was found to affect commuting to different job categories differently. Also, new highway infrastructure hampered transit mode share, regardless of job type. The aggregate all-jobs model was found to dilute some differences between the transit mode choices of people commuting to different job categories. Finally, increases in accessibility by transit were found to augment transit mode share, while people in more socially disadvantaged areas were more likely to commute by transit in any job category. This study reveals findings that may be of interest to land use and transportation planners working toward boosting regional transit ridership, while also attaining social equity goals.

Increasing public transit ridership is a central goal in many recent regional transportation plans in Canada (*1–3*). This goal is in response to several pressing needs, including the desire to alleviate road congestion, decrease emissions, address social equity issues, and attend to mobility needs of an aging population. Moreover, regional and municipal governments are making substantial investments in new transit infrastructure to encourage car drivers to switch to public transit for daily commutes. While new transit infrastructure would be expected to increase transit ridership, research in recent years has underscored the importance of a variety of factors that influence the decision to take transit in addition to transit availability. Studies that focus too heavily on proximity to stations when predicting future ridership might miss the fact that mode decisions are based on multiple factors (*4*). Mode choice literature shows several influential factors such as urban form or infrastructure (*5*), individuals' attitudes (*6*), and sociodemographics (*7*).

N. Foth and A. M. El-Geneidy, School of Urban Planning, Suite 400, 815 Sherbrooke Street West, and K. Manaugh, McGill School of Environment, 805 Sherbrooke Street West, McGill University, Montreal, Quebec H3A 2K6, Canada. Corresponding author: A. M. El-Geneidy, ahmed.elgeneidy@mcgill.ca.

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In the Toronto, Ontario, region in Canada, previous work has shown that the most socially disadvantaged areas had better accessibility to jobs by public transit and lower transit travel times relative to the rest of the region between 1996 and 2006 (*8*). In the same time period, the movement of socially disadvantaged groups away from downtown Toronto's concentration of transit services is therefore a concerning trend in regard to the goal of providing transit services to those who may benefit the most. The change in socially disadvantaged residential locations, as well as the introduction of new automobile and transit infrastructure in the Toronto region, led to the question of whether these significant changes influenced transit use over time among commuters in different job categories. Most studies concerning mode choice and accessibility do not distinguish between different types of employment (*9, 10*). With 2 years of data, before the construction of infrastructure (1996) and after (2006), this paper explores how infrastructure and socioeconomic factors affect changes in transit mode share over time in Toronto. This question sits at the nexus of land use and transport planning as planners and engineers attempt to align transit supply and social equity outcomes with travel demand to desired destinations.

The paper is structured as follows. First, a literature review covers mode choice research. Next, the context of the Toronto study area is presented, followed by the section on methodology, which outlines the statistical modeling method, variables used, and expected outcomes. The fourth section presents the data sources. The section on findings explains trends in commuting and statistical model outcomes, and the discussion compares findings with previous research. Last, the findings and implications of this research are summarized.

LITERATURE REVIEW

Most of the non-trip-related explanatory variables in mode choice studies fall into two main groups: socioeconomic factors and built environment characteristics (*11*). The first two parts of the literature review discuss how travel behavior is influenced by socioeconomic factors and the built environment, while the third addresses travel by occupation type.

Socioeconomic Variables and Indicators

Mode selection depends in large part on the personal characteristics of travelers. Income is the most prevalent of the socioeconomic variables used in previous studies. Researchers use income to describe social exclusion, transport disadvantage, and transport equity issues (*12–15*). Lower income at the household or neighborhood scale is associated with higher transit use (*5, 12, 16, 17*) and with greater transit dependency, defined as the lack of a driver's license or access to a car (*18*). Consequently, when many transit-dependent residents do not have adequate access to destinations, social isolation can intensify (*19*). Lower incomes also relate to other factors such as selecting residential locations close to better transit facilities, which often tend to be downtown (*20–22*). Immigrant status is another commonly used explanatory variable: immigrants are found to patronize transit more (*13, 23, 24*). In regard to different transit types, higher education influences train patronage positively and is negatively related to bus use (*5, 9*). A combination of several socioeconomic factors often play a role in mode choice. To capture varying socioeconomic characteristics, many studies use a composite social disadvantage indicator (*8, 25–31*).

Built Environment Variables and Accessibility

In a review of the influence of the built environment on travel behavior, Cao et al. confirm that, even when self-selection is accounted for, characteristics of the built environment do influence travel behavior (*32*). Residential proximity to bus stops is correlated with higher levels of transit ridership (*17, 33*), while others find that destination density is a more important factor (*34*). However, not all transit modes are considered equal by users. Bento et al. conclude that a 10% increase in bus supply results in a 1.3% decrease in the probability of driving, while adding the same amount of rail supply is estimated to decrease driving by 4.2% (*5*).

Many commuting studies use the concept of accessibility by measuring the destinations that can be reached by using a transit network. Higher accessibility to jobs corresponds with shorter commutes (*35*) and explains about half the variation in commute distance (*36*) or 10% variation in commute time when regression models are compared (*7*). Chen et al. find that high job accessibility by transit to work significantly predicts a decrease in car mode share (*34*). Accessibility by transit also has a positive influence on transit use. Moniruzzaman and Páez find that an increase in accessibility to 10,000 jobs relates to a 0.2% to 0.5% increase in transit mode share (*17*).

Travel by Job Categories

Many of the aforementioned studies do not distinguish between occupational categories. However, a few studies differentiate travel characteristics by job type. For example, professionals have been found to have longer commute durations (*7*). In Toronto's Census Metropolitan Area, Moos and Skaburskis find that managers commute from the suburbs, and professionals, service, and general office workers commute from the central city (*37*). Lin and Long use job categories to define neighborhood types in their travel behavior study, but do not isolate job categories from other variables to determine differences in travel patterns (*38*). Assessing determinants of mode share by job category has the potential to contribute more variegated findings to mode share and commuting research. In addition, the geographic distribution of access to different jobs is an important aspect of understanding regional equity.

CONTEXT

The Greater Toronto and Hamilton Area is Canada's most populous region. For this study, the city of Toronto and its surrounding municipalities of Mississauga, Brampton, Vaughan, Richmond Hill, and Markham were selected because these suburban municipalities have significant public transit connections with Toronto. The Toronto region serves as an appropriate case study as several changes to the region's transport infrastructure were made between 1996 and 2006. Highway 407, a tolled expressway opened in 1997, augmented accessibility to destinations for suburban municipalities surrounding the city of Toronto. In addition, the transit system received capital improvements. In 2004, the Sheppard subway extension began operation with four new stations. Moreover, seven new GO Train (heavy rail) stations were added to the commuter rail network, bringing the total number of stations in the region to 56 (see Figure 1).

The region grew in both population and number of jobs between 1996 and 2006 with a general trend of suburbanization for both (*39*). Notably, the 10% most socially disadvantaged areas show a suburbanizing trend from 1996 to 2006 (*8*). The shifting in concentrations of population and employment was not even throughout the entire region, which led to changes in the spatial relationship between home and work, with some job types experiencing more change than others.

METHODOLOGY

To determine the magnitude of the effect of various factors on commuters' selection of transit and to understand whether these determinants vary by job category, four multiple linear regression analyses are used. A pooled data set with year dummy variables and interaction variables is used to isolate the effects at different times. The first model tests the independent variables for all job types. The other three models analyze the same variables by job category: office or professional (office), retail or sales and service (retail), and manufacturing, construction, and transport (trades). The dependent variable in the respective models is the percentage of transit share by traffic analysis zone (TAZ) for each job category. The selected explanatory variables fall in three categories: accessibility, social disadvantage, and transport networks, plus a year dummy to capture the general changes in transit mode share between 1996 and 2006. First, accessibility to jobs (by category) by transit measures the potential benefits that the transit system provides residents. Further, an interaction variable of accessibility and a social disadvantage indicator tests whether the decile of most socially disadvantaged commuters will take transit more given higher accessibility to jobs by transit available compared with less socially disadvantaged groups. To assess change over time, the question of whether accessibility to jobs becomes more important for predicting transit share in 2006 than in 1996 is tested by using a year interaction variable.

Accessibility is measured with the well-known gravity model, which can be expressed as

$$A_{im} = \sum_j O_j \exp\left(\theta C_{ijm}\right)$$

where

A_{im} = accessibility at point i to potential activity at point j by using mode m,
O_j = opportunities at point j, and
$\exp(\theta C_{ijm})$ = negative exponential function to travel between points i and j by using mode m.

The negative exponential cost function was derived from observed work trips from the 2006 Transport Tomorrow Survey (TTS) [more

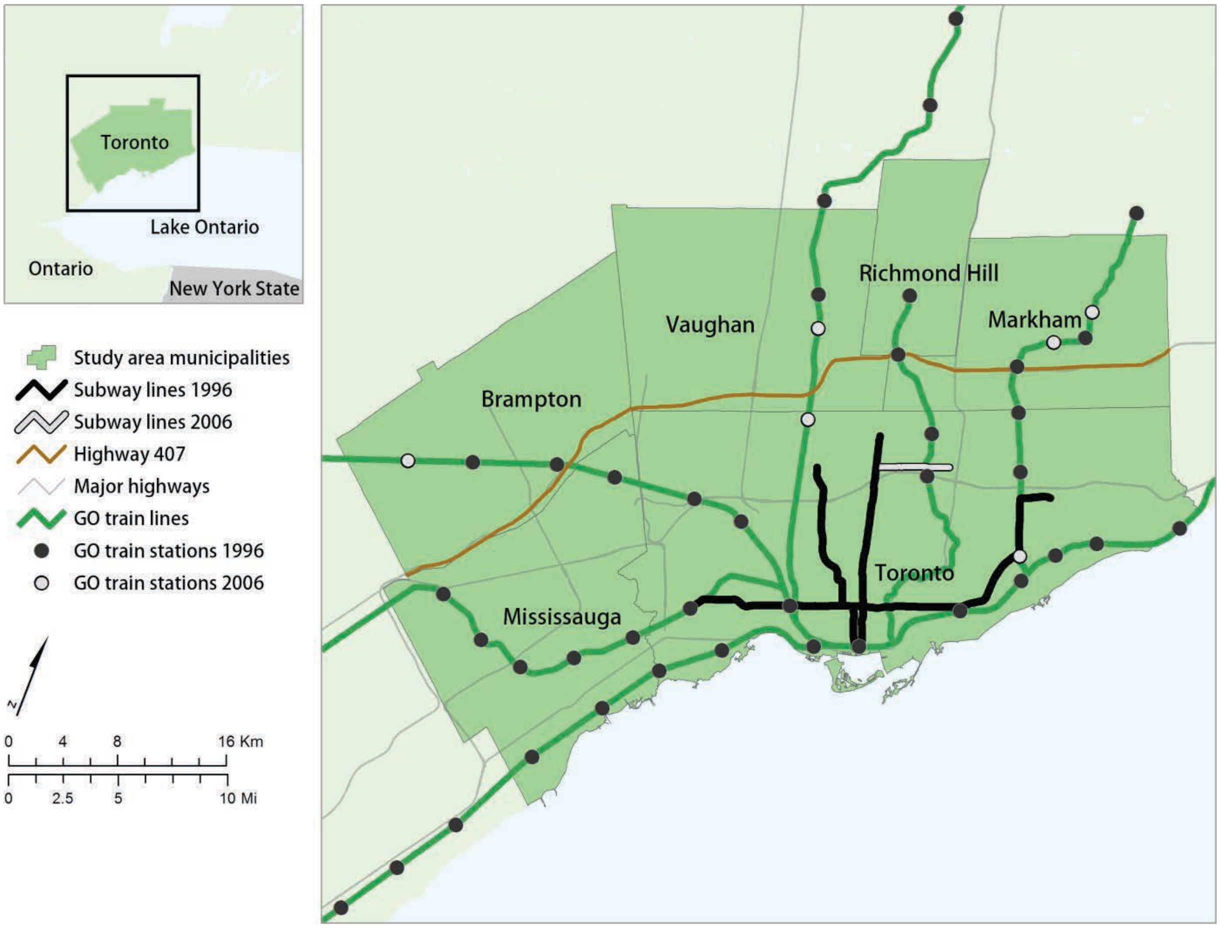

FIGURE 1 Context map of study area. (Source for data: DMTI Spatial, Inc; Metrolinx, and Statistics Canada; for projection: North American Datum 1983 and Ontario Lambert.)

details can be found in Foth et al. (*8*)]. The gravity measure takes into account the diminishing attractiveness of potential activity locations farther away more so than simple threshold (or cumulative) measures of accessibility.

The next group of variables accounts for socioeconomic characteristics, specifically social disadvantage. A composite social disadvantage indicator developed for use in travel behavior research is used (*8*). It is a standardized sum of median household income, percentage of unemployed in the labor force, percentage of population that immigrated to Canada in the past 5 years, and percentage of households spending more than 30% of their income on rent. Because many socioeconomic variables are highly correlated, the use of a combined indicator provides a more robust understanding of community deprivation and social equity issues beyond the single variable of income. In line with previous work, it was expected that more socially disadvantaged TAZs would be associated with larger transit shares. Moreover, the 10% most socially disadvantaged TAZs and the 10% least socially disadvantaged TAZs were tested, and similar trends were expected. The last variable in this group assesses whether the 10% most socially disadvantaged people were likely to take transit more in 2006 than in 1996.

The last group of variables includes the number of subway stations, the number of GO Train stations, and proximity to the new Highway 407. Based on research that found that more than 50% of people are willing to walk up to 900 m to reach a rapid transit station, but none farther than 1,750 m, a 1,000-m network buffer is used to define a catchment area around each station (*40*). Last, a local bus frequency variable is included to account for the effect of local bus service, as well as the difference in bus service between 1996 and 2006.

DATA

To address the research questions, data sets from several sources were collected. The percentage of transit share for all jobs and three job categories comes from the TTS for 1996 and 2006 (*41*, *42*). Transit mode share includes buses, the subway, and the GO commuter train. The TTS is conducted by the University of Toronto and collects travel behavior information via telephone interviews every 5 years. The 2001 TAZ spatial definitions, with the 1996 and 2006 data matched, are used. In the study area, there were 914 TAZs in 1996, with 21 added in 2001. The survey uses expansion factors to achieve data proportional to the TAZs' populations.

To calculate the gravity-based accessibility measures, 1996 and 2006 in-vehicle transit time was used. To compare data sets, the TTS categories were matched to the 10 national occupation categories: office or professional (management, business or finance

TABLE 1 Descriptive Statistics for Continuous Variables

Variable	Mean 1996	Mean 2006	Standard Deviation 1996	Standard Deviation 2006
Local buses (per hour)	66.2	59.7	65.3	58.5
Accessibility by transit to all jobs	71,359	76,778	19,318	27,718
Accessibility by transit to office or professional jobs	42,588	48,212	12,570	18,302
Accessibility by transit to retail or sales and service jobs	17,110	17,037	4,583	6,118
Accessibility by transit to manufacturing, construction, and transport	11,719	11,594	2,404	3,693

or administration, natural and applied sciences, health, education or law or social or community or government services, and art or culture or recreation or sport); manufacturing, construction, and transport (trades or transport, natural resources or agriculture products, and manufacturing or utilities); and retail or sales and service (sales and service). Summary statistics are presented in Table 1.

The social disadvantage indicator was generated by using 1996 and 2006 census data at the census tract level and was converted to the TAZ level (*43, 44*). In cases in which more than one census tract matched with one TAZ, census tract indicator values were weighted by population and summed. Since the social indicator data for 1996 and 2006 have different ranges, they are normalized by using deciles. The last group of data includes regional information about transport infrastructure and service in 1996 and 2006. The number of local buses per hour that pass through a TAZ during morning peak travel hours was provided by the University of Toronto (*45, 46*). In addition, information on whether a TAZ is close to subway stations and Highway 407 in either time period is captured. Finally, a 1,000-m street network buffer was generated around the 1996 and 2006 subway stations and Highway 407 to identify the TAZs affected by these infrastructures.

FINDINGS

This section is divided into three parts. First, commuting trends are presented for the Toronto area in 1996 and 2006, including transit mode share and changes in accessibility to jobs by transit for all jobs, and for the three job categories. Second, the way the statistical models were tested and finalized is described, and third, the results of the regression analyses for the all-jobs model and for the different job category models are explained.

Commuting Trends

Although the region experienced changes including the suburbanization of both jobs and socially disadvantaged residential areas, as well as the implementation of new subway stations, GO Train stations, and a highway, the overall mode shares remained relatively constant over time. Between 1996 and 2006, there was a ≤1% change in mode shares and automobile drivers continued to be the overwhelming majority, roughly 66% in both years. The second largest group was made up of commuters who took the bus, the subway, or both (17.7% in 2006). The GO Train serves a relatively small percentage of commuters. Active mode shares stayed relatively constant over time, with a roughly 3.7% and 0.7% mode share for walking and cycling, respectively. Overall, there was a moderate increase in the number of transit users; aggregated transit mode share (subway, bus, and GO Train) showed an overall increase of 1.0% of commuters taking transit to work (from 19.5% to 20.5%). However, changes varied noticeably by job type (see Table 2). For instance, during the 10-year period, there was a clear distinction between office workers using transit more (+2.6%) and trades employees using transit less (–3.6%). Transit mode share for retail workers stayed relatively constant at about 24%.

The percentage of transit commuters is not equally distributed throughout the region (see Figures 2 and 3). Suburban areas, not surprisingly, had far fewer transit users compared with TAZs in the city of Toronto. Interestingly, the only municipality around Toronto that has a relatively consistent transit share across the TAZs is Mississauga (west of downtown along the lake). This area had the first GO Train line, which may partly explain this outcome. The TAZs with the highest percentages of transit users are generally clustered around the downtown area and subway lines.

TABLE 2 Absolute and Percentage of Transit Share by Job Category in Study Area, 1996 and 2006

Job Category	1996 Sum	1996 Percentage	2006 Sum	2006 Percentage	Change Absolute	Change Percentage
All jobs	301,436	22.2	365,418	23.2	+63,982	+1.1
Office or professional	180,508	23.6	214,132	26.2	+33,624	+2.6
Retail or sales and service	72,385	24.8	119,351	24.0	+46,966	–0.8
Manufacturing, construction, and transport	48,543	16.0	31,935	12.4	–16,608	–3.6

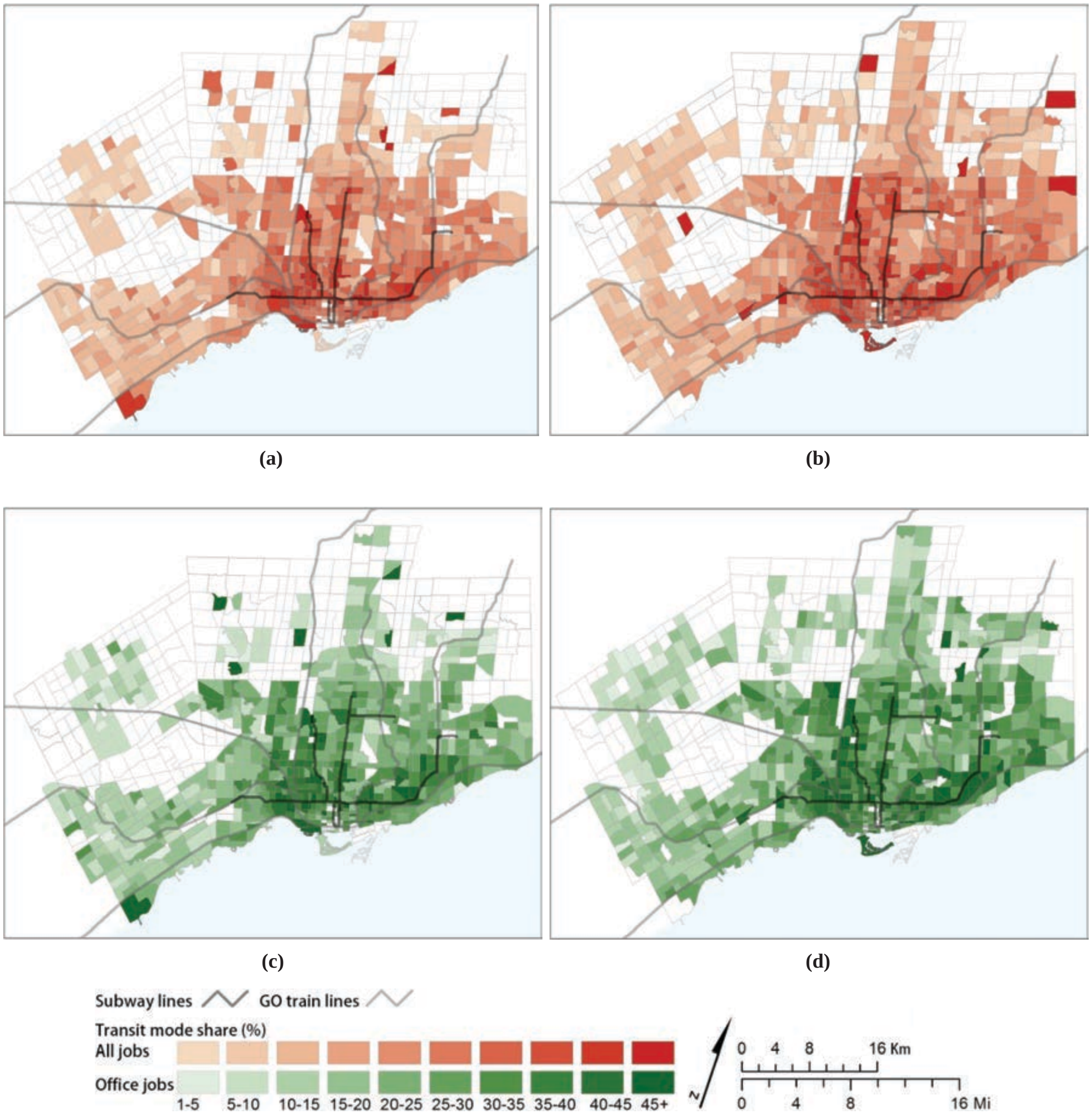

FIGURE 2 Percentages of transit mode share for (*a*) all jobs, 1996; (*b*) all jobs, 2006; (*c*) office and professional jobs, 1996; and (*d*) office and professional jobs, 2006. (Source for data: Transportation Tomorrow Survey, Statistics Canada, and DMTI Spatial, Inc.; for projection: North American Datum 1983 and Transverse Mercator.)

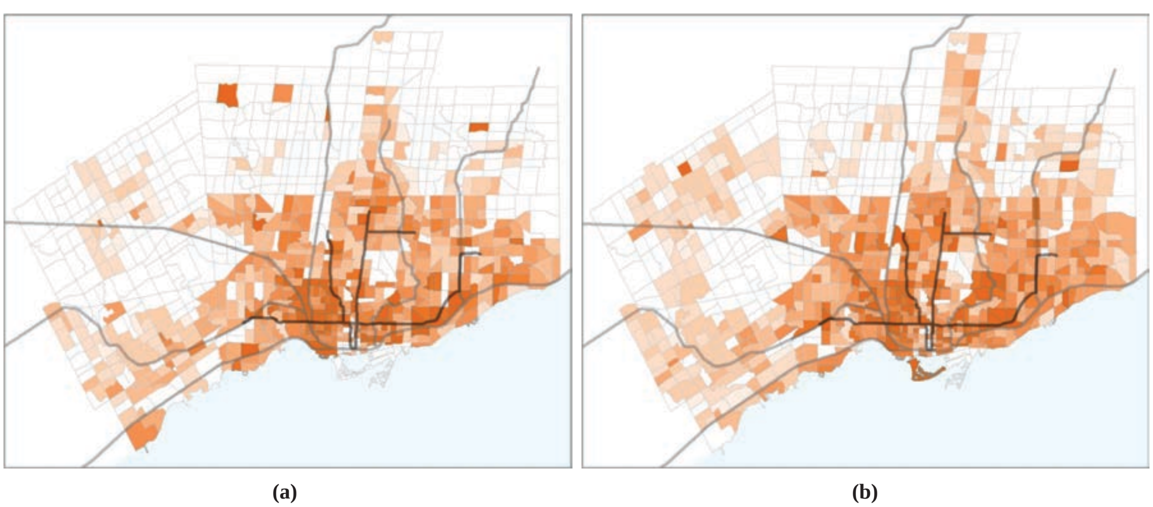

FIGURE 3 Percentages of transit mode share for (*a*) retail or sales and service jobs, 1996 and (*b*) retail or sales and service jobs, 2006.

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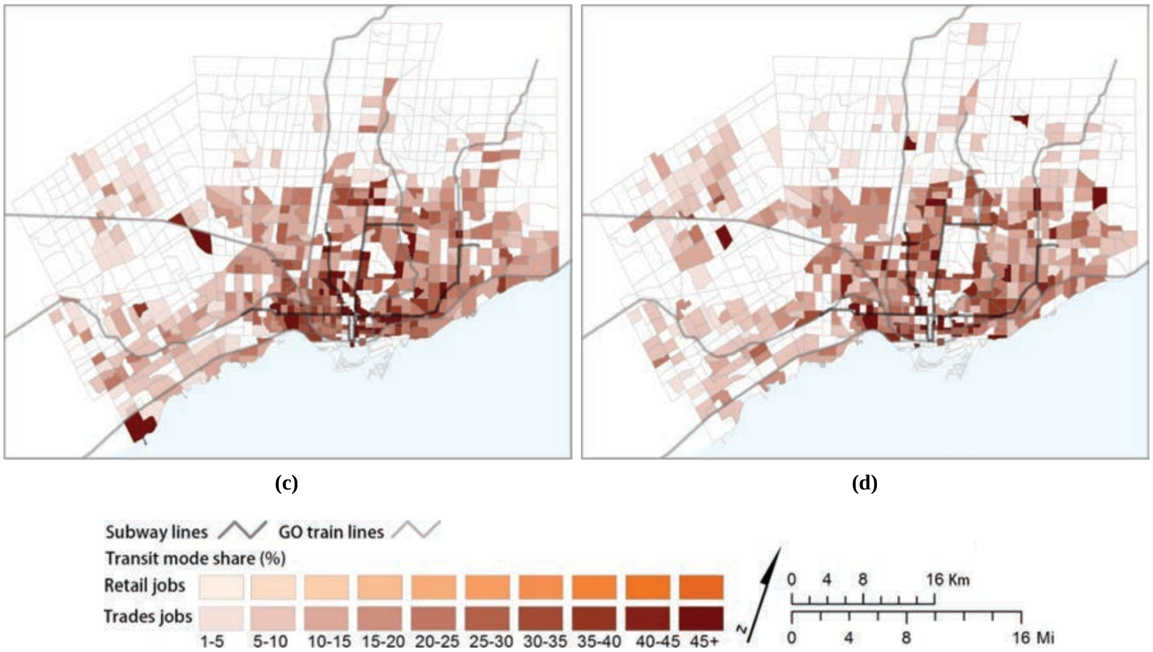

FIGURE 3 *(continued)* **Percentages of transit mode share for (*c*) manufacturing, construction, and transport jobs, 1996, and (*d*) manufacturing, construction, and transport jobs, 2006. (Source for data: Transportation Tomorrow Survey, Statistics Canada, and DMTI Spatial, Inc.; for projection: North American Datum 1983 and Transverse Mercator.)**

By job category, the distribution of transit users for all jobs closely resembles the office jobs distribution. Office commuters generally live closer to downtown, but are spread throughout the region. The retail or sales and service (retail) transit share maps have similar distributions. However, compared with the other job types, the trades job group has fewer TAZs with transit riders and the concentrations appear slightly more evenly distributed over the region. Over time from 1996 to 2006, there is a general trend of greater transit mode share around the subway lines for all jobs. Nevertheless, the trades job maps show that transit users seem less concentrated in 2006 than in 1996, a finding that reflects the mode share trend. Furthermore, trades commuters seem to be moving away from the city center and from subway lines, over time.

The potential effect of the GO Train extension is visible on the maps, particularly the new stations to the northeast and northwest.

Accessibility

Accessibility measures capture accessibility to each job category via the transit network. Figures 4 and 5 display accessibility to jobs by transit for each job category. Some TAZs do not have an accessibility value because there is no direct transit service, or there are no residences in those TAZs. All-jobs, office, and retail jobs have a similar distribution, and accessibility expands around the subway from 1996 to 2006. In contrast, trades job accessibility roughly surrounding the subway lines in 1996, shifts toward the northwest, farther away from downtown and the subway lines in 2006. These trends are reflected in the previous transit mode share maps.

Regression Findings and Discussion

Table 3 displays findings for the all-jobs model and the three job category models with statistically significant variables noted. The all-jobs model is discussed next, and then the three job type models are explored by highlighting similarities and differences.

All-Jobs Model

All statistically significant variables in the all-jobs model are at the 99% confidence level. The "Year 2006" dummy variable indicates that people took transit 1.7% more in 2006 than in 1996. Several network and infrastructure variables are noteworthy and point to the role of transit service and land use. The frequency of local buses has a statistically significant and positive effect on transit mode share to work for all jobs; an addition of 100 buses passing through a TAZ corresponds to a 2.0% increase in transit use. However, the subway is visibly the spine of the Toronto transit system. Proximity to a subway shows the largest coefficient in the all-jobs model: TAZs within 1,000 m of a subway station in either year are likely to have a 7.7% higher transit mode share compared with other TAZs in the region. This finding supports previous research that transit proximity at residential origins is a notable predictor of higher transit mode shares (*5, 17, 33, 38*), even while controlling for socioeconomic characteristics and job accessibility.

Although the subway is a statistically significant predictor of transit share, the interaction variable "Subway station interacting with 2006" shows that the new Sheppard subway line, opened in 2002, does not explain transit share more in 2006 than in 1996, and in fact the coefficient is negative (an important factor is that four stations were added, a change which affected only a small sample of all TAZs in the study area). This finding demonstrates that these stations did not alter transit mode share in the TAZs in proximity to them. However, there may be several years of lag in the change of land use patterns to adjust to the new subway line. This issue deserves further evaluation in the long term.

In 2006, after the construction of Highway 407, commuters residing in TAZs within 1,000 m of the new highway were 3.6% less

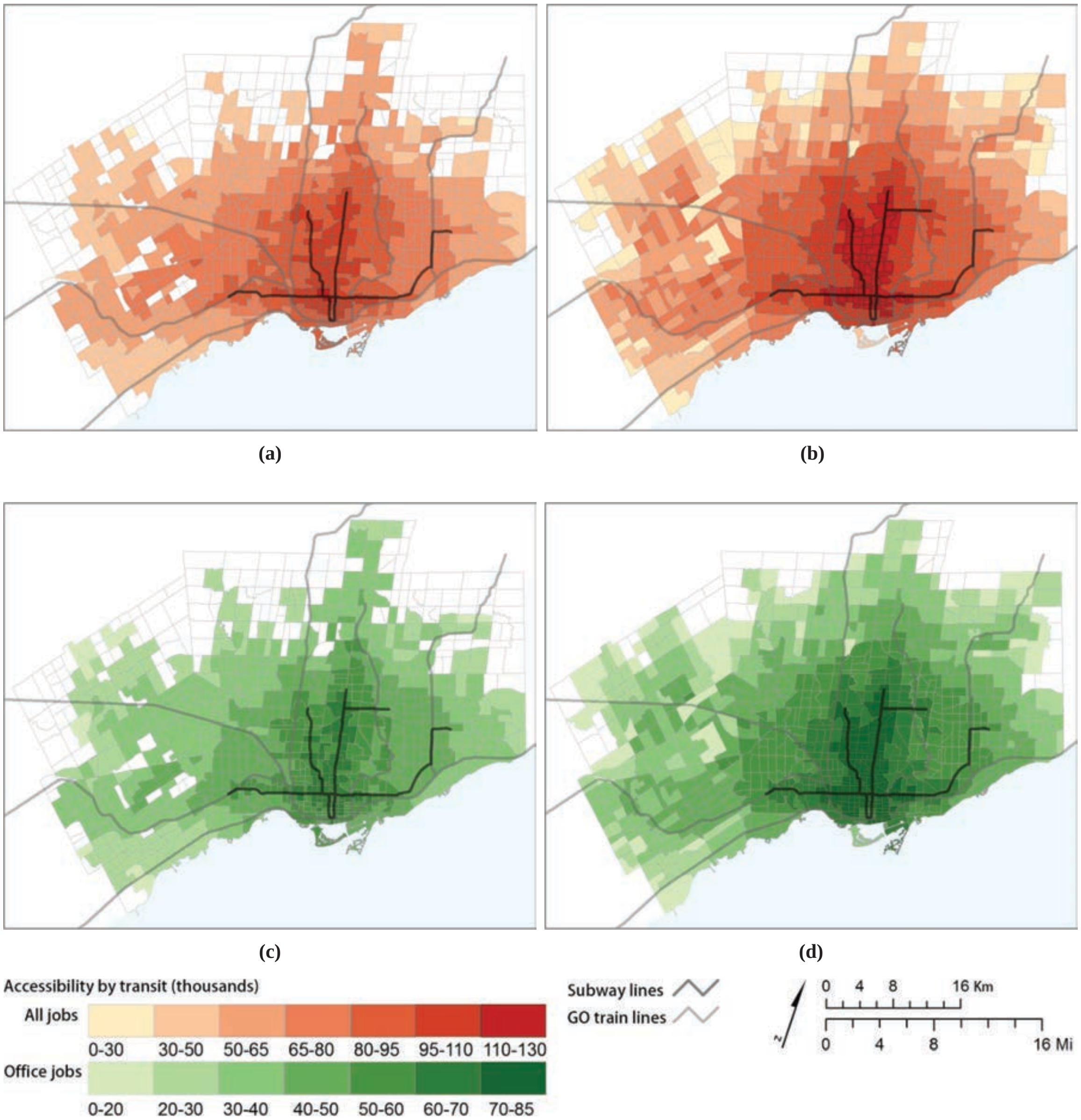

FIGURE 4 Accessibility by transit to (*a*) all jobs, 1996; (*b*) all jobs, 2006; (*c*) office and professional jobs, 1996; and (*d*) office and professional jobs, 2006. (Source for data: Transportation Tomorrow Survey, Metrolinx, and DMTI Spatial, Inc.; for projection: North American Datum 1983 and Transverse Mercator.)

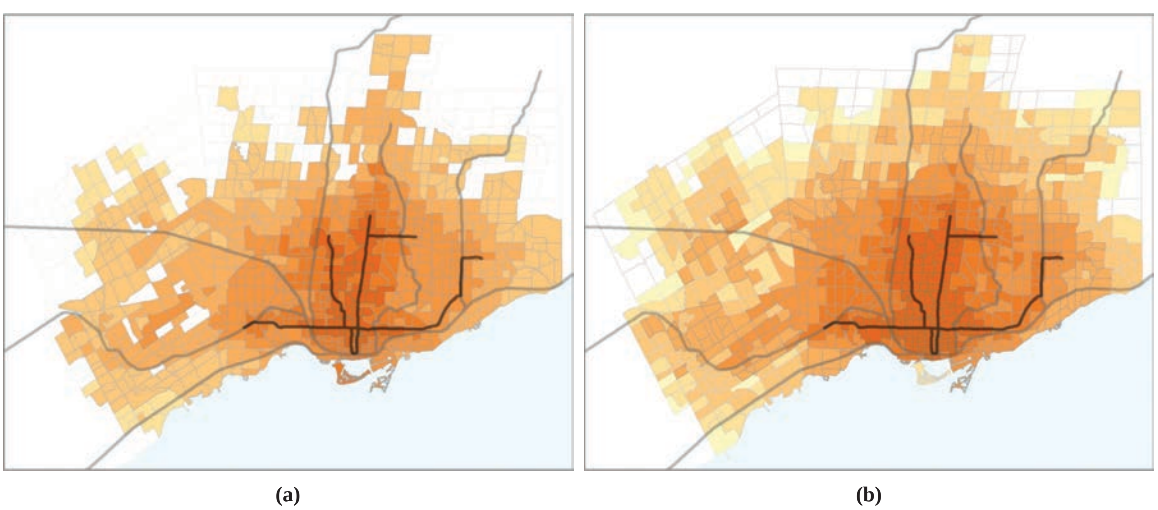

FIGURE 5 Accessibility by transit to (*a*) retail or sales and service jobs, 1996 and (*b*) retail or sales and service jobs, 2006.

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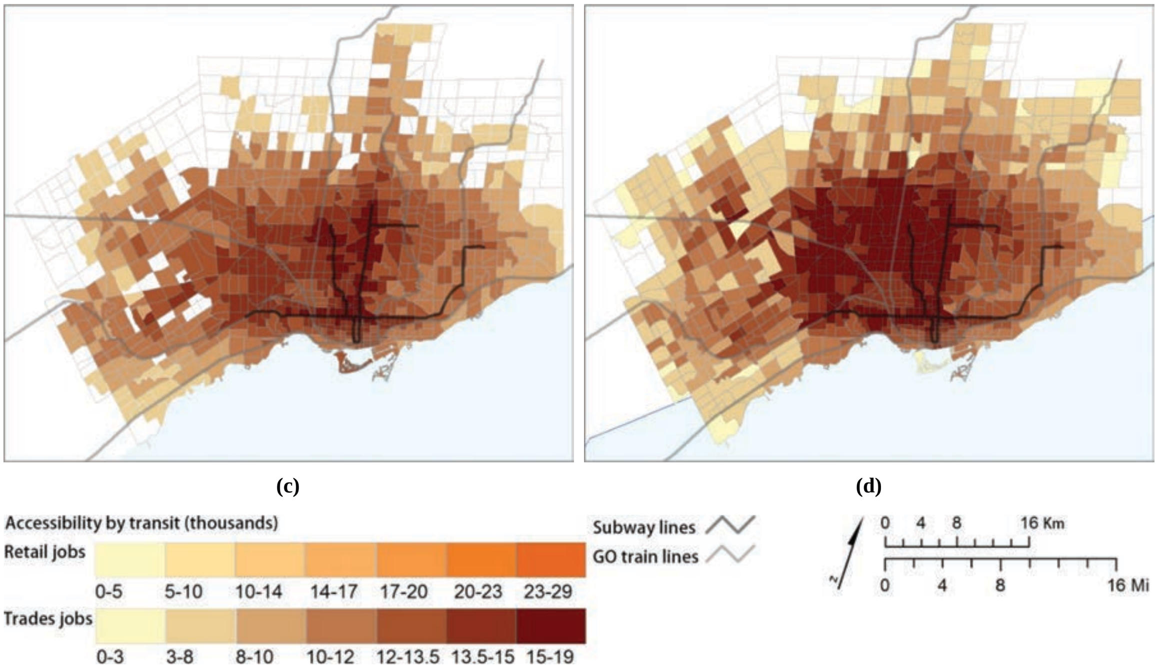

FIGURE 5 *(continued)* **Accessibility by transit to (*c*) manufacturing, construction, and transport jobs, 1996; and (*d*) manufacturing, construction, and transport jobs, 2006. (Source for data: Transportation Tomorrow Survey, Metrolinx, and DMTI Spatial, Inc.; for projection: North American Datum 1983 and Transverse Mercator.)**

TABLE 3 Regression Results

	All Jobs[a]		Office, Professional[b]		Retail, Sales, Service[c]		Manufacturing, Construction, Transport[d]	
Variable	Coefficient	*t*-Stat.	Coefficient	*t*-Stat.	Coefficient	*t*-Stat.	Coefficient	*t*-Stat.
[constant]	–0.013	–1.639	0.010	0.984	–0.033**	–2.555	–0.022*	–1.691
Year 2006	0.017***	2.720	0.019**	2.464	0.011	1.204	–0.004	–0.407
Local bus frequency (hundreds)	0.020***	4.236	0.027***	4.742	0.021***	3.047	0.010	1.464
Subway station	0.077***	8.441	0.061***	5.496	0.059***	4.374	0.113***	8.890
Subway station interacting with 2006	–0.019	–1.623	–0.015	–1.084	–0.020	–1.206	–0.067***	–4.011
Highway 407	–0.036***	–2.936	–0.041***	–2.650	–0.047**	–2.503	–0.038**	–2.101
Social disadvantage indicator (by decile)	0.011***	10.400	0.012***	8.691	0.016***	10.271	0.014***	8.926
Accessibility by transit to all jobs (10%)	0.02***	13.757	—	—	—	—	—	—
Most disadvantaged (Decile 1) interacting with accessibility by transit to all jobs	0.003***	2.797	—	—	—	—	—	—
Accessibility by transit to office or professional jobs (10%)	—	—	0.021***	11.072	—	—	—	—
Most disadvantaged (Decile 1) interacting with accessibility by transit to office or professional jobs	—	—	0.003	1.542	—	—	—	—
Accessibility by transit to retail or sales and service jobs (10%)	—	—	—	—	0.021***	9.539	—	—
Most disadvantaged (Decile 1) interacting with accessibility by transit to retail or sales and service jobs	—	—	—	—	0.012	1.833	—	—
Accessibility by transit to manufacturing, construction, and transport jobs (10%)	—	—	—	—	—	—	0.001***	3.636
Most disadvantaged (Decile 1) interacting with accessibility by transit to manufacturing, construction, and transport jobs	—	—	—	—	—	—	0.032***	3.246

NOTE: Dependent variable = transit percentage of mode share by job type (each model); *t*-stat. = *t*-statistic; — = not included in model.
[a] R^2 = .52.
[b] R^2 = .41.
[c] R^2 = .37.
[d] R^2 = .27.
*90% confidence level; **95% confidence level; ***99% confidence level.

likely to commute by transit compared with commuters in other TAZs in the region. The same TAZs were tested in 1996 before the highway was completed, and none of the models displayed statistical significance (this variable was dropped from the model presented here). These results echo Kawabata's finding that proximity to highways increased disparity between accessibility by transit and by car during a 10-year period (*47*). Socially disadvantaged populations are consistently more likely to take public transit: transit share is predicted to increase by 1.1% for each decile increase in social disadvantage.

Accessibility to all jobs by transit is positive and statistically significant. An increase of accessibility by transit by 10% to jobs in general is associated with a 2.0% increase in transit share; this finding supports the inclusion of accessibility as an important aspect of the bundle of performance measures to evaluate projects whose goal is to increase transit mode share. The interaction variable of accessibility to jobs by transit in 2006 did not show an impact on transit mode share and was also dropped from the model, indicating that accessibility had a consistent effect on commuter transit mode share from 1996 to 2006.

The interaction variable accessibility by transit to all jobs multiplied by the most socially disadvantaged decile is statistically significant. Results for the all-jobs model show that if a TAZ is in the most socially disadvantaged decile, an increase in accessibility by 10,000 jobs raises the likelihood of taking transit by 0.3%—in addition to the 1.6% increase resulting from changes in accessibility noted above. That finding demonstrates that commuters in the most socially disadvantaged TAZs respond to an increase in accessibility even more than other commuters do.

Job Category Models

When the job category models are analyzed, some variables have coefficients similar to the all-jobs model, such as Highway 407 and the social indicator variables. At the same time, there are a number of differences between the job category models and the aggregated all-jobs model that tell a more nuanced story about transit mode share. In comparison with the R-squared value for the all-jobs model (.52), the R-squared values in the job category models are slightly lower (office .41, retail .37, and trades .27). The "Year 2006" variable is statistically significant only for the office or professional (office) jobs category, with a 1.9% increase in the likelihood to commute by transit in 2006. The retail or sales and service (retail) and manufacturing, construction, and transport (trades) job models show marginal impact for the 2006 variable.

Running counter to the original hypothesis, the magnitude of the effect of accessibility by job category (expressed as a percentage) stays relatively constant for the all-jobs, office jobs, and retail jobs categories (2.0% change for every 10% change in accessibility). It is different, and smaller, only for the trades jobs category (0.1%). In other words, an increase in transit accessibility to trades jobs, while controlling for other factors, is expected to have less of an effect on mode share than that for other job categories. An addition of 100 local buses during the peak period in a TAZ has a statistically significant effect on commute by transit for the job categories office (2.7%) and retail (2.1%), but not for trades jobs. Concerning proximity to subway stations, the trades job model shows the largest coefficient in the study. There is an 11.3% increase in the likelihood for trades workers to take transit to work if living within 1,000 m of a subway station. Subway station proximity for other job categories is also a relatively strong predictor of transit share (office at 6.1% and retail at 5.9%). This finding demonstrates that some job categories are more likely to respond to transit infrastructure than others.

The interaction variable of subway and 2006 is statistically significant only in the trades jobs model, and it is negative. The Sheppard subway stations do not serve trades workers trying to commute to skills-matched jobs compared with the other job categories. The map illustrating accessibility to trades jobs in the previous section (Figure 5) confirms that the concentrations of trades jobs are not well-served by the Sheppard subway. In contrast to the effect of subways on transit mode share, the construction of Highway 407 had a statistically significant negative effect across all job models: office at −4.1% and retail at −4.7% and trades at −3.8%.

Finally, the interaction variable of accessibility by transit and most socially disadvantaged TAZs demonstrates that some socially disadvantaged workers respond to increases in accessibility more than others. Of the job category models, only the trades job model is statistically significant. That finding shows that the most socially disadvantaged workers with trades jobs are 3.2% more likely to take transit with an increase in accessibility by 10,000 skills-matched jobs compared with less socially disadvantaged workers. For social disadvantage deciles in general, each decile increase of social disadvantage corresponds with an increase in transit use (office at 1.2%, retail at 1.6%, and trades at 1.4%).

CONCLUSION

This study examines mode share change over time with a focus on accessibility to different job categories and the location of new transit and highway infrastructure. It was found that retail or sales and service and office workers are most likely to commute by transit with an increase in accessibility to skills-matched jobs by transit in Toronto. This finding suggests that workers in some job categories are more likely than others to commute by transit if accessibility increases by improved transit networks or concentration of desired destinations.

Findings for social disadvantage demonstrate the importance of social equity goals in transportation planning. An increase in social disadvantage correlates with increased transit shares and affects all workers regardless of job category. Moreover, with an increase in accessibility for the 10% most socially disadvantaged areas, manufacturing, construction, and transport workers are likely to take transit even more. This finding highlights the importance of using accessibility as a performance measure when infrastructure projects that aim to increase transit mode share among socially disadvantaged populations are evaluated. In regard to transport infrastructure, the presence of subway stations in either year is a predictor of transit mode share. Yet, it was found that new subway stations do not necessarily increase transit mode share for certain job categories, such as manufacturing, construction, and transport, as this occupational group does not benefit from the new transit infrastructure. This finding can be related mainly to the location of the new subway projects and its relation to the distribution of jobs in the region. Last, new highway infrastructure considerably impedes an increase in transit mode share for all commuters, regardless of job type.

Results from this study show that while changes in transit infrastructure affect workers across job categories, job types differ in their response to the same variables. These variations add to the complexity of commuting travel behavior and contribute to the body of mode share research. The methodology presented in this study could be of interest to land use and transportation planners who seek to boost transit ridership in their regions.

There are a few limitations in this study. First, as aggregate level relationships do not necessarily hold true at the individual level, results at the TAZ level are not intended to be interpreted for the individuals in each TAZ (*48*). Second, because the general office and professional or technical job categories from the TTS data were combined, these findings should be interpreted with some caution. Other uncontrolled-for differences among job categories (opening hours, for example) may be important in determining mode choice; however, such information was not available to include in this study. Although conclusions from context-specific studies should not be simply imported to another context, these findings would help transportation researchers and planning practitioners to understand that the determinants of transit mode share vary by job category and to understand how transportation, social, and economic changes in a region affect transit use over time. Future research in which historical information was related to movement in job locations in specific industry categories could lead to a better understanding of the changes in behavior among employees in these categories. Also the use of longitudinal data that follow individuals at the disaggregate level over time to monitor their changes in home location in response to changes in transport infrastructure, accessibility, and job locations is recommended.

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