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Economic impacts on local businesses of investments in bicycle and pedestrian infrastructure: a review of the evidence

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ABSTRACT

Local officials in North America frequently face opposition to new or expanded bicycle or pedestrian facilities. The most vocal opponents are usually motorists and local business owners who fear that the removal of or reductions in vehicular parking or travel lanes will reduce patronage from motorists and that any increased patronage from pedestrians or cyclists will not offset the lost revenues. A lack of direct evidence on the economic impacts of facilities on local businesses has made it difficult to support or debunk such fears. A lack of quantitative evidence in particular has prevented the incorporation of such impacts into cost–benefit analyses. The issue has received enough attention from researchers in recent years that a review of the evidence is now warranted. We reviewed the relevant literature and identified 23 studies, focusing on the US and Canada, that either (1) quantified and compared consumer spending between active travellers and automobile users ($n = 8$), or (2) quantified an economic impact to local businesses following the installation of bicycle or pedestrian facilities ($n = 15$). Taken together, the studies indicate that creating or improving active travel facilities generally has positive or non-significant economic impacts on retail and food service businesses abutting or within a short distance of the facilities, though bicycle facilities might have negative economic effects on auto-centric businesses. The results are similar regardless of whether vehicular parking or travel lanes are removed or reduced to make room for the active travel facilities. The studies also highlight best practices for designing future research. Ten of the 15 studies that quantified an economic impact to local businesses used both before-and-after data and comparison sites or other statistical controls for variables unrelated to the active travel facility "treatment;" six of those used statistical testing.

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Bicycle facilities; pedestrian facilities; active travel; local business; economic impacts

Introduction

"[Safe bike lanes are a] no regret investment," European Commission Vice President Frans Timmerman, October, 2020. (Sutton, 2020)
"People were just crazy angry about it," Newton City Councilor Alicia Bowman, referring to opposition to the installation of a bike lane that involved the removal of parking, October, 2020. (MilNeil, 2020)

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This article has been republished with minor changes. These changes do not impact the academic content of the article.

Cities across North America have often faced opposition when proposing new or expanded bicycle and pedestrian facilities. An ambitious plan to install bike lanes throughout New York City starting in 2007, for example, provoked a heated backlash that played out in community meetings, the local media, and public protests (Sadik-Khan, 2016). Although the city succeeded in installing an extensive network of 1,375 miles of bike lanes, opposition continues to bubble up when new facilities are proposed (Hu, 2021). Many other cities confronted similar if more muted controversy following the reallocation of street space to bicycles and pedestrians in response to the COVID-19 pandemic. As cities move to make the initial changes permanent, seeing them as a "no regret" approach, they often face opposition and even anger from at least some parts of the community.

The most vocal opponents in such cases are usually people who drive and local business owners. Because active travel infrastructure often requires the removal of or reduction to vehicular parking or travel lanes, opponents worry that the active travel infrastructure will make it harder to drive or park in the project area (Bubbers, 2019; Chapple, McCoy, & Poirier, 2018). Business owners worry that this will reduce patronage from customers arriving by car, and that any increased patronage from customers arriving by foot or bicycle will not offset the lost revenues (Bopp, Sims, & Piatkowski, 2018; Drennen, 2003; Liu & Shi, 2020b; McCoy, Poirier, & Chapple, 2019). This opposition can impede and even prevent approval and implementation of active travel projects. A lack of direct evidence on the economic impacts of facilities on local businesses has made it difficult to support or debunk the claims of negative economic impacts on local businesses (Hack, 2013; New York City Department of Transportation, 2013; Stantec, 2011); the lack of quantitative evidence in particular has prevented the incorporation of such impacts into cost–benefit analyses.

Although bicycle and pedestrian investments generate many direct and indirect economic impacts (Flusche, 2012; Krizek, 2007; Weigand, 2008) the direct impacts of active travel facilities on businesses abutting or in close proximity to them are often at the heart of local controversies. The issue of economic impacts on local businesses has received enough attention from researchers in recent years that a stand-alone review of the evidence is now warranted and could be especially helpful in informing local debates. In this paper we examine the literature on the economic impacts to local businesses of new or improved bicycle and pedestrian facilities. Taken together, the 23 studies we reviewed indicate that creating or improving active travel facilities generally has positive or non-significant economic impacts on retail and food service businesses abutting or within a short distance of the facilities, though bicycle facilities might have negative economic effects on auto-centric businesses (like gas stations, auto repair shops, auto parts stores, and large home-goods stores). The results are similar regardless of whether vehicular parking or travel lanes are removed or reduced to make room for the active travel facilities. Overall, the available evidence suggests that fears of disastrous consequences for local businesses are unfounded.

Method

We reviewed the literature on the economic impacts on local businesses of creating or improving bicycle and pedestrian facilities. Guided by the types of concerns voiced by business owners and discussed above, we focused our review on studies that (1) quantified and compared consumer spending between active travellers (bicyclists or pedestrians) and automobile users, or (2) quantified an economic impact to local businesses following the installation of bicycle or pedestrian facilities. We define bicycle and pedestrian facilities as infrastructure or streetscape amenities designed to support active travel. Bicycle facilities include bicycle paths (class I facilities, though they are typically not located adjacent to local businesses), bicycle lanes (class II facilities), bicycle boulevards (class III facilities, usually demarcated with sharrows), cycle tracks (class IV facilities), and bicycle parking, for example.[1] We did not include bikeshare facilities in this review. Pedestrian facilities include sidewalks, pedestrian plazas, pedestrian seating, pedestrian crossings (or improvements thereto), and landscaping of the pedestrian space, among other amenities. We define local businesses as businesses abutting or in close proximity to the active travel facilities. We define economic impacts as the direct impacts to local businesses from creating or improving active travel facilities, indicated by such measures as local business sales (or sales tax revenues), number of customers, average visitor spending, employment, commercial vacancy rates, new business openings, and business owner perceptions. Active travel investments also have other economic impacts, ranging from the job creation and materials purchases associated with construction of active travel facilities to the indirect economic effects of improved health and safety related to active travel (Flusche, 2012; Krizek, 2007; Weigand, 2008). But we focus here on the economic impacts most visible and directly relevant to local businesses.

To identify sources, we searched the Transportation Research International Documentation (TRID) database, Web of Science, and Google Scholar in the summer of 2020 using the following search terms:

> ("bicycle facilities" OR "bicycle infrastructure") AND ("economic" OR "business" OR "property value" OR "sales"), and ("pedestrian facilities" OR "pedestrian infrastructure") AND ("economic" OR "business" OR "property value" OR "sales")

We also reviewed the reference lists from the selected sources to identify additional studies that did not appear in our web searches. Because so few peer-reviewed studies examine our topic of interest – the economic impacts on local businesses of creating or improving bicycle and pedestrian facilities – we included both peer-reviewed studies and non-peer-reviewed "gray" literature. That is why we searched Google Scholar – to locate more gray literature. In total, our searches yielded 23,320 results, 97% (22,600) of which came from our Google Scholar searches. We screened each of the 720 documents retrieved from the TRID and Web of Science searches by scanning the title, abstract, and/or other available summary. For the two Google Scholar searches, we screened about 1,000 total records, using the same scanning approach. We stopped screening once we reached 100 consecutive irrelevant records. We found 91 documents that appeared to be relevant out of the nearly 1,750 documents we screened. We reviewed the full text of those documents.

We excluded studies (either on screening or after full document review) that did not either (1) quantify and compare consumer spending between active travellers and automobile users, or (2) quantify direct impacts to local businesses from creating or improving active travel facilities, using the definitions of bicycle facility, pedestrian facility, local business, and economic impact provided above. We did not exclude studies based on research design. But we did restrict our review to original research studies; we excluded second-hard reports of study results, even if we could not find the original research document cited in the report. We also restricted our review to studies reported in the English language, studies published between 2000 and 2020, and studies in the United States and Canada. We focused on studies in the US and Canada in large part because opposition to new active travel facilities has often been fierce in those two countries (Bubbers, 2019; Chapple et al., 2018; Sadik-Khan, 2016), making this research particularly relevant and useful for planners and policymakers there. In addition, a preliminary review of our search records indicated that the vast majority of relevant English-language studies were done in the US and Canada, which is unsurprising given the relative surge in active travel projects (and accompanying opposition) there compared to European countries with more established active travel facilities (Kornas, Bornbaum, Bushey, & Rosella, 2017; Pucher, Buehler, & Seinen, 2011).

In total, we found 23 studies meeting our inclusion criteria, including 5 peer-reviewed articles, 4 research reports produced by universities, 5 reports produced by a governmental agency, 5 reports produced by a non-profit organisation or consulting firm, and 4 student theses. We examine the studies' findings and methodologies in the next section, then summarise our results and discuss the implications for practice and future research in the final section.

Results

Table 1 lists the 23 studies, their locations, their research topics, and the number and types of facilities studied (only for the studies that quantify the economic impacts to local businesses following the installation of specific active travel facilities).

Of the 23 studies we reviewed, eight analyzed the differences in visitor spending in a commercial area by the travel mode the visitors used to get there. Three of the studies looked at Toronto, Ontario. Two studied San Francisco, California. And one each was based in Portland (Oregon), Victoria (British Columbia), and Davis (California). Taken together, the eight studies indicate that cyclists and pedestrians generally spend more per month in commercial areas than visitors who arrive by car or transit, but do not reliably spend different amounts per trip.

The remaining 15 studies analyzed the economic impacts of specific active travel facilities (or networks of facilities) on local businesses. Those studies analyzed a total of 45 unique facilities in 16 cities in the US and Canada – New York City (10 facilities), San Francisco (7), Minneapolis, Minnesota (5), Seattle, Washington (4), Denver, Colorado (3), Portland (2), Vancouver, British Columbia (2), Chicago, Illinois (2), Indianapolis, Indiana (2), Memphis, Tennessee (2), Toronto (1), Calgary, Alberta (1), Oakland, California (1), Los Angeles, California (1), and Washington, DC (1). The facilities included 35 bicycle facilities, six pedestrian facilities, and four mixed facilities with both pedestrian and bicycle infrastructure. Of the bicycle facilities, 17 were individual class IV cycle track projects, 14 were individual class II bicycle lane projects, two were class III bicycle boulevard projects, one was a group of four cycle track projects in downtown Calgary, and one was the full network of bicycle lanes and boulevards added between 1996 and 2013 in San Francisco. The pedestrian facilities included plazas, street seating, street lighting, trees and

Table 1. Summary of studies on consumer spending by travel mode.

Source	Study location	Research topic	Number of facilities	Facility types
Arancibia et al. (2019)	Toronto, Ontario, Canada	Economic impact to local businesses after installation of active travel facilities	1	Bicycle facility
Bent and Singa (2009)	San Francisco, California, USA	Consumer spending by travel mode	-	-
Chan et al. (2016)	Toronto, Ontario, Canada	Consumer spending by travel mode	-	-
City of Calgary (2016)	Calgary, Alberta, Canada	Economic impact to local businesses after installation of active travel facilities	Group of 4 facilities	Bicycle facilities
City of Oakland (2017)	Oakland, California, USA	Economic impact to local businesses after installation of active travel facilities	1	Bicycle facility
Clifton et al. (2013)	Portland, Oregon, USA	Consumer spending by travel mode	-	-
Drennen (2003)	San Francisco, California, USA	Economic impact to local businesses after installation of active travel facilities	1	Bicycle facility
Forkes and Smith (2010)	Toronto, Ontario, Canada	Consumer spending by travel mode	-	-
Liu and Shi (2020b)	Memphis, Tennessee, USA Minneapolis, Minnesota, USA Portland, Oregon, USA San Francisco, California, USA	Economic impact to local businesses after installation of active travel facilities	7	Bicycle facilities and pedestrian facilities
Liu and Shi (2020a)	Indianapolis, Indiana, USA Minneapolis, Minnesota, USA Seattle, Washington, USA	Economic impact to local businesses after installation of active travel facilities	7	Bicycle facilities and pedestrian facilities
McCormick (2012)	Los Angeles, California, USA	Economic impact to local businesses after installation of active travel facilities	1	Bicycle facility
McCoy et al. (2019)	San Francisco, California, USA	Economic impact to local businesses after installation of active travel facilities	Entire network	Bicycle facilities
Monsere et al. (2014)	Austin, Texas, USA Chicago, Illinois, USA Portland, Oregon, USA San Francisco, California, USA Washington, DC, USA	Economic impact to local businesses after installation of active travel facilities	6	Bicycle facilities
New York City (2012)	New York City, New York, USA	Economic impact to local businesses after installation of active travel facilities	4	Bicycle facilities, pedestrian facilities, and mixed facilities
New York City (2013)			6	

(*Continued*)

Table 1. Continued.

Source	Study location	Research topic	Number of facilities	Facility types
	New York City, New York, USA	Economic impact to local businesses after installation of active travel facilities		Bicycle facilities, pedestrian facilities, and mixed facilities
Poirier (2018)	San Francisco, California, USA	Economic impact to local businesses after installation of active travel facilities	3	Bicycle facilities
Popovich and Handy (2014)	Davis, California, USA	Consumer spending by travel mode	-	-
Rijo (2015)	Denver, Colorado, USA	Economic impact to local businesses after installation of active travel facilities	3	Bicycle facilities
Rowe (2013)	Seattle, Washington, USA	Economic impact to local businesses after installation of active travel facilities	2	Bicycle facilities
San Francisco City Transportation Authority (2010)	San Francisco, California, USA	Consumer spending by travel mode	-	-
Stantec (2011)	Vancouver, British Columbia, Canada	Economic impact to local businesses after installation of active travel facilities	2	Bicycle facilities
Straatsma and Berkhout (2014)	Victoria, British Columbia, Canada	Consumer spending by travel mode	-	-
Sztabinski (2009)	Toronto, Ontario, Canada	Consumer spending by travel mode	-	-

landscaping, medians, and various other streetscape additions or alterations, often in combination. The mixed facilities were all located in New York City and paired either cycle tracks or bike lanes with streetscape improvements for pedestrians. Most of the 15 studies assessed the economic impact of the facilities with before and after data on local business sales, but some used number of customers, self-reported customer spending, commercial vacancy rates, commercial property values, employment, or business owner perceptions. Most (11) of the studies also compared data from comparison sites. Only six of the studies used statistical testing to improve their inferences. Taken together, the 15 studies indicate that creating or improving active travel facilities generally has positive or non-significant economic impacts on retail and food service businesses abutting or within a short distance of the facilities.

The rest of the results section is split by topic. We first discuss the eight studies on visitor spending by travel mode. We then discuss the 15 studies on the economic impacts of specific active travel facilities, with subsections for bicycle facilities, pedestrian facilities, and mixed facilities.

Spending by travel mode

One indication of the direction of the economic impact to local businesses of adding active travel facilities in the same area is the difference in spending habits of visitors based on the travel mode they use to get there. It is generally well established in the active travel literature that adding bicycle and pedestrian facilities to an area tends to increase cyclist and pedestrian use of that area (Volker, Handy, Kendall, & Barbour, 2019a, 2019b). That increased use should translate into increased spending at local businesses in the area if consumer spending remains the same among visitors who arrive by other travel modes (like driving and transit). However, business owners often worry that adding active travel facilities will dissuade motorists from visiting the area, leading to a net decline in spending (Bopp et al., 2018; Drennen, 2003; Liu & Shi, 2020b; McCoy et al., 2019). The net effect on spending depends on two factors: changes in the number of trips by each mode after installation of an active travel facility, and the average spending of each group of consumers (by travel mode).

At least eight studies have compared visitor spending by travel mode. Table 2 summarises the location, methods, and findings of the eight studies.

Four of the studies were in the US, and four were in Canada. Six of the studies – two in San Francisco, three in Toronto, and one in Victoria – were done via intercept surveys of adult passersby in downtowns or retail corridors of urban areas. One study utilised cross-sectional surveys of residents of an entire city, with questions targeted at consumer spending in the downtown area of Davis, California (Popovich & Handy, 2014). Another study used exit surveys of patrons leaving restaurants, bars, and convenience stores across a range of neighbourhood types in Portland, Oregon (Clifton et al., 2013).

All eight studies calculated and compared *per-month* spending by travel mode, which reflects the combination of number of trips and spending per trip. Six of the studies concluded that cyclists and/or pedestrians spent more per month than motorists, though only two of them confirmed that the amounts were statistically different (Forkes & Smith, 2010; Popovich & Handy, 2014). The Portland study found that cyclists and pedestrians spent more, on average, at restaurants, bars, and convenience stores than those who drove, but motorists spent more at supermarkets (Clifton et al., 2013). The eighth study – one of the three Toronto studies – found no statistically significant difference between how likely motorists and non-motorists were to spend over $100 per month (Straatsma & Berkhout, 2014).

Four of the eight studies also analyzed *per-trip* spending by travel mode. The results were more mixed. Both San Francisco studies found that those who arrived on foot and those who arrived by bike, taxi, or other (a lumped category) spent less per trip than motorists on average (Bent & Singa, 2009; San Francisco City Transportation Authority, 2010), though neither tested the results statistically. A study from a smaller California city (Davis) found that cyclists spent more on average on downtown retail purchases than motorists (food service, bar, and other service business purchases were excluded), a difference which was marginally significant statistically ($p = 0.128$) (Popovich & Handy, 2014). The Portland study found that pedestrians spent more on average at bars than motorists, but less at restaurants and convenience stores, and much less at supermarkets. It found that cyclists spent more on average at convenience stores than motorists, but less at restaurants and bars, and much less at supermarkets. The study also found that both cyclists and pedestrians spent much less at supermarkets than motorists, though the supermarkets were located in less urban areas (only 3 of 11 in central business districts or urban core neighbourhoods) than the restaurants (22 of 39), bars (9 of 13), and convenience stores (9 of 26) (Clifton et al., 2013). The latter findings is not surprising, given that grocery shoppers are limited in their purchases by the hauling capacity of their chosen

Table 2. Summary of studies on consumer spending by travel mode.

Source	City	Area & context	Method	Mode	Spending/ trip	Spending/ month
Bent and Singa (2009)	San Francisco, California, USA	Downtown	Intercept surveys ($n =$ 1,187)	Walk Bike/taxi/other Transit Auto	$47 $62 $40 $88	$291 $152 $274 $259
Chan et al. (2016)	Toronto, Ontario, Canada	Queen Street (a commercial corridor near downtown)	Intercept surveys ($n =$ 698)	Walk	-	58% spend > $100
				Bike	-	57% spend > $100
				Transit	-	39% spend > $100
				Auto	-	37% spend > $100
Clifton et al. (2013)	Portland, Oregon, USA	13 bars, across a range of contexts (CBDs, urban cores, and regional centres) in the Portland metropolitan region	Intercept surveys as patrons left businesses ($n = 99$)	Walk Bike Transit Auto	$22.30 $16.90 $19.00 $19.98	$63.94 $81.90 $36.25 $40.78
Clifton et al. (2013)	Portland, Oregon, USA	26 convenience stores across a range of contexts (CBDs, urban cores, regional centres, suburban town centres, and suburban areas) in the Portland metropolitan region	Intercept surveys as patrons left businesses ($n = 260$)	Walk Bike Transit Auto	$6.02 $7.95 $7.46 $7.61	$64.81 $81.76 $60.37 $68.95
Clifton et al. (2013)	Portland, Oregon, USA	39 restaurants across a range of contexts (CBDs, urban cores, regional centres, suburban town centres, and suburban areas) in the Portland metropolitan region	Intercept surveys as patrons left businesses ($n = 281$)	Walk Bike Transit Autos	$17.56 $10.97 $15.64 $19.52	$32.01 $48.40 $49.39 $40.06
Clifton et al. (2013)	Portland, Oregon, USA	11 supermarkets restaurants across a range of contexts (urban cores, regional centres, suburban town centres, and suburban areas) in the Portland metropolitan region	Intercept surveys as patrons checked out or left businesses ($n = 17{,}919$)	Walk Bike Transit Autos	$31.42 $36.61 $35.86 $57.39	$386.18 $337.83 $300.58 $440.19
Forkes and Smith (2010)	Toronto, Ontario, Canada	Bloor Street (a retail corridor)	Intercept surveys ($n =$ 510)	Non-auto	-	Significantly more likely to spend >$100 ($p<0.000$)
				Auto	-	Significantly less likely to spend >$100 ($p<0.000$)

(*Continued*)

Table 2. Continued.

Source	City	Area & context	Method	Mode	Spending/ trip	Spending/ month
Popovich and Handy (2014)	Davis, California, USA	Downtown Davis (material goods retailers only)	Random cross-sectional surveys of city residents	Bike Auto	$59.16 $53.83	$248.62 $182.10
San Francisco City Transportation Authority (2010)	San Francisco,z California, USA	Columbus Avenue (a residential and retail corridor)	Intercept surveys (n∼800)	Walk Bike/taxi/other Transit Auto	$36 $41 $36 $52	$360 $328 $252 $208
Straatsma and Berkhout (2014)	Victoria, British Columbia, Canada	Downtown	Intercept surveys (*n* = 504)	Walk Bike Transit Auto	-	No significant difference in reported monthly spending between modes
Sztabinski (2009)	Toronto, Ontario, Canada	Bloor Street (a retail corridor)	Intercept survey	Walk	-	76% reported spending ≥$100
				Bike	-	50% reported spending ≥$100
				Transit	-	34% reported spending ≥$100
				Auto	-	39% reported spending ≥$100

transportation mode (Clifton et al., 2013). One could expect a similar result at any business where large-volume purchases are common, like big-box retail stores.

Taken together, the four studies reporting on spending per trip indicate that active travellers do not reliably spend more or less per trip in urban downtowns or retail corridors than motorists. That would mean that adding a bicycle or pedestrian facility to an urban downtown or retail corridor would not reduce consumer spending at local businesses – especially restaurants, bars, and smaller retail stores – unless it reduced more motorist trips to those businesses than the number of additional cyclist and pedestrian trips it generated.

Economic impacts of bicycle and pedestrian facilities

The second group of studies reviewed provides more direct measures of the direction and magnitude of the economic impact on local businesses. At least 15 studies have analyzed the economic impacts of specific active travel facilities (or networks of facilities) on local businesses abutting or within a short distance of the facilities. The studies used a wide range of methods to assess the economic impact of 45 unique active travel facilities (35 bicycle facilities or facility networks, six pedestrian facilities, and four projects with both bicycle and pedestrian facilities) in business districts, commercial corridors, or other urban areas across 16 cities in the US and Canada. Tables 3–5 summarise the studies of bicycle facilities, pedestrian facilities, and mixed facilities, respectively. The tables include the location and a description of facilities added and removed, the metrics used to gauge the economic impacts on local businesses, the analytic method used, the use of control sites, the study timeframe, and the directional results by metric (positive economic impact, negative impact, or an unclear or non-significant effect).

The studies use a wide range of metrics to gauge the economic effects on local businesses, including retail and/or food service sales (used for 31 of the facilities), employment (14 facilities), visitor spending (nine facilities), number of customers (eight facilities), commercial vacancy rates or number of new businesses (five facilities), commercial property values (one facility), and merchant perceptions (one facility). Some studies use more than one metric for each facility (Arancibia et al., 2019; City of Calgary, 2016; City of Oakland Department of Transportation, 2017; Liu & Shi, 2020a, 2020b; McCormick, 2012; Poirier, 2018). Regardless of metric, 12 of the 15 studies (analyzing 37 facilities) compared economic data from before and after the active travel facility was completed. The other three studies surveyed either businesses (Drennen, 2003; Stantec, 2011) or local residents (Monsere et al., 2014) after the facilities were completed to gauge how much the facility had affected business sales or patronage.

Knowing how much an economic indicator changes after an active travel facility intervention is essential to understanding the facility's economic impact on local businesses. But it is not sufficient: "Because urban economies are a complex system, changes in sales for individual businesses can be the result of many different factors; street design is just one" (New York City Department of Transportation, 2013, p. 11). To get a truer picture of the economic impact of active travel facilities on local businesses, it is important to control for variables unrelated to the active travel facility "treatment", either with statistical modelling and/or by using a comparison site that had similar baseline characteristics but was not treated with an active travel facility (or accompanying removal of or reduction in vehicular travel facilities).

Eleven of the 15 studies (analyzing 37 facilities) compared the economic effects on businesses abutting or within a short distance of the active travel facilities to those in one or more "control" sites (Arancibia et al., 2019; Liu & Shi, 2020a, 2020b; McCormick, 2012; McCoy et al., 2019; New York City Department of Transportation, 2012, 2013; Poirier, 2018; Rijo, 2015; Rowe, 2013; Stantec, 2011). Ten of those studies used data from both before and after the facility installation; only Stantec (2011) did not. And six of the studies (analyzing 20 facilities) used statistical testing techniques to better discern whether the active travel treatments were indeed correlated with – if not the cause of – changes in economic indicators (Arancibia et al., 2019; Liu & Shi, 2020a, 2020b; McCormick, 2012; McCoy et al., 2019). Those six studies provide a more internally valid indication of the direction of the economic impact of active travel facilities on local businesses than the studies that only present descriptive statistics of the economic impact metrics. The six studies all show either a statistically significant positive correlation (eleven bicycle facilities and two pedestrian facilities) or no statistically significant effect one way or the other (seven bicycle facilities), as shown in Tables 3 and 4 and discussed by facility type below. None of the studies shows a negative correlation.

The nine studies that did not use statistical testing also found positive economic outcomes for a majority of the studied active travel facilities. They found positive effects for 10 bicycle facilities (City of Oakland Department of Transportation, 2017; Drennen, 2003; Monsere et al., 2014; New York City Department of Transportation, 2012, 2013; Poirier,

Table 3. Summary of studies on the economic impacts of bicycle facilities on local businesses.

Source	City and street	Added	Removed	Length	Analytic method	Study timeframe	Measure	Effect
Arancibia et al. (2019)	Toronto, Ontario, Canada – Bloor Street[a]	Bike lanes on both sides of the street	136 on-street vehicular parking spaces	~1.5 miles	Descriptive statistics, difference-in-proportions testing, difference-in-difference analysis, and logistic regression; control = yes	8 months pre-installation to 9 months post-installation	Monthly spending by visitors	Positive, but no sig. diff. from control
							Commercial vacancy rate	No or unclear effect
							Number of customers – retail stores	Positive
							Number of customers – food service/bars	Positive
							Number of customers – service businesses	Positive
							Overall conclusion	No negative economic impact
City of Calgary (2016)	Calgary, Alberta, Canada – 8th Avenue, 9th Avenue, 12th Avenue, 5th Street[b]	Two-way cycle tracks on all four streets	Unclear	~4.0 miles across all four facilities	Descriptive statistics; control = no	9 months pre-installation to 15 months post-installation	Weekly spending by visitors (visitor intercept survey)	Negative
							Weekly visits to businesses (visitor intercept survey)	No or unclear effect
							Customers per day (merchant survey)	Negative
City of Oakland (2017)	Oakland, California, USA – Telegraph Avenue[b]	Parking-protected cycle tracks on both sides of the street	One vehicular travel lane in each direction	~0.5 miles	Descriptive statistics; control = no	7 months pre-installation to 5 months post-installation	Retail sales tax revenues	Positive
							New businesses	Positive
Drennen (2003)	San Francisco, California, USA – Valencia Street[a]	Bike lanes on both sides of the street	One vehicular travel lane	~2.0 miles	Descriptive statistics; control = no	4.5 years post-installation	Merchant perceptions of "impact on business and sales"	Positive
Liu and Shi (2020b)	Memphis, Tennessee, USA – Madison Avenue[b]	Bike lanes on both sides of the street	One vehicular travel lane in each direction	~1.25 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time	Multiple years pre- and post-installation	Retail sales	Positive
							Retail employment	Negative
							Food service sales	No or unclear effect

(*Continued*)

Table 3. Continued.

Source	City and street	Added	Removed	Length	Analytic method	Study timeframe	Measure	Effect
					series; control = yes			
Liu and Shi (2020b)	Memphis, Tennessee, USA – Broad Avenue[b]	Two-way parking-protected bike lane	Width of travel lanes reduced	~0.3 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time series; control = yes	Multiple years pre- and post-installation	Retail sales Retail employment Food service employment	No or unclear effect No or unclear effect Positive
Liu and Shi (2020b)	Minneapolis, Minnesota, USA – Central Avenue[b]	Bike lanes on both sides of the street	Width of travel lanes reduced	~1.25 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time series; control = yes	Multiple years pre- and post-installation	Retail sales Retail employment Food service sales Food service employment	No or unclear effect Positive Positive Positive
Liu and Shi (2020b)	Minneapolis, Minnesota, USA – Franklin Avenue[b]	Bike lane	One parking lane	~0.75 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time series; control = yes	Multiple years pre- and post-installation	Retail employment Food service employment	No or unclear effect Positive
Liu and Shi (2020b)	San Francisco, California, USA – 17th Street[b]	Bike lanes on both sides of the street	Some vehicular parking	~0.5 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time series; control = yes	Multiple years pre- and post-installation	Retail sales Retail employment Food service sales Food service employment	Positive or no effect Positive or no effect Negative or no effect Negative or no effect
Liu and Shi (2020b)	Portland, Oregon, USA – Stark Street & Oak Street Corridor[b]	A bike lane on each of two parallel one-way streets	One vehicular travel lane on each street	~0.75 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis,	Multiple years pre- and post-installation	Retail sales Retail employment Food service sales Food service employment	Positive Positive Positive or no effect

					interrupted time series; control = yes			No or unclear effect
Liu and Shi (2020a)	Indianapolis, Indiana, USA – Massachusetts Avenue[b]	Two-way cycle track	One vehicular travel lane	~0.3 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time series; control = yes	Multiple years pre- and post-installation	Retail employment	No or unclear effect
							Food service employment	Positive
Liu and Shi (2020a)	Indianapolis, Indiana, USA – Virginia Avenue[b]	Two-way cycle track	One vehicular travel lane	~0.75 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time series; control = yes	Multiple years pre- and post-installation	Retail employment	No or unclear effect
							Food service employment	Positive
							Food service sales	Positive
							Food service wages	Positive
Liu and Shi (2020a)	Minneapolis, Minnesota, USA – Riverside Avenue[b]	Bike lanes on both sides of the street	One vehicular travel lane	~0.75 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time series; control = yes	Multiple years pre- and post-installation	Retail sales	No or unclear effect
							Retail employment	No or unclear effect
							Food service sales	No or unclear effect
							Food service employment	No or unclear effect
Liu and Shi (2020a)	Minneapolis, Minnesota, USA – North Second Street[b]	Bike lanes on both sides of the street	One vehicular parking lane and width reduction of vehicular travel lanes	~3.25 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time series; control = yes	Multiple years pre- and post-installation	Retail sales	Positive
							Retail employment	No or unclear effect
							Food service employment	Positive
Liu and Shi (2020a)	Seattle, Washington, USA – Second Avenue[b]	Two-way cycle track	Parking lane and one vehicular travel lane replaced with a	~0.75 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis,	Multiple years pre- and post-installation	Retail employment	Positive
							Food service employment	No or unclear effect

(*Continued*)

Table 3. Continued.

Source	City and street	Added	Removed	Length	Analytic method	Study timeframe	Measure	Effect
			combo left-turn/ parking lane		interrupted time series; control = yes			
Liu and Shi (2020a)	Seattle, Washington, USA – Broadway[b]	Two-way cycle track	Various re-arrangements	~1.25 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time series; control = yes	Multiple years pre- and post-installation	Retail employment	No or unclear effect
							Food service employment	Positive
McCormick (2012)	Los Angeles, California, USA – York Boulevard[c]	Bike lanes on both sides of the street	Two vehicular travel lanes replaced with a centre turn lane	~1.3 miles	Descriptive statistics, difference-in-means testing, difference-in-proportions testing, hedonic price modelling; control = yes	5 years pre-installation to 6 years post-installation	Commercial property values	No or unclear effect
							Sales tax revenue	No or unclear effect
							Business turnover	No or unclear effect
							New business openings	No or unclear effect
McCoy et al. (2019)	San Francisco, California, USA[d]	Bike lanes or bike boulevards	Varies	Varies	Descriptive statistics, difference-in-means testing, multivariate regression; control = yes	1996–2014 (number of years of pre- and post-installation data varies – depends on the construction date of the nearest bicycle facility)	Business sales (storefront retail, food service, and other service-providing businesses)	Mostly no effect, except negative effect for auto-oriented and home goods business on corridors with bike lanes
Monsere et al. (2014)	Austin, Texas, USA – Barton Springs Road[e]	One-way cycle track	Nothing	~0.5 miles	Descriptive statistics; control = no	~1 year post-installation	Likelihood of nearby residents visiting a business on the corridor (from post-intervention survey)	Positive
Monsere et al. (2014)	Chicago, Illinois, USA – Dearborn Street[b]	Two-way cycle track	One vehicular travel lane and 21 vehicular parking spaces	~1.2 miles	Descriptive statistics; control = no	~1 year post-installation	Likelihood of nearby residents visiting a business on the corridor (from post-intervention survey)	Negative
		One-way cycle tracks on both	Parts of a dedicated turn or bus lane	~0.8 miles	Descriptive statistics; control = no	~1 year post-installation	Likelihood of nearby residents visiting a	Negative

Monsere et al. (2014)	Chicago, Illinois, USA – Milwaukee Avenue[b]	sides of the street	and 69 vehicular parking spaces				business on the corridor (from post-intervention survey)	
Monsere et al. (2014)	Portland, Oregon, USA – NE Multnomah Street[b]	One-way cycle tracks on both sides of the street and 27 vehicular parking spaces	Bike lanes on both sides of the street and two vehicular travel lanes	~0.8 miles	Descriptive statistics; control = no	~1 year post-installation	Likelihood of nearby residents visiting a business on the corridor (from post-intervention survey)	Positive
Monsere et al. (2014)	San Francisco, California, USA – Oak and Fell Streets[c]	One-way cycle tracks along a couplet of one-way streets	28 vehicular parking spaces on one street and 27 on the other, plus a bike lane on one street	~0.3 miles	Descriptive statistics; control = no	~1 year post-installation	Likelihood of nearby residents visiting a business on the corridor (from post-intervention survey)	Positive
Monsere et al. (2014)	Washington, D.C., USA – L Street[b]	One-way cycle track	Parts of a vehicular travel lane and 150 vehicular parking spaces	1.12 miles	Descriptive statistics; control = no	~1 year post-installation	Likelihood of nearby residents visiting a business on the corridor (from post-intervention survey)	Positive
New York City (2012)	New York City, New York, USA – First and Second Avenues[b]	One-way cycle tracks on both streets, and dedicated bus lanes on both streets	Unclear	Unclear	Descriptive statistics; control = yes	1 year pre-installation to 3 years post-installation	Commercial vacancy rate	Positive (reduced vacancy)
New York City (2013)	New York City (Manhattan), New York, USA – 9th Avenue[b]	Cycle track (one-way street)	One vehicular travel lane replaced with a left-turn lane	~0.5 miles	Descriptive statistics, aggregated trend analysis; control = yes	1 year pre-installation to 3 years post-installation	Retail and food service sales	Positive
Poirier (2018)	San Francisco, California, USA – Valencia Street[a]	Bike lanes on both sides of the street	One vehicular travel lane	~2.0 miles	Descriptive statistics; control = yes	2 years pre-installation to 2 years post-installation	Total sales at local-serving businesses	Positive
							Total sales at all businesses	Positive
							Sales/employee at local-serving businesses	Positive
Poirier (2018)	San Francisco, California, USA –	Sharrows on one vehicular	Unclear	~0.3 miles	Descriptive statistics; control = yes	2 years pre-installation to 2 years post-installation	Total sales at local-serving businesses	Positive
								Negative

(*Continued*)

Table 3. Continued.

Source	City and street	Added	Removed	Length	Analytic method	Study timeframe	Measure	Effect
	Columbus Avenue[c]	travel lane in each direction					Total sales at all businesses	
							Sales/employee at local-serving businesses	Negative
							Sales/employee at all businesses	Positive
Poirier (2018)	San Francisco, California, USA – Polk Street[a]	Bike lane on one side of the street	Unclear	~0.25 miles	Descriptive statistics; control = yes	2 years pre-installation to 2 years post-installation	Total sales at local-serving businesses	Positive
							Total sales at all businesses	Negative
							Sales/employee at local-serving businesses	Positive
							Sales/employee at all businesses	Negative
Rijo (2015)	Denver, Colorado, USA – Larimer Street[a]	Bike lanes on both sides of the street	One vehicular travel lane	~1.0 miles	Descriptive statistics, aggregated trend analysis; ANOVA with post-hoc means difference test; control = yes	20 months pre-installation to 3 years post-installation	Total sales at retail, food services, accommodations, and some arts, entertainment and recreation businesses	Positive
							Total sales tax revenues from retail, food services, accommodations, and some arts, entertainment and recreation businesses	Positive
Rijo (2015)	Denver, Colorado, USA – 15th Street[b]	Cycle track (one-way street)	One vehicular travel lane	~0.7 miles	Descriptive statistics, aggregated trend analysis; ANOVA with post-hoc means difference test; control = yes	38 months pre-installation to 15 months post-installation	Total sales tax revenues from retail, food services, accommodations, and some arts, entertainment and recreation businesses	Positive
Rijo (2015)	Denver, Colorado, USA – 15th Street[b]	Sharrows on one vehicular travel lane (one-way street)	Nothing	~0.3 miles	Descriptive statistics, aggregated trend analysis; ANOVA with post-hoc	38 months pre-installation to 15 months post-installation	Total sales tax revenues from retail, food services, accommodations, and some arts,	No effect

					means difference test; control = yes		entertainment and recreation businesses	
Rowe (2013)	Seattle, Washington, USA – Greenwood Avenue North[b]	Bike lanes on both sides of the street	One vehicular travel lane	~1.0 miles	Descriptive statistics, aggregated trend analysis; control = yes	1 year pre-installation to 2 years post-installation	Retail sales	No effect or unclear
Rowe (2013)	Seattle, Washington, USA – NE 65th Street[b]	Bike lane on one side of the street and sharrows on the other side	12 vehicular parking spots	Unclear	Descriptive statistics, aggregated trend analysis; control = yes	1.5 years pre-installation to 1.25 years post-installation	Retail sales	Positive
Stantec (2011)	Vancouver, British Columbia, Canada – Dunsmuir Street[b]	Two-way cycle track	One-way bike lane and 16 parking spaces	~0.5 miles	Descriptive statistics; control = yes	1 year post-installation	Self-reported sales from retail, service, and hotel businesses	Negative
Stantec (2011)	Vancouver, British Columbia, Canada – Hornby Street[b]	Two-way cycle track	One-way bike lane and 156 parking spaces	~1.25 miles	Descriptive statistics; control = yes	6 months post-installation	Self-reported sales from retail, service, and hotel businesses	Negative

[a]Retail corridor; [b]Business district; [c]Mixed residential and commercial corridor; [d]Mixed commercial and recreational corridor; [e]All streets in the city with class II or class III bicycle facilities added between 1996 and 2013.

Table 4. Summary of studies on the economic impacts of pedestrian facilities on local businesses.

Source	City and street	Added	Removed	Length	Analytic method	Study timeframe	Measure	Effect
Liu and Shi (2020b)	San Francisco, California, USA – Polk Street[a]	Street trees and lighting	One vehicular travel lane	~0.5 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time series; control = yes	Multiple years pre- and post-installation	Retail sales	Positive
							Retail employment	Positive or no effect
							Food service sales	Positive
Liu and Shi (2020a)	Minneapolis, Minnesota, USA – Lyndale Avenue South[a]	Landscaped median, curb extensions, ADA upgrades, and pedestrian-scaled lighting	One vehicular travel lane in each direction	~3.0 miles	Descriptive statistics, aggregated trend analysis, difference-in-difference analysis, interrupted time series; control = yes	Multiple years pre- and post-installation	Retail sales	Positive
							Retail employment	No or unclear effect
							Food service sales	No or unclear effect
							Food service employment	Positive
New York City (2012)	New York City (Brooklyn), New York, USA – Pearl Street[a]	Pedestrian plaza	Unclear	Unclear	Descriptive statistics; control = yes	1 year pre-installation to 3 years post-installation	Retail and food service sales	Positive
New York City (2012)	New York City (Manhattan), New York, USA – Pearl Street[a]	Seasonal seating area for local patrons	One vehicular travel lane	Unclear	Descriptive statistics; control = yes	1 year pre-installation to 3 years post-installation	Retail and food service sales	Positive
New York City (2013)	New York City (Manhattan), New York, USA – St. Nicholas/ Amsterdam Avenue[b]	Intersection re-designed to reduce vehicle-pedestrian conflict points, narrow pedestrian crossings, and convert roadway to landscaped pedestrian space with seating; some vehicular parking added	Reduced the number of travel lanes entering the intersection	~0.25 miles (across all streetscape improvements)	Descriptive statistics, aggregated trend analysis; control = yes	1 year pre-installation to 2 years post-installation	Retail and food service sales	Positive
New York City (2013)	New York City (Brooklyn), New York, USA – Willoughby Plaza[a]	A plaza with seating, trees, and planters	Vehicular travel lanes and parking	~0.1 miles	Descriptive statistics, aggregated trend analysis; control = yes	1 year pre-installation to 3 years post-installation	Retail and food service sales	Positive
New York City (2013)	New York City (Manhattan), New York, USA – Columbus Avenue[b]	Parking-protected bike lane (one way); landscaped pedestrian safety islands	Vehicular travel lanes were narrowed	~1.0 miles	Descriptive statistics, aggregated trend analysis; control = yes	1 year pre-installation to 2 years post-installation	Retail and food service sales	No or unclear effect

[a]Business district; [a]Mixed residential and commercial corridor or hub.

2018; Rowe, 2013), four pedestrian facilities (New York City Department of Transportation, 2012, 2013), and three mixed facilities (New York City Department of Transportation, 2012, 2013). They found no or unclear effects for three bicycle facilities and one mixed facility (Poirier, 2018; Rowe, 2013). And they found negative effects for five bicycle facilities (City of Calgary, 2016; Monsere et al., 2014; Stantec, 2011).

Overall, the studies indicate positive effects for the vast majority of active travel facilities – 57% for bicycle facilities, 100% for pedestrian facilities, and 75% for mixed facilities. However, the differences in contexts, facility types, and economic indicators and analytic methods used between the 15 studies prevent estimation of an average magnitude of the effect. The 15 studies are discussed in more detail in the next three subsections, organised by facility type (bicycle, pedestrian, and mixed).

Bicycle facilities

All 15 studies analyzed at least one bicycle facility (Table 3). The 15 studies estimated the economic impact on local businesses of 35 unique bicycle facilities, including 17 individual cycle track projects, 14 individual bicycle lane projects (one of which – the Valencia Street bicycle lane in San Francisco – was analyzed by two different studies: Drennen, 2003; Poirier, 2018), two bicycle boulevard projects, a group of four cycle track projects in downtown Calgary (City of Calgary, 2016), and the full network of bicycle lanes and boulevards added between 1996 and 2013 in San Francisco (McCoy et al., 2019). The individual facilities ranged in length from 0.25 miles to 3.25 miles, with averages of 0.71 miles for cycle track facilities, 1.2 miles for bicycle lanes, and 0.3 miles for bicycle boulevards.

The studies found positive economic effects for 20 of the 35 facilities (57% of the facilities), including 14 facilities that were accompanied by vehicular travel lane removal or width reduction, or removal of on-street vehicular parking spaces. The studies found unclear or no significant economic effects for 10 facilities (29%), including the entire network of class II (bike lanes) and class III (bicycle boulevards) facilities in San Francisco that were added between 1996 and 2013 (McCoy et al., 2019). The studies found negative economic effects for five facilities (14%), including the group of four cycle track projects in downtown Calgary. But none of the three studies that reported negative economic effects used statistical testing, and all of them had additional limitations that prevent statistically supported conclusions about the economic effect (City of Calgary, 2016; Monsere et al., 2014; Stantec, 2011). By contrast, the six studies (analyzing 18 facilities) that used statistical testing techniques found either positive or no significant economic impact on local businesses.

The two most recent studies to use statistical testing are Liu and Shi (2020a and 2020b). They are also the most comprehensive in terms of the number of geographies studied and the breadth of statistical modelling employed. The two studies analyzed the economic impacts from 12 bicycle facility additions, including two in Indianapolis, two in Memphis, four in Minneapolis, one in Portland, one in San Francisco, and two in Seattle. There were seven class II bike lanes and five class IV cycle tracks. The authors first selected at least one comparison corridor for each facility. They then applied aggregated trend analysis as well as two quasi-experimental econometric modelling techniques – difference-in-difference analysis and interrupted time series analysis. They used four sources of data (Census Longitudinal Employer-Household Dynamics data, Quarterly Census of Employment and Wages data, retail sales tax data, and National Establishment Time

Table 5. Summary of studies on the economic impacts of mixed bicycle and pedestrian facilities on local businesses.

Source	City and street	Added	Removed	Length	Analytic method	Study timeframe	Measure	Effect
New York City (2012)	New York City, New York, USA – Union Square North[b]	One-way cycle track, pedestrian plaza, and redesigned intersections	Unclear	Unclear	Descriptive statistics; control = yes	1 year pre-installation to 3 years post-installation	Commercial vacancy rate	Positive (reduced vacancy)
New York City (2013)	New York City (Brooklyn), New York, USA – Vanderbilt Avenue[a]	Bike lanes on both sides of the street, pedestrian safety islands, and a tree-lined median on one block	One vehicular travel lane in each direction replaced with a centre turn lane	~0.3 miles	Descriptive statistics, aggregated trend analysis; control = yes	1 year pre-installation to 3 years post-installation	Retail and food service sales	Positive
New York City (2013)	New York City (Bronx), New York, USA – Bronx Hub[a]	Curb bulbouts and other pedestrian space, planters, trees, and a network of new bike lanes in and out of the area	Reduced the number of travel lanes entering the intersection	~0.5 miles (across all streetscape improvements)	Descriptive statistics, aggregated trend analysis; control = yes	1 year pre-installation to 3 years post-installation	Retail and food service sales	Positive
New York City (2013)	New York City (Manhattan), New York, USA – Columbus Avenue[c]	Parking-protected bike lane (one way); landscaped pedestrian safety islands	Vehicular travel lanes were narrowed	~1.0 miles	Descriptive statistics, aggregated trend analysis; control = yes	1 year pre-installation to 2 years post-installation	Retail and food service sales	No or unclear effect

[a]Retail corridor or hub; [b]Business district; [c]Mixed residential and commercial corridor.

Series data) and four primary economic indicators (retail sales, retail employment, food service sales, and food service employment). For the aggregated trend analysis, they compared baseline economic indicator data (often the average from the three years before construction) to the three years after construction. They used a longer timeline for the econometric analyses, including data from multiple years pre- and post-facility installation. For nine of the 12 study sites, they concluded that the addition of the bicycle facility had positive economic impacts on local businesses (where their metrics showed either all positive effects or a mix positive effects and non-significant effects), despite removal of or reductions in vehicular travel lanes or on-street parking spaces accompanying seven of the bicycle facilities. That included all five of the cycle tracks and four of the bike lanes. They found unclear or insignificant economic impacts on the remaining three bike lanes.

In addition to Liu and Shi's (2020a, 2020b) two studies, four other studies used statistical testing to analyze the economic effects of bicycle facility additions. Rijo (2015) assessed the economic impact of three bicycle facilities installations in Denver, Colorado – a 0.7-mile class IV cycle track (and associated removal of one vehicular travel lane), a 1.0-mile class II bike lane (and associated removal of one vehicular travel lane), and a 0.3-mile class III bike boulevard. For each facility, the study compared gross sales and total sales tax from businesses along the length of the facility to those of similar businesses along three comparison corridors and the city as a whole. The study focused on businesses in the retail and food and accommodations services sectors, along with a few other consumer-focused businesses; it excluded auto-centric businesses like gas stations and car repair shops. The study employed aggregate trends analysis and ANOVA with post-hoc means difference testing, using data for the 20 months before and three years after installation of the bike lane and the 38 months before and 15 months after installation of the cycle track and bike boulevard. The study found positive effects for both the cycle track and bike lane and an insignificant difference in effect for the bike boulevard relative to the comparison sites.

Besides Rijo (2015) and Liu and Shi's (2020a, 2020b) two studies, the other three studies that used statistical testing found largely null effects (Arancibia et al., 2019; McCormick, 2012; McCoy et al., 2019). McCoy et al. (2019) used National Establishment Time Series data for over 3,000 storefront retail, food service, and other service-providing businesses in San Francisco to model the average change in sales following installation of a class II or class III bicycle facility. The study included all class II and III facilities added between 1996 and 2012, and measured the change in sales as the average sales for a business in the year (s) after installation of the nearest facility minus the average sales in the year(s) prior to facility construction (in 2014 US dollars; number of years pre- and post-intervention varied by year of installation). The authors used multivariate regression to model the change in sales, controlling for proximity to the bike infrastructure (businesses within 100 feet of a facility were considered to be abutting), business type and age, change in the number of on-street parking spaces associated with installation of class II facilities, and various other neighbourhood and corridor characteristics. The study found no statistically significant association between change in sales and either location on the same corridor as a class II or class III facility or change in on-street parking on corridors with class II facilities. However, the model results did show a significant positive association between change in sales and being located on a "neighborhood" road with a class II facility, and a statistically significant decrease in sales for automobile-oriented businesses (like gas stations and car dealerships) and home goods stores abutting a class II facility.

Arancibia et al. (2019) analyzed the economic impact of a 1.5-mile class II bike lane addition (and associated removal of 136 on-street parking spaces) on Bloor Street in downtown Toronto using five metrics: (1) monthly spending by visitors, (2) commercial vacancy rates, (3) number of customers at retail businesses there, (4) number of customers at food service businesses and bars, and (5) number of customers at service businesses. The authors obtained the visitor spending data via surveys of visitors to the treatment corridor (Bloor Street) and a comparison street, conducted eight months before, and two and nine months after facility installation. They assessed commercial vacancy rates using field observations from the treatment and control corridors one month before and nine months after facility installation. They obtained the customer data from surveys of merchants seven months before, and three and nine months after facility construction. The study used difference-in-proportions tests and logistic regression to analyze the visitor spending data, both between the treatment and control corridors and longitudinally within the treatment corridor. The study also used difference-in-proportions tests – albeit just with data from the treatment corridor – to assess the impact of the bike lane addition on business patronage. The study compared descriptive statistics to assess the effect on commercial vacancy rates. Overall, the study found no negative economic impacts to local businesses from the bike lane addition.

McCormick (2012) analyzed the economic effect on local businesses of a road diet that converted two of the vehicular travel lanes into a left-hand turn lane and class II bike lanes on both sides of a 1.3-mile stretch of York Boulevard in Los Angeles. The study found no significant difference (using a Chi-square test) in business turnover or new business creation post-road diet between the treatment corridor and a contiguous 0.9-mile portion of York Boulevard that did not receive a road diet. The study likewise found no significant pre–post or treatment-control difference in commercial and residential property sale prices, using both t-tests and hedonic price modelling. The study also found no clear economic effect from its qualitative analysis of aggregate sales tax revenue.

In addition to the six studies (covering 18 facilities) that employed statistical testing, another seven studies that did not use statistical testing also found non-negative economic impacts on local businesses following the installation of bicycle facilities. Those seven studies found positive or unclear effects from 12 separate facilities, two class IV cycle tracks in New York City (New York City Department of Transportation, 2012, 2013), two cycle tracks in Seattle (Rowe, 2013), one cycle track in Oakland (City of Oakland Department of Transportation, 2017), one cycle track in Austin (Monsere et al., 2014), one cycle track in Portland (Monsere et al., 2014), one cycle track in Washington, DC (Monsere et al., 2014), and a cycle track, two class II bike lanes, and a class III bike boulevard in San Francisco (Drennen, 2003; Monsere et al., 2014; Poirier, 2018). However, only four of those studies used comparison sites to help control for variables unrelated to the active travel facility "treatment."

The New York City Department of Transportation (2012)found that the commercial vacancy rate declined 47% for abutting businesses after the installation of class IV cycle tracks (along with dedicated bus lanes) on First and Second Avenues in Manhattan, compared to a 2% increase borough wide. The NYC Department of Transportation (2013) also found a relatively greater increase in retail and food service sales (excluding auto-centric businesses) along a 0.5-mile stretch of 9th Avenue three years after installation of a one-way cycle track than in the borough as a whole or any of the three comparison corridors.

Rowe (2013) found that retail sales in the year following installation of cycle track (on one side of the street) and bike boulevard (on the other) on NE 65th Street in Seattle increased comparatively more for the businesses in the project corridor than in either the comparison corridor or the neighbourhood as a whole. That same study also found relatively equivalent trends in retail sales from businesses along the treatment corridor, comparison corridor, or neighbourhood for the three years after installation of a 1.0-mile cycle track on Greenwood Avenue. The fourth study to use comparison sites – Poirier (2018) – compared the percentage change in total sales and sales per employee for businesses abutting three separate bicycle facilities to all other businesses in the blocks surrounding the facilities across a 5-year time frame (2 years before installation of the facilities compared to the 2 years post installation). They found a relatively greater percentage increase in both metrics for businesses abutting the 2.0-mile bike lane installed on Valencia Street (including for both all abutting businesses and a local-serving subset of those businesses that excluded auto-centric businesses) than for the non-abutting businesses in the control blocks. They found mixed effects for other two facilities, a 0.3-mile class III bike boulevard on Columbus Avenue and a 0.25-mile bike lane on Polk Street.

Overall, the studies that used statistical testing and/or comparison sites found positive (15) or otherwise non-negative (10) economic effects for 25 of the 35 total facilities. By contrast, only three studies we reviewed found negative economic impacts (from a total of five separate facilities). And all three studies had methodological limitations that prevent statistically supported conclusions about the direction of the economic effect (City of Calgary, 2016; Monsere et al., 2014; Stantec, 2011). The City of Calgary (2016) surveyed pedestrians (intercept surveys) and merchants along four corridors in downtown Calgary both before and after class IV cycle tracks were added to the corridors. The surveys showed a reduction in average visitor spending per month after the facilities were added (despite respondents reporting an identical visitation frequency), as well as a reduction in the average number of customers per day reported by businesses. But the study did not use any comparison sites or perform any statistical modelling to control for larger economic trends or other factors that could account for the reductions in reported spending and customer visits.

Monsere et al. (2014) surveyed residents within a quarter mile of recently installed class IV cycle tracks in six urban areas about whether they were more or less likely to visit a business in the corridor after the cycle tracks were added. A greater percentage of the surveyed residents near two of the facilities (both in Chicago) responded that they were less likely to visit a business than responded that they were more likely to do so (though a majority indicated there was no change). But these results do not necessarily mean that businesses near those two facilities suffered economically (or benefited economically in the other four locations). For one, the study asked about visitation frequency but not spending per trip – it is possible that residents shopped less frequently at the affected businesses, but spent more when they did. In addition, residents are likely not the only patrons at the affected businesses, so changes in their spending patterns might not actually correlate to economic changes for the businesses. Furthermore, any changes in residents' shopping behaviour could be caused by unrelated economic trends or other factors. As the authors of the study note, "[t]here are several challenges in identifying connections between bicycle facilities and economic changes. These changes may be subtle or tied to an overall change in character of a corridor or neighborhood" (Monsere et al., 2014, p. 136).

Stantec (2011) surveyed retail, service, and hotel businesses along two corridors in Vancouver, British Columbia in which class IV cycle tracks had recently been added, as well as businesses in two comparison corridors. The 32% ($n = 73$) of businesses that responded reported an average decline in sales of 11% on one street and 2% on another, compared to a 1% decline and 2% increase on the respective control corridors. However, due to the small sample size and for other reasons, the authors did not test the statistical significance of the differences in reported sales trends or control for other variables. Furthermore, the authors noted that the survey responses might be biased towards those businesses that were vocally opposed to the cycle tracks from the beginning (there was organised business opposition to the cycle tracks before they were installed): "since the averages established in the grade-level [business tenants] and owners surveys may reflect the more vocal minority, they must be moderated to some degree by the non-respondents that make up the majority of businesses" (Stantec, 2011, p. 19).

While the three studies that found negative impacts had significant methodological limitations, there is some evidence from the other studies that adding bicycle facilities might dampen sales for auto-centric businesses abutting the facilities. For example, McCoy et al. (2019, p. 277) found that while "bicycle infrastructure and changes in on-street parking supply generally did not have a significant effect on the change in sales" in San Francisco, auto-centric businesses on streets with class II bike lanes showed a statistically significant decline in sales, after controlling for other factors in their ordinary least squares regression model. Poirier (2018) similarly found that while local-serving businesses (which excluded auto-centric businesses) abutting a retail corridor (Polk Street) in San Francisco had a relative increase in sales compared to non-abutting businesses, all abutting businesses (which included auto-centric businesses) had a relative decline in sales. Liu and Shi (2020b) obtained a similar result for businesses along another retail corridor (17th Street) in San Francisco where class II bike lanes were added in each direction. Using an aggregated trend analysis, they found a relatively greater increase in sales and employment among the subset of abutting retail businesses that excluded auto-focused businesses than for all retail businesses combined.

In sum, the weight of the evidence indicates that bicycle facilities are likely to provide a positive – or at least non-negative – economic co-benefit to local retail and food service businesses, even where vehicular travel lanes or parking are removed or reduced in the process. However, there is some evidence from three of the studies reviewed that auto-focused businesses (like auto parts or repair shops, gas stations, and large home-goods stores) might experience stagnant or reduced sales (Liu & Shi, 2020b; McCoy et al., 2019; Poirier, 2018). Between the different types of bicycle facilities, the studies indicate that class II bike lanes and class IV cycle tracks might be more likely to produce positive economic benefits for local businesses than class III bicycle boulevards. The three studies that examined bicycle boulevard additions all found an unclear or insignificant economic effect (McCoy et al., 2019; Poirier, 2018; Rijo, 2015).

Pedestrian facilities

Four of the 15 studies analyzed at least one pedestrian facility (Table 4). The four studies estimated the economic impact on local businesses of six unique pedestrian facilities, including 0.5 miles of street trees and lighting in a San Francisco business district (Liu & Shi, 2020b), about three miles of landscaped median, curb extensions, disability access upgrades, and pedestrian-scaled lighting in a Minneapolis business district (Liu & Shi, 2020a), a pedestrian plaza in Brooklyn (New York City Department of Transportation, 2012), a seasonal seating area for local patrons in Manhattan (New York City Department of Transportation, 2012), a 0.25-mile conversion of roadway into landscaped pedestrian space with seating along with a redesigned intersection in Manhattan (New York City Department of Transportation, 2013) and a pedestrian plaza with seating, trees, and planters in Brooklyn (New York City Department of Transportation, 2013). The studies found positive economic effects for all six facilities, including five facilities that were accompanied by vehicular travel lane removal or width reduction, or removal of on-street vehicular parking spaces.

The only two studies to use statistical testing were Liu and Shi (2020a and 2020b). They analyzed the economic impacts from two of the eight total pedestrian facility additions across all studies. As discussed above, the authors of those studies first selected at least one comparison corridor for each facility. They then applied aggregated trend analysis as well as two quasi-experimental econometric modelling techniques using four sources of data and four primary economic indicators. For the aggregated trend analysis, they compared baseline economic indicator data from the year before construction to data for the three years after installation. They used a longer timeline for the econometric analyses, including data from multiple years pre- and post-facility installation. They concluded that the addition of each pedestrian facility – 0.5 miles of street trees in San Francisco and a landscaped median and other streetscape modifications and amenities in Minneapolis – had positive economic impacts on local businesses. Their metrics showed a mix of positive effects and non-significant effects for both facilities, despite removal of vehicular travel lanes in both cases.

While the other two studies did not employ statistical testing, they did use comparison sites to make better inferences about the economic impact of three of the studied facilities. The NYC Department of Transportation (2012) found that retail sales (excluding auto-centric businesses) increased 172% for the surrounding businesses after installation of pedestrian plaza in Brooklyn, compared to an 18% increase borough-wide. The NYC Department of Transportation (2013) also found that retail and food service sales (excluding auto-centric businesses) increased proportionally more at the businesses adjacent to both a 0.25-mile roadway-pedestrian space conversion in Manhattan and a pedestrian plaza in Brooklyn than those in the respective boroughs and three comparison sites for the projects (two and three years after installation, respectively).

In sum, the weight of the evidence indicates that pedestrian facilities are likely to provide a positive economic benefit to local retail and food service businesses (the focus of all four studies), even where vehicular travel lanes or parking are removed or reduced in the process.

Mixed facilities (bicycle and pedestrian)

Two of the 15 studies analyzed at least one facility that included both pedestrian and bicycle infrastructure improvements (Table 5) (New York City Department of Transportation, 2012, 2013). The two studies estimated the economic impact on local businesses of four mixed facilities in total, all in New York City, including a one-way cycle track and pedestrian plaza in Union Square North (New York City Department of Transportation, 2012), 0.3 miles of class II bike lanes, pedestrian safety islands, and a tree-lined median in Brooklyn (New York City Department of Transportation, 2013), improved pedestrian space in the Bronx Hub along with a network of new bike lanes in and out of the hub (New York City Department of Transportation, 2013), and one mile of a one-way cycle track and landscaped pedestrian safety islands in Manhattan (New York City Department of Transportation, 2013). They found positive economic effects for the first three facilities, two of which included removal of vehicular travel lanes. They found no major effect one way or the other for the fourth combined facility in Manhattan. The studies did not use statistical testing, but they did use comparison sites to make better inferences about the economic impact of the facilities. The studies used aggregated trend analysis for all four facility-level analyses, where they compared data from one year before facility construction to data from two or three years after construction for either retail and food service sales (the Brooklyn, Bronx Hub, and Manhattan facilities) or commercial vacancy rate (the Union Square North cycle track and pedestrian plaza) for the ground-level businesses abutting or nearby the facility addition versus all retail and food service businesses borough-wide.

Implications for practice and future research

A growing body of literature has attempted to measure the economic impacts on local businesses of new or improved bicycle and pedestrian facilities, particularly in the US and Canada. The impact is most commonly measured as changes in local business sales, but studies have also used number of customers, visitor spending, commercial vacancy rates, commercial property values, employment, and business owner perceptions as proxies for the economic effects on local businesses. These impacts are in addition to the many other types of direct and indirect economic impacts generated by active travel investments, including the direct economic impact of facility construction in the form of jobs created and materials purchased, as well as the indirect economic impacts from health improvements associated with active transportation. The 23 studies we reviewed can be roughly categorised into two groups: (1) those that analyze the differences in visitor spending in a commercial area by the travel mode the visitors used to get there; and (2) those that analyze the economic impacts of specific active travel facilities (or networks of facilities) on local businesses.

The eight studies in the first group used surveys to estimate per-visitor spending in primarily urban commercial areas of Toronto (three studies), San Francisco (two), Victoria (one), Portland (one), and Davis (one). The results indicate that cyclists and pedestrians generally spend more per month in urban downtowns and retail corridors than visitors who arrive by car, but do not reliably spend different amounts per trip. One implication of those results is that adding a bicycle or pedestrian facility in urban downtowns or retail corridors would not reduce consumer spending at local businesses unless it reduced more motorist trips to the area than the number of additional cyclist and pedestrian trips it generated. We do not review the literature on the effect of active travel facilities on motorist volumes here. But there is evidence that active travel improvements like road diets (Gudz, Fang, & Handy, 2016; Huang, Stewart, & Zegeer, 2002) and complete streets retrofits (Shu, Quiros, Wang, & Zhu, 2014) can increase bicycling or pedestrian volumes while having little to no effect on vehicular traffic flow. In addition, a recent review of the literature on changes in bicycle ridership following installation of a new bicycle facility concluded that "sizeable percentage increases in ridership can be expected along the routes of new Class I, Class II, and Class IV facilities" (Volker et al., 2019a, p. 20; Volker & Handy, 2019).

The 15 studies in the second group assessed the economic impact of 45 unique active travel facilities in business districts, commercial corridors, or other urban areas across 16 cities in the US and Canada, usually using before and after data on local business sales or another economic indicator. The 45 facilities comprised 35 bicycle facilities (17 individual cycle track projects, 14 individual bike lane projects, two individual bike boulevard projects, one group of four cycle track projects, and the full network of bike lanes and boulevards added between 1996 and 2013 in San Francisco), six pedestrian facilities (including plazas, street seating, street lighting, trees and landscaping, medians, and various other streetscape additions or alterations), and four mixed facilities (pairing either cycle tracks or bike lanes with streetscape improvements for pedestrians; all in New York City). Taken together, the results from the second group of studies indicate that creating or improving active travel facilities generally has positive or non-significant economic impacts on retail and food service businesses abutting or within a short distance of the facilities, even when vehicular parking or travel lanes are reduced to make room for the active travel facilities. While three of the 15 studies found negative economic impacts from a total of five separate facilities (all of which were bicycle projects), all three had methodological limitations that prevent statistically supported conclusions about the direction of the economic effect. However, the more robust studies provide some evidence that bike facilities could have negative economic effects on auto-centric businesses (like gas stations, auto repair shops, auto parts stores, and large home-goods stores).

With respect to the question of variation by facility type, the studies indicate that cycle tracks and bike lanes might be more likely to have positive economic effects on local businesses than bike boulevards. For pedestrian and mixed facilities, the wide range of potential streetscape improvements makes generalisation difficult, especially given the relatively limited literature. But the four studies we reviewed indicate almost universally positive effects – they found positive economic impacts from all six pedestrian facilities and three of the four mixed facilities they analyzed (with the fourth mixed facility showing no major effect one way or the other). These results are consistent with studies showing the positive economic impacts on local businesses of neighbourhood walkability, including through hedonic price modelling (Pivo & Fisher, 2011) and market analysis (Boarnet, Joh, Siembab, Fulton, & Nguyen, 2011).

In addition to their substantive results, the second group of studies also highlights lessons for designing future research on the economic impacts to local businesses of adding active travel facilities. The most robust studies – those from which inferences can most validly be drawn – will both (1) use before-and-after data to calculate the degree of change in the chosen economic indicator, and (2) control for variables unrelated to the active travel facility "treatment", with statistical modelling and/or by using one or more comparison sites that had similar baseline characteristics but was not treated with an active travel facility (Arancibia et al., 2019; Liu & Shi, 2020b; New York City Department of Transportation, 2013; Tehnopolis Group, 2016). Without using data from before and after facility construction, it is difficult to determine whether an economic impact occurred. A common rule of thumb is to use at least one year of data pre-intervention and two years of data post-intervention, at least when analyzing business sales, though it is always better to have more data points and might be necessary for some statistical analyses, like interrupted time series (Liu & Shi, 2020b) Even with ample before-and-after data, it is still difficult to discern whether the economic impact on local businesses was caused by adding the active travel facility or something else (like a broader shift in the economy) without also using comparison sites or covariate controls.

The choice of economic indicator is also important. Most studies we reviewed used a measure of sales from businesses abutting the studied facility, usually retail and/or food service sales (or sales tax). Sales data is ideal because it is the most direct and immediate measure of economic impacts to local businesses, and because it can often be obtained for all businesses of interest from a governmental or other repository, which avoids the self-selection or other biasing that can happen when surveying business owners or customers. However, sales data is not always readily available, especially in Canada (due to information and privacy laws, as discussed in Arancibia et al., 2019) and in US jurisdictions that do not collect sales tax (though private sector sources of sales data, like the National Establishment Time Series, can sometimes be used instead, like in McCoy et al., 2019, and Liu & Shi, 2020a, 2020b). In those cases, researchers can use a different metric (like employment) or approximate business sales with surveys (e.g. of consumer spending, as in Arancibia et al., 2019).

Employing these best practices can be time-consuming and expensive, which is likely one reason there are not more such studies. Even so, 10 of the 15 studies we reviewed used both before-and-after data and controls, and six studies went further and used statistical testing to improve inferences about the economic effect on local businesses of adding active travel facilities. These methods ranged from simple tests for differences in means or proportions (Arancibia et al., 2019; McCormick, 2012; McCoy et al., 2019) to analysis of variance with post-hoc means difference testing (Rijo, 2015) to hedonic price modelling (McCormick, 2012) and multivariate regression (Arancibia et al., 2019; McCoy et al., 2019), to difference-in-difference analysis (Arancibia et al., 2019; Liu & Shi, 2020a, 2020b) and interrupted time series modelling (Liu & Shi, 2020a, 2020b). Although the number of studies is relatively small, the quality of the studies is generally good.

Overall, the evidence reviewed in this paper is important as cities move to increase their investments in bicycle and pedestrian facilities as a part of efforts to reduce driving as a way to forestall climate change or for other reasons altogether. Opposition to bicycle and pedestrian investments often stems from concerns over negative impacts on local businesses, particularly in the US and Canada. The available evidence suggests that such fears are unfounded and that local governments can indeed invest in bicycle and pedestrians without regret.

Note

1. Bike facilities are typically classified as class I (bike or shared use paths), class II (bike lanes), class III (marked routes shared with vehicles), or class IV (cycle tracks) bicycle facilities. The California Department of Transportation (2017) and Fitch, Thigpen, Cruz, and Handy (2016) illustrate the four types of facilities and describe the classifications in more detail.

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