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Measuring the Local Economic Impacts of Replacing On-Street Parking With Bike Lanes

Daniel Arancibia, Steven Farber, Beth Savan, Yvonne Verlinden, Nancy Smith Lea, Jeff Allen & Lee Vernich

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A Toronto (Canada) Case Study

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ABSTRACT

Problem, research strategy, and findings: Bike lane projects on retail streets have proved contentious among merchant associations in North America, especially when they reduce on-street parking. A limited but growing number of studies, however, detect neutral to positive consequences for merchants following bike lane implementation. In 2016, the City of Toronto (Canada) removed 136 on-street parking spots and installed a pilot bike lane on a stretch of Bloor Street, a downtown retail corridor. Using a case–control and pre–post design, we surveyed merchants and shoppers to understand the impacts of the bike lanes on economic activities. We find no negative economic impacts associated with the bike lanes: Monthly customer spending and number of customers served by merchants both increased on Bloor Street during the pilot.

Takeaway for practice: Our findings are consistent with an improving economic environment at the intervention site. Downtown retail strips may therefore be suited to tolerate bike lanes and even benefit from increased retail activity. Pre and post surveys can provide valuable insights into local economic impacts of streetscape changes affecting merchants along city streets, especially where access to sales data is limited.

Keywords: bike lanes, local economic impact, on-street parking

With a surge in the number of bike lane projects across North America, some local merchants on affected streets have expressed concerns about potential reductions in customers because of associated on-street parking losses. As a result, planners and politicians have sometimes shown reluctance to support or recommend bike lanes in commercial streets at the cost of on-street parking.

A unique opportunity to explore the local economic impacts of bike lanes materialized when the City of Toronto (Canada) identified a segment of Bloor Street, a vibrant commercial street, as a major cycling corridor in the city's Ten Year Cycling Network Plan (City of Toronto, 2016). In August 2016 the city installed bike lanes on a 2.4-km (1.5-mile) stretch of Bloor Street as a pilot project. Determining local economic impact was originally outside of the scope for the city's study. In this context, a team of University of Toronto and The Centre for Active Transportation researchers collaborated with the City of Toronto and business improvement areas (BIAs) to survey merchants and shoppers to understand economic activities before and after the installation of the bike lanes.

A project report intended for Toronto's stakeholders and decision makers is available online (Smith Lea et al., 2017). In this study, we provide a substantially different, more technical account of the research and its implications geared toward the academic planning community and planning practitioners.

We first examine eight prior studies that investigate bike lanes' effects on local businesses. We then outline how we investigated these effects in Bloor Street using a case–control study. We use four indicators to assess economic activity: estimated customer counts from merchant surveys, estimated spending and visit frequency from visitor surveys, and vacancy counts. We find all indicators point to increased economic activity

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on Bloor Street following the installation of the bike lane. We conclude by demonstrating how the study contributes to a growing body of empirical research aimed at understanding the impacts of bike lanes on local retailers and service providers. Though we advise against extrapolating our results to other streets with markedly different consumer behaviors and urban forms, our results suggest bike lanes can be added to vibrant, downtown retail streets without negative impacts. Bike lanes on Bloor Street were made permanent in November 2017.

Studying the Impacts of Cycling Infrastructure on Local Economies and Customer Mode Share in North American Cities

Local Economic Impacts of Bicycling Infrastructure in North America

Urban interventions affect local economies at many different scales. A large and growing body of research reflects a diverse set of approaches to conceptualizing and calculating economic impacts, from cost–benefit and investment return analyses to tracking changes in employment, vacancies, retail sales, or property values (Hicks, Keil, & Spector, 2012; Krizec, 2007; Pivo & Fisher, 2011). We are primarily concerned here with impacts affecting local merchants in an urban North American context. Early works addressing this include Edminster and Koffman's (1979) "moderately positive" evaluation of three North American transit malls and Weisbrod and Pollakowski's (1984) mixed-results assessment of eight downtown improvement projects. Edminster and Koffman (1979) use customer and merchant surveys, retail sales, and vacancy rates in their evaluation, whereas Weisbrod and Pollakowski (1984) track the number of retailers and employment in the study areas. Contemporary examples include the use of citywide consumer surveys to assess the opening of a big box store in Davis (CA) by Sciara, Lovejoy, and Handy (2018), who find that "experiential" aspects of shopping downtown likely protected urban businesses from negative impacts.

Focusing on the impacts of bike lanes specifically, we looked for North American studies addressing bike lanes' effects on urban merchants. Despite the importance of economic impacts on cycling infrastructure decision making, we found only eight studies—six quantitative and two qualitative—that measure this. Because most of these studies have not been described previously in the academic literature, we describe them in some detail here. Results from the six quantitative studies are presented in Table 1.

Two New York City (NY) Department of Transportation (NYC DOT) studies published in 2012 and 2013 are landmark evaluations of sustainable street improvements' economic impacts. They both find associations between bike lanes and improved retail sales. The first study notes a substantial rise (177%) in cyclists accompanied retail growth along Manhattan's controversial 1st and 2nd Avenue bike lanes, for example (Kramer, 2011; NYC DOT, 2012). The second study uses up to 7 years of sales data (2005–2011) to evaluate interventions. Use of taxable sales data, multiple controls, and multiyear evaluations make these studies' results reliable indicators of bike lanes' potential economic benefits. Unfortunately, maintenance of on-street parking at most interventions means these reports do not address the potential trade-offs of losing on-street parking.

Similarly, McCormick (2012) finds no adverse economic impacts by using merchant and customer surveys, retail sales data, and property values to evaluate bike lanes' effects on York Boulevard in Los Angeles (CA). On-street parking also coexisted with painted bike lanes. The author relies on tax and property value data sets from 2000 to 2005 (pre–bike lanes) and 2006 to 2011 (post–bike lanes) for his comparison. Merchant and customer surveys collected in 2011 provide the valuable insight that merchants overestimated the number of customers who arrived by car, a finding consistent with a series of other studies that could help explain merchant opposition to traffic and parking lane removal for bike lane installations (Chan et al., 2016; Forkes & Smith Lea, 2010; McCormick, 2012; Stantec, 2011; Sztabinski, 2009).

Rowe's (2013) evaluation of bike lanes in two Seattle (WA) neighborhoods considers a site where on-street parking was replaced with a bike lane in 2011. Sales at this site increased drastically in 2012 compared with sales in 2010, whereas sales at a control site and neighborhood-wide remained steady. Sales were also stable between 2009 and 2012 at another site where bike lanes were installed in 2010 and at its control site. The author concludes concerns about significant detrimental impacts on local merchants prove unjustified.

The City of Calgary (2016b) also carried out a comprehensive study of a downtown cycle track network pilot project involving on-street parking removal. This survey-based study finds a drop in monthly customer per capita spending and a drop in average number of customers per day as reported by merchants between 2014 and 2016. Because no controls were used, it is difficult to ascertain whether reduced spending and

Table 1

Quantitative North American studies measuring the economic impact of bike lanes on commercial streets.

Study	Location	Context	Methods	Findings
NYC DOT (2012)	New York (NY)	The study looked at economic impacts of recently implemented protected bike lanes: • 9th Avenue • Manhattan's 1st and 2nd Avenues (bus lanes were also added to these streets) • Union Square North (pedestrian realm was also improved at this location)	Taxable sales data and retail vacancy data were used to estimate economic impacts over a period of 2–3 years from the completion of each project, comparing the data at each site with borough-wide metrics as control.	• 9th Avenue saw a 49% increase in retail sales (compared with 3% borough-wide) • Manhattan's 1st and 2nd Avenues saw a drop of 47% in commercial vacancies (compared with a 2% increase borough-wide) • Union Square North vacancies decreased by 49% (compared to a 5% increase borough-wide)
McCormick (2012)	Los Angeles (CA)	A portion of York Boulevard, a commercial street, received a road diet treatment including a painted bicycle lane, whereas another portion did not. Bike lanes installed were intermittent and separated from the sidewalk by on-street parking. This study looks at the economic impacts of that intervention.	Merchant surveys ($n=115$), customer surveys ($n=50$), retail sales data, and property values were examined to evaluate bike lanes' impact. A case–control and before–after comparison of each of these areas was conducted.	• The study found a neutral result with no adverse economic impacts • Survey results suggest merchants overestimated the number of customers who arrived by car
NYC DOT (2013)	New York	The study looked at economic impacts around recently implemented protected bike lanes: • Vanderbilt Avenue (traffic calming measures were also implemented) • Columbus Avenue (this was a parking-protected bike lane) • Bronx Hub • St. Nicholas and Amsterdam Avenues (intersection)	Taxable sales data were used to estimate economic impacts over a period of 2–3 years from the completion of each project, comparing the data at each site with borough-wide metrics and specific comparison sites with similar characteristics.	• Vanderbilt Avenue saw an increase in retail sales of 102% (compared with 64% at comparison sites) • Columbus Avenue saw a 20% increase in sales (compared with 11% in comparison sites) • Bronx Hub saw an increase of 50% in sales (compared with 18% borough-wide) • St. Nicholas and Amsterdam Avenues saw an increase in sales of 48% (compared with 7% at comparison sites)

(*Continued*)

Table 1 (*Continued*)

Study	Location	Context	Methods	Findings
Rowe (2013)	Seattle (WA)	The study looked at economic impacts on commercial nodes adjacent to two painted bike lanes in Seattle over 3 years (including a year prior to implementation): • Latona and 65th Neighborhood Business District (where bike lanes replaced on-street parking) • Greenwood neighborhood	Aggregated before–after retail sales data for the commercial nodes were examined over time and compared against comparison sites.	• Increase in sales of up to 400% in Latona and 65th Neighborhood Business District compared with steady sales at a comparison site • Sales remained steady in the Greenwood neighborhood • Positive outcomes may not be due to bike lanes, but concerns about significant detrimental impacts on local merchants were not justified
City of Calgary (2016b)	Calgary (AB, Canada)	Study of a cycle track network pilot project consisting of 6.5 km of protected bike lanes in downtown streets. The pilot's duration was 18 months. Economic vitality was one of nine themes examined in this study. Approximately 370 parking spots were removed to accommodate the bike lanes, but 500 new parking stalls were created nearby to offset this loss.	Economic vitality was measured with before–after customer surveys inquiring about spending and visit frequency ($n = 380$) and merchant surveys inquiring about the number of customers served ($n = 251$). No controls were used.	• Drop in monthly customer per capita spending from 153 CAD to 131 CAD, but average number of weekly visits by each customer remained constant at 3.5 • Drop in average number of customers per day as reported by merchants from 112 to 92 • **Note:** Alberta was experiencing a severe recession at the time of this study
Poirier (2018)	San Francisco (CA)	This study examines the performance of businesses abutting the following painted bike lanes over a period of 5 years: • Valencia Street • Polk Avenue Columbus Avenue (where sharrows were painted) was also studied and questionably described as a bike lane	Longitudinal firm-level data from the National Establishment Time-Series data set were used to track before–after sales along the bike lanes, using non-abutting businesses in the vicinity for comparison.	• No catastrophic negative impacts were detected • Both sites with bike lanes experienced a marked increase in sales following implementation; Columbus Avenue saw a decrease in sales compared with non-abutting businesses • Bike lanes positively affected local-serving businesses more than other types

Note: CAD = Canadian dollars.

customers resulted from the pilot or from unrelated economic trends. At the time, the Province of Alberta was undergoing a severe economic recession. The city acknowledges this in their final report, stating, "The influence of the cycle tracks is difficult to extract from the overall economic downturn" (City of Calgary, 2016a; Gibson, 2016). Interpretation of these results is further complicated by the city's addition of more than 500 parking stalls intended to offset parking losses, which produced a net gain of 130 parking spots before the pilot's end (City of Calgary, 2016a).

Poirier's (2018) study is unique both in its use of longitudinal firm-level data from the National Establishment Time-Series data set to track sales along two bike lanes in San Francisco (CA) and in its chosen control. The performance of businesses abutting the bike lanes was compared over 5 years with businesses in the vicinity but not abutting the bike lane. This atypical approach toward selecting a control means that many "non-abutting" businesses used for comparison are a few meters away from the bike lanes, whereas others are up to 1 km away. Businesses at both Valencia Street and Polk Street experienced a marked increase in sales following implementation of bike lanes between 1999 and 2001 and 2004 and 2006, respectively (Poirier, 2018). On-street parking was maintained at both sites but was marginally affected at Valencia Street.

One of the two qualitative studies we found also centers on Valencia Street's bike lanes, using merchant surveys to study perceptions (Drennen, 2003). Four years after the bike lane's 1999 implementation, merchants' responses were overwhelmingly positive, with 65.4% reporting that the bike lanes had a positive impact on business and sales and only 3.8% suggesting a negative impact. These findings match those of Poirier (2018), who identifies a positive economic impact for all business types.

Stantec (2011) prepared the second qualitative study for the City of Vancouver (Canada). Its aim is to study the economic impacts of upgrading bicycle facilities on two streets from unidirectional unprotected bike lanes to bidirectional protected cycle tracks. Stantec (2011) uses merchant surveys, collected during a single sampling event in 2011, to inquire about sales. The Downtown Vancouver Business Improvement Association vocally opposed the cycle tracks, and the Canadian Federation of Independent Businesses produced a report showing virtually no support for improved cycling infrastructure (CTV News BC, 2010; Smith, 2010). Only 32% of merchants responded to the Stantec survey. At the time of the survey, one cycling facility (Dunsmuir) was 1 year old, and the other (Hornby) had been completed 4 months prior. Merchants reported a 2% decrease in sales in Dunsmuir and 11% in Hornby. Businesses in comparator streets reported a 2% increase and a 1% decrease, respectively. The study authors warn that due to low response rates and the limited time the new infrastructure had been in place, it is difficult to assess the extent to which sales were affected. A sidewalk customer survey also reveals that merchants who responded to the merchant surveys overestimated people driving into the neighborhood (40% estimated versus 20% measured) and underestimated people arriving by bicycle (4% estimated versus 8% measured). In the 6 years following the implementation of the cycle tracks, the Downtown Vancouver Business Improvement Association gradually shifted their stance and now champion the cycle tracks, with their president saying they provide "a competitive edge" (Lovgreen, 2017).

Customer Modes of Transportation and Spending

Numerous studies investigate how spending relates to customer mode choices. Four different studies suggest cyclists are higher per capita monthly spenders than customers arriving by car (Chan et al., 2016; Clifton et al., 2013; Sztabinski, 2009; Transportation Alternatives, 2012). A fifth study, which uses an online survey rather than customer intercept surveys to obtain data, concludes that cyclists' and drivers' spending behaviors in downtown Davis (CA) were equivalent (Popovich & Handy, 2014). This suggests increases in cycling traffic may have positive economic impacts despite an associated loss of parking. Clifton et al. (2012, 2013) and Poirier (2018) suggest cyclists might be particularly inclined to spend money on "local-serving" businesses like restaurants and neighborhood shops.

In eight studies investigating traditional retail strips and dense urban areas, only two studies show automobile mode shares in excess of 21% (Bent & Singa, 2008; Chan et al., 2016; Clifton et al., 2012; Forkes & Smith Lea, 2010; McCormick, 2012; Stantec, 2011; Sztabinski, 2009; Transportation Alternatives, 2012). The lowest measured shares were in New York's East Village (4%) and Toronto's Queen Street West (4%), and the highest were in Portland's (OR) central business district (34%) and Los Angeles' York Boulevard (28%; Chan et al., 2016; Clifton et al., 2013; McCormick, 2012; Transportation Alternatives, 2012). This is in stark contrast with suburban North American regions, where automobile-related mode share can climb to 78% even in transit-friendly cities like Portland (Clifton et al., 2012).

Overall, the existing literature suggests bike lanes have a neutral to positive impact on commercial activity, even when some on-street parking is lost. This is consistent with the notion that only a small portion of customers arrive by car in North America's dense urban areas and traditional shopping strips. Furthermore, the spending behaviors of cyclists compare favorably to those arriving by other modes. We explore these relationships within the Bloor Street pilot study, which elicited strong parking-related opposition from some merchants while receiving broad community support.

Toronto's Bloor Street: Bike Lanes Added to One of Canada's Iconic Commercial Strips

Study Context

In Toronto, Bloor Street is home to a vibrant mix of retailers, restaurants, bars, and service providers. Since 2007, civil society organizations had been requesting through yearly demonstrations that bike lanes be added to Bloor Street, but concerns about traffic impacts and loss of on-street parking turned the issue contentious (Bells on Bloor, 2015). Nearly 20 km of Bloor Street was identified as a major cycling corridor in the City of Toronto's (2016) Ten Year Cycling Network Plan. It represents a priority east–west route, with important linkages to existing cycling facilities and to many neighborhoods with high cycling mode shares.

In August 2016, the city installed bike lanes along 2.4 km of Bloor Street as a 1-year pilot, stretching from Avenue Road in the east to Shaw Street in the west. Figures 1A and 1B show these areas. BIAs were supportive of the pilot provided that its economic impacts were measured and included among the variables to determine its permanence.

The street, which ranges in width from 12.2 to 16.2 m over this stretch, consisted of two traffic lanes in each direction prior to bike lane installation. Parking was allowed during off-peak hours as shown in Figure 1D. This was reconfigured into one traffic lane in each direction with turning lanes at intersections, one lane of curbside parking (alternating sides), and a curbside bike lane in each direction protected by flexi-post bollards, as shown in Figure 1E. A total of 136 on-street parking spots were removed, constituting nearly half of the on-street parking in this section. When nearby public and privately run parking lots are considered, however, this reduction only amounts to 10% of convenient customer parking (City of Toronto, 2017).

Study Area

Our study area consists of a 1.5-km section of Bloor Street, bounded by the east and west borders of the Bloor Annex and Korea Town BIAs, respectively, and falls within the 2.4-km bike lane pilot area as shown in Figure 1A. This stretch contains two- and three-story buildings with shops, services, and restaurants on the ground floor. We selected Danforth Avenue from Broadview Avenue to Chester Avenue as a control site without bike lanes. Danforth Avenue is the continuation of Bloor Street 3 km east of the study location, and it is a suitable control site because of its similarity in scale, business composition, and subway access. The Yorkville neighborhood and the Prince Edward Viaduct (a 500-m-long bridge that marks the end of Bloor Street and the beginning of Danforth Avenue) act as buffers between the study area and the control site, shown in Figure 1C.

The City of Toronto's (2015) employment survey shows the business composition of Korea Town and Bloor Annex as just more than one-third bar and restaurant establishments and just less than one-third each retail and service establishments. The chosen control site is similar but offers more retail and fewer restaurants. The two sites are also similar demographically, as shown in Table 2, with the caveat that Bloor Street is closer to the University of Toronto St. George campus. Students may be more strongly represented among customers and traffic because of this proximity.

Evaluating Local Economic Impacts of Bike Lanes in Toronto's Bloor Street

Approach and Study Design

We preferred a survey-based approach for assessing economic impacts and used Sztabinski's (2009), Forkes and Smith Lea's (2010), and the National Bicycle and Pedestrian Documentation Project's (2010) instructions to inform our survey design. We used a combination of merchant and visitor surveys for various reasons: They allowed our research team to determine shifts in mode share, detect changes in customer spending patterns and consumer behavior, identify travel patterns, and measure perceptions of safety. These tools also provided valuable insights into attitudes through open-ended questions, including support of or opposition to the project.

The University of Toronto research team proposed four economic impact indicators, which all study partners agreed upon (including partner BIAs):

1. Estimated customer counts (merchant surveys).
2. Estimated monthly customer spending (visitor surveys).

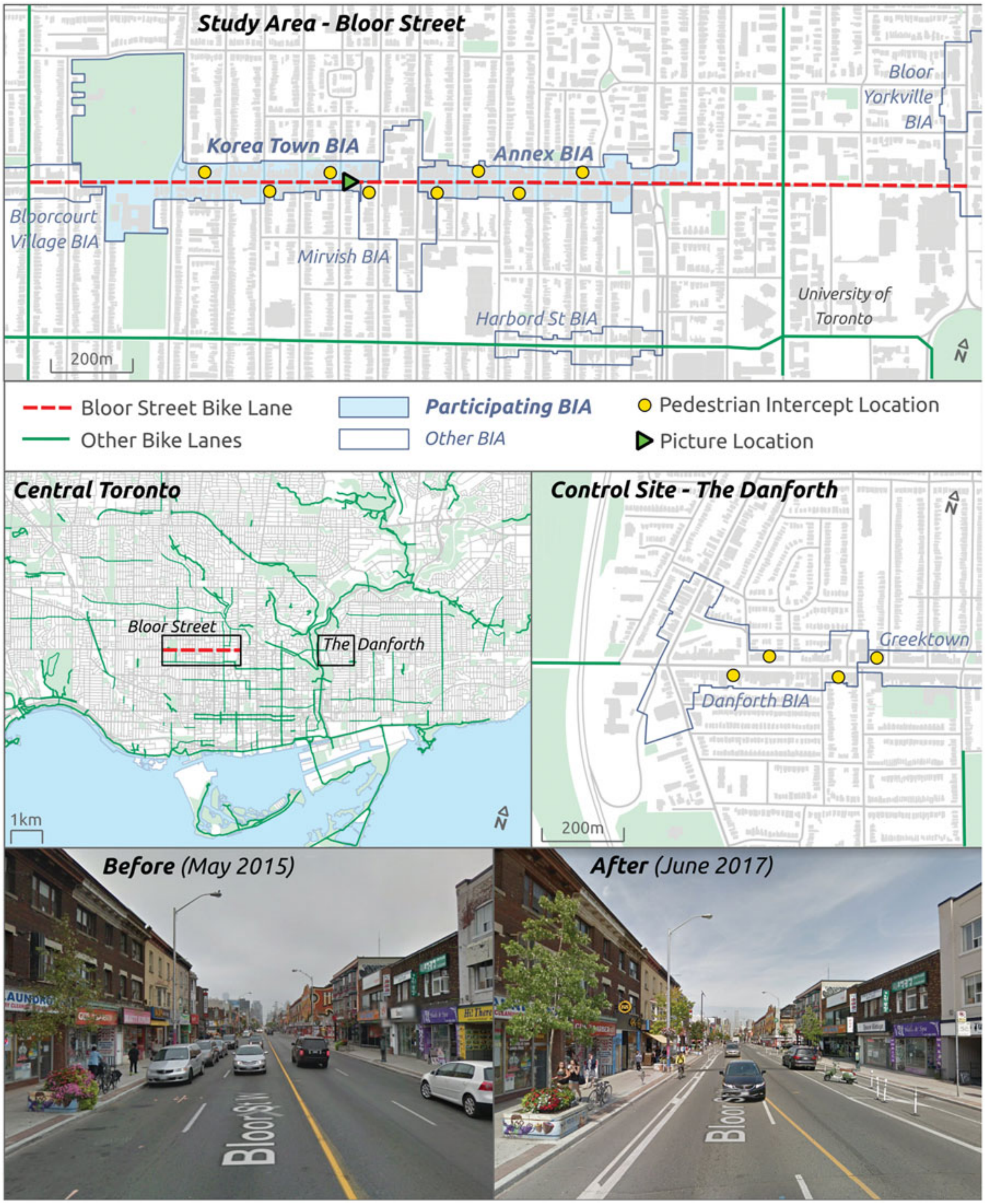

Figure 1. (A) The study area and its features. (B) View of the study and control areas in relation to the rest of the city. (C) The control area. (D) Before and (E) after photographs of the street configuration.
Data sources: City of Toronto, 2017, Google, 2015, 2017.

3. Estimated visit frequency (visitor surveys).
4. Business vacancy counts (street-level fieldwork).

We decided to study the change in indicator values through a pre–post study with a case–control design. Data were collected before and after the bike lane's installation on Bloor Street and along the control site on Danforth Avenue. Data collection began in October 2015, approximately 1 year prior to installation of the bike lane, with follow-up

Table 2

Select demographic indicators from the latest Canadian census (Statistics Canada, 2018) comparing the Bloor Corridor (intervention site) with Danforth Avenue (control site).

	Bloor Street (intervention site)	Danforth Avenue (control site)
Population density per km^2	8,634	8,221
Average age, years	40.53	41.3
Median household income after tax, CAD	$60,102	$69,304
Recent immigrant (2001–2016)	8.09%	5.90%
Visible minority	25.67%	19.22%
Unemployed	5.13%	4.31%
Residential mobility (moved in past year)	20.37%	11.20%
Commute by bike	15.84%	7.76%

Note: Data were obtained by combining census tracts abutting each site. CAD = Canadian dollars.

collection occurring in October 2016 and again in May 2017.

A demographically diverse team of trained University of Toronto students administered the merchant and visitor surveys at the Bloor Street and Danforth Avenue study sites. Surveyors used a paper version of the surveys to record respondents' answers for the 2015 sampling period. Tablets were used to record responses for all surveys in the 2016 and 2017 sampling periods. A dedicated Korean translator was on hand for all merchant and visitor surveys conducted in Korea Town.

We designed the merchant survey primarily to gather perceptions of customer counts. We also collected data about travel patterns. Surveyors approached all ground-level merchants between Montrose Avenue and Madison Avenue at Bloor Street and between Broadview Avenue and Playter Boulevard at Danforth Avenue. We only used surveys completed by an owner or manager, and each establishment was visited up to four times if store owners or managers were unavailable. Following multiple unsuccessful visits, surveyors left an information sheet with contact information to conduct the survey by phone, which some merchants did. Of the businesses approached in the study, 62% participated, completing 452 surveys on Bloor Street but only 73 surveys at Danforth Avenue. This discrepancy in sample size is an important limitation of our study because it prevents us from meaningfully comparing customer counts between the two sites.

We designed the sidewalk visitor survey to capture estimated customer spending, visit frequency, visitor travel patterns, and attitudes toward the bike lane. We selected monthly spending as a prime impact variable because of its stability compared with daily spending, which could fluctuate significantly depending on day of the week or time of day.

Surveying for the visitor survey took place during 2- to 6-h periods between 11 a.m. and 8 p.m. on both weekdays and weekends, with most sampling taking place between noon and 5 p.m. Surveyors asked every third person walking on the sidewalk to participate at defined sampling points and switched sampling points at specified time intervals. We show these sampling points in Figures 1A and 1C. To reduce bias, the script of both survey types did not mention bike lanes but instead introduced itself as "a survey regarding local businesses and how people get here." Questions mentioning bike lanes were not asked until after economic data had been gathered. In all, 3,005 visitors to Bloor Street and Danforth Avenue were surveyed.

We made vacancy counts with a street-level scan. Researchers walked the entire length of the pilot bike lane installation area and the control site to note which ground-level businesses were in use. The first count was in July 2016 and the second was in July 2017.

Data Analysis

We conducted two types of data analyses. First, a descriptive analysis compared the results between pre- and post-installation. For the visitor survey, the postinstallation period combined results from the 2016 and 2017 collection cycles to increase the sample size and level of statistical confidence. Each period was kept separate for the merchant survey, however, which collected responses from the same merchants multiple times. The analysis also compared results between the study area (Bloor Street) and control (Danforth Avenue). We used descriptive statistics to test whether a) significant changes in economic activity occurred in the study area and b) changes observed in the study area were significantly different from those in the control site. Our team used classical difference of means and one-way analyses of variances to explore the former, whereas a difference-in-differences test was used for the latter, which accounted for the sampling error in each of the four samples (Pre/post × Case/control) used to measure rates of change in the two study sites.

Recognizing that many factors influence people's spending habits and visiting patterns, including age, gender, trip purpose, and transportation choices, we used regression analysis to capture the bike lane's effect on spending and visit frequency and to control for any other differences in the survey samples. Fixed effects for time period and sampling site were used in ordinary least squares and binomial logit regressions of monthly visitor frequency and customer expenditures, respectively. For the latter, we categorized ordinal responses into two groups, less than and more than 100 Canadian dollars (CAD) spent per month.

Limitations From Timing and Seasonality

The timing of data collection was subject to project approvals and the City of Toronto's reporting requirements for the Bloor Street pilot project. The decision to conduct the surveys in the fall was informed by the National Bicycle and Pedestrian Documentation Project's (2010) data collection instructions, which establish that surveys should ideally be conducted in mid-September. BIA representatives were also supportive of surveying in the fall: Although no mid-winter or mid-summer sampling represents a study limitation, fall provides a more representative sample of year-round economic activity than summer or winter measurements could independently. Project approval dates meant we first conducted visitor surveys in October 2015 and merchant surveys in November 2015. For comparability purposes, we collected visitor and merchant surveys 1 year later, in October and November 2016, respectively. We conducted the third round of data collection in May 2017 (both visitor and merchant surveys) to accommodate the city's timelines for reporting on the pilot. The *City of Toronto Cycling Study* (2010) finds that seasonal cycling incidence is similar in spring and fall, suggesting that transportation behaviors at these times are similar and thus comparable. The May 2017 visitors' survey on Bloor Street contained fewer respondents from the 30-years-or-younger age category than other collection cycles. This difference is likely because fewer university students take classes in May than in October.

Several survey questions required respondents to report on travel and spending behavior. Respondents likely based their answers on the previous months, so their retail and transportation experiences in late summer/early fall may be different from those in late winter/early spring. The NYC DOT recommends monitoring economic impact for 2 to 3 years following a streetscape change to account for possible anomalies (NYC DOT, 2013). This was not possible in this study because of the political constraints of the 1-year pilot.

Other Data and Limitations

Retail sales tax data were not available to the study team or to the City of Toronto. Unlike in the United States, these data are generally not accessible in Canada because of information and privacy laws, which prevented us from examining sales data as in NYC DOT's (2012, 2013) studies. The Ontario BIA (Archer & McGibbon, 2017) does not recommend collecting retail sales data by surveying merchants because of challenges with data sourcing, transparency, accuracy, and business owners' reluctance to share actual retail sales information. For these reasons, and considering the problematic outcome of Stantec's (2011) surveys inquiring about retail sales in Vancouver, the study partners collectively decided to rely on vacancy rates, self-reported customer counts, visit frequency, and customer spending to assess local economic impacts.

We were interested in other data sources that we could not access during the pilot, including public transit usage, parking usage, collision reports, and data from card payment processing providers. Except for transit usage, these data sets were eventually collected by the City of Toronto (2017) for their separate impact evaluation of the pilot. The city's parking study finds the pilot area experienced a 5.95% net loss of parkers (City of Toronto, 2017). If this rate applied to shoppers specifically, it potentially meant a reduction of 0.6% of customers in the pilot area. This assumes—as per our measurements—that 10% of shoppers arrived by car and were affected. Likewise, collisions were tracked, and their rates significantly decreased: Bicycle-motorized vehicle collisions remained constant at around 22 per year, though the volume of cyclists increased by 49% (City of Toronto, 2017). This is consistent with our survey findings on perceptions of safety, shown in the online Technical Appendix A, where the percentage of cyclists who "felt safe" riding on Bloor Street increased from 9.3% to 77.1%. Other types of collisions and near-misses also decreased (City of Toronto, 2017).

City of Toronto staff also obtained credit and debit card transaction data from Moneris, Canada's largest processor of card-based payments. Card-based spending increased 4.45% in the pilot area, compared with 3.73% in the area surrounding the pilot and 2.21% at Danforth Avenue (same control site as in our study; City of Toronto, 2017). These data are consistent with our findings of an improving business environment in the pilot area. City staff also reported an increase in consumption of 4.96% citywide, which was marginally higher than that of the pilot area and more than double the growth rate at the Danforth Avenue control site (City of Toronto, 2017).

There are important limitations, however, with using debit and credit card transaction data to estimate changes in the business environment. An increase in the value of payments made with cards does not necessarily entail an increase in the value of all payments made, and more research is needed to understand how these figures fluctuate over time. Nevertheless, transaction data remain another useful economic indicator consistent with a stable or improving local economy.

Note on the Control Merchant Sample

Because of a smaller control site and lower participation rates, we could not obtain a large enough merchant sample on Danforth Avenue to conduct reliable statistical analyses comparing merchant data. We collected only 28 merchant surveys at the control site in 2015, 22 in 2016, and 23 in 2017, with a response rate that dropped from 56% pre-intervention to less than 41% in post-intervention samples. This contrasts with our Bloor Street sample, which averaged 150 merchants and a 66% response rate in each cycle (a detailed breakdown is in Table 3). Other control site data are still useful for assessing larger trends in spending, travel patterns, and attitudes.

Economic Indicators on Bloor Street Improved or Remained Stable Following the Installation of Bike Lanes

Reported Monthly Spending per Customer Increased on Bloor Street

Descriptive statistics, sample sizes, and test results are summarized in Table 3 (merchant survey) and Table 4 (visitor survey). Table 4 presents raw proportions for the visitor survey, as well as the significance levels of a series of independent sample difference of proportions tests. An expanded version of Table 4 can be found in Technical Appendix A. In addition, Figures 2A and 2B display average customer spending per month pre-/post-intervention on Bloor Street and Danforth Avenue, respectively. We discuss visitor survey results and their implications (including derived mode share) below before considering merchant survey results, our regression modeling outcomes, and vacancy rate findings.

We find visitors to Bloor Street were more likely to spend more than $100 per month following the implementation of the bike lanes than before ($p < .001$). Spending grew even more among cyclists ($p < .1$). The proportion of visitors spending more than $100 among those arriving by car also increased substantially ($p < .05$).

On Danforth Avenue, the proportion of customers spending more than $100 per month also increased significantly; the increase was not significantly different from the increase on Bloor Street.

Proportion of Cyclists Increased on Bloor Street, Proportion of Drivers Held Steady

Another interesting insight is that the proportion of visitors arriving at Bloor Street by car did not change significantly, but the proportion of visitors arriving by bicycle more than doubled from 6.9% to 18.1% ($p < .001$). Although not a direct economic impact, mode share data are worth addressing in this context where some merchants feared the reduction of on-street parking would lead to a sharp drop in customers.

These mode share trends are observable not just among "all visitors" but also when examining visitors who specifically declared they were on a retail trip (shopping, services, or restaurant). On the day of the survey—and just for retail trips—the proportion of customers arriving by car did not change (8.8% pre-intervention, 8.9% post-intervention), whereas the proportion arriving by bicycle rose from 7.4% to 19.6% ($p < .001$).

Table 3

Merchant survey results: Relevant descriptive statistics.

	Bloor 2015: Before bike lanes	Bloor 2016: After bike lanes	Bloor 2017: After bike lanes	Test 1[a]	Test 2[b]	Test 3[c]
Sample size	163	153	136			
Response rate	69%	66%	62%			
Business type surveyed						
Retail	30.3%	27.5%	37.5%			ψ
Food service/bar	38.7%	44.4%	41.9%			
Service	30.3%	26.8%	19.1%		*	
Other	0.6%	1.3%	1.5%			
No. customers						
Serve >100 customers on a weekday	33.8%	40.0%	55.0%		***	*
Retail	27.3%	44.7%	52.1%		*	
Food service/bar	48.3%	49.2%	70.9%		*	*
Service	18.2%	20.6%	30.8%			
Serve >100 customers on a Saturday	46.3%	57.6%	61.5%	ψ	*	
Retail	37.2%	55.3%	61.7%		*	
Food service/bar	67.8%	75.9%	83.6%		ψ	
Service	23.7%	29.4%	19.2%			

Notes:
a. 2015–2016 Bloor prop test.
b. 2015–2017 Bloor prop test.
c. 2016–2017 Bloor prop test.
[ψ]Significant at .1 level. *Significant at .05 level. **Significant at .01 level. ***Significant at .001 level.

Table 4

Descriptive statistics results for visitor surveys.

	Bloor: Before bike lanes	Bloor: After bike lanes	Control (Danforth): Before	Control (Danforth): After	Test 1[a]	Test 2[b]	Test 3[c]	Test 4[d]	Test 5[e]
Sample size	842	1,577	173	412					
Expenditure >$100 per month									
All visitors	44.2%	53.3%	56.8%	69.9%	***	**	**	***	
Bike subset	44.4%	58.1%	61.5%	62.7%	ψ				
Driver subset	34.3%	51.3%	48.3%	67.9%	*	*		*	
Transit subset	34.8%	31.6%	41.5%	48.1%				**	
Walk subset	53.1%	62.8%	66.7%	81.8%	*	*	*	***	
Visits 15 or more days per month									
All visitors	47.3%	60.5%	55.0%	66.8%	***	**	ψ	*	
Bike subset	58.9%	67.4%	69.2%	67.3%					
Driver subset	25.0%	50.0%	34.5%	48.7%	***				
Transit subset	28.3%	38.2%	31.7%	38.3%	**				
Walk subset	63.3%	71.4%	70.6%	85.4%	**	**		***	
Travel mode on day of survey									
Walk	49.8%	48.0%	50.6%	48.4%					
Bike	6.9%	18.1%	7.7%	12.7%	***			*	ψ
Car	8.3%	9.9%	17.3%	19.2%			***	***	
Transit	35.0%	24.1%	24.4%	19.7%	***		**	ψ	
Travel mode: Just retail trips									
Walk	48.2%	48.2%	52.4%	50.0%					

(*Continued*)

Table 4 (*Continued*)

	Bloor: Before bike lanes	Bloor: After bike lanes	Control (Danforth): Before	Control (Danforth): After	Test 1[a]	Test 2[b]	Test 3[c]	Test 4[d]	Test 5[e]
Bike	7.4%	19.6%	9.7%	10.3%	***			***	**
Car	8.8%	8.9%	15.3%	21.3%			*	***	
Transit	35.6%	23.3%	22.6%	18.4%	***		**	ψ	
Travel mode: Just shopping trips									
Walk	54.8%	52.1%	55.6%	51.1%					
Bike	8.0%	22.0%	11.1%	11.4%	***			**	**
Car	6.2%	8.0%	14.4%	19.6%			*	***	
Transit	31.1%	17.9%	18.9%	17.9%	***		*		*
Parking									
Find it difficult to find car parking	7.8%	32.6%	14.3%	24.7%	***				ψ

Notes:
a. Difference-in-proportions test: pre-Bloor to post-Bloor.
b. Difference-in-proportions test: pre-Danforth to post-Danforth.
c. Difference-in-proportions test: pre-Bloor to pre-Danforth.
d. Difference-in-proportions test: post-Bloor to post-Danforth.
e. Difference-in-differences test: Change on Bloor vs. change on Danforth.
[ψ]Significant at .1 level. *Significant at .05 level. **Significant at .01 level. ***Significant at .001 level.

Although the proportion of cyclists increased at Danforth Avenue as well, a difference-in-differences test finds the increase at Bloor Street was significantly larger, especially for just retail trips and shopping trips ($p < .01$). It is important to note that mode share calculations reflect proportions, not volumes. A relative decrease in transit mode share does not necessarily imply a drop in transit ridership: It could indicate more people arriving through other modes, whereas transit ridership remains steady.

Mode share data also show only a limited proportion of customers were likely to be directly inconvenienced by the bike lanes: Before the intervention, 91.7% of customers surveyed on Bloor Street had not arrived by car. Although the proportion of those arriving by car remained constant, those reporting difficulties finding parking rose from 7.8% to 32.6% ($p < .001$). Likewise, those reporting these difficulties on Danforth Avenue increased from 14.3% to 24.7%. The differences in parking difficulties at Bloor Street and Danforth Avenue post-intervention were not significant.

Number of Customers Served by Merchants Increased on Bloor Street

Results for the descriptive analysis of merchant survey data and sample sizes are presented in Table 3, with each row corresponding to a different survey variable. The first three columns provide raw proportions, and the next three summarize the results of difference-in-proportions *t* tests. There are two differences in the design of these tests compared with that of the visitor

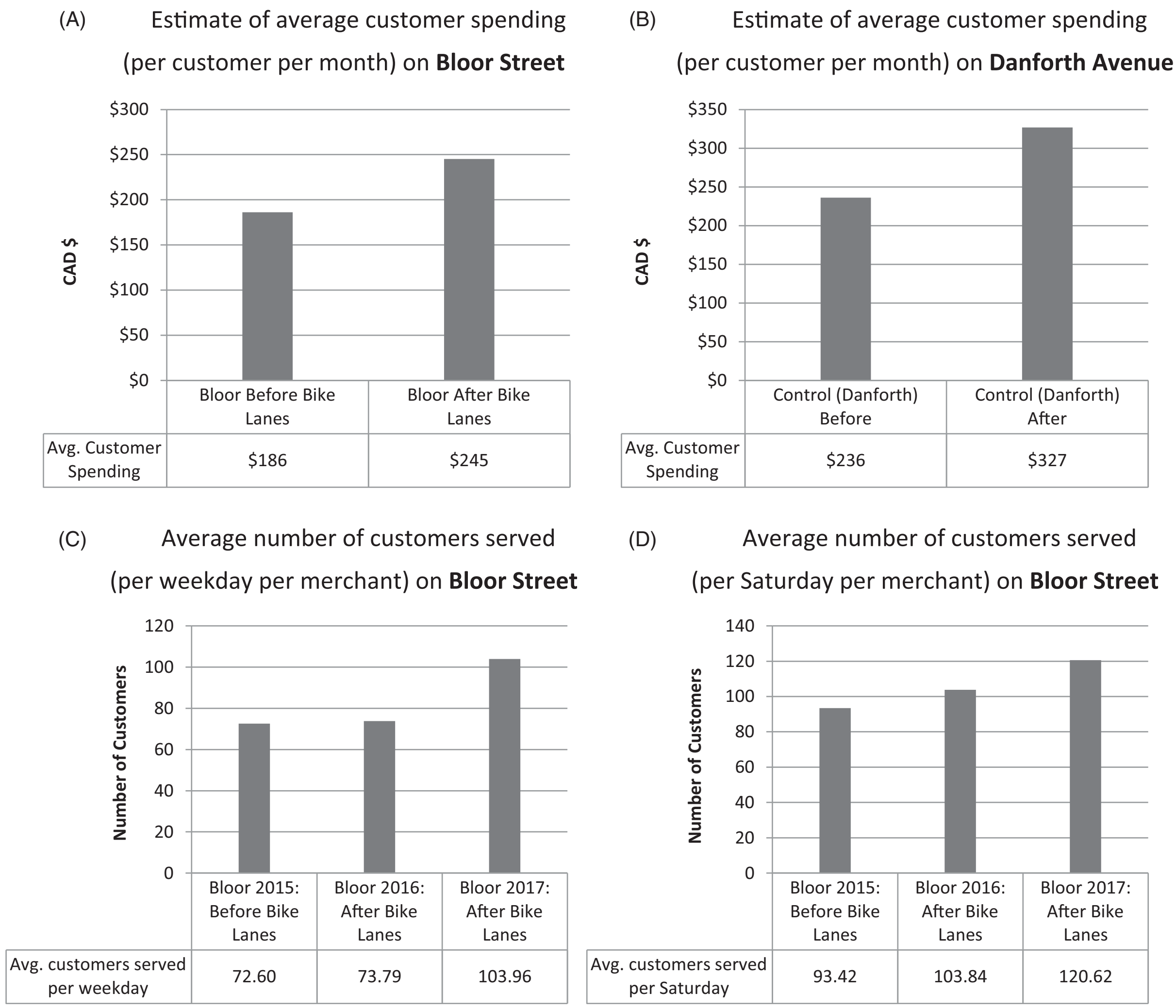

Figure 2. (A) Estimate of average customer spending per customer per month on Bloor Street. (B) Estimate of average customer spending per customer per month on Danforth Avenue, control site. (C) Average number of customers served per weekday per merchant on Bloor Street. (D) Average number of customers served per Saturday per merchant on Bloor Street.

survey. First, the two post samples cannot be merged because they contain repeated measurements from the same merchants. Second, we omit comparisons with the Danforth Avenue site because the merchant sample size is small and therefore not suitable for detailed statistical analysis. An expanded version of Table 3 is found in Technical Appendix B.

The number of merchants on Bloor Street reporting more than 100 customers per day increased substantially and significantly for food service/bar and retail establishments on both Saturdays and weekdays. No significant changes were detected for service establishments. This significant increase in the reported number of customers suggests the higher monthly spending per customer measured in the visitor surveys effectively translates to more economic activity on Bloor Street (as opposed to a shift in the proportion of customers due to a loss in some customer demographics). For reference, Figures 2C and 2D show the average number of customers served per merchant on Bloor Street for weekdays and Saturdays, respectively.

People Arriving by Bicycle and Those Who Support the Bike Lanes Report Higher Monthly Spending

We use regression modeling to quantify the independent effects of the bike lane on self-stated visitor expenditures and visiting frequency by controlling for the effects of visitor-related characteristics such as age, gender, place of residence, etc. As for the descriptive statistics performed earlier, we combine the two post–bike lane samples.

A list of the variables present in the multivariate models is provided in Technical Appendix C. The full sample includes 3,005 respondents. However, after cleaning the data for missing entries, the analysis sample was reduced by 3.1% to 2,912 respondents. Despite the loss of sample size, there are no systematic differences between the variable means in the full sample and analysis sample.

More detailed descriptions and the results of three logistic regression model specifications for the monthly expenditure variable are provided in Technical Appendix D. The most basic model (Model 1) shows that all else being equal, post-implementation visitors on Bloor Street were 50% more likely to spend more than $100 per month compared with the pre-implementation visitors (odds ratio = 1.48, $p = .055$). Increases were also apparent for Danforth Avenue, as indicated by the ratio of the two odds ratios (2.1/1.2 = 1.75).

The coefficients for control variables in the expenditure models indicate significant positive effects of living and working in the area, of visit frequency, and of being middle-aged. Gender is insignificant in all model specifications.

Model 2, which interacts cycling with the strata terms, shows cyclists had a 16% increase in odds of spending $100 per month compared with other mode users on Bloor Street. This provides evidence that the overall increase in likelihood of spending in the post–Bloor Street strata is attributable to the increase among cyclists.

The third model, which focuses on visit purpose and bike lane support, shows visitors who were on a shopping/restaurant/service trip when intercepted were also twice as likely to spend $100 or more per month, and those who provided positive feedback about the bike lane were 24% more likely to spend $100 per month.

Visit Frequency on Bloor Street Went Up by 3 Days per Month

We also explore changes in self-stated visit frequency using ordinary least squares regression (details are provided in Technical Appendix E). A moderate goodness-of-fit is indicated by the R^2 of 43%. Here, we interpret regression coefficients as the marginal effect of a one-unit increase in each variable on the number of days visited per month. The main finding is visit frequency on Bloor Street went up by 3 days per month, whereas visit frequency on Danforth Avenue saw no significant change. Furthermore, the model indicates walkers and cyclists visit at about the same level of frequency, whereas drivers and transit users visited nearly 4 days fewer per month. Unsurprising, those living or working in the study area visited 13 more days per month compared with others. Interestingly, there were no significant differences between genders or age groups.

Vacancy Rates Held Steady

Vacancy rates held steady in the study area and control site between July 2016 and July 2017. In our Bloor Street study area, there was one less commercial vacancy in 2017, a −0.4% change. In the entire bike lane pilot project area, from Avenue Road to Shaw Street, one more vacancy was reported, representing a 0.3% increase. At the control site there were two fewer vacancies in 2017, a −1.7% change. Details are shown in Table 5.

Bloor Street Bike Lanes: Positive or Neutral Impact

Our results indicate the business environment on Bloor Street improved during the time of the study: Reported visitor spending rose, visit frequency increased, estimated customer counts show growth in the number of customers, and vacancy rates held steady.

It is worth noting that more than 70% of visitors walked or took transit to Bloor Street both before and after the intervention. These visitors' journeys were mostly unaffected by the street's reconfiguration, and any changes in visiting and spending habits among most visitors were likely in response to factors unrelated to the bike lane.

Results from the Danforth Avenue (control) site are helpful to assess whether changes in these local economic indicators suggest a positive or neutral impact. Danforth Avenue performed equivalently in terms of visitor spending, and vacancy rates decreased slightly. There were no changes in visit frequency in the control site compared with a 3-day increase in the pilot area.

Other data we collected from the visitor survey are consistent with positive changes in the pilot area. The proportion of shoppers driving to the neighborhood remained unchanged at 9%, and that of shoppers arriving on bicycles rose considerably from 8% to 22%. Furthermore, although people arriving by car were more likely to experience difficulties finding parking on Bloor Street than before, the proportion of respondents reporting this problem was not significantly different from that at the control site.

Table 5

Changes in vacancies and vacancy rates.

Location	No. ground-level commercial spaces	2016: Vacancies before Bloor bike lanes (vacancy rate)	2017: Vacancies after Bloor bike lanes (vacancy rate)	Change in vacancies (change in vacancy rate)
Bloor Corridor, entire length of bike lane, Avenue Rd. to Shaw St.	345	24 (7.0%)	25 (7.2%)	+1 (+0.3%)
Bloor Corridor, only in Korea Town and Bloor Annex BIAs	247	16 (6.5%)	15 (6.1%)	−1 (−0.4%)
Control (Danforth), Broadview Ave. to Chester Ave.)	116	6 (5.2%)	4 (3.4%)	−2 (−1.7%)

We also find monthly customer spending was related to proximity rather than parking. Being close makes it easier to visit, and those who live or work in the area were found to visit 13 days more per month than those who live or work further away. Locally based visitors were 2.6 times more likely to spend at least $100 per month. For each additional day visited, the likelihood of spending $100 or more increased by 7.3%.

Most people making these short, frequent trips chose to walk and, increasingly, to cycle. People who drove or took transit visited nearly 4 fewer days per month. More visiting affords more opportunities to spend, and on Bloor Street, people who walk or bike were the most likely to spend $100 or more per month, both before and after the bike lane's installation. After installation, cyclists had a 16% increased likelihood of spending at least $100 over people who walked. These findings align with the results of a 2009 study in the Bloor Annex neighborhood, which also finds people on bikes and on foot visited the most often and spent the most money per month (Sztabinski, 2009).

Of nearly 2,000 visitors surveyed in the post-test, more than 90% of those on Bloor Street and more than 80% on Danforth Avenue arrived without a car. Despite the potential need to carry items purchased, shoppers were not more likely than other visitors to use a car.

Lessons for Research

We find visitor and merchant surveys useful tools for assessing the economic impacts of projects affecting merchants along commercial strips. Surveying merchants and customers before and after interventions leads to more meaningful results than can be obtained with a single survey after implementation, as in Stantec (2011). A large sample of visitor surveys is important to track monthly customer spending and allows for robust calculations of mode share, whereas data on customer counts (derived from merchant surveys) are useful to appropriately contextualize these results. Partnering with local businesses contributes to higher merchant participation rates.

Although debit and credit card transaction data are not advisable as a standalone indicator of economic impacts without an understanding of how these values fluctuate over time, this type of data can be used prospectively to complement survey-based studies. It may prove especially useful where retail sales data are unavailable. Parking data may likewise be used to complement and inform mode share estimates derived from visitor surveys.

We encourage researchers to include controls (comparison sites) in their studies and to allocate additional resources to collect representative samples if necessary. The complete absence of controls in the economic impact study conducted by the City of Calgary (2016a), for example, makes its findings difficult to interpret: Did bike lanes contribute to reducing economic activity, or do the data reflect a regional economic downturn? Control sites may consist of similar neighborhoods and/or citywide measurements. NYC DOT

(2013) offers the most comprehensive execution, with multiple controls for each site. Poirier (2018) uses neighboring but not abutting businesses as control with interesting results, and McCormick (2012) successfully uses adjacent sections of the same street, but these solutions may not offer enough buffer from the intervention depending on the context.

Lessons for Planning Practitioners

Overall, our study results are consistent with the literature. We find no evidence of the negative economic impacts following the installation of the bike lanes that many merchants fear (McCormick, 2012; NYC DOT, 2012, 2013; Rowe, 2013). This appears to confirm the suitability of bike lane installations in vibrant downtown retail streets and should encourage the design and implementation of similar bike lane interventions in other merchant-lined urban streets with similar visitor profiles.

Because many cyclists already frequented Bloor Street, we would not extrapolate our findings to neighborhoods where customer behavior is markedly different in this regard. Streets like Queen Street West in Toronto, where Chan et al. (2016) find that only 4% of visitors arrived by car (and 19% cycled), are ideal candidates in terms of their business environments' likely resilience when adding bike lanes at the cost of parking. Our results suggest food service establishments, bars, and retail in these locations may not only withstand but possibly benefit from such interventions. This is consistent with previous findings by Poirier (2018) and Clifton et al. (2012, 2013).

Based on our experience, we advise planners to consider incorporating local economic impact indicators in projects where merchants participate as major stakeholders. Doing so results in a more transparent and evidence-based decision-making process. Nevertheless, the results of our study and others cited above suggest that in settings where cyclists, pedestrians, and transit users predominate, cycling infrastructure is unlikely to constrain local economic activity. Moreover, prospective parking loss should be expressed as a potential impact on only that share of visitors arriving by car and as a proportion of total available spots in the neighborhood. Merchant concerns regarding loss of car parking may reflect overestimations in car mode share among their customers.

Our study provides evidence that downtown corridors lined with retail, like Bloor Street, are strong candidates to benefit from the inclusion of bike lanes at the cost of some on-street parking. Toronto's Bloor Street bike lanes were made permanent on November 7, 2017, with City of Toronto councilors voting overwhelmingly in favor of the project (36–6). City staff and the media described the pilot project as Toronto's most intensely studied transportation project (Rieti, 2017).

ABOUT THE AUTHORS

DANIEL ARANCIBIA *(daniel.arancibia@utoronto.ca) completed an MSc in planning at the University of Toronto and is an independent scholar.* ***STEVEN FARBER*** *(steven.farber@utoronto.ca) is an assistant professor in the Department of Human Geography at the University of Toronto Scarborough.* ***BETHSAVAN*** *(b.savan@utoronto.ca) is senior lecturer emeritus in the Department of Geography and Planning and School of the Environment at the University of Toronto.* ***YVONNE VERLINDEN*** *(yverlinden@cleanairpartnership.org) is a project manager at The Center for Active Transportation at Clean Air Partnership.* ***NANCY SMITH LEA*** *(nsmithlea@cleanairpartnership.org) is the director of The Center for Active Transportation at Clean Air Partnership.* ***JEFF ALLEN*** *(jeff.allen@utoronto.ca) is a PhD student in the Department of Geography and Planning at the University of Toronto.* ***LEE VERNICH*** *(lee.vernich@utoronto.ca) is the director of the Office of Research at the Dalla Lana School of Public Health at the University of Toronto.*

ORCID

Daniel Arancibia *http://orcid.org/0000-0002-7759-6864*
Steven Farber *http://orcid.org/0000-0002-3870-5984*
Jeff Allen *http://orcid.org/0000-0001-9575-7169*

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SUPPLEMENTAL MATERIAL

Supplemental data for this article can be found on the publisher's website.

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