**CITY OF CAMBRIDGE**
Community Development Department

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To: Yi-An Huang, City Manager

From: Iram Farooq, Assistant City Manager for Community Development

Date: February 7, 2024

Re: Cycling Safety Ordinance Economic Impact Study

Please find attached the Cycling Safety Ordinance (CSO) Economic Impact Report. Additional information on this study, including this full report is available at www.cambridgema.gov/econimpactstudy.

## BACKGROUND

In 2022, the City Council requested that the Community Development Department's Economic Opportunity and Development Division study the impact of installation of separated bike facilities along commercial corridors on local businesses, positive or negative, with the goal to help inform current and future installations of bike lanes.

The City entered into an inter-agency agreement with Volpe National Transportation Systems Center (Volpe) in January 2023 to conduct the study. The study scope includes identifying and collecting relevant economic data to create a baseline and evaluate impacts of installations to date and creating a methodology that can also be used for analysis and reporting in future years as the bike network is implemented. The initial steps of the work included reviewing similar studies from other cities to identify best practices in methodology and potential data sources. The goal was to create a sustainable data set that includes objective, local data that is available and can be updated on a consistent basis.

## STUDY HIGHLIGHTS

- Finding reliable data sources was a challenge. Studies from other communities used data sources not available locally in Cambridge (e.g. local sales tax). Data from third party organizations (such as Safegraph) was also found unreliable because it was missing local data for many quarters. Data used and recommended for future reporting includes customer and business surveys, commercial real estate

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occupancy/vacancy data, and Longitudinal Employer-Household Dynamics (LEHD) employment data.

- The study's findings of impacts are inconclusive. The retail and small business environment in 2023, and the preceding years while the separated bike facilities were being installed, was deeply influenced by macroeconomic impacts of the COVID-19 pandemic, inflation, high interest rates, supply chain issues, and increase in online shopping. This makes it difficult to determine what component of economic impact being experienced by businesses are attributable to separated bike facilities and what is the impact of broader macroeconomic factors.
- Looking at the quantitative data, the study found little to no difference between an area with a separated bike lane and a similar area without one. If there are differences, they are not statistically significant.
- We conducted a business survey and got responses from 300 businesses, a 20% response rate. The business survey results qualitatively showed that in separated bike lane corridors some businesses saw a decrease in sales since installation.

**NEXT STEPS**

It is important to continue to collect data to understand short- or long-term economic impacts due to the separated bike lane installation. We intend to utilize the blueprint created by Volpe to analyze and report findings until the bicycle network installation required by the CSO is complete.

City staff have already found the study recommendations useful for improving future data sets and reporting. Specifically, we will conduct customer intercept surveys more frequently and clarify the business survey questions to ask about impacts explicitly around fully separated bike lanes and not street changes in general. CDD staff will work with the Traffic, Parking, and Transportation Department to gather and use parking utilization data pre- and post-installation of separated bike facilities.

The CSO Economic Impact Study brings together quantitative and qualitative data, and we expect that this will provide a shared understanding as a starting point to help City staff communicate better with the business community. It will also help us understand current on-street business impacts and which mitigation efforts are the most effective.

# City of Cambridge: Cycling Safety Ordinance Economic Impact Study

**January 2024**

Prepared for:

**The City of Cambridge**

**Community Development Department**

U.S. Department of Transportation
Volpe Center

## Notice

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# 1. Introduction

The Cambridge City Council passed the Cycling Safety Ordinance (CSO)[1] in 2019, requiring installation of separated facilities along the portion of the network designated for greater separation in the Cambridge Bicycle Network Vision.[2] In 2020, the ordinance was amended to establish a more specific timeframe for installing approximately 25 miles of separated bicycle lanes within the city. As of 2023, just under 10 miles of separated bike lanes have been installed[3] since May 1, 2020, in addition to other bicycle facilities that were developed prior to the CSO. An expanded network of protected bike lanes has been associated with rising numbers of bike trips made in the city and a downward trend in injury rates.[4] At the same time, the installation of separated bicycle facilities in commercial corridors has raised concerns among some stakeholders about the associated loss of parking and loading spaces and potential impacts on retail trade and other businesses.

This study was conducted by the Volpe National Transportation Systems Center under an Inter-Agency Agreement with the City of Cambridge. It uses a mixed-methods approach, i.e., with both quantitative and qualitative data, to assess the impacts of protected bicycle lane infrastructure projects in Cambridge on retail sales and overall neighborhood economic vitality. It includes a review of existing published literature and prior studies on this topic; a summary of the study methodology; and an analysis of available data across multiples sources and datasets, including Census data on employment and income, commercial databases covering real estate and retail sales, and survey responses from local business owners and customers. In the final section, the findings are distilled into a set of overall conclusions and suggestions for future studies.

In addition to formal data analysis, stakeholder feedback was an important component of this study. The City has maintained a website with updated information, including the study's statement of work, background information on the CSO, interim deliverables, and status updates.[5] In addition, both City staff and members of the Volpe Center team attended public meetings to share updates on progress, receive feedback and suggestions from stakeholders, and answer questions. These included a public information session on July 17, 2023, and meetings of the City Council's Committee on Economic Development and University Relations on May 2, 2023, and July 20, 2023. City staff also provided a brief update to a meeting of the Cambridge business associations on March 14, 2023, and the CSO Advisory

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[1] For more information on the Cycling Safety Ordinance, see: https://www.cambridgema.gov/streetsandtransportation/policiesordinancesandplans/cyclingsafetyordinance

[2] For more information on the Cambridge Bike Plan, see: https://www.cambridgema.gov/Departments/communitydevelopment/2020bikeplanupdate/2020bicyclenetworkvision

[3] City of Cambridge, Cycling Safety Ordinance Progress Report: Year 3 (2023). https://www.cambridgema.gov/-/media/Files/Traffic/2023/csoseparatedbikelaneyear3_final.pdf

[4] City of Cambridge, Bicycling in Cambridge: Data Report 2023 (2023). https://www.cambridgema.gov/-/media/Files/CDD/Transportation/Bike/bikereports/20231023bicyclingincambridgedatareport_final.pdf

[5] https://www.cambridgema.gov/CDD/Projects/EconDev/cyclingsafetyordinanceeconomicimpactstudy

Committee on September 26, 2023.

Through public meetings and other channels of feedback, suggestions were provided by City Council members, interested residents, and business owners. In particular, feedback was received regarding available data sources and past studies. Relevant feedback was incorporated where possible, including exploration of potential data sources and review of publicly available past studies regarding the economic impacts of bicycle facilities, where possible.

## 1.1 Scope and Terminology

This study is focused primarily on financial and economic impacts and is not intended as a holistic assessment of investments in protected bicycle facilities. Notably, the study does not directly address safety outcomes, user satisfaction, cost-effectiveness, or broader impacts on travel behavior, mode choice, or operations of the transportation system, though some of these aspects are covered in the published literature that was reviewed. Although the CSO is often referenced, the study includes some separated bike facilities which predate the CSO and does not include all CSO corridors. In addition, much of the study focuses on comparing specific bicycle "treatment" corridors (i.e., streets that have either a fully separated or quick build bike lane) against matched "control" corridors (i.e., streets with no separated bike lane), so not all bike corridors in the city are addressed at the same level of detail.

Many different terms can be used to refer to on-street bicycle facilities. For simplicity, this report generally uses the term "protected" or "separated" bike lane, to refer to bicycle lanes that are physically separated from traffic using flexible bollards or similar devices.

# 2. Past Studies

Several studies, both in and outside the United States, have been conducted regarding the installation of safe and complete street measures such as separated bike lanes and impacts on economic measures at nearby businesses, such as employment and retail sales. Each study uses different data and methodology to assess the economic impact of changes in roadway composition including but not limited to the installation of bike lanes and removal of parking.[6]

## 2.1 New York City Department of Transportation (NYCDOT): The Economic Benefits of Sustainable Streets[7]

This project demonstrates methods for comparing economic data using several case studies in New York City which include bicycle improvements among other safe and complete street measures such as bus-related improvements and traffic calming. The primary data source used for analysis is city sales tax filings. The study also uses limited commercial lease and rent and city-assessed market value data, noting limited availability of the lease and rent data and difficulty obtaining its historical data. The retail sales tax filing data is noted to be a strong data source because of its availability at the individual business level. Another advantage of tax data is that it is universal and does not rely on voluntary collection. However, a disadvantage of these data noted is privacy restrictions. This study also considers but does not use other datasets including real estate transaction data, business establishment creation or loss, employment, and building permit information. The study specifically excludes addresses not located on the ground floor, to eliminate the potential for other filing addresses such as apartments or office buildings in the study area.

Each neighborhood case study in the analysis notes the before and after context of the area and the goals of improvements. The analysis uses seven case study areas and compares economic data to both comparison areas and the entire borough as controls. Comparisons are made pre-construction (i.e., a baseline period), during construction, and post construction. Comparison areas were selected in two ways: large areas (i.e., the borough in which the project is located), and comparison sites which were based either on similar retail mix within a neighborhood or sites with similar street characteristics. Where possible, multiple comparison sites were identified.

This study finds that sales increase after construction, however, not in a substantially different way than controls for most case studies. In some cases, the improvement area overperformed comparison areas, and in others the comparison sites overperformed the improvement area or saw similar changes.

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[6] Note: All studies discussed preceded the COVID-19 pandemic.

[7] NYCDOT, "Economic Benefits of Sustainable Streets," 2013, https://www.nyc.gov/html/dot/downloads/pdf/dot-economic-benefits-of-sustainable-streets.pdf.

## 2.2 Bloor Street West Bike Lane Pilot Project Evaluation[8]

This study summarizes findings using before and after data for a pilot bike corridor in Toronto, Ontario, including impacts on cycling volumes, traffic volumes, travel times, safety, parking and curbside demands, local businesses, and public perception. To assess curbside impacts including parking, site visits occurred on a by-request basis to review issues with loading. The study notes that some businesses had access to other delivery locations (e.g., rear of building) and some adjusted delivery schedules. Loading zones were established as a result of stakeholder engagement. In the study area, parking was reduced from both sides of the street to one side of the street only, with extended hours. Total paid parking spots were reduced by 10%.

To assess impacts on businesses, the study included both a survey of merchants and a pedestrian intercept survey. The merchant survey included both the study corridor and a control area. The merchant survey reported on changes in the number of customers. The pedestrian survey included frequency of visits, monthly spending, mode of transportation, and parking difficulties (where applicable). The study also examined vacancy rates over time and point-of-sale data for the study corridor, the surrounding area as a control, a control area/district with similar characteristics, and a control area which includes all businesses in the city of Toronto. Data for the year prior to the pilot and the year of the pilot were compared.

This study finds that total vehicle parking was reduced by approximately 6%. During peak times, the study found that usage of parking exceeded 85% of capacity, indicating difficulty finding parking. Minimal impacts were observed on side streets. Merchants in both the control and the study area saw a growth in the number of customers, with smaller growth noted in the study area. Visitors reported more visits after the installation, compared to no changes in the control area. Visitor-reported monthly spending increased at a similar rate in the study and control areas. Visitors reported increased difficulty in parking at similar rates in both the study and control areas. Vacancy rates were steady in the study area and declined in the control area by a small amount. Overall transactional volume growth was seen in the pilot study area and across all control areas. Per-transaction size declined in the study area and in all controls.

[8] "Bloor Street West Bike Lane Pilot Project Evaluation," 2017, https://www.toronto.ca/wp-content/uploads/2017/10/8ef6-cycling-bloor-backgroundfile-107582.pdf.

## 2.3 Understanding Economic and Business Impacts of Street Improvements for Bicycle and Pedestrian Mobility[9]

This study summarizes findings which compare four types of economic data and three different analytical approaches which are used to evaluate the impact of street improvements on economic variables such as sales or employment. The study uses four data sources: annual Census Longitudinal Employer-Household Dynamics data for number of jobs at the Census block level, Quarterly Census of - Employment and Wages data at the establishment level, National Employment Time Series at the establishment level, and retail sales tax data at the establishment level.

The study identifies treatment and control corridors. The authors note that identifying treatment and control corridors can be data-driven or be guided by local experts. The study notes that obtaining enough data for a data-driven approach can be difficult and uses a combined approach which has local experts identify corridors and then validates those areas using available data. To evaluate economic impacts, the study uses three econometric approaches. These are aggregated trend analysis (similar to the NYCDOT study), difference-in-difference analysis, and interrupted time series analysis. These methods are applied to case studies in Portland, OR, San Francisco, CA, Minneapolis, MN, and Memphis, TN. Findings were generally that street improvements have positive or nonsignificant impacts.

The study also compares the different data sources and analysis methods used, and notes that tradeoffs exist between ease of interpretability and econometric rigor. Methods with more econometric rigor and which may allow for causal inference, [10] have data restrictions which make their applicability in other studies contingent on data availability.[11]

[9] Jenny Liu and Wei Shi, "Understanding Economic and Business Impacts of Street Improvements for Bicycle and Mobility – A Multicity Multiapproach Exploration," *TREC Final Reports*, 2020, https://doi.org/10.15760/trec.248.

[10] For a detailed discussion, see, for example, Joshua D. Angrist and Jorn-Steffen Pischke, Mostly Harmless Econometrics: An Empiricist's Companion (Princeton University Press, 2009).

[11] The authors explore three types of analysis. Aggregate trend analysis, as noted by the authors, is valuable because of ease of interpretability, but lacks econometric rigor which would allow for causal inference. The authors examine both absolute and indexed values. Difference-in-difference analysis estimates difference in the variables of interest pre- and post- improvement between treatment and control corridors. This type of analysis requires panel or cross-sectional data for the treatment and control corridors, with the assumption that absent the intervention (in this case, bicycle facilities), the difference in trends between the corridors would remain constant. This type of analysis allows for causal inference. Finally, interrupted time series analysis examines the trends in the variable of interest before and after the intervention, through either a change in the intercept or a change in the slope in the post intervention period, relative to the pre-intervention period. The authors note that this type of analysis requires a longer time series, both pre- and post-intervention, but has advantages due to the fact that it does not rely on control corridors.

## 2.4 Bicycle Infrastructure and Commercial District Change[12]

This study examines impacts of bicycle infrastructure on businesses by using secondary data on business performance in the San Francisco Bay Area. This study also involved an intercept survey of customers in paired corridors to examine mode choice and consumer behavior, where pairs were determined based on business density and mix, as well as population demographic and mode choice characteristics. The study examines the impacts of several types of bicycle facilities, notably Class II (dedicated bike lanes) and Class III facilities (shared roadways). However, Class IV facilities, separated bicycle lanes, were indistinguishable in the underlying data used by the study from Class II facilities (dedicated bicycle lanes), and were excluded from analysis in the study.

The study uses the National Establishment Time Series (NETS) database, and notes that drawbacks to this data source include potential inaccuracy of data and infrequency of updates. The variables examined were sales, employees, location, industry, and the years at the location. In order to designate relevant businesses for the study ArcGIS was used to draw a 100-foot buffer to capture businesses which abut bicycle facilities.

Variables examined by the authors included business performance in the form of sales and business turnover. For sales, before and after installation averages were calculated. For business turnover, the probability of a business closing was calculated. Other variables used included roadway characteristics and demographic information for the surrounding neighborhood.

The results of the study regarding impacts of facilities were not conclusive, and varied by roadway type and business type. The authors state that the facilities have a "generally mixed effect" on sales at the business level.

[12] Karen Chapple, Raleigh McCoy, and Joseph Poirier, "Bicycle Infrastructure and Commercial District Change," 2018, https://www.urbandisplacement.org/wp-content/uploads/2021/08/bike_infrastructure_commercial_district_change.pdf.

# 3. Review of Available Data Sources

Based on the literature review and research regarding available data sources, a variety of datasets were considered for analysis. These datasets include data related to economic factors such as commercial rental rates, employment levels, sales, and business vacancies, as well as data related to transportation activity such as pedestrian and bike counts. To supplement available third-party datasets, business and pedestrian intercept surveys were also conducted by the city. A summary of datasets used is shown in Table 1, and a summary of datasets which were considered but determined not to be useful and/or available are shown in Table 2.

While economic data related directly to sales such as sales transaction data or sales tax data at the quarterly level would be the preferred data source for analysis, sources for these types of data are not readily available from the Commonwealth of Massachusetts and from businesses owners directly. After reviewing available data, point of interest (POI) transaction data, Longitudinal Employer-Household Dynamics employment data and commercial real estate data on rental rates and vacancies were explored as the basis for analysis, with supplemental data from the City of Cambridge. In addition, a survey of businesses was conducted by the City of Cambridge, and the City also conducted a pedestrian intercept survey. The datasets described were combined using geographic information, as described in Section 4.2.

**Table 1. Study Data Sources**

| Data Source | Description of Source and Potential Relationship to Study | Explored in Study | Rationale |
|---|---|---|---|
| Longitudinal Employer-Household Dynamics (LEHD) employment data | U.S. Census database of employers and employees, including earnings and demographics. LEHD data could be used to track changes in employment and businesses near newly installed bike facilities, relative to a control group. LEHD Origin-Destination Employment Statistics dataset with workplace area characteristics can be used to analyze employment by census block. | Yes | Due to data privacy, obtaining access to LEHD at a level with more granularity than the census block level would involve long lead times. Data at the census block level does not allow the level of detail necessary to identify businesses facing a particular roadway improvement. However, census blocks can be assigned to a corridor based on a radius from the roadway. Data at the annual level is more aggregated than would be preferred and does not allow for precise measurement of changes in employment relative to the completion date of a project.<br><br>Employment levels tend to be a lagging and indirect indicator of changes in retail activity but may be used to validate control areas where sufficient data are available. These data are available in 2011 through 2020 at the time of analysis, but sufficient data is not available for more recent installations.<br><br>This dataset is useful in identifying existing trends in employment for census blocks near specific bike corridors compared to a control area. |
| Parking information | Parking availability information or studies are limited in availability. Notably, one study was conducted in the area of the Brattle Street corridor (after installation only, conducted in 2018)[13] and the mid-Cambridge Street corridor (before and after installation).[14] | Limited use | These data sets do not provide direct evidence regarding changes in business sales but allow other information to be viewed in context. However, data availability is limited. |
| Business establishments opened/closed and by type of establishment | City-collected data on business openings and closings | Limited use | Business openings and closings are affected by many factors and can be difficult to associate with changes in bike facilities or other projects. However, the data may be useful in providing context for other findings. |

[13] Brattle Street Parking Memo – Cambridge Massachusetts. https://www.cambridgema.gov/~/media/Files/CDD/Transportation/Projects/brattlestbikefacility/BrattleStreetParkingStudyMemoFinalT32219forweb.pdf

[14] Cambridge Street Parking Memo – Cambridge Massachusetts. https://www.cambridgema.gov/-/media/Files/CDD/Transportation/Projects/cambridgestreet/CambridgeStreetParkingMemo.pdf

| Data Source | Description of Source and Potential Relationship to Study | Explored in Study | Rationale |
|---|---|---|---|
| Sidewalk and in-person customer intercept surveys | City-collected survey data from shopper intercepts at bike project locations and controls. These data provide information on mode of travel and purpose of trip. | Yes | These data sets do not provide direct evidence of changes in business sales but allow other information to be viewed in context. |
| Business surveys | City-collected data from surveys of business owners in affected locations versus control groups. This will provide information on changes in retail activity relative to a pre-COVID baseline. | Yes | Because the survey is voluntary and the recent or planned bicycle facility projects are public in nature, there are several sources of potential bias including nonresponse bias.<br><br>In addition, many macro- and micro-economic factors other than bike projects can affect sales volumes. Nonetheless, the survey data, as a supplement to other data sources, will provide a direct source of information on changes in the business environment in addition to information regarding perceived impacts. |
| Commercial real estate lease rate and/or occupancy/vacancy data | Private sector providers such as CoStar estimate rental rates and vacancy rates for commercial properties. Data on properties near bike projects can be compared to a control group.[15] | Yes | Because the value of urban real estate hinges on the commercial desirability of its location, changes in rents can provide a useful indirect measure of changes in retail activity and overall accessibility. Occupancy/ vacancy data also provide a secondary measure.<br><br>These datasets are credible as they are used widely in the real estate industry, and they permit geographic analysis. Although property values are also available through the city assessor, these involve longer time lags, and the assessment methodology may not account for smaller changes in neighborhood access.<br><br>Use of data is dependent on availability for identified corridors, and some data review and cleaning will be necessary to permit analysis. |

[15] As noted above, the City collects data on ground floor business vacancies, which includes business information and length of vacancy. However, the level of granularity for the length of vacancies varies.

| Data Source | Description of Source and Potential Relationship to Study | Explored in Study | Rationale |
|---|---|---|---|
| Point of interest (POI) transaction data | Information from electronic transactions can be purchased from a POI data company such as SafeGraph. | Yes | POI transaction data provides anonymized credit and debit card transaction information which can be used to track local sales trends directly. Use of this data required a purchase of the dataset. Key limitations are the exclusion of non-credit card transactions, and the lack of transparency regarding potential gaps in the data. The earliest available data is from 2019.<br><br>The data contains primarily full-service restaurants, snack and nonalcoholic beverage bars, limited-service restaurants, hair/nail/skin care services, and fitness centers. The dataset includes both chain and independent businesses at the store level by month. Variables of interest are total sales amount, spending per customer, number of transactions, or number of customers. |
| Bike lane information | Geographic and time information regarding bike lane installation | Yes | Assessing bike lane impacts requires location and timing information for impacted corridors. |

**Table 2. Other Data Sources Considered**

| Data Source | Description of Source and Potential Relationship to Study | Explored in Study | Rationale |
|---|---|---|---|
| Payment processor transaction data | Information from credit card and other electronic transactions could be purchased from a financial institution and used to track changes in retail sales directly. | No | Unable to find a private sector partner willing to provide such data. There would also be key limitations, such as not providing information on cash or out-of-network transactions. |
| City of Cambridge local-option meals tax | These data can be used to shed light on changes in restaurant sales, but not on other retail sectors. | No | Lack of information on other retail sectors makes the use of this dataset as a primary source of information insufficient. In addition, data are only available at aggregate level from the State. |
| Massachusetts Department of Revenue meals and sales tax data | Sales and meals tax receipts are based on retailers' own tax documentation, can be analyzed geographically, and provide direct evidence of changes in retail activity. Most retail activity is covered (except for groceries and clothing). | No | The Massachusetts Department of Revenue is unable to release the data at a granular enough level to be of use due to taxpayer privacy considerations. |
| Quarterly Census of Employment and Wages employment and wage data | Data from reports filed by employers subject to unemployment compensation laws, produced publicly at the city/town and county level by NAICS industries. | No | The level of detail for publicly available data is too aggregated to be useful. Massachusetts is a non-signatory state, indicating that projects wishing to use establishment level data for research or other purposes are approved based on individual state laws. Obtaining data at the establishment level would involve approvals and long lead times. If possible, obtaining this data may be worth future consideration for any extension of this analysis. |
| National Establishment Time Series employment and sales data | This product was established as a potential source via literature review of past studies. Data is produced from Dun & Bradstreet commercial/marketing data and constructed by Walls and Associates consulting group. This is an annual series from 1990-2021 that is establishment location (address) based and contains information on employment and historical sales. | No | Data fidelity (e.g., data accuracy, completeness) could be a potential concern. There are also concerns regarding the potential cost of the data and time lag for procurement for this project. This dataset has been used in other studies, and may be worth future consideration for any extension of this analysis. |
| Pedestrian and Bike Counts | City-collected counts of pedestrian and bike traffic at multiple locations, including before-and-after studies at bike facilities. | No | While this information would provide useful context, the information was not available at the level of detail required for analysis. |

# 4. Methodology

To assess the economic impacts of bike lanes in the City of Cambridge, control (i.e., areas without separated bike lane installation) and treatment (i.e., areas with separated bike lane installation) corridors were identified. Treatment corridors were identified through several criteria including the installation of separated bicycle facilities, corridor length, bicycle facility installation date, and input from the City. The corridor length is an important factor to consider in order to estimate any economic impact. Some installations identified in a review of past projects were over a very small geographic area (e.g., less than 0.1 miles), which would make analysis difficult. Similarly, the corridor installation date is an important factor to consider. Corridors which were installed quite recently would not have sufficient data to assess any economic variables in the corridor post-installation. Depending on the timing of a bike lane installation, these impacts may not be separable from COVID-19 impacts (e.g., any bike lane which was completed in 2020), so the timing of installation was also considered relative to the pandemic.

Control corridors were identified based on input from the City as well as comparison of economic and other variables (e.g., employment mix). Controls for some analysis also included Citywide variables, in particular employment. Identifying corridor location and parameters as well as construction start, and end dates is essential for identifying any potential economic impacts. Changes to the roadway outside of bicycle lane installation such as bus lane installation or other roadway construction were identified. It may not be possible to separate any impacts of bicycle lane installation from other roadway changes if they occurred at the same time or in subsequent periods.

Controls were generally identified through one of three methods:

- Citywide trends,
- Nearby corridors (e.g., surrounding area), or
- Comparable corridors (e.g., business size/industry mix and traffic flows are similar)

## 4.1 Dataset Construction and Corridor Definition

In order to identify treatment corridors for this analysis, several factors were considered including the installation of separated bike lanes, the directionality (one or both directions) of the bicycle facility installation, the length of the installation, and the completion date of the installation. Additional input was provided by the City regarding corridors of interest. The selected corridors, a description of their approximate location, the length of the corridor, and the completion date, are included in Table 3. It should be noted that the corridors defined in this study cover only a portion of the total bicycle facilities currently constructed and planned under the CSO.

**Table 3. Study Corridor Definitions**

| Corridor | Approximate Location | Length (mi) | Completion Date |
|---|---|---|---|
| **Brattle St.**[16] | Brattle Street, from approximately Eliot Street to Mason Street (both directions) | 0.2 | July 2017 |
| **Mass Ave. – Roseland/Beech**[17] | Massachusetts Avenue (Mass Ave.), from approximately Roseland Street to Beech Street (both directions) | 0.41 | August 2022 |
| **Cambridge St. – Quincy/Fayette**[18] | Cambridge Street, from approximately Quincy Street to Fayette Street (both directions) | 0.6 | August 2017 |
| **Mass Ave. – Alewife/Dudley**[19] | Massachusetts Avenue, from approximately Dudley Street to Alewife Brook Parkway (both directions) | 0.9 | Fall 2021 |
| **Mass Ave. – Trowbridge/Pleasant**[20] | Massachusetts Avenue, from approximately Trowbridge Street to Pleasant Street | 0.92 | September 2021 |
| **Western Ave.**[21] | Western Avenue, from approximately Auburn Street to Memorial Drive | 0.6 | Winter 2015/2016 |

Identifying control corridors presents difficulties, particularly given the geography of Cambridge. The city does not follow a grid system, so, for example, identifying a similar parallel roadway that did not receive a separated bicycle facility installation is often not possible. To identify control corridors given Cambridge's roadway system characteristics, several factors were considered, including proximity to the treatment corridor and business mix relative to the treatment corridor.[22] It is a requirement that control corridors did not have a separated bicycle facility installation during the study time period. However, some control corridors do have planned separated bicycle facility installations at a future date. Other considerations, where possible, included the roadway characteristics (e.g., one way, two-way). The list

[16] See: https://www.cambridgema.gov/Departments/trafficparkingandtransportation/News/2017/07/separatedbikelanesinstalledonmassaveandbrattlestreet

[17] See: https://www.cambridgema.gov/streetsandtransportation/projectsandprograms/portersquaresafetyimprovements

[18] See: https://www.cambridgema.gov/cdd/projects/transportation/cambridgestreetbicyclesafetydemonstrationproject

[19] See: https://www.cambridgema.gov/streetsandtransportation/projectsandprograms/massavedudleysttoalewifebrookpkwy

[20] See: https://www.cambridgema.gov/streetsandtransportation/projectsandprograms/midmassavesafetyimprovementproject

[21] See: https://www.cambridgema.gov/cdd/projects/transportation/westernavenue

[22] Both business mix and proximity would be preferable. However, for corridors such as Cambridge St. – Quincy/Fayette, finding a comparable business mix and proximity was difficult due to the presence of a hospital in the corridor.

of control corridors and their descriptions are shown in Table 4. Some roadway factors which could be confounding to analysis include roadway features which may be specific to a corridor, and in some cases included roadway construction. Examples include the extended construction beginning in 2012 on Western Ave. which included major roadway reconstruction, and the designated bus lanes in the area of the Mass Ave. – Alewife/Dudley corridor.

**Table 4. Control Corridor Definitions**

| Treatment Corridor | Control Corridor | Description of Control Corridor | Reasoning |
|---|---|---|---|
| **Brattle St. (2017)** | JFK St. | JFK Street, from approximately South Street to Memorial Drive | Proximity |
| **Mass Ave. – Roseland/Beech (2022)** | Mass Ave. – Forest /Chauncy | Massachusetts Avenue, from approximately Forest Street to Chauncy Street | Proximity |
| **Cambridge St. – Quincy/Fayette (2017)** | Mt. Auburn St. | Mount Auburn Street, from approximately Gerrys Landing Road to Longfellow Park | Business Mix |
| **Mass Ave. – Alewife/Dudley (2021)** | Mass Ave. – Rice/Walden | Massachusetts Avenue, from approximately Rice Street to Walden Street | Proximity |
| **Mass Ave. – Trowbridge/Pleasant (2021)** | Cambridge St. | Cambridge Street, from approximately Oakland Street to Max Avenue | Business Mix |
| **Western Ave. (2016)** | Pearl St. | Pearl Street from approximately Granite Street to Green Street | Business Mix |

## 4.2 Geographic Alignment of Datasets

Geographic information from the datasets was aligned with bike lanes using a distance radius from the project (roadway segment) of 100 yards, as shown in Figure 1 for treatment corridors.[23] The buffer was made using the QGIS Geographic Information System software. Control corridors were defined geographically in a similar way, using a radius of 100 yards, as shown in Figure 2. Based on the information available and the construction start and end dates, appropriate datasets of economic variables were identified.

[23] To define the corridors geographically based on their definitions in Section 3.1, a QGIS Geographic Information System layer was created with the approximate bicycle facility locations overlayed on the relevant roadway.

Where possible, trend analysis was conducted to assess whether the impacted areas have seen differentiated economic impacts after the installation of a bike lane relative to the identified control(s). Comparison of treatment corridors and control corridors was conducted using available data which assesses the following:

- Whether parking was impacted relative to the control(s). Ideally, detailed parking information such as available spaces by type (e.g., metered) and loading zones, and occupancy, would be examined before and after the installation of separated bicycle facilities. However, detailed post-installation parking information was only available for some corridors. Other parking comparison, aside from review of existing parking studies, was not possible given available information.
    - The Brattle Street On-Street Parking Study[24] was designed to provide information regarding parking occupancy only after the installation of a separated bicycle facility. The study examines parking in the study area overall, on Brattle Street, Streets North of Brattle Street, and Streets South of Brattle Street in March 2018 (post-installation). It should be noted that the geographic area analyzed in this study does not align to the study corridor buffer of 100 yards defined for this report. Considering parking on Brattle Street only, the study finds that only on Brattle Street, few unoccupied spaces were observed in the study, with occupancy exceeding 95 percent, while occupancy varies on surrounding roadways in the study area and is generally lower than on Brattle Street.
    - The Cambridge Street On-street Parking Study[25] examined both pre-installation and post-installation parking. The existing supply of 1065 spaces was proposed to be cut to 971, a removal of 94 spaces in the study area. The study examined parking in the study area overall, on Cambridge Street, Streets North of Cambridge Street, and Streets South of Cambridge Street in 2017 (pre-installation) and 2018 (post-installation). It should be noted that the study radius does not align to the study corridor radius of 100 yards defined for this report. The study finds that the 2018 parking demand is met by available spaces.
    - The Western Ave. Post-Construction Evaluation[26] includes parking utilization information for the Western Ave. corridor. However, this corridor includes many other features beyond the installation of separated bicycle facilities, notably curb extensions. Parking spaces were reduced from 133 to 108 in the study area on Western Ave.

[24] Brattle Street Parking Memo – Cambridge Massachusetts. https://www.cambridgema.gov/~/media/Files/CDD/Transportation/Projects/brattlestbikefacility/BrattleStreetParkingStudyMemoFinalT32219forweb.pdf

[25] Cambridge Street Parking Memo – Cambridge Massachusetts. https://www.cambridgema.gov/-/media/Files/CDD/Transportation/Projects/cambridgestreet/CambridgeStreetParkingMemo.pdf

[26] Post Construction Evaluation Report, Western Avenue, Cambridge, Massachusetts. https://www.cambridgema.gov/~/media/Files/CDD/Transportation/Projects/WesternAvenue/Western_Report_Final_2019_01_18.pdf

- Whether economic variables such as sales, employment, vacancy, or rents changed relative to the control(s), and
- Comparison of survey responses relative to the control(s).

Given the lack of one universally available dataset for analysis, analysis varies depending on the corridor identified and the timeline of the installation. For example, for a more recent installation, POI transaction data was available, while for older installations, employment or real estate data were the only available data sources. Where possible, multiple datasets were used.

Using the 100-yard radius defined above, economic data was aligned with corridors. This was possible for several datasets, including the LEHD data, SafeGraph data, and business survey results.[27] While the geographic units of each dataset varied – LEHD data is at the Census Block level, while SafeGraph and business survey data are at the individual business level -the process for geographic definition was the same. Any unit (e.g., business, census block) was considered to be included in a corridor if the geographic location of the unit is within the 100-yard radius of the corridor. Results of this alignment at the Census Block level are shown in Figure 3 for the three pre-2019 treatment corridors and their respective control corridors. Census Blocks are not uniform in size or shape, as is seen in the figure, and Blocks were included in a corridor only if a portion of the Block was inside the 100-yard radius.[28] When aligning the LEHD data with the corridors, block geometries from the 2020 Census were used. The SafeGraph data were aligned with the corridors using the geographic coordinates provided. The business survey results were aligned with the corridors by geocoding the business addresses (i.e., converting the street addresses to geographic coordinates) using the Open Street Map/Nominatum web service in the QGIS Geographic Information System software.[29] For both the SafeGraph data and the business survey, businesses were included in a corridor if the geographic coordinate was inside the 100-yard radius.

[27] CoStar data was extracted using a built-in online tool. Given that the online tool requires manual polygon definition, radii used may not be an exact match for corridors defined in Section 3.2.

[28] For a small number of census blocks (n=5), the corridor definitions and 100-yard radius used resulted in blocks being assigned to multiple corridors. In these cases, manual review was required to determine the assignment of the block to a corridor. In the case where an overlap was assigned between a treatment and control corridor, the block was assigned to the treatment corridor. In the case where the block was assigned to more than one corridor of the same type (e.g., multiple control corridors), the block was reviewed visually using a map to determine appropriate corridor assignment based on relative proximity and block shape.

[29] The street addresses reported in the business survey data were adjusted to improve the accuracy of the geocoding. The types of changes made included using proper cases (only capitalizing the first letter), removing unit designations (e.g., suite #2), correcting or completing spelling errors (replacing “Mass Ave” with “Massachusetts Ave”), consistently labeling the street type (e.g., using Ave, St, and Blvd).

**Figure 1. Study Corridor Definitions and 100-Yard Radii (Base Map Source: ESRI)**

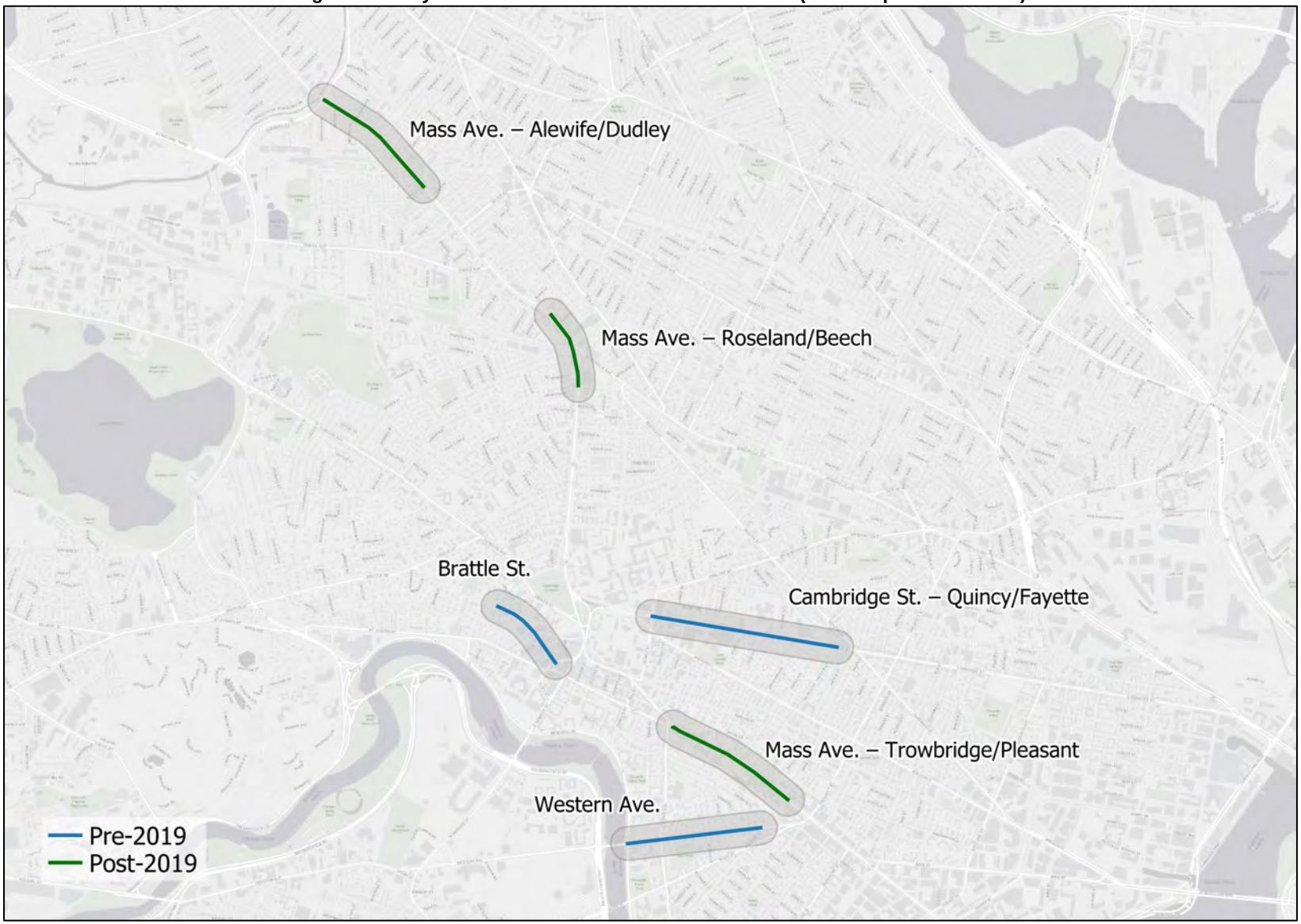


**Figure 2. Control Corridor Definitions and 100-Yard Radii (Base Map Source: ESRI)**

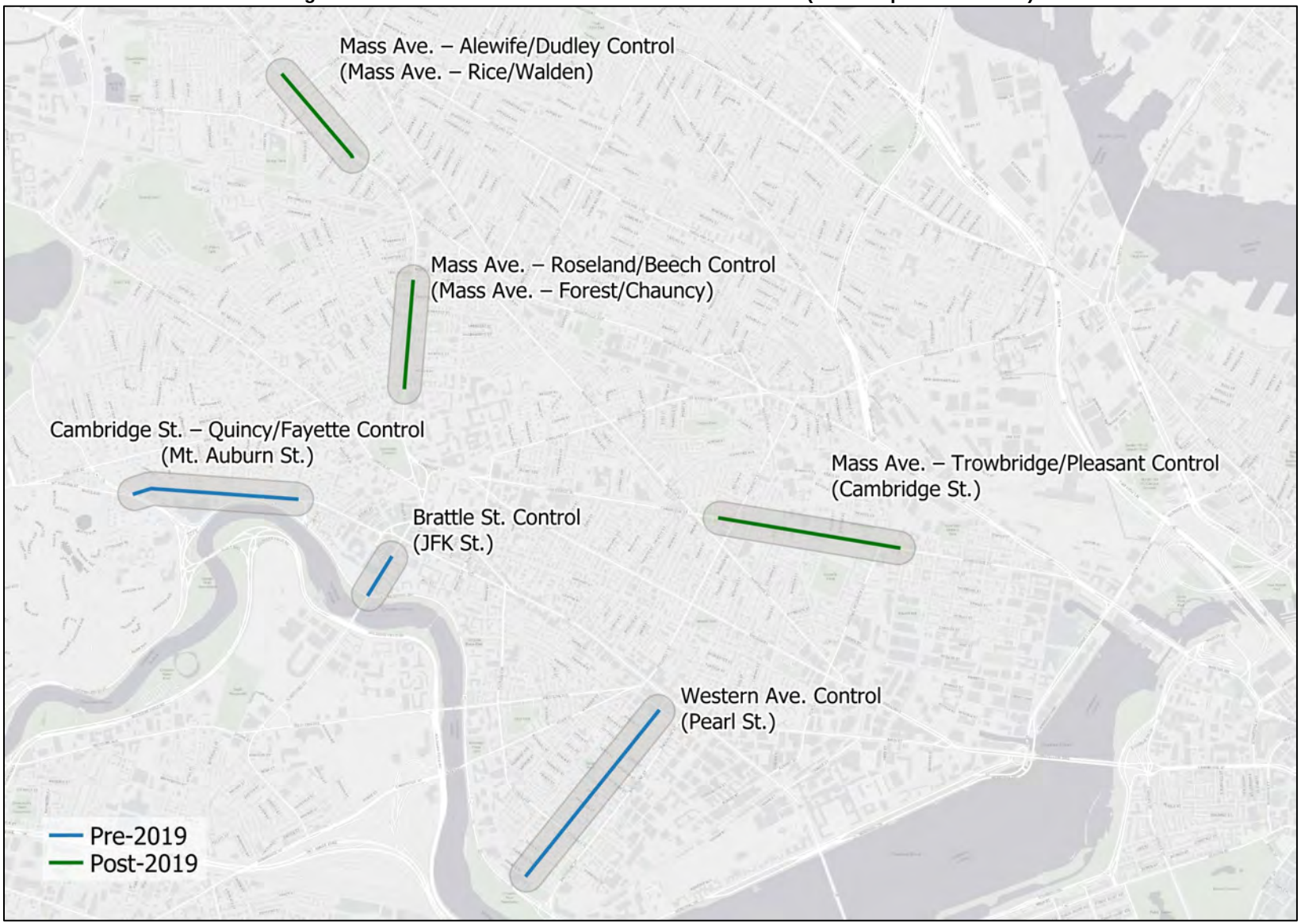
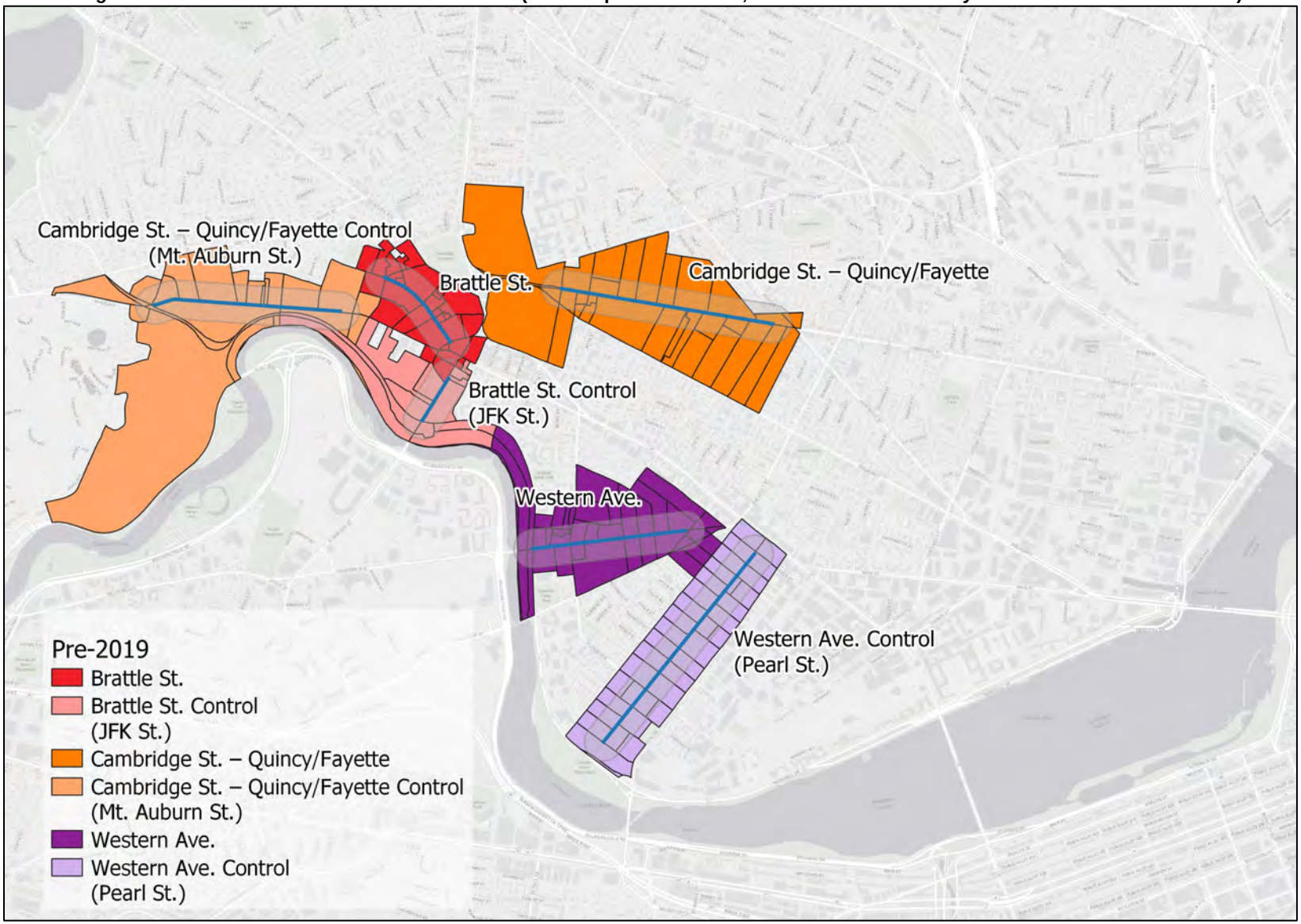


**Figure 3. Pre-2019 Corridors and Census Blocks (Base Map Source: ESRI; Census Block Geometry Source: U.S. Census Bureau)**



# 5. Analysis

## 5.1 Corridor Analysis Using the Longitudinal Employer-Household Dynamics Data[30]

As noted in the Section 1 and Section 3, data on employment and income levels can be used as a proxy for retail sales and overall neighborhood vitality in the context of bicycle facility construction.

The Census Bureau develops and maintains the Longitudinal Employer-Household Dynamics (LEHD) program to provide public-use data on employer and employee workforce dynamics.[31] While several data options are available for researchers, the LEHD Origin-Destination Employment Statistics (LODES) were used for this study to measure employment trends in predefined protected bike lane treatment corridors against control corridors and citywide and regional averages. Specifically, the LODES Workplace Area Characteristics contains information at the Census Block level on total jobs, the number of workers by age and income cohorts, and number of jobs by NAICS sector, in addition to other demographic data. Data is available for public use for most states from 2002 through 2020 at an annual level (Massachusetts data is available from 2011 through 2020).

In this analysis, Census Block level GIS shapefiles were aligned and grouped with the bike lane and treatment corridors of interest, using corridor definitions as defined in Section 4.1 and Section 4.2.[32] Census Blocks are not uniform in size or shape, and Blocks were considered to be included in a corridor only if a portion of the Block was inside the designated corridor radius (see Figure 3).[33]

The primary use of this data is centered on pre-2019 bike lane construction. This was required given that data is only available through 2020 and enough observations pre- and post-construction are needed to determine and analyze trends. Table 5 details the LODES data considered, data properties and notes of data transformation.

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[30] U.S. Census Bureau. (2023). LEHD Origin-Destination Employment Statistics Data (2002-2020). Washington, DC: U.S. Census Bureau, Longitudinal-Employer Household Dynamics Program accessed at https://lehd.ces.census.gov/data/#lodes. LODES 8.1

[31] See: https://lehd.ces.census.gov/

[32] For pre-2019 bike lanes, these control corridors are defined as follows: the control corridor for Brattle – Mason/Eliot is JFK St. from approximately South St. to Memorial Dr., the control corridor for Cambridge St. – Quincy/Fayette is Mt. Auburn St. from approximately Gerrys Landing Rd. to Longfellow Park, and the control Corridor for Western Ave. is Pearl St. from approximately Granite St. to Green St.

[33] For a small number of census blocks (n=5), the corridor definitions and 100-yard radius used resulted in blocks being assigned to multiple corridors. In these cases, manual review was required to determine the assignment of the block to a corridor. In the case where an overlap was assigned between a treatment and control corridor, the block was assigned to the treatment corridor. In the case where the block was assigned to more than one corridor of the same type (e.g., multiple control corridors), the block was reviewed visually using a map to determine appropriate corridor assignment based on relative proximity and block shape.

**Table 5. LEHD LODES Workplace Area Characteristics Data Considered**

| Variable Considered | Data Properties | Notes |
|---|---|---|
| Employment (Total Jobs) | Total annual employment by Census Block | Sector level employment aggregated to total by defined corridor; constructed for control(s) versus treatment |
| Employment Distribution | Annual distribution of jobs by sector/industry (in percentage terms) | Corridor level distribution of employment; constructed for control(s) versus treatment |
| Wage Distribution | Categorical range of monthly earnings: <$1,259, $1,250-$3,333, >$3,333 | Corridor level earnings; constructed for control(s) versus treatment |
| Sector Level Employment | NAICS sector annual employment | Corridor and sector level employment; constructed for control(s) versus treatment |

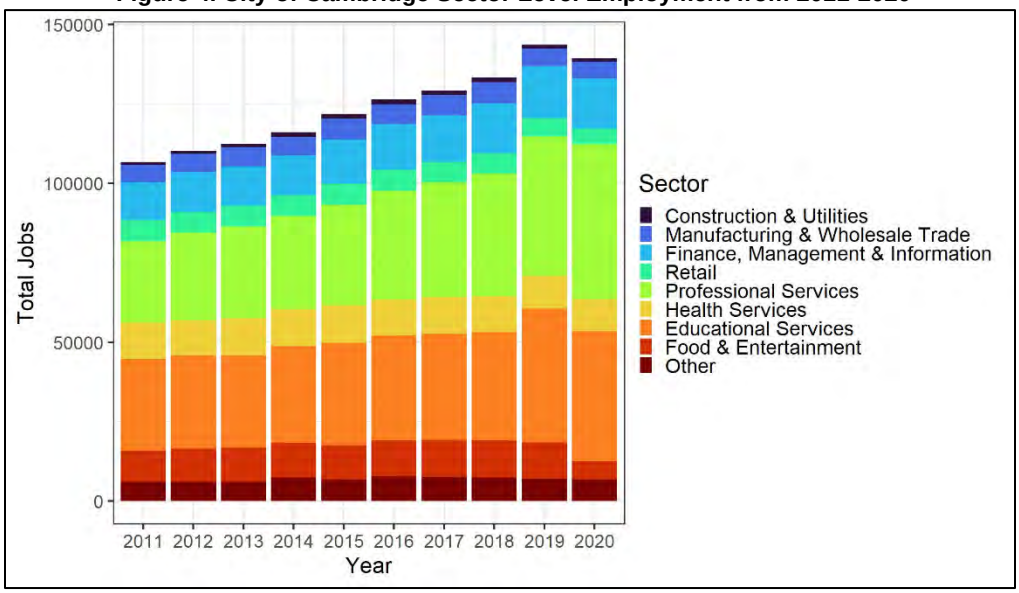
However, challenges existed with the initial set of data considered, and ultimately the focus of the analysis centered on food and retail sector employment.[34] One key challenge is that the public LODES employment data are aggregated at a level that makes it difficult to identify trends, particularly with the retail and food sectors that are of greatest interest, as these make up a relatively small share of total employment. Figure 4 presents the sector level employment in the city of Cambridge from 2011-2020, which shows retail, and food and entertainment services making up roughly 12% of total employment in 2019,[35] while educational and professional services making up the majority of employment (60%). Additionally, while the distribution of employment was an important second order consideration when identifying potential control corridors, it was not directly relevant to the analysis of trends pre- and

[34] For the purposes of this analysis, this includes jobs in NAICS sectors 44-45 (Retail Trade), NAICS sector 71 (Arts, Entertainment and Recreation), and NAICS sector 72 (Accommodation and Food Services).

[35] Retail, and food and entertainment sector jobs accounted for approximately 15% of jobs in 2012, and 8% of jobs in 2020, while educational and professional services accounted for 52% of jobs in 2012, and 64% of jobs in 2020.

post-construction of bike lanes. Finally, consideration of monthly earnings presented data limitations as the ranges used in public data are too broad to draw any conclusion of wage trends or impacts.

**Figure 4. City of Cambridge Sector Level Employment from 2011-2020**[36]




Additional findings on Cambridge-wide job trends for food and retail were included to complement the trends for each treatment and control corridor as shown in Figure 4, discussed above, in Figure 5, which shows total job trends in Cambridge versus all other areas in the surrounding Boston-Cambridge-Newton, MA area, and in Figure 6, which shows food and retail job trends in Cambridge versus all other areas in the surrounding Boston-Cambridge-Newton, MA area.[37] Total job trends, indexed to 2011, are increasing in both Cambridge and the surrounding area in all years except 2020, with steeper increases seen in Cambridge. However, food and retail jobs in Cambridge versus the surrounding area show a flatter trend than the surrounding area and show declines beginning in 2019.

[36] Data Source: LEHD LODES. Sectors were defined using NAICS Code information and combine some smaller categories to allow for visualization.

[37] For the purposes of this analysis, this includes all census blocks in the state of Massachusetts within the Boston-Cambridge-Newton, MA-NH combined statistical area that are not within the City of Cambridge, MA.

**Figure 5. Total Jobs in Cambridge and Surrounding Area (2011-2020) (Indexed = 1 in 2011)**

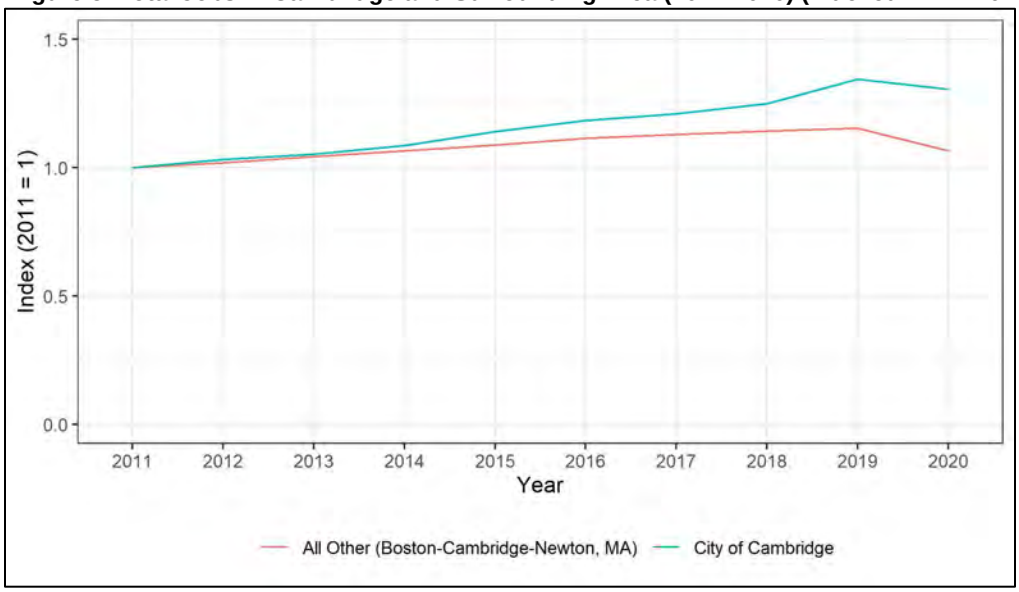
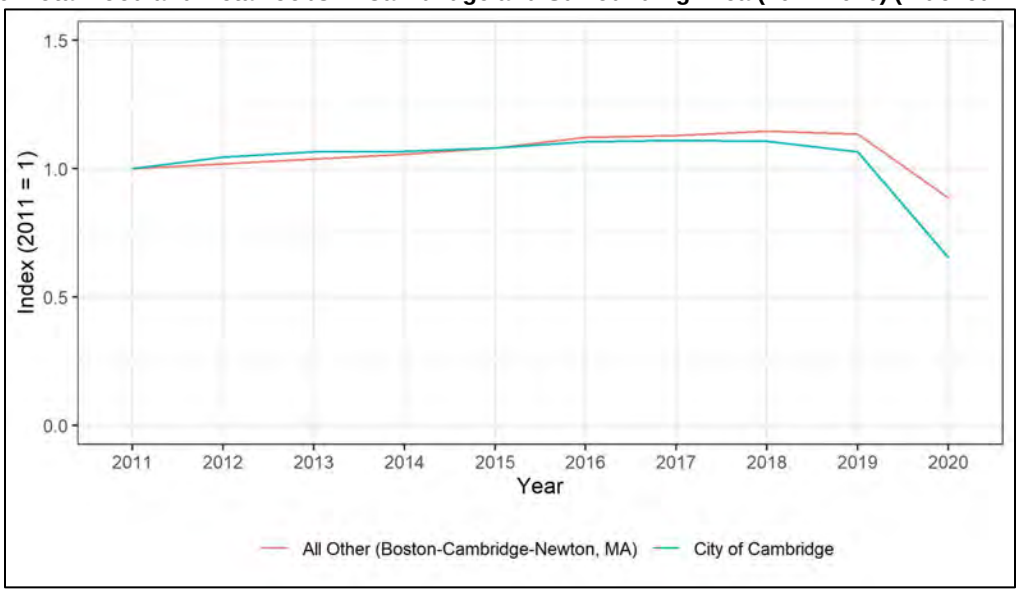



**Figure 6. Total Food and Retail Jobs in Cambridge and Surrounding Area (2011-2020) (Indexed = 1 in 2011)**




As noted in Section 4.1, the following three treatment and control corridors were considered using the LODES data and are presented below: Brattle St., Cambridge St. – Quincy/Fayette, and Western Ave. **The comparisons made between treatment and controls should be considered qualitative and do not support direct causal inferences.** The reasons why are twofold: firstly, the time related restrictions of annual data may obscure the treatment effects or trends post-bike lane construction. Depending on the length and timing of the bike lane construction, any potential impacts could be difficult to detect when examined at an annual level. Secondly, any causal link and measurable impact from the construction of

bike lanes on corridor level employment would need to be addressed with the appropriate statistical methods for causal analysis under pseudo-experimental controls (e.g., difference-in-difference regression analysis). This is not possible given the aforementioned geographic and temporal data aggregation. With these limitations in mind, qualitative examination of the corridors indicates that there was generally little difference in employment trends between treatment and control corridors during the relevant time periods before and after bike facility construction. More detailed information on each corridor follows below.

### 5.1.1 Brattle St.

The food and retail job numbers for the Brattle St. treatment and control corridors are presented in Figure 7. The corridors have slightly diverging trends through 2015/2016, where job growth is relatively flat in the control corridor and increasing for the treatment corridor before trending slightly downwards leading up to the construction of the bike lane in 2017. Both corridors see a decrease in jobs during the post-construction period. The effects from the COVID-19 pandemic and subsequent lockdowns had roughly the same impact on food and retail jobs between the treatment and control corridors, both losing approximately 50% of jobs.

Figure 8 includes the Cambridge citywide index of food and retail jobs and indexes the job totals to 2011 values for comparison against the treatment and control corridors. The difference in job growth trends pre- and post-bike lane construction is minimal when compared against the citywide index, and confirms the decrease observed in the control corridor from 2016-2019. Taken together, the comparison in trends point towards no noticeable impact on food and retail jobs from the construction of the separated bike lane relative to either the control corridor or citywide.

**Figure 7. Food and Retail Jobs Comparison, Brattle St. and Brattle St. Control (JFK St.) (2011-2020)**

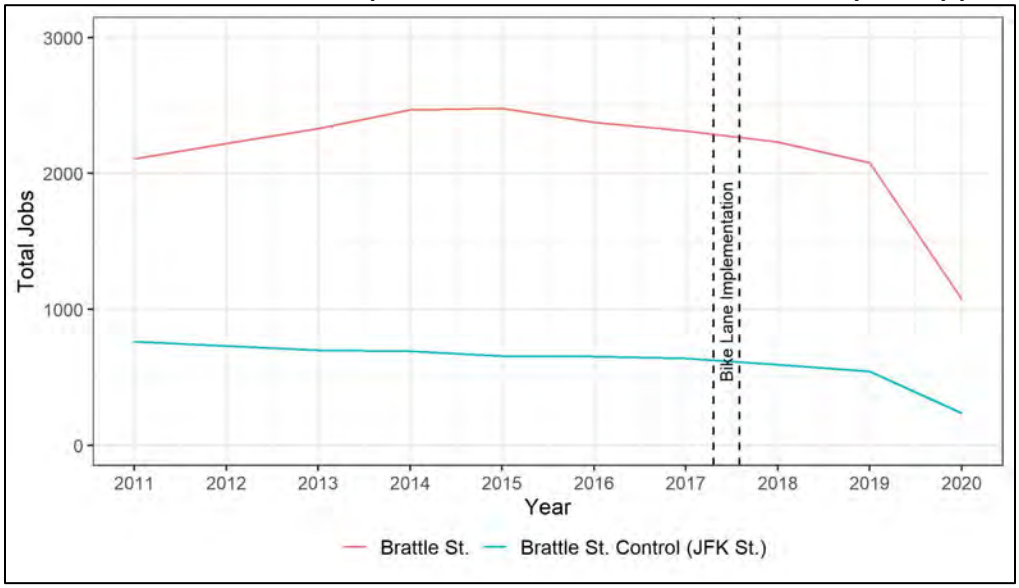
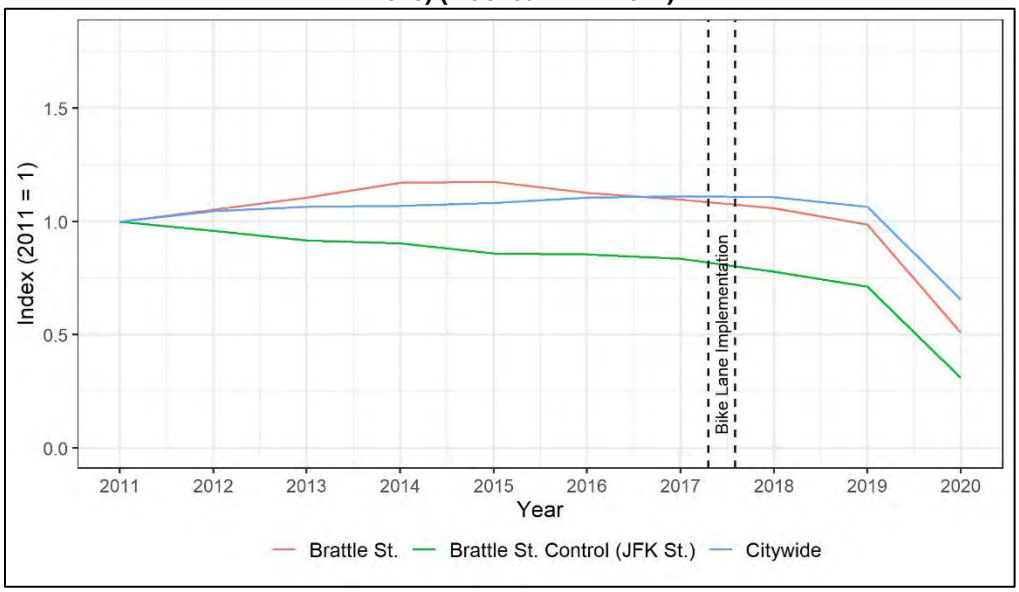


**Figure 8. Food and Retail Jobs Comparison, Brattle St., Brattle Street Control (JFK St.), and Citywide (2011-2020) (Indexed = 1 in 2011)**




### 5.1.2 Cambridge St. – Quincy/Fayette

A comparison of food and retail jobs for the Cambridge St. treatment and control corridors is presented in Figure 9 and a Cambridge citywide comparison is presented in Figure 10. As noted in Section 4.1, defining a control corridor was challenging given the distribution of jobs of the surrounding blocks and neighborhoods are predominately health services, particularly jobs in a hospital in the project area (which would be less likely to be affected by any bike lane construction). Given the very small number of jobs represented in the food, retail, and entertainment sectors in the treatment and control corridors, graphs should be interpreted with caution. The resulting control has fewer total food and retail jobs relative to treatment corridor with noisier trends given its limited size. The trends in the treatment corridor show job growth from 2016 through the construction of the bike lane in 2017 and 2018. From 2018 to 2019 job growth was flat before declining sharply due to the pandemic. When compared to the citywide trends (Figure 10), the treatment and control corridors saw above average growth in jobs through the bike lane construction period and a similar pause in growth from 2018 to 2019. Overall, the trend in job growth appears unchanged in the treatment corridor after the construction of the bike when compared against either control or citywide measures.

**Figure 9. Food and Retail Jobs Comparison, Cambridge St. – Quincy/Fayette and Cambridge St. – Quincy/Fayette Control (Mt. Auburn St.) (2011-2020)**

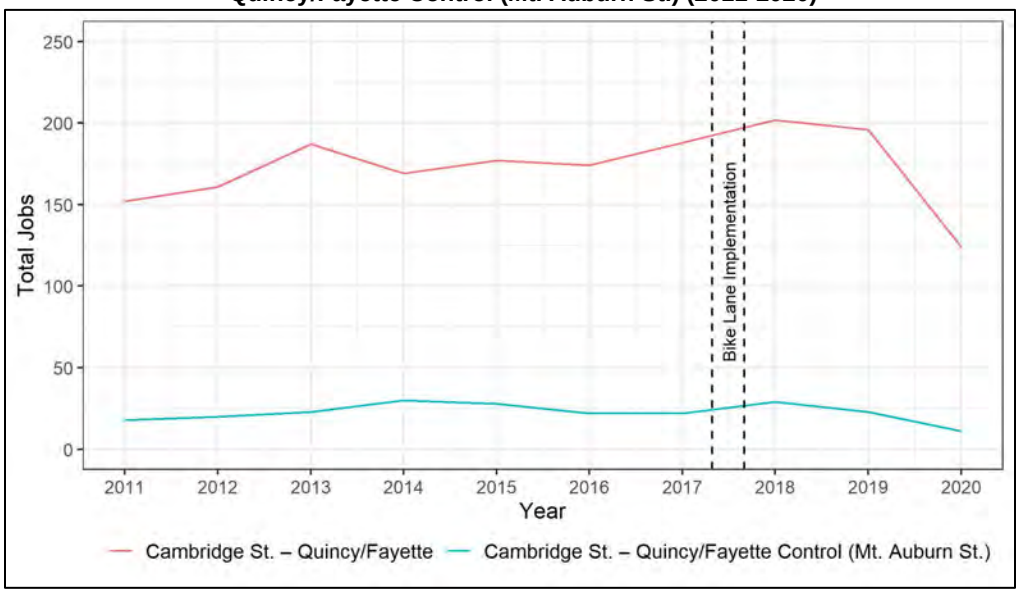
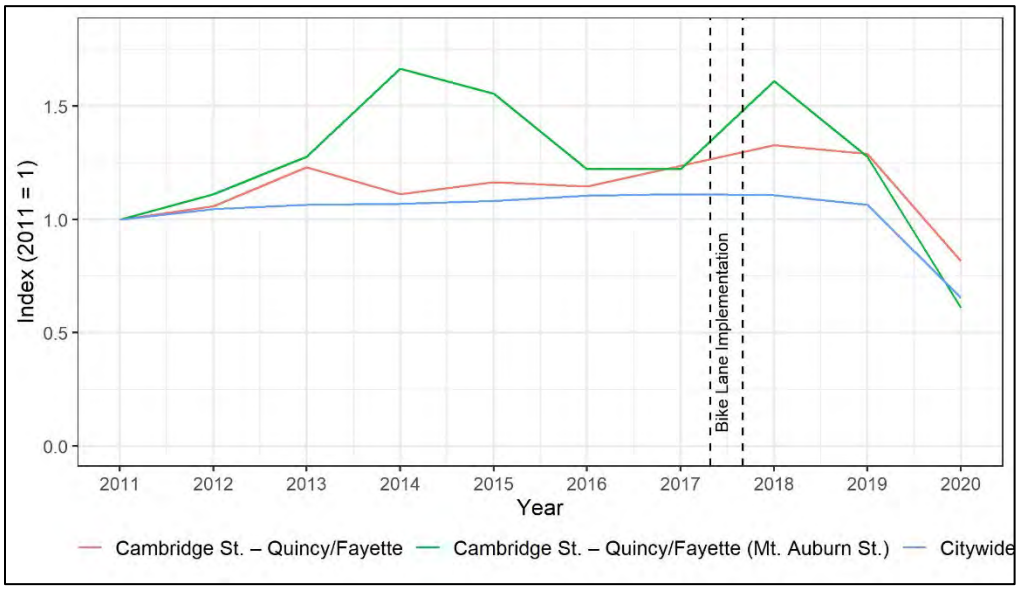


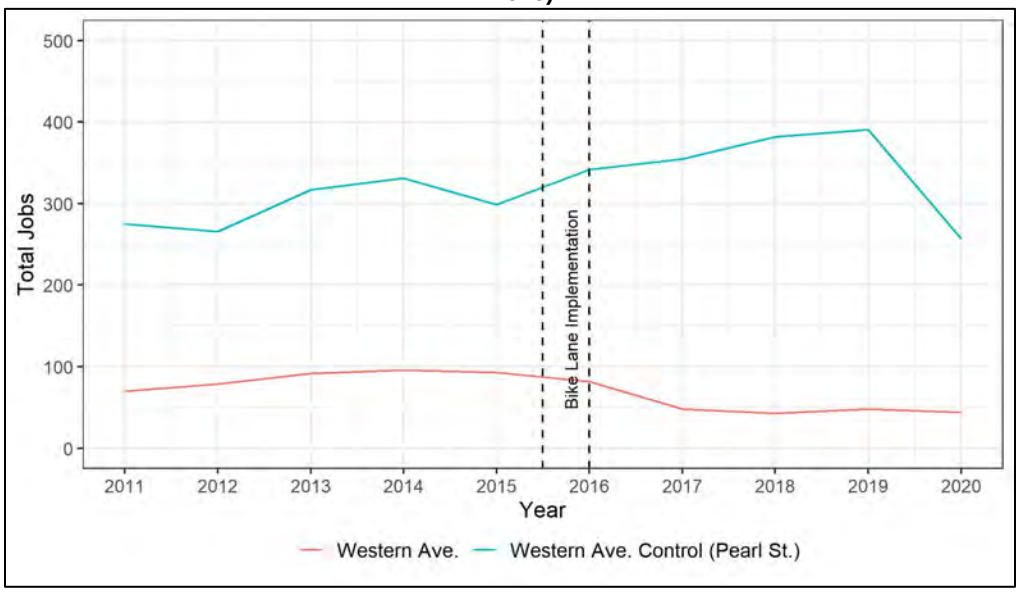

**Figure 10. Food and Retail Jobs Comparison, Cambridge St. – Quincy/Fayette, Cambridge St. – Quincy/Fayette Control (Mt. Auburn St.), and Citywide (Indexed = 1 in 2011)**



### 5.1.3 Western Ave.

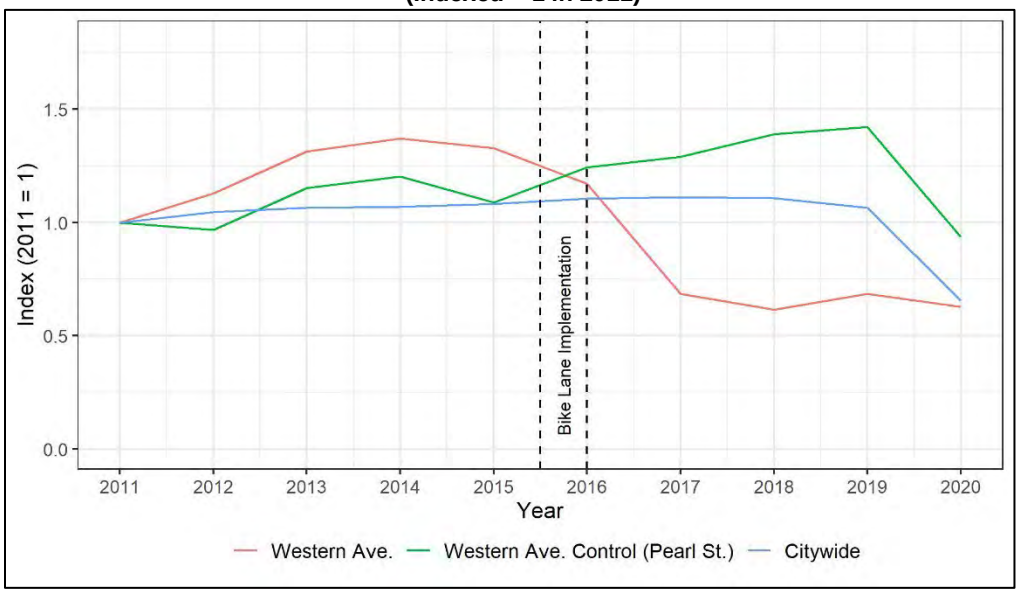
Figure 11 and Figure 12 present the comparison of food and retail job trends for Western Ave. against the control corridor and Cambridge citywide index, respectively. Given the very small number of jobs represented in the food, retail, and entertainment sectors in the treatment corridor, graphs should be interpreted with caution. The treatment and control corridor show a difference in the overall trends, with the control increasing throughout the period examined, while the treatment sees some job growth prior to construction of the bike lane, but a decrease in jobs prior to and after construction in 2015 through 2018 before remaining flat from 2018 to 2020. When compared to the citywide index, the treatment corridor's decline in jobs can be seen beginning in 2015, with the steepest reduction in 2016 to 2017. No hard conclusion can be drawn from the differences in trends; however, the employment data points to some job loss post- construction in the food and retail sectors, but the declining trend in jobs in those sectors began prior to bike lane construction. It should be noted that "major utility reconstruction" on this project began in September 2012, with final paving and painting occurring in the second half of 2015 through early 2016, which is considered to be the bike lane implementation period.[38]

**Figure 11. Food and Retail Jobs Comparison, Western Ave. and Western Ave. Control (Pearl St.) (2011-2020)**




[38] See: https://www.cambridgema.gov/~/media/Files/CDD/Transportation/Projects/WesternAvenue/Western_Report_Final_2019_01_18.pdf

**Figure 12. Food and Retail Jobs Comparison, Western Ave., Western Ave. Control (Pearl St.), and Citywide (Indexed = 1 in 2011)**




# 5.2 SafeGraph Point of Interest Consumer Data Considerations

## 5.2.1 Data Source and Variables

Another approach to analyzing the effects of protected bike facilities on retail sales is with location-based estimates of transaction volume. Point of Interest (POI) consumer sales data compiled by SafeGraph was purchased by the study team for potential analysis. The sales data is estimated for individual establishments at the monthly level from January 2019 through March 2023. SafeGraph uses a proprietary process to aggregate transaction data to the point of interest (establishment) level.[39]

In theory, the POI sales data should be a reasonable proxy to measure the overall economic health of commercial sections or corridors of the city. Establishment level sales data was readily mapped to corridors that received a separated bike lane during this period (treatment) and to identified control corridors (see Section 4.1 on corridor definition) using latitude and longitude information in the SafeGraph data, as well as business address information. SafeGraph also provided a state-specific expansion factor that was used to translate the unadjusted SafeGraph observations into estimates of actual retail sales volume, i.e., adjusting for the fact that the size of SafeGraph's sample varies over time.

[39] See: https://docs.safegraph.com/docs/spend

### 5.2.2 Data Quality

An initial review of the list of retail and restaurant establishments found reasonable coverage city-wide; however, issues were apparent in both the quality of the sales data and the coverage at the monthly and quarterly level for individual establishments. Significant and unexpected variation in the sales data exists at the establishment level, making both the absolute value and rate of change questionable. In one instance, sales data for a restaurant increased by over 100-fold for two quarters before coming back to its previous average quarterly value, which is unlikely to be explained by any real-world phenomenon.

The other major concern is the lack of data coverage at the monthly/quarterly level. Given that the data is monthly in its initial level of aggregation, one missing quarter indicates no data recorded in three consecutive months in the dataset. For example, a corridor of interest had 88 identified establishments, but 15 of them had only a single non-missing quarterly observation over the entire time series (Q1/2019 – Q3/2023, or 17 quarters). Moreover, over half the establishments had 3 or more missing quarterly data points, making the dataset unsuitable for discernment of trends using typical statistical techniques.

The issues of missing data and data variation are clearly linked in the underlying data generation process, making any inference in high level trends or other more sophisticated modeling efforts (e.g., difference-in-difference regression analysis[10]) invalid. Details regarding the data coverage are shown in Table 6 for an example corridor (Mass Ave. – Roseland/Beech).

**Table 6. Count of Businesses by Number of Missing Observations: Mass Ave. – Roseland/Beech**

| Count of Missing Observations (Quarterly) | Count of Businesses |
|---|---|
| 0 | 23 |
| 1 | 9 |
| 2 | 8 |
| 3 | 2 |
| 4 | 1 |
| 5 | 4 |
| 6 | 2 |
| 7 | 1 |
| 8 | 2 |
| 9 | 1 |
| 10 | 2 |
| 11 | 5 |
| 12 | 3 |
| 13 | 2 |
| 14 | 6 |

| Count of Missing Observations (Quarterly) | Count of Businesses |
|---|---|
| 15 | 2 |
| 16 | 15 |
| **Total** | **88** |

### 5.2.3 Conclusions

Overall, unexplained inconsistencies in the data including a large number of missing observations and implausibly high and low values make this dataset unsuitable for any statistical analysis at the geographic level required for this study. As such, no conclusions can be drawn from this dataset.

## 5.3 Exploration of CoStar Data

CoStar Group is a company that provides commercial real estate information and analytics for real estate transactions (sales and leasing). Private sector providers such as CoStar[40] estimate rental rates and availability rates for commercial properties.[41] Commercial real estate lease rate and/or occupancy/availability data is useful for providing additional context regarding the commercial desirability of corridor locations. Because the value of urban real estate hinges on the commercial desirability of its location, changes in rents can provide a useful indirect measure of changes in retail activity and overall accessibility. Occupancy and availability data also provide a secondary measure, if the market rents fall below a tenant's current contract rent, the tenant may choose to vacate or relocate.

These datasets are credible as they are used widely in the real estate industry, and they permit geographic analysis in which data on properties near bicycle facility projects can be compared to a control group, or data on properties near bicycle facility projects can be compared before and after the installation.[42]

### 5.3.1 Data Source and Variables

In order to process the data for the appropriate treatment and control corridors, as defined in Section 4.1, the City extracted commercial business rental data using polygons in the online tool available

[40] See: https://www.costar.com/

[41] Although property values are also available through the city assessor, these can involve longer time lags for availability.

[42] The City maintains an existing subscription to CoStar Group for other purposes.

through CoStar.[43] Extracted information includes the list of included businesses, as well as several quarterly measures, including the number of buildings, the available square footage, availability as a percent of total square footage of rentable building area, and the overall rental rate (per square foot) for all service types. Historical data availability varies by corridor.

### 5.3.2 Data Quality

In considering the quality of the data, both the number of buildings represented in the data in each corridor and the total number of observations in the time series of availability and overall rent information were considered.[44] Ideally, a data series for analysis would contain actual individual business unit level information over time. However, the available data only allows for a snapshot of business units (i.e., at a single point in time), or a time series of historical data for a group of business units. If data were available at the business unit level over time, further statistical analysis would be possible. For the analysis conducted, the time series information was used at the corridor level, but given the lack of transparency in the processes used to aggregate values extracted in the dataset, in particular rental rates, interpretation should be made with caution.

The number of businesses represented in the data varies substantially by corridor. Given that the data quality varies by corridor, analysis was not possible for all identified corridors. In particular, the Western Ave and Cambridge Street corridors and their respective controls, as defined in Section 4.1, did not have a large number of buildings represented in the data.

Additionally, some corridors had substantial missing rent data and/or availability data in the period from 2013 Q1 to 2023 Q2 (42 quarters). The Cambridge St. treatment and control corridors, as well as the Mass Ave. – Trowbridge/Pleasant and Western Ave. corridors all have over 50% of quarters with missing data for rent and/or availability (Table 7). As a result, these corridors were not considered for analysis.

**Table 7. Missing Rent and Availability Data 2013 Q1 – 2023 Q2**

| Corridor | Percent of Quarters Missing Rental Rate | Percent of Quarters Missing Availability |
|---|---|---|
| Mass Ave. – Alewife/Dudley | 24% | 21% |
| Mass Ave. – Alewife/Dudley Control (Mass Ave. – Rice/Walden) | 5% | 0% |
| Brattle St. | 19% | 2% |
| Brattle St. Control (JFK St.) | 33% | 2% |

[43] Given that the online tool requires manual polygon definition, radii used may not be an exact match for other corridors analyzed in different portions of this report.

[44] Variables used were “Vacant Available % Total”, and “All Service Type Rent Overall.” See: https://www.costar.com/about/costar-glossary

| Corridor | Percent of Quarters Missing Rental Rate | Percent of Quarters Missing Availability |
|---|---|---|
| Cambridge St. – Quincy/Fayette | 52% | 50% |
| Cambridge St. – Quincy/Fayette Control (Mt. Auburn St.) | 93% | 100% |
| Mass Ave. – Roseland/Beech | 12% | 0% |
| Mass Ave. – Roseland/Beech Control (Mass Ave. – Forest/Chauncy) | 24% | 0% |
| Mass Ave. – Trowbridge/Pleasant | 100% | 0% |
| Mass Ave. – Trowbridge/Pleasant Control (Cambridge St.) | 19% | 0% |
| Western Ave. | 0% | 2% |
| Western Ave. Control (Pearl St.) | 90% | 81% |

### 5.3.3 Analysis

Summary statistics are shown in Table 8. Analysis corridors include Mass Ave. – Alewife/Dudley, Brattle St., and Mass Ave. – Roseland/Beech and their respective controls. As noted in Section 4.1, some corridors, such as Mass Ave. – Alewife/Dudley, have characteristics which make defining control corridors difficult, such as designated transit lanes.

**Table 8. Summary Statistics (Treatment and Control Corridors): 2013 Q1 – 2023 Q2**

| Statistic | Availability |
|---|---|
| **Mean** | 0.050 |
| **Median** | 0.044 |
| **Standard Deviation** | 0.039 |
| **Min** | 0.001 |
| **Max** | 0.183 |
| **N (Quarter & Corridor Observations)** | 241 |

To analyze the corridors, the time period following the installation of separated bike lanes was considered to be a treatment period (i.e., the treatment is the installation of separated bicycle facilities), and the period prior to and during installation was considered to be a pre-treatment period. For the three corridors examined, the time periods used for treatment and pre-treatment assignment are shown in Table 9.

**Table 9. Treatment Period Assignment by Treatment Corridor[45]**

| Treatment Corridor | Pre-Treatment Period (Separated Bicycle Facilities Not Installed) | Treatment Period (Separated Bicycle Facilities Installed) |
|---|---|---|
| Mass Ave. – Alewife/Dudley | 2013Q1 – 2021Q3 (n=35) | 2021Q4 – 2023Q2 (n=7) |
| Brattle St. | 2013Q1 – 2017Q2 (n=18) | 2017Q3 – 2023Q2 (n=24) |
| Mass Ave. – Roseland/Beech | 2013Q1 – 2022Q2 (n=38) | 2022Q3 – 2023Q2 (n=4) |

The variables of interest used for analysis were the average availability and the average overall rent. Two comparisons were made for each corridor analyzed. The first comparison is between the pre-treatment and treatment period averages[46] within a single corridor, using a t-test for comparison of means for the treatment corridors.[47] The null hypothesis of the test is that the difference of the means between the two groups compared is zero. A statistically significant difference indicates a difference in the means of the two groups for the variable of interest. However, no causal inference should be made from the results of the t-test. In other words, statistically significant results indicate only that the mean values differ, not that the treatment (i.e., installation of protected bike lanes) was the cause of that difference. When considering a difference in means, there are several alternative hypotheses that can be considered. The first is that the difference in means is not equal to zero, the second is that the pre-treatment mean is greater than the treatment period mean (the difference between the values is positive), and the third is that the treatment period mean is greater (the difference between the values is negative). Depending on the sign of the difference in the means, it is possible to infer that there is an increase or decrease in the (space) availability (i.e., where lower availability in the treatment period relative to the pre-treatment period indicates fewer vacancies available to rent). Conversely for overall rent, depending on the sign, inference can be drawn on an increase or decrease in rent.

Table 10 shows the pre-treatment and treatment period comparison for Mass Ave. – Alewife/Dudley, Brattle St., and Mass Ave. – Roseland/Beech for the availability in treatment corridors. For Mass Ave. – Alewife Dudley, the null hypothesis that there is no difference between the pre-treatment and treatment values is not rejected. For Brattle St., the null hypothesis that there is no difference in the means is rejected at the five percent significance level, and there is higher average availability in the treatment period. Conversely, for Mass Ave. – Roseland Beech, the null hypothesis is rejected at the one percent significance level, and there is a lower average availability in the treatment period. Given these

[45] N reflects total possible quarters of data in period.

[46] As discussed above, the construction of the dataset affects what analysis is possible. While availability (i.e., whether a building is available for rent) is generally considered a binary variable, the construction of the data set, which includes a time series of shares of available space as a continuous variable, a t-test for equality of means is used in this analysis for comparison of availability.

[47] T-tests for equality of means are used to compare the mean values of two groups and a specified confidence level is used to accept or reject the null hypothesis that the means are the same, that is, a statistically significant value indicates confidence that the means are not equal. Analysis can also consider the power of the test, which can be interpreted as the probability that the test of significance will correctly estimate a difference in the values when it does exist.

conflicting results, the results of this test are not conclusive when considering the (space) availability variable. It should also be noted that both Mass Ave. corridors considered have a small number of post-treatment quarters for analysis. Ideally, future analysis would consider additional post-treatment quarters as the information becomes available.

**Table 10. Pre-treatment versus Treatment Average Availability by Corridor**

| Treatment Corridor | Pre-Treatment Period – Mean Availability | Treatment Period – Mean Availability | P value: Ha = mean (pre-treatment)-mean(treatment) < 0 | P value: Ha = mean (pre-treatment)-mean(treatment) > 0 |
|---|---|---|---|---|
| **Mass Ave. – Alewife/Dudley** | 0.020 | 0.016 | | 0.1775 |
| | (0.002) | (0.003) | | |
| | n=27 | n=6 | | |
| **Brattle St.** | 0.036 | 0.063 | 0.0401* | |
| | (0.012) | (0.010) | | |
| | n=18 | n=23 | | |
| **Mass Ave. – Roseland/Beech** | 0.078 | 0.025 | | 0.0045** |
| | (0.006) | (0.003) | | |
| | n=38 | n=4 | | |

Standard Errors in Parentheses: p<0.05*, p<0.01**, p<0.001***

A pre-treatment and treatment period analysis for Mass Ave – Alewife/Dudley, and Brattle St. on the overall rent in the treatment corridors was also conducted. For both corridors, the analysis showed that treatment period rent is higher than pre-treatment period rent (in unadjusted terms). However, in real terms, the average rents before and after installation are not different. As is noted above, rental rates have a higher share of missing entries in the dataset, and the methods for calculating these values were not transparent.

Another comparison that can be made is between each treatment corridor and its respective control corridor for the pre-treatment and treatment periods, also using a t-test for comparison of means. The results of this test are shown for an example corridor, Brattle St., in Table 11.[48] There is not a statistically significant difference in average availability between the treatment and control corridors in the pre-treatment period or in the treatment period at the five percent level. However, in the treatment period, the null is rejected at a ten percent level, indicating higher availability rates in the control corridor relative to the treatment corridor.

[48] This corridor was selected due to the availability of the largest number of both pre- and post-treatment quarters among analysis corridors.

**Table 11. Control Corridor versus Treatment Corridor Average Availability**

| Corridor and Period | Control Corridor - Mean Availability | Treatment Corridor - Mean Availability | P value: Ha = mean (pre-treatment)-mean(treatment) > 0 |
|---|---|---|---|
| **Brattle St. – Pre-Treatment Period** | 0.036 | 0.036 | 0.507 |
| | (0.008) | (0.012) | |
| | n=17 | n=18 | |
| **Brattle St. – Treatment Period** | 0.083 | 0.063 | 0.062 |
| | (0.008) | (0.010) | |
| | n=24 | n=23 | |

Standard Errors in Parentheses: p<0.05*, p<0.01**, p<0.001***

### 5.3.4 Conclusions

In summary, comparisons of space availability or rental data can be made between the pre-treatment (installation) period and treatment (post-installation) period for bike lane corridors, as well as between treatment corridors and their respective controls. Utilization of CoStar as a data source revealed several substantial sources of error for this analysis. As discussed previously, an ideal data source for commercial rental prices or availability rates would include historical data for individual units or buildings which includes actual and/or estimated rental value, and availability percentage. However, data extracts used for analysis were not at the individual business level, and instead historical data was available at the more aggregate corridor level. Even at the aggregate level, data included many missing values in either rent, availability, or both, and the definitions of the variables lacked transparency in terms of the process for aggregation.

Examining corridors with the least missing data resulted in conflicting results for different corridors when comparing the pre-treatment (pre-installation of separated bicycle facilities) time periods to the treatment (post-installation) periods. That is, the Brattle St. treatment area showed an increase in availability (more vacancies) in the post-installation period, while the Mass Ave – Roseland/Beech treatment area showed a reduction (fewer vacancies) in the post-installation period. These impacts met thresholds for statistical significance but were relatively small in practical terms. When conducting the analysis on the basis of comparing treatment and control corridors, the results were not significant in the treatment period. Overall, only limited inferences can be drawn from the CoStar real estate data, but they generally indicate that differences in commercial property within corridors and between time periods, or between treatment and control corridors, are not substantial and may vary by location. Looking forward, planning for a similar analysis for future projects should consider the availability of individual business-level information as well as sufficient pre- and post-treatment time period availability.

# 6. Surveys Conducted by the City of Cambridge

## 6.1 Review of Literature

McCormick (2012)[49] administered a business survey via interview for a corridor in Los Angeles regarding perceived impacts of car and bike lanes. The survey included questions on business tenure, whether the building is owned or rented, and the number of employees. The survey also included questions regarding perceived impacts on business access of traffic calming, increased/decreased car lanes, and bicycle lanes. The survey included an oral consent script. McCormick notes that for speed of implementation, the survey primarily uses yes/no or multiple-choice formats. The survey was administered in both English and Spanish and was administered in person. The sample was developed using a comprehensive list of active businesses to develop the population using an online mapping database of assessor information and field visits. The businesses in the survey sample were selected using a random number generator. It is noted that response rates were low and additional businesses were selected.

Sztabinski (2009)[50] administered a merchant survey for a corridor in Toronto regarding perceived impacts of reduced parking to businesses. The survey methodology involved requesting a manager or business owner complete the survey, and three follow ups with each business. The survey was only administered to ground-floor merchants. The survey content regarded customers served, percent of customers estimated to be driving, and expected change in customers in hypothetical scenarios which would remove parking. The survey totaled 5 questions, and 61 out of 110 surveyed businesses responded. The survey response rates varied by type of business, with store owners responding at a higher rate than restaurants and bars or service businesses. Sztabinski notes study limitations regarding the lack of random sampling and potential bias to surveying only ground-floor merchants, as well as seasonality.

As noted in Section 2.4, Chappel et al. (2018) conducted an intercept survey of customers in paired corridors, where pairs were determined based on business density and mix, as well as population demographic and mode choice characteristics, to examine mode choice and consumer behavior. The survey questionnaire included 20 questions regarding the current shopping trip (business type, projected spending), travel to the area (on the current trip, frequency, and frequency by bike), and

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[49] Cullen McCormick, "York Blvd: The Economics of a Road Diet," 2006, https://nacto.org/docs/usdg/yorkblvd_mccormick.pdf.

[50] Fred Sztabinski, "Bike Lanes, On-Street Parking and Businesses: A Study of Bloor Street in Toronto's Annex Neighbourhood," 2009, https://www.bikeleague.org/sites/default/files/bikeleague/bikeleague.org/programs/bicyclefriendlyamerica/bicyclefriendlybusiness/pdfs/toronto_study_bike_lanes_parking.pdf.

demographic information (access to a car of bicycle, income, and home location). The survey ultimately had 250 valid responses. Findings of the intercept survey were generally mixed or counterintuitive, and the authors note that intercept survey findings do not establish causal impacts of bicycle infrastructure.

## 6.2 Business Survey

In order to supplement other data sources, the City conducted a survey of local businesses regarding trends in business and sales with respect to bike lane installations and parking. The City met with relevant stakeholders such as the City Council and business associations while developing the survey, determined the final survey population, and distributed and administered the survey.

### 6.2.1 Methodology

The survey methodology first developed a list of eligible Cambridge businesses in order to define the survey population. Next, a survey questionnaire was developed with input from the Volpe Center.

#### *6.2.1.1 Determining Survey Population*

Initial planning for the survey indicated that, generally, first floor businesses would be preferred for the survey population, but some businesses such as medical offices that are not on the first floor have expressed concerns regarding the impacts of bike lanes and parking changes. Instead of considering the business's physical address, the City determined that the survey population would include businesses of specific types (e.g., medical, retail, service, recreation, food).[51] The initial list began with businesses that have permits or licenses with the City, [52] however, this is not universal, and the list was supplemented with available information from other sources.[53] Final manual review to determine relevant businesses included the addition of missing medical professionals, new businesses, and missing businesses

[51] More specifically, in reviewing data, relevant NAICS codes were determined to be 44, 45, 53, 62, 71, 72, 81. Businesses with a NAICS code of 0, blank, or NA were not removed from the list developed by the City.

[52] Within the existing business list from the city, NAICS code was generated based on available SIC Code fields, duplicates were identified and manually reviewed based on the account name and address, and manual review was conducted to identify street addresses if the field was empty in the underlying data. Addresses were also reviewed to confirm that the location and zip code were consistent with addresses in the City of Cambridge.

[53] Supplemental information from INFOUSA was used to determine addresses and to add additional samples in NAICS code 62. For exact business name matches between the City's data and the INFOUSA data where supplemental information was required, the address from INFOUSA was used and manual review using internet search was also conducted. If no match could be made with the INFOUSA database, an address was assigned via manual review using internet search where possible. Businesses which could not be identified via internet search, businesses with addresses outside the City of Cambridge, closed businesses, and corporate office buildings were removed where possible. For manual review of apparent duplicate records, where possible, the company name was used over the name of a person in assigning the business name, and the City's existing business data was used over the INFOUSA data, as it was considered to be more reliable.

identified by the City. The initial list of survey recipients included 1,675 businesses within the City of Cambridge. The City also allowed businesses (if not contacted) to contact the City in order to be included in the survey effort.

#### *6.2.1.2 Survey Questionnaire*

Survey topics included business characteristics such as tenure, address, type of business, and number of customers. The survey also included changes to business revenue since 2019 (pre-COVID baseline), whether a bike lane was installed/changed near the business in the last several years (including prior to 2020), perceived business impacts of bike lanes/street changes, and whether parking or loading zones were impacted near the business, and any perceived business impacts of parking or loading zone changes. A complete list of survey questions is included in Appendix A.

Based on feedback received prior to survey design, and the lack of availability of tax data from the Commonwealth of Massachusetts, consideration was given to allowing businesses to voluntarily share data that they may consider relevant to this study. This survey question was noted as optional, and respondents had the opportunity to note whether the City should follow up with the respondent so that the respondent could securely share information with the City. The question was noted as optional to minimize potential impacts on survey response rates. Prior to survey administration, it was expected that the number of businesses that would opt in to this option would be small, but given anecdotal feedback received by the City prior to survey administration, the question was included. In total, one business chose to share sales data with the City. Analysis of this information is not included in this report.

### 6.2.2 Survey Administration

The survey was administered beginning on July 5, 2023, and the final responses analyzed in this report were as of September 5, 2023.[54] The survey was conducted via an online survey tool, with unique URLs for individual businesses. The initial survey notification was sent via mail to increase confidence in authenticity, with an explanation of the study and the Cycling Safety Ordinance.[55] In order to increase the response rate, the City conducted follow-ups using email, phone, and/or in person notification using fliers provided to businesses. Instructions were provided that the survey should be completed by the owner or manager of the business, when possible, to ensure the accuracy of information.

[54] The survey remained open through October 31, 2023, ultimately receiving 320 responses. Responses received after September 5, 2023 were evaluated qualitatively, however the responses reported in this report only include responses received as of September 5, 2023.

[55] See: "Cycling Safety Ordinance," https://www.cambridgema.gov/en/streetsandtransportation/policiesordinancesandplans/cyclingsafetyordinance.

### 6.2.3 Survey Response Rate and Coverage

In total, the City received 277 survey responses. Out of the survey population of 1,697 potential businesses, 231 businesses were removed from the list for a variety of reasons as shown in Table 12.[56] As a result, the total population of recipients is considered to be 1,590 businesses, and the associated response rate based on this number is approximately 17%.

**Table 12. Survey Response[57]**

| Removal Reason | Eligible | Count |
|---|---|---|
| Wrong address/Mail returned/Email returned | Unknown | 107 |
| Closed/moved/does not exist | No | 66 |
| Duplicate | No | 22 |
| Part of hospital or university/Otherwise ineligible | No | 12 |
| Refusal | Yes | 9 |
| Outside Geography | No | 7 |
| Other - Unknown | Unknown | 5 |
| Other - New Business | Unknown | 3 |
| Incomplete | Yes | 1189 |
| Partial Complete/Complete | Yes | 277 |
| **Total** | **N/A** | **1697** |

Table 13 shows the distribution of outgoing sample and survey response across business zip code. The 02139 zip code had the most businesses (36%), and this share is similar to the outgoing distribution in that zip code (33%). However, it should be noted that the 02140 zip code is over-represented in the surveyed businesses compared to the overall outgoing sample, with 28% of responses in that zip code compared to 19% of the outgoing population, and conversely the 02138 zip code is underrepresented in the survey businesses, with 24% of responses in that zip code, compared to 34% of the outgoing population. While the City made efforts to follow up with non-respondents, the survey was voluntary, and the businesses and any associated responses may not be representative of the full population of businesses in the City.

[56] Some businesses were removed in the calculation of response rate. These included closed businesses, businesses that have moved or do not exist, duplicates, and businesses outside the City of Cambridge. Businesses that are located in or are part of a hospital or university or other ineligible space (e.g., large office building) were also removed. Businesses which had returned letters are considered to have unknown eligibility, and businesses which refused the survey through contact with the City are considered eligible non-respondents.

[57] As of September 5, 2023

Table 13. Survey Response by Zip Code

| Zip Code | Completed - Count (Percent) | Not Started- Count (Percent) | Total - Count (Percent) |
|---|---|---|---|
| 02138 | 67 (24%) | 481 (37%) | 548 (34%) |
| 02139 | 99 (36%) | 420 (32%) | 519 (33%) |
| 02140 | 77 (28%) | 221 (17%) | 298 (19%) |
| 02141 | 29 (10%) | 132 (10%) | 161 (10%) |
| 02142 | 5 (2%) | 59 (4%) | 64 (4%) |
| **Overall** | **277** | **1313** | **1590** |

### 6.2.4 Survey Responses

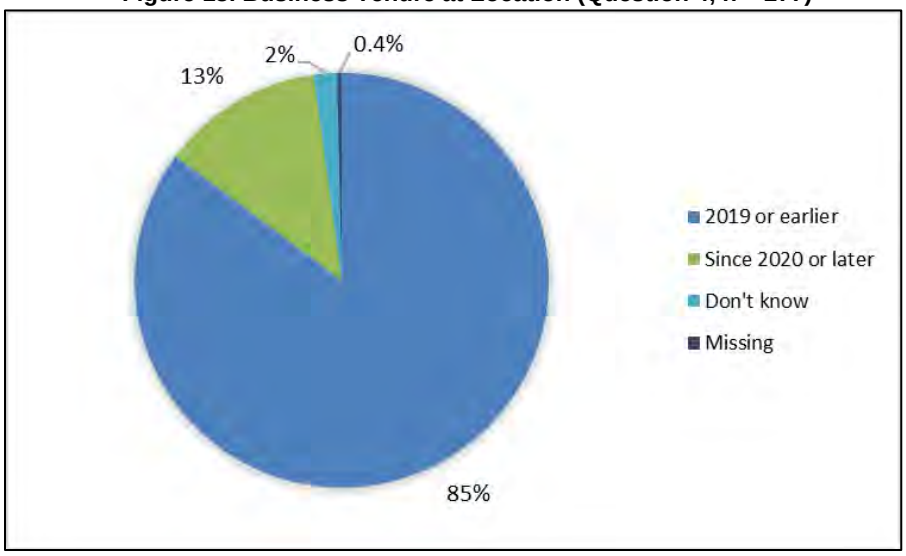
The survey questionnaire addressed both questions regarding general business characteristics, the impact of bicycle facilities, and parking. Each topic is discussed in detail in the following sections. All responses are reported for the full set of 277 businesses unless otherwise specified. Survey responses were geolocated to correspond with the six treatment corridors outlined in Section 4.1 and 4.2, (see Figure 1 ). Given small sample sizes, analysis at the individual corridor level was not possible, both in considering any statistical analysis and for the purposes of not reporting data which could identify the response of any particular business to the survey.

For the purposes of analyzing the business survey responses, businesses were categorized as being in a treatment corridor if they are located within the defined 100-yard corridor radius of any of the six treatment corridors, in a control corridor if they are located within the defined 100-yard corridor radius of any of the six control corridors, and non-corridor if they are located outside of all defined corridor radii of the 12 treatment and control corridors (see Section 4.2 for geographic corridor definitions). As noted in Section 4.1, the corridors explored in this study are reflective of only a portion of total bicycle facilities in the City, and therefore, non-corridor businesses may or may not have separated bicycle facilities or bicycle facilities of any type depending on their location.

#### *6.2.4.1 General Business Characteristics – Overall*

The majority of businesses responding to the survey opened prior to 2020, with only 12.6% reporting that they have been at their location since 2020 or later (Figure 13).

**Figure 13. Business Tenure at Location (Question 4, n = 277)**




The largest group of responding businesses were identified as dining or takeout, at 30%, and the second largest group is retail sales at 25%, followed by professional services (example: medical office), at 20%, and then personal services (examples: hair salon, childcare) at 16%, as shown in Table 14.[58]

**Table 14. Reported Business Type (Question 3, n = 277)**

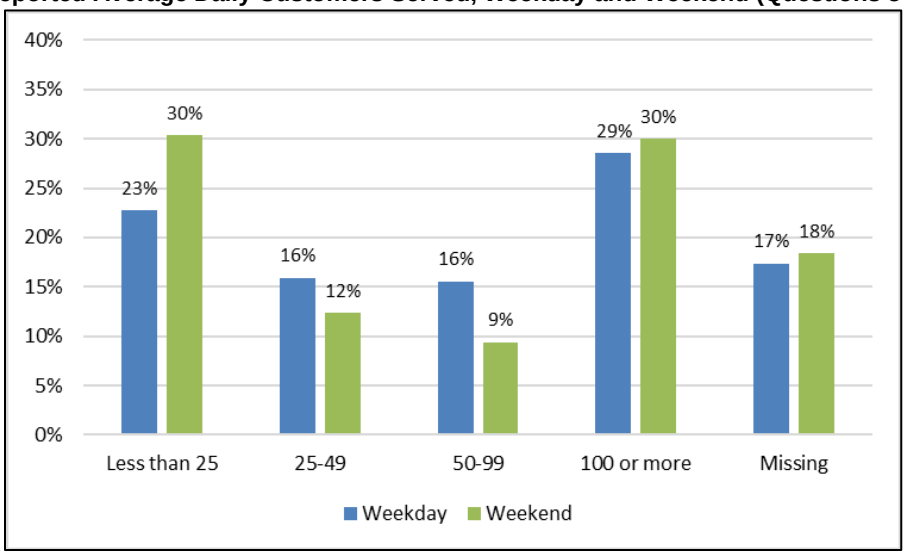
| Business Type | Count (Percent) of Responses |
|---|---|
| **Dining/Takeout** | 82 (30%) |
| **Personal Services** | 43 (16%) |
| **Professional Services** | 56 (20%) |
| **Retail Sales** | 68 (25%) |
| **Other** | 24 (9%) |
| **Missing** | 4 (1%) |

The reported average daily number of customers served on weekdays and weekends show similar distributions (Figure 14), with the largest share of businesses reporting less than 25 customers (23%

[58] "Other" responses were reviewed for this question and reassigned to the business type categories identified in the question, where appropriate.

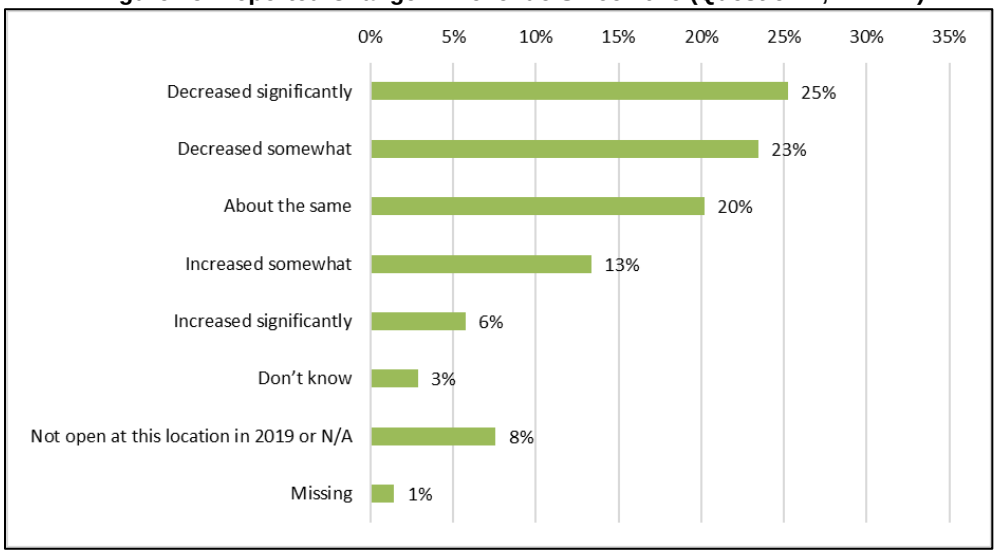
weekday, 30% weekend) or 100 or more customers (29% weekday, 30% weekend), and fewer businesses reporting intermediate scale values. However, it should be noted that the large number of missing responses (17% weekday, 18% weekend) to these questions indicates that it may be difficult for businesses to answer this question without prior preparation.

**Figure 14. Reported Average Daily Customers Served, Weekday and Weekend (Questions 5 and 6, n = 277)**



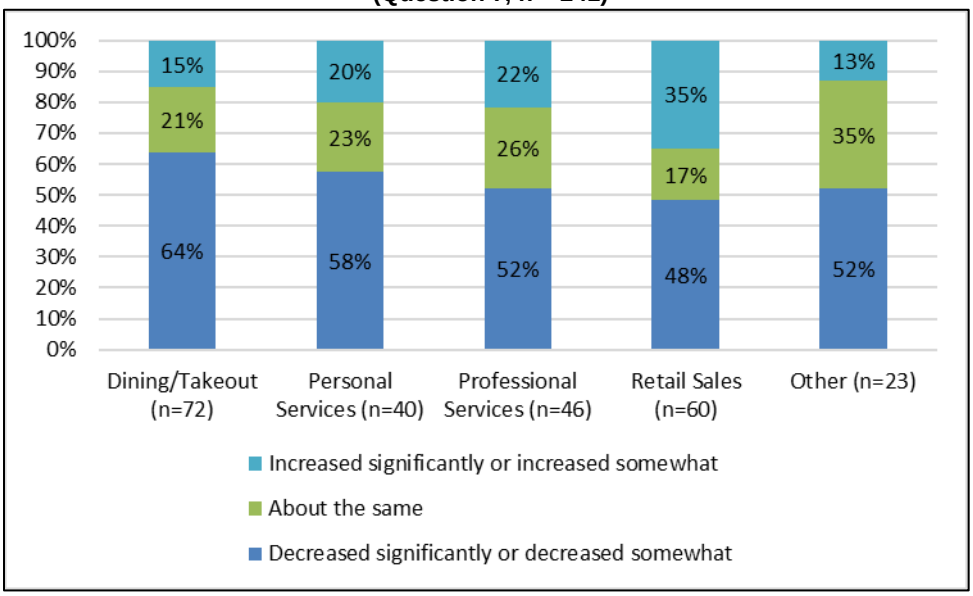

About half of survey businesses reported current overall revenue has decreased significantly (25%) or decreased somewhat (23%) since 2019 at the surveyed location. The next largest share of businesses is those reporting that revenue is about the same (20%) compared to a 2019 baseline, and fewer businesses report that revenue has increased somewhat or significantly since 2019, with 13% of businesses reporting that revenue has increased somewhat, and 6% of businesses reporting that revenue has increased significantly (Figure 15).

**Figure 15. Reported Change in Revenue Since 2019 (Question 7, n = 277)**



The types of businesses reporting an increase versus a decrease in revenue since 2019 varied. Figure 16 shows the share of responses indicating revenue increased, decreased, or is about the same among the business reporting a revenue change (i.e., removing don't know, N/A, and missing responses) by business type. Dining/Takeout businesses had the largest share reporting a decrease in revenue, at 64%, while retail sales had the largest share reporting an increase in revenue, at 35%.

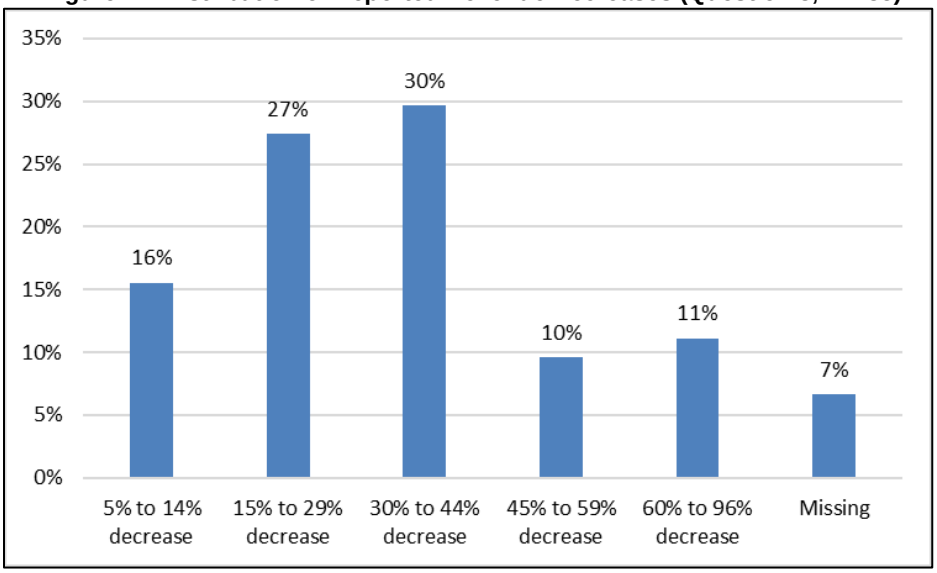
**Figure 16. Share of Responses Indicating Increase or Decrease in Revenue Since 2019 by Business Type (Question 7, n = 241)[59]**




Among businesses reporting that revenue decreased significantly or decreased somewhat, the majority of businesses reported decreases in revenue less than or equal to 44%. The largest group of businesses reported a 30% to 44% decrease, followed by businesses reporting a 15% to 29% decrease. Figure 17 shows the distribution of reported revenue decreases in percentage terms, for businesses reporting decreased revenue relative to 2019.

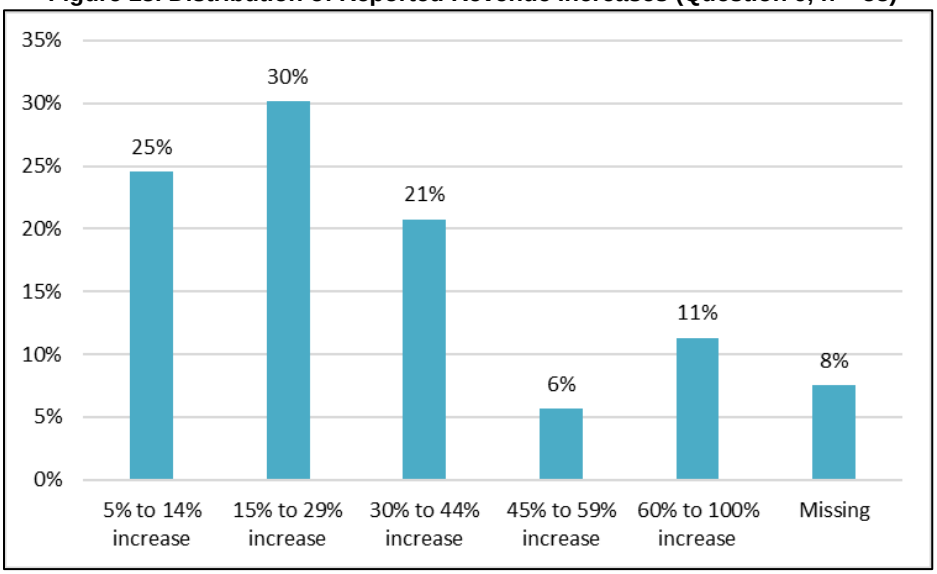
[59] Values excludes Don't Know, N/A, and Missing Responses to Question 7.

**Figure 17. Distribution of Reported Revenue Decreases (Question 8, n=135)[60]**




Among businesses reporting that revenue increased significantly or increased somewhat, the majority of business reported increases in revenue less than or equal to 44%. The largest group of businesses reported a 15% to 29% increase, followed by businesses reporting a 5% to 14% increase. Figure 18 shows the distribution of reported revenue increases in percentage terms, for businesses reporting increased revenue relative to 2019.

**Figure 18. Distribution of Reported Revenue Increases (Question 9, n = 53)[61]**




[60] Base is business reporting revenue decreased significantly or decreased somewhat in Question 7.

[61] Base is business reporting revenue increased significantly or increased somewhat in Question 7.

#### *6.2.4.2 General Business Characteristics – Corridor Assignment*

Figure 19 shows business type by corridor assignment. Businesses that are in a treatment corridor are in any of the treatment corridors identified for this study, and the control corridor businesses are in identified control corridors (see Section 4 for corridor definitions).

**Figure 19. Business Type by Corridor Assignment – Treatment versus Control (Question 3, n=166)**

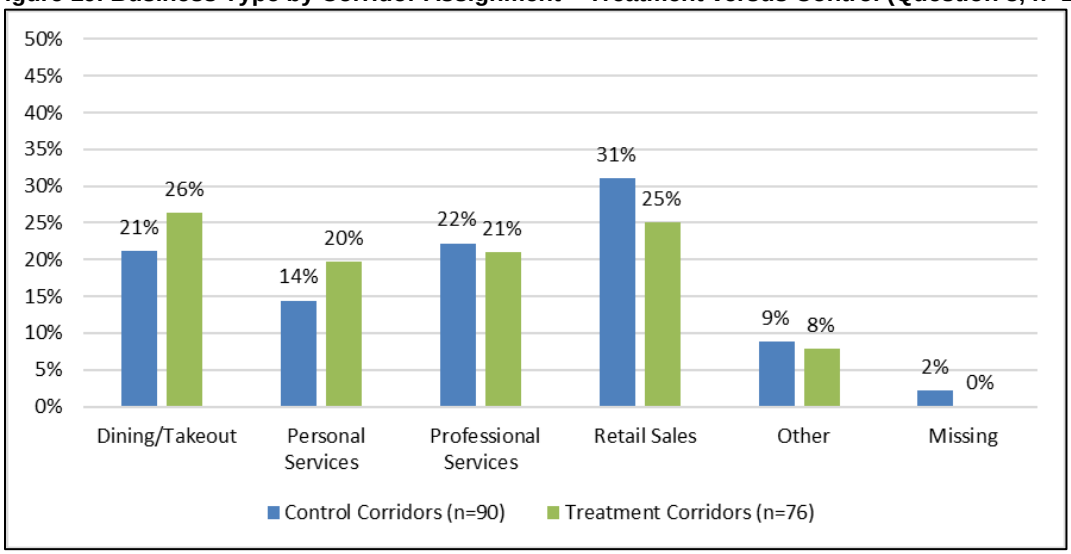
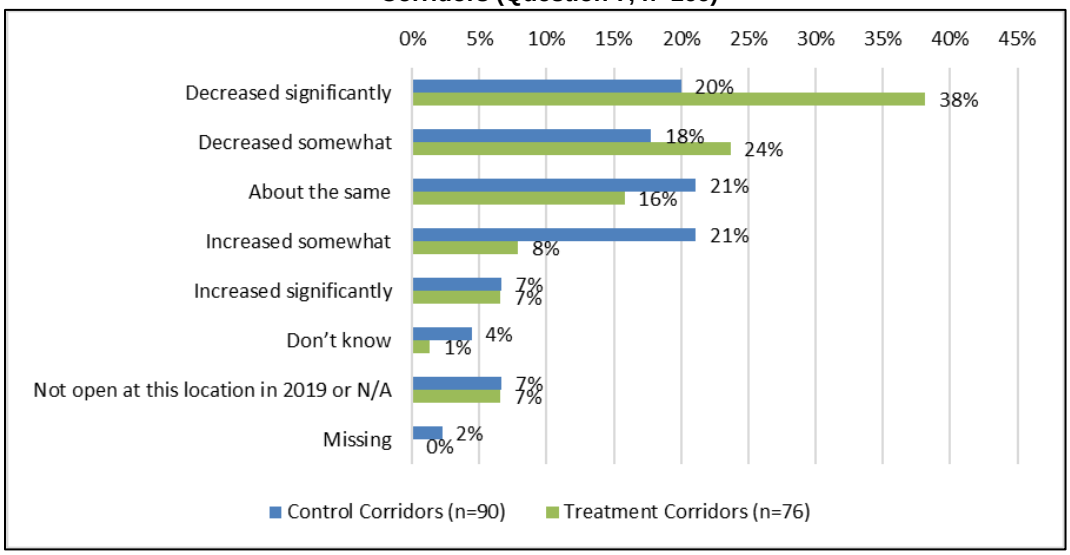



Figure 20 shows the reported change in revenue since 2019 by corridor assignment. Treatment-corridor businesses reported that revenue decreased significantly (38%) more than businesses in control corridors (20%), and reported that revenue was about the same or increased somewhat less than businesses in control corridors. Comparing the share of businesses in the treatment versus control group reporting any decrease in revenue, a larger share of businesses in the treatment corridor report any decrease ($p<0.01$).[62]

[62] Using a X-squared test for equality of proportions, one-sided. Share of respondents reporting decreased significantly or decreased somewhat.

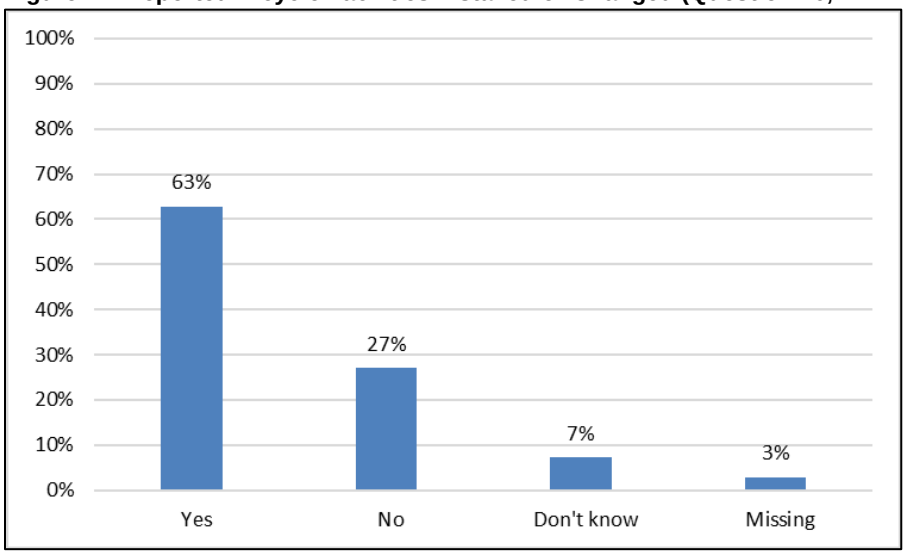
**Figure 20. Reported Change in Revenue Since 2019 by Corridor Assignment - Treatment versus Control Corridors (Question 7, n=166)**




### *6.2.4.3 Bicycle Facilities – Overall*

Just under two thirds (63%) of businesses reported that bicycle facilities, such as protected bike lanes, have been installed or expanded in the immediate area of their business in the past few years, while 27% report that no bicycle facilities have been installed or expanded (Figure 21). It should be noted that while treatment and control corridors were assigned based on recent construction of separated bicycle facilities, the survey questions referred to any bicycle facility type.

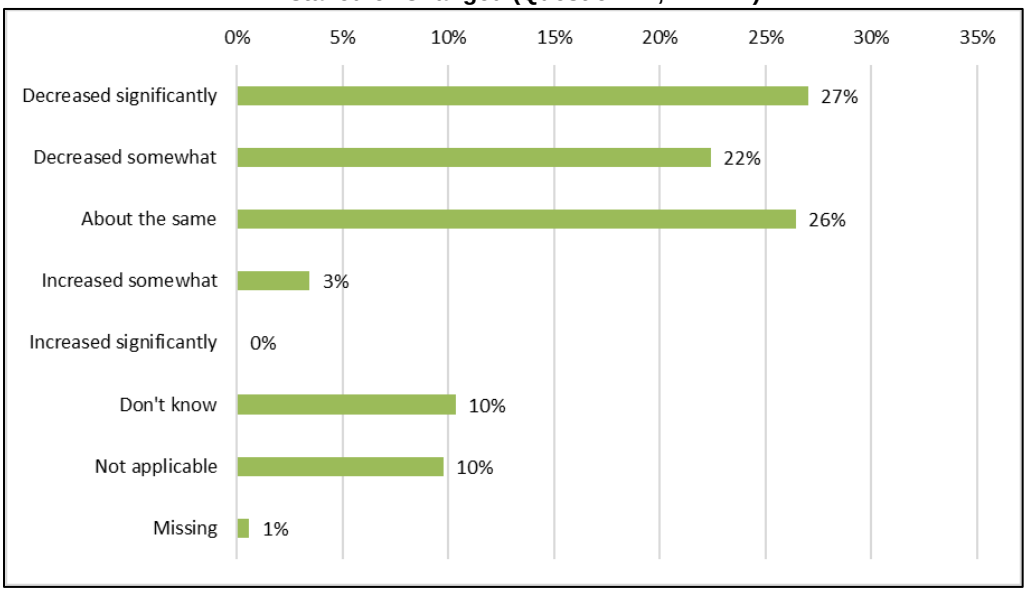
**Figure 21. Reported Bicycle Facilities Installed or Changed (Question 10, n = 277)**




Among businesses reporting bicycle facilities were installed, about half of businesses report changes resulted in a decrease in the overall level of revenue for their businesses at that the surveyed location,

with 27% reporting a significant decrease, and 22% reporting that revenue decreased somewhat. Very few businesses (3%) reported that revenue increased somewhat as a result of bicycle facility installation or expansion, and no businesses reported a significant increase in revenue. Among businesses reporting that bicycle facilities were installed or expanded, 26% reporting that revenue is about the same, 10% reported that they did not know the impact on revenue, and an additional 10% responded "not applicable".[63]

**Figure 22. Reported Bicycle Facility Impact on Revenue Among Businesses Reporting Bicycle Lanes Installed or Changed (Question 11, n = 174) [64]**




### *6.2.4.4 Bicycle Facilities – Corridor Assignment*

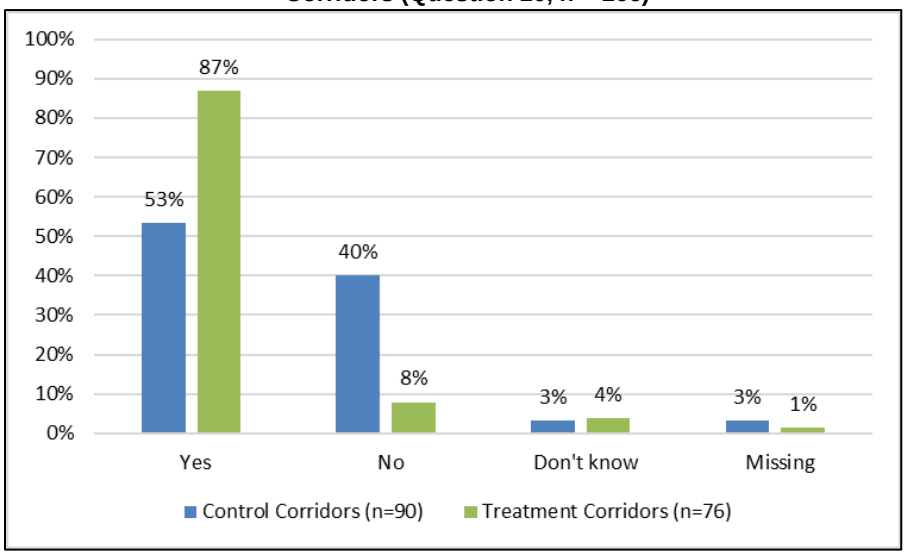
Figure 23 shows the reported change in bicycle facilities by corridor assignment for treatment and control corridors. The vast majority of treatment corridor businesses (87%) reported that bicycle facilities were added or changed in the last few years, compared to about half (53%) of businesses located in control corridors. While the control corridors do not currently have separated bike lanes, the question wording referred to any installation or changes to bicycle facilities, and the radius used by businesses from their business when responding to the questionnaire may vary, as well the physical location of a business within a corridor varies. Given that some corridors assigned for this study were constructed prior to 2019, the 8% of businesses in treatment corridors that reported facilities did not change in the last few years may be a reasonable response. Comparing the share of businesses in the treatment versus control group reporting any change in bicycle facilities, a larger proportion of

[63] Interpretation of the don't know and not applicable responses is ambiguous, and future surveys may benefit from allowing businesses to elaborate on those response options if selected.

[64] Base is businesses who responded yes to Question 10.

treatment corridor businesses report any change (p<0.001).[65]

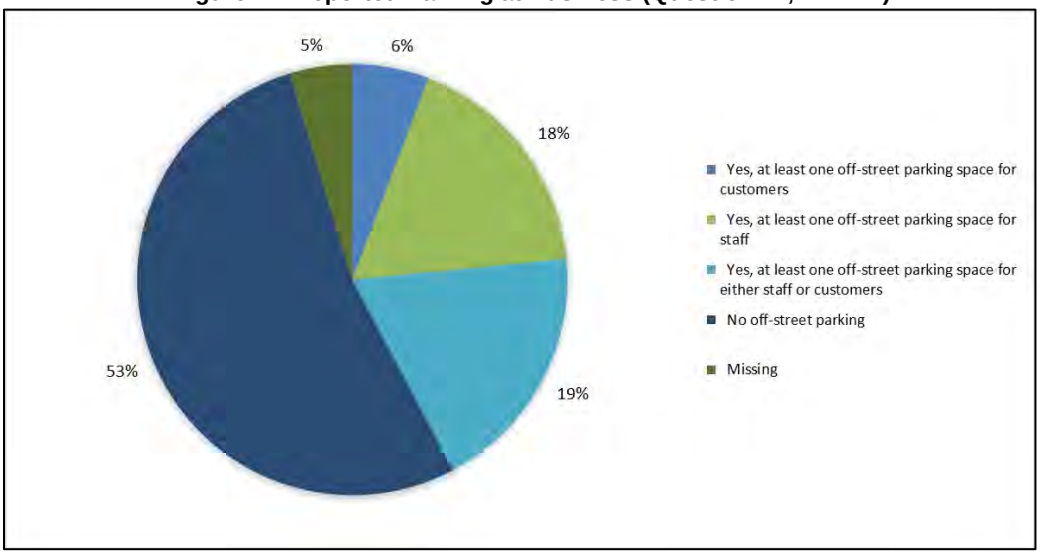
**Figure 23. Reported Bicycle Facilities Installed by Corridor Assignment – Treatment versus Control Corridors (Question 10, n = 166)**




#### *6.2.4.5 Parking – Overall*

Among surveyed businesses, 53% reported that their business has no off-street parking for staff or customers. Off-street parking for either staff or customers was reported by 19% of businesses, off-street parking for staff was reported by 18% of businesses, and 6% of businesses reported off-street parking for customers (Figure 24).

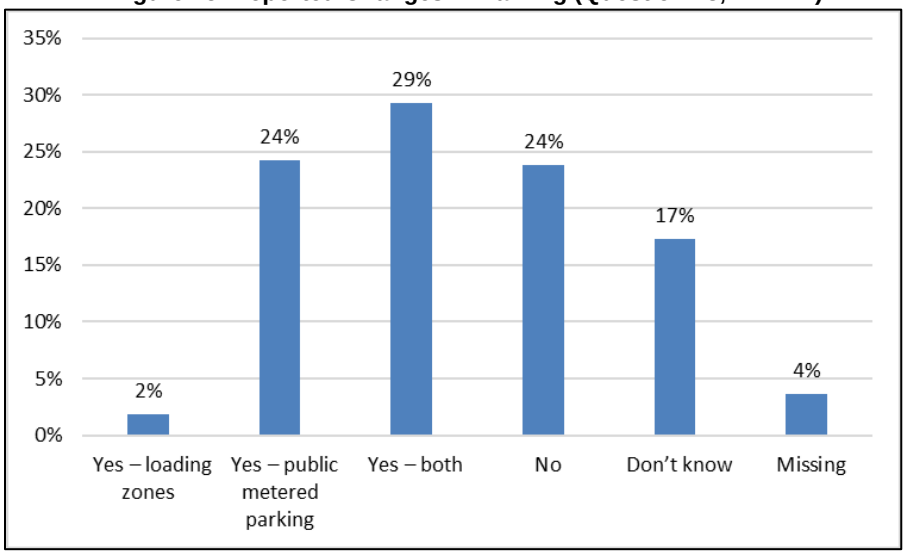
**Figure 24. Reported Parking at Business (Question 12, n = 277)**




[65] Using a X-squared test for equality of proportions, one-sided. Share of respondents reporting Yes.

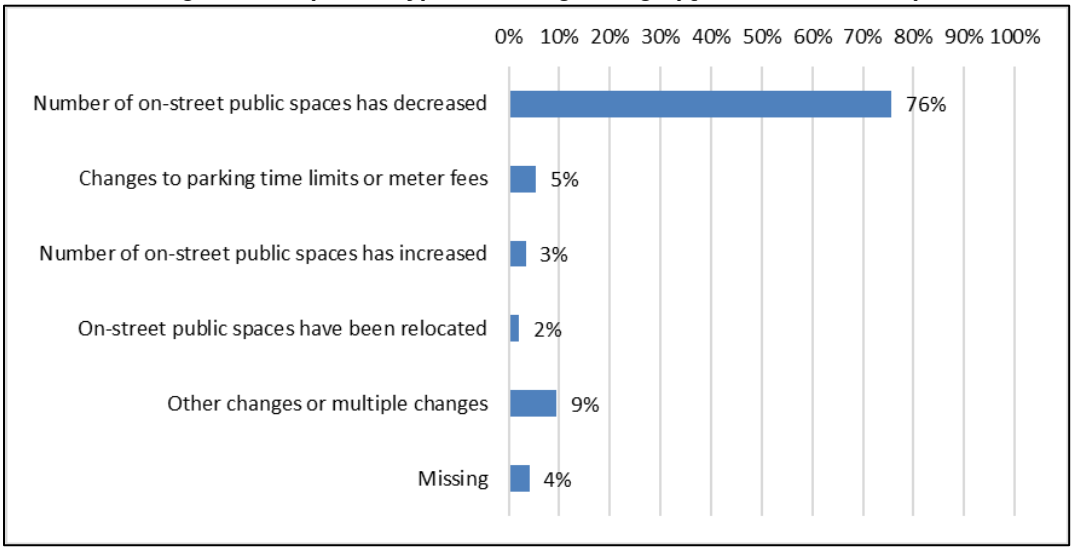
The majority of surveyed businesses reported changes in public metered parking or loading zones in the immediate area of their business in the last few years, including 29% of businesses reporting changes in both parking and loading zones, 24% reporting changes in public metered parking, and 2% reporting changes in loading zones. About a quarter, 24%, of businesses reported no changes in parking, and 17% of businesses reported that they did not know (Figure 25).

**Figure 25. Reported Changes in Parking (Question 13, n = 277)**




Among businesses reporting any change in on-street metered parking, the vast majority (76%) reported that the number of on-street public spaces has decreased (Figure 26).

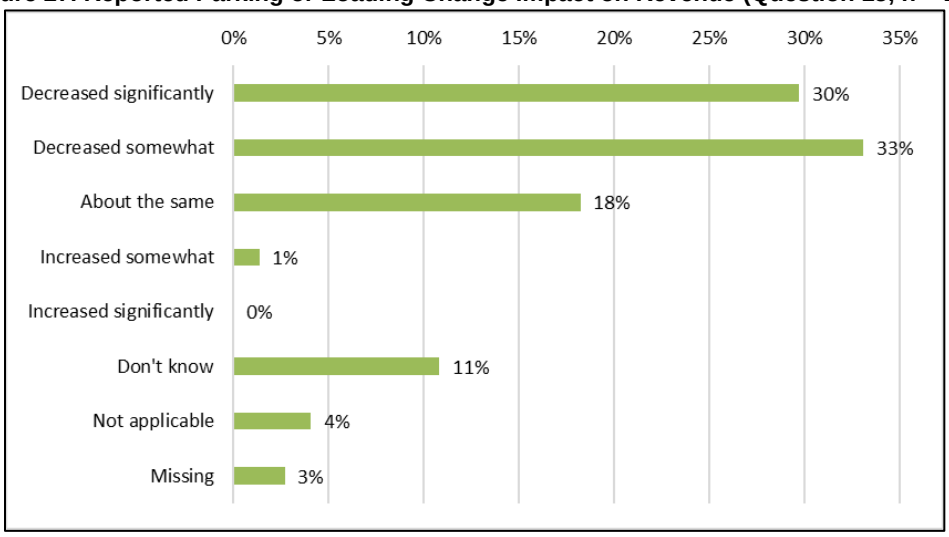
**Figure 26. Reported Type of Parking Change (Question 14, n = 148)[66]**




[66] Excludes business which responded yes-loading zones, no, don't know, or missing to Question 13.

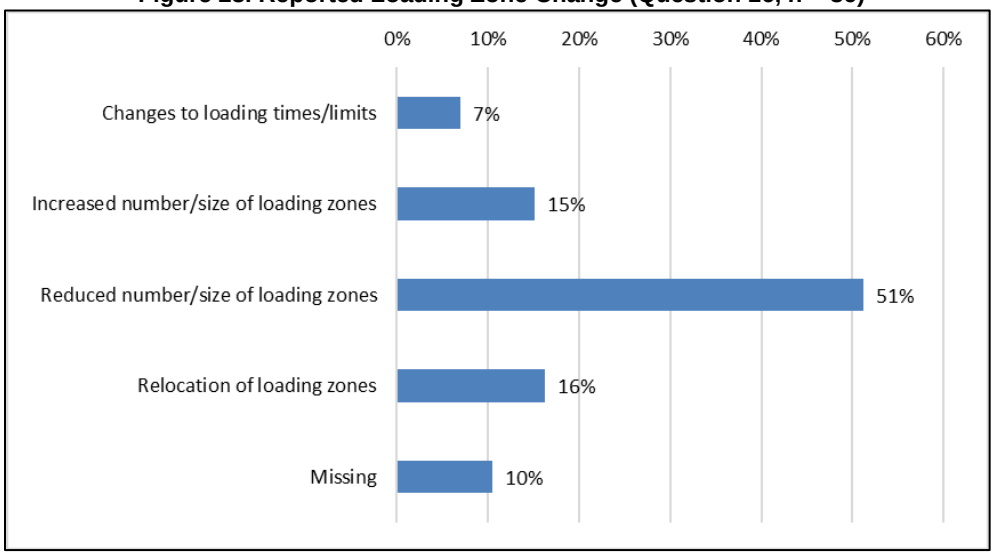
Among businesses reporting any change in on-street metered parking, the majority reported that parking or loading zone changes had a negative impact on revenue, with 30% reporting that revenue decreased significantly as a result of changes to on-street metered parking, and 33% reporting that revenue decreased somewhat (Figure 27).

**Figure 27. Reported Parking or Loading Change Impact on Revenue (Question 15, n = 148)[67]**




Among businesses reporting any change in loading zones, the majority (51%) reported that the number or size of loading zones has decreased (Figure 28).

**Figure 28. Reported Loading Zone Change (Question 16, n = 86)[68]**

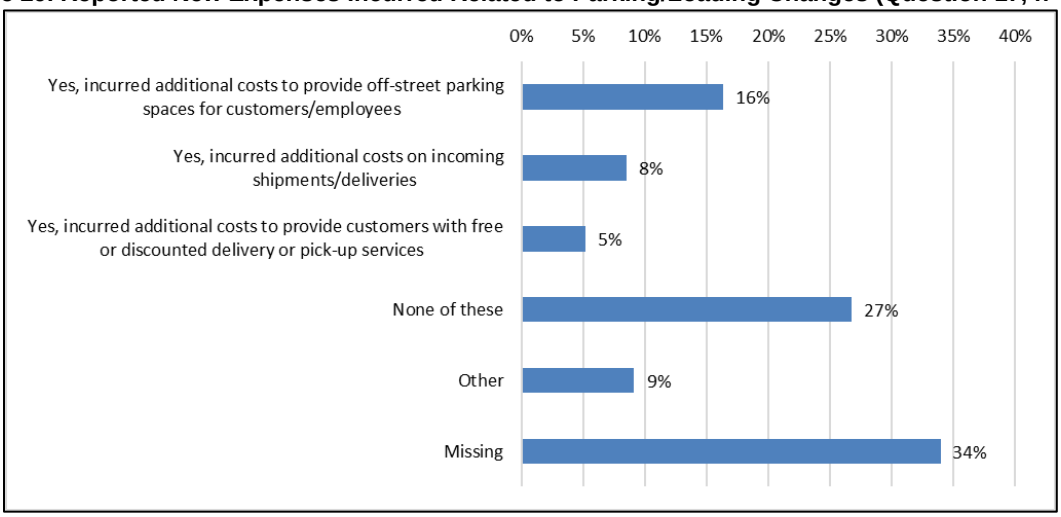



[67] Excludes business which responded yes-loading zones, no, don't know, or missing to Question 13.

[68] Excludes business which responded yes-public metered parking, no, don't know, or missing to Question 13.

Among businesses reporting any parking or loading changes, 30% reported additional costs including costs to provide off-street parking spaces (16%), additional costs on incoming shipments (8%), or additional costs to provide customers with delivery or pickup (5%), and an additional 9% of businesses reported other costs (Figure 29).

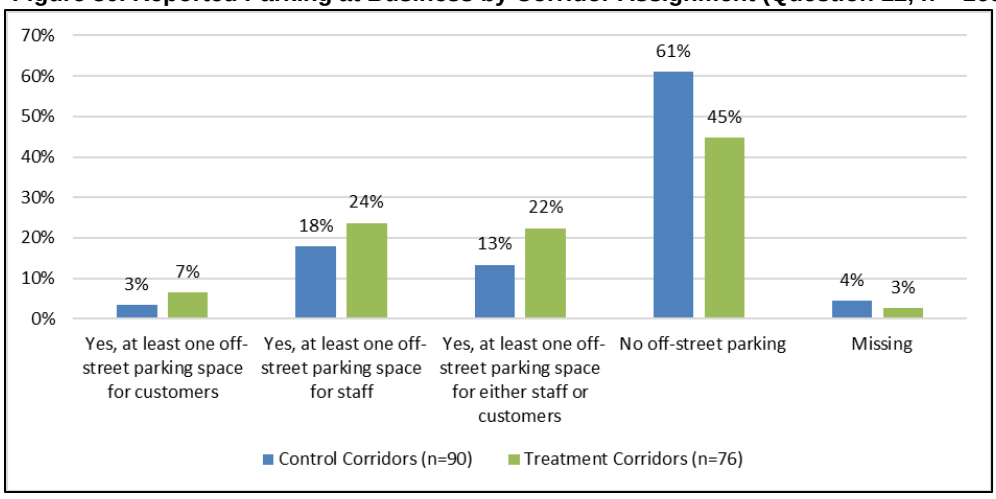
**Figure 29. Reported New Expenses Incurred Related to Parking/Loading Changes (Question 17, n = 153)** [69]




### *6.2.4.6 Parking – Corridor Assignment*

Figure 30 shows the reported parking at businesses by corridor assignment. Businesses that are in a treatment corridor are in any of the treatment corridors identified for this study. The share of control-corridor businesses reporting that they do not have off-street parking (61%) is relatively higher than the share of treatment-corridor businesses (45%).

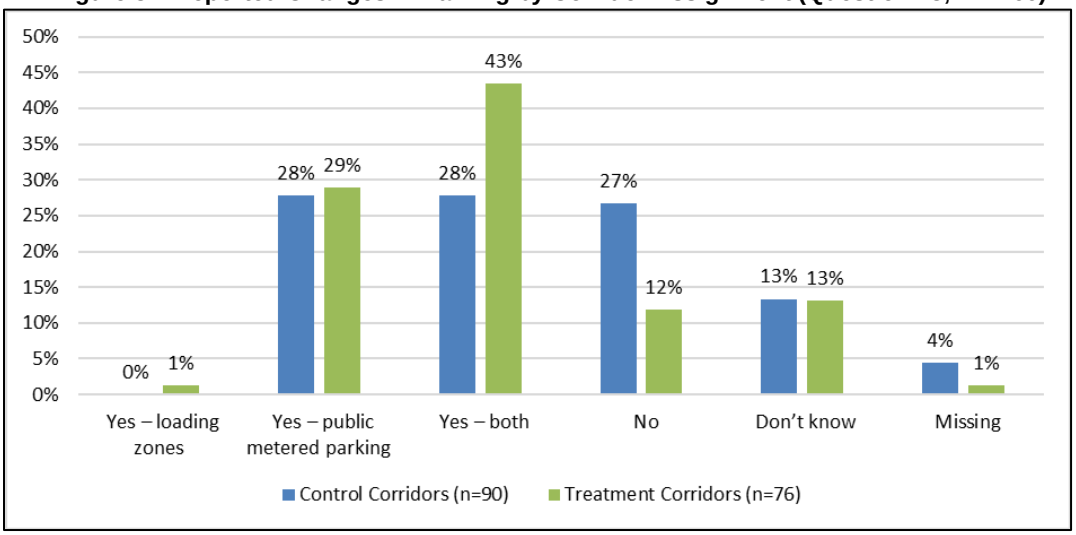
**Figure 30. Reported Parking at Business by Corridor Assignment (Question 12, n = 166)**




[69] Excludes business which responded no, don't know, or missing to Question 13.

Figure 31 shows the reported changes in on-street parking or loading by corridor assignment. Notably, 43% of treatment-corridor businesses reported changes in both parking and loading, compared to 28% of control corridor businesses. Comparing the share of businesses in the treatment versus control group reporting any change in parking or loading, a larger share of treatment corridor businesses report any change ($p<0.05$).[70]

**Figure 31. Reported Changes in Parking by Corridor Assignment (Question 13, n = 166)**




### 6.2.4.7 *Open Ended Responses*

The survey also included a question which allowed businesses to provide additional comments on the impact of recent traffic or transportation changes near their business. Open ended responses were reviewed and categorized into themes. The results of this categorization are shown in Table 15. Overall, 180 open-ended responses were received. However, totals do not sum to 180, as each response could be categorized into multiple themes. A detailed summary with responses categorized by theme is shown in Table 16.

**Table 15. Summary of Open-Ended Responses (Question 18, n = 180)**

| Type | Count of Responses |
|---|---|
| Negatives | 194 |
| Neutral | 29 |
| Positives | 11 |
| Other impacts | 26 |
| Suggestions | 14 |

[70] Using a X-squared test for equality of proportions, one-sided. Share of respondents reporting yes – loading zones, yes – public metered parking, or yes – both.

**Table 16. Detailed Summary of Open-Ended Responses (Question 18, n = 180)**

| Type | Description | Count of Responses |
|---|---|---|
| Negatives | Bike lanes general negative impact on business/customers | 7 |
| Negatives | General or Other negative impact to business/customers | 13 |
| Negatives | Bike lanes caused removal of parking spaces that led to negative impact on business (lost customers, difficulty hiring, late patients, lost revenue) | 24 |
| Negatives | General or Other causes removal of parking spaces that led to negative impact on business (lost customers, difficulty hiring, late patients, lost revenue) | 33 |
| Negatives | Worried for future removal of parking that will impact business | 21 |
| Negatives | People in pain, pregnant, special needs, seniors, cannot bike or take public transport; lost safe access for people in wheelchairs; no accessible parking | 14 |
| Negatives | Bike lanes cause longer travel times, increased traffic (lane restrictions, block travel lanes, customers look for parking, interfere with side streets) | 12 |
| Negatives | General or Other causes to longer travel times, increased traffic (lane restrictions, customers look for parking, interfere with side streets) | 20 |
| Negatives | Delivery and pickup more challenging | 9 |
| Negatives | Need loading zones/loading is primary concern/lack of loading zones negative impact on business | 11 |
| Negatives | Cyclists not staying in lanes/using sidewalks, not obeying traffic laws causing safety concerns | 11 |
| Negatives | More worried about ped safety | 5 |
| Negatives | Moved locations due to parking removal | 2 |
| Negatives | Falling property values with loss parking | 1 |
| Negatives | Worried about loss outdoor dining space | 1 |
| Negatives | Paying for employees to park off-street; lease spaces for customers | 5 |
| Negatives | Delivery drivers parking in bike lanes/double park, blocking traffic; cars parked/idling in no-parking zones | 4 |
| Negatives | Difficult to get maintenance people into our area | 1 |
| Neutral | No issues with parking, parking not a big factor (local emp/residents walk), shifted to over modes | 7 |

| Type | Description | Count of Responses |
|---|---|---|
| Neutral | Sales/business relatively the same, no impact | 15 |
| Neutral | Unsure | 3 |
| Neutral | Has dedicated parking lot | 4 |
| Positives | Bike lanes are positive, improve quality of life (QOL), easier for customers/employees to bike | 10 |
| Positives | General - Vibes are better; safer | 1 |
| Other impacts | Nearby spaces consistently taken by construction/utility vehicles, general construction impact | 10 |
| Other impacts | Increase in delivery app revenue (less profitable) | 3 |
| Other impacts | COVID Impacts (reduced business, increase prices) | 5 |
| Other impacts | Neighbors are mad about meters in front of their houses | 1 |
| Other impacts | Lost more parking due to outdoor dining than bike lanes | 1 |
| Other impacts | Frustrated by traffic signal timing/traffic patterns | 2 |
| Other impacts | Closure of parking garage was difficult | 1 |
| Other impacts | Outdoor dining is positive, increased business and foot traffic | 3 |
| Suggestions | Wants peak hour bike lane with off peak parking | 1 |
| Suggestions | Add bike lanes not on major roadway | 2 |
| Suggestions | Educate about bike lanes | 1 |
| Suggestions | Needs safe bicycle parking/racks | 2 |
| Suggestions | Enforce those traffic laws for bikes and cars | 3 |
| Suggestions | Would like parking/loading zones to stay with bike lanes | 1 |
| Suggestions | More public parking lots/metered parking | 2 |
| Suggestions | Lower speed limit and share road with bikes | 1 |
| Suggestions | Make residential spots 2 hours | 1 |

## 6.3 Customer Intercept Surveys

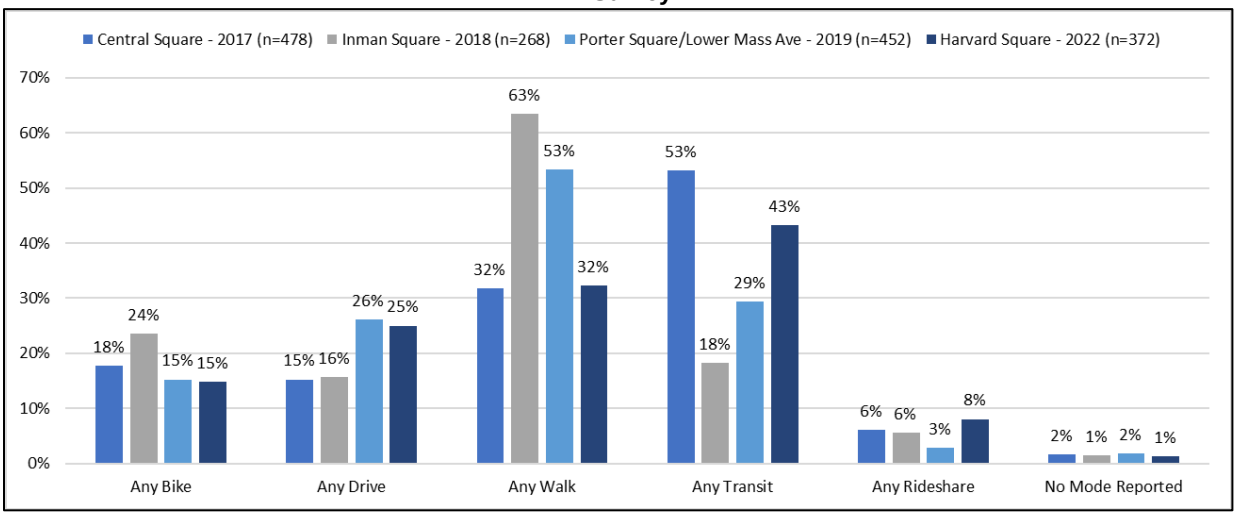
Customer intercept surveys can be useful in determining trends in a variety of factors including trip purpose, trip mode, customer demographics, and customer spending. To supplement other data sources, the City conducted a customer intercept survey in the summer of 2023. The City has also

conducted customer intercept surveys in previous years in various locations throughout the City. While these data do not provide direct evidence regarding changes in business sales, they allow other information to be viewed in context by providing trip mode and trip purpose information.

### 6.3.1 Historical Data – Trip Mode

The City has conducted intercept surveys in previous years,[71] most recently Harvard Square in 2022, Porter Square/Lower Mass Ave in 2019, Inman Square in 2018, and Central Square in 2017. In past years, intercept survey efforts were targeted to a single location in the City. Figure 32 shows the share of respondents reporting each trip mode. Respondents could report more than one mode, so values do not sum to 100%.[72] Among historical respondents, walking and transit generally are the most popular modes. Due to the voluntary nature of the survey, the respondents and any associated responses may not be representative of the full population of residents or visitors to the surveyed locations.

**Figure 32. Share of Respondents Reporting Each Mode (for First Two Modes Reported) by Historical Survey**




### 6.3.2 Summer 2023 Intercept Survey Methodology

The survey was conducted as a customer intercept survey in several locations throughout the City of Cambridge in July and August of 2023. Survey topics included respondent characteristics such as age, trip purpose, trip frequency, trip mode(s), and spending amount. Survey questions were intended to be as comparable as possible with previous customer intercept surveys conducted by the City in wording, although analysis comparing the previous surveys and the current surveys should be conducted with

[71] See: https://data.cambridgema.gov/Economic-Development/Commercial-District-Customer-Intercept-Survey-Resp/ejhf-g6hj/data

[72] For respondents reporting more than two modes, the first two modes reported in the data are included.

caution due to changes in methodology and questionnaire wording. The survey questionnaire can be found in Appendix A.

### 6.3.3 Summer 2023 Intercept Survey Administration

The survey was administered from July 13, 2023 to August 11, 2023. The survey was conducted via in-person intercept, in several locations. The locations were: Alewife/Fresh Pond, Central Square (which includes Mass Ave. to Harvard Square), East Cambridge/Cambridge Street, Harvard Square, Huron Village, Inman Square, Kendall Square and Porter Square (which includes both North and South Mass Ave.).

### 6.3.4 Summer 2023 Intercept Survey Response

In total, the City received 214 survey responses. The distribution of responses by location is shown in Table 17. The largest number of responses were in Central Square (49 responses) and Harvard Square (42 responses). The survey was voluntary, and the respondents and any associated responses may not be representative of the full population of residents of or visitors to the surveyed locations.

**Table 17. Intercept Survey Response by Location**

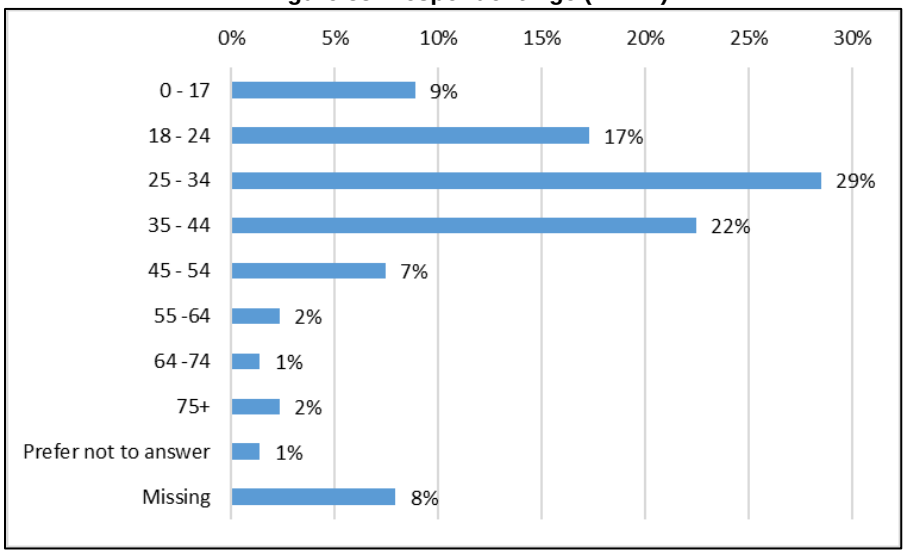
| Location | Count (Percent) of Responses |
|---|---|
| **Alewife / Fresh Pond** | 11 (5%) |
| **Central Square** | 49 (23%) |
| **East Cambridge / Cambridge Street** | 18 (8%) |
| **Harvard Square** | 42 (20%) |
| **Huron Village** | 8 (4%) |
| **Inman Square** | 35 (16%) |
| **Kendall Square** | 28 (13%) |
| **Porter Square/N. Mass Ave.** | 23 (11%) |
| **Total** | **214** |

### 6.3.5 Summer 2023 Intercept Survey Responses

#### *6.3.5.1 Respondent Characteristics*

Most respondents to the intercept survey were between 18 and 44 years old, with 17% aged between 18 and 24, 29% aged between 25 and 34, and 22% aged between 35 and 44 (Figure 33).

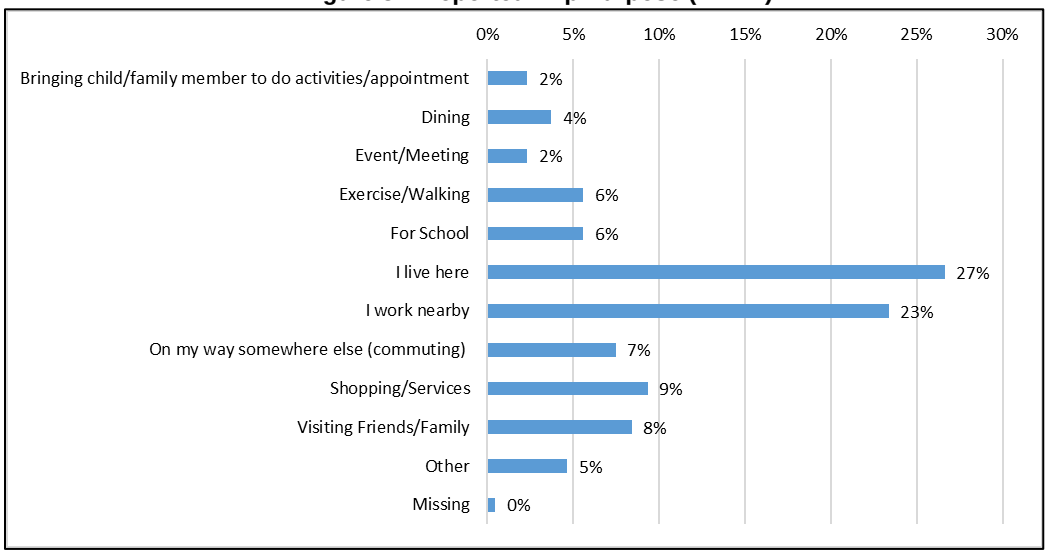
**Figure 33. Respondent Age (n=214)**




### 6.3.5.2 *Trip Purpose and Frequency*

Over half of respondents reported that they live, work, or attend school in the area as their primary trip purpose.[73] Among respondents, 9% reported that their primary trip purpose was shopping or services, and 4% reported that their primary trip purpose was dining (Figure 34).

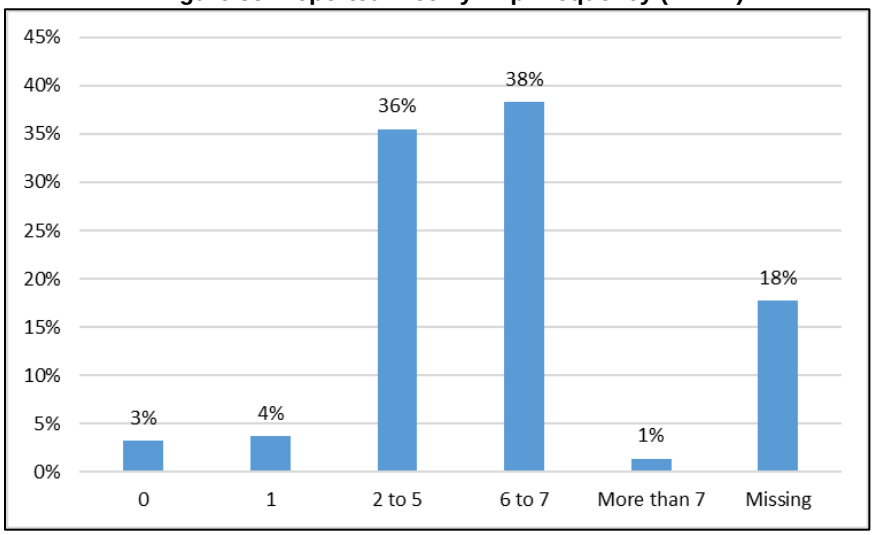
**Figure 34. Reported Trip Purpose (n=214)**




[73] For respondents reporting more than one purpose, the first purpose noted is considered primary.

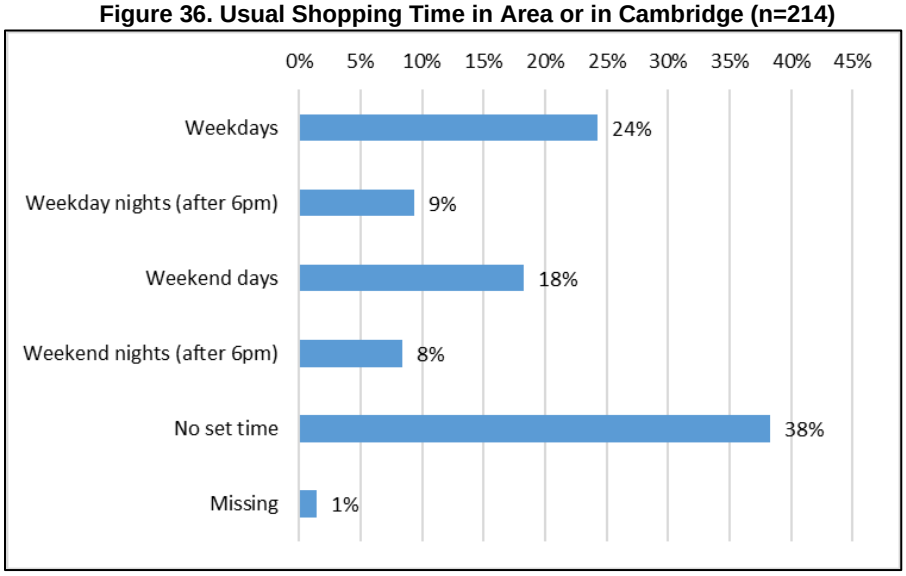
Among survey respondents, the reported weekly trip frequency is shown in Figure 35. Many respondents report multiple trips per week, with 4% reporting two trips per week, 36% reporting 2 to 5 trips per week, 38% reporting 6 to 7 trips per week and 1% reporting more than 7 trips per week.

**Figure 35. Reported Weekly Trip Frequency (n=214)**




Survey respondents vary in the time that usually shop in the area or in Cambridge. The largest group of respondents is those reporting no set time, at 38%, followed by weekdays (24%), and weekend days (18%), as shown in Figure 36.

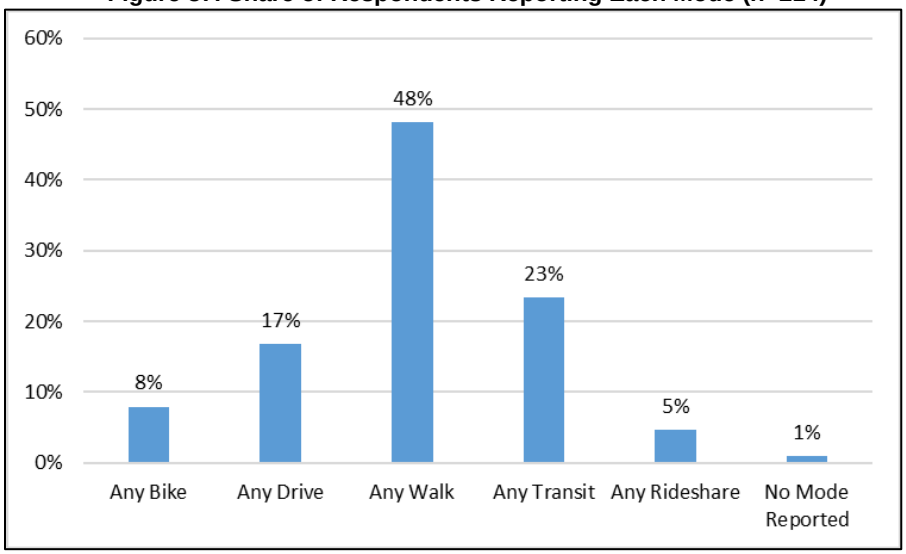
**Figure 36. Usual Shopping Time in Area or in Cambridge (n=214)**



#### 6.3.5.3 *Trip Mode*

The share of respondents reporting each mode was calculated, and results are shown in Figure 37.[74] The most common mode was any walking, reported by about half of respondents, followed by any transit at 23%, and any driving at 17%.

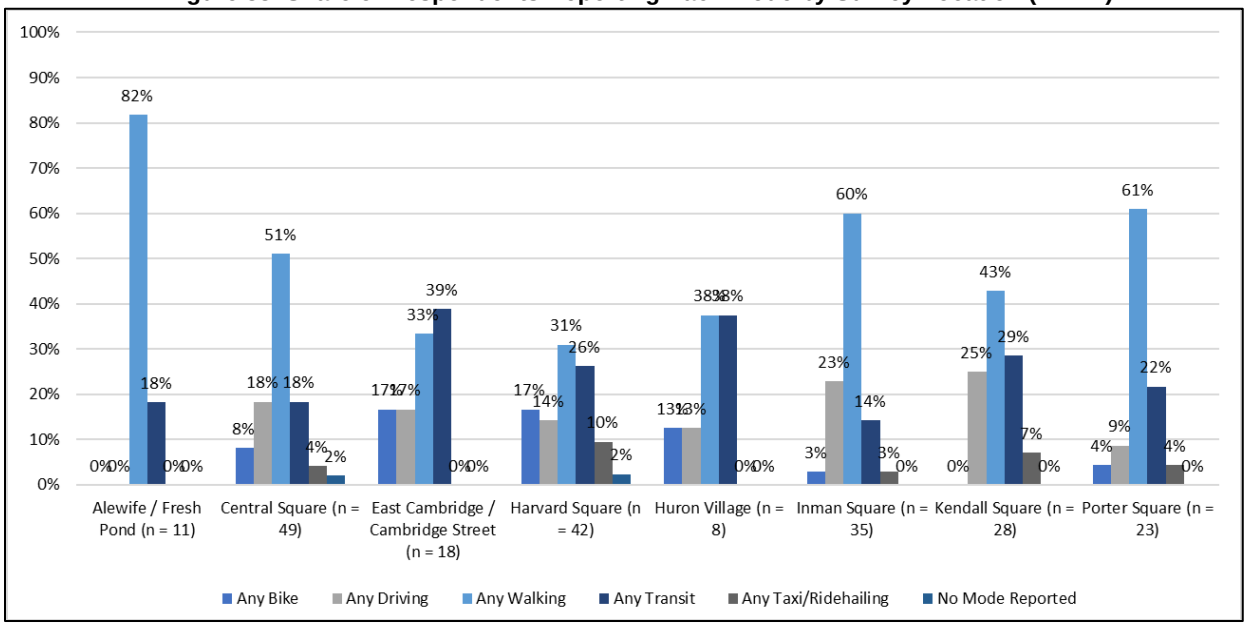
**Figure 37. Share of Respondents Reporting Each Mode (n=214)**




When mode choice is considered by location, results vary (Figure 38). While any walking is reported by the largest share of respondents in most surveyed locations, any transit is reported by the largest share of respondents in East Cambridge/Cambridge Street and Huron Village. The areas with the largest shares reporting any bicycle travel are East Cambridge/Cambridge Street and Harvard Square, both at 17% of respondents surveyed in that area.

[74] Respondents could report more than one mode, so values do not sum to 100%.

**Figure 38. Share of Respondents Reporting Each Mode by Survey Location (n=214)**




The survey also included questions regarding car (Table 18) and bicycle (Table 19) parking location where applicable, and a question regarding the amount of time taken to find parking (Table 20).

**Table 18. Reported Bicycle Parking Location (n=34)**

| Car Parking Location | Count of Responses |
|---|---|
| City permit parking | 10 |
| Metered parking | 18 |
| Parking garage | 4 |
| Other | 2 |
| Total | 34 |

**Table 19. Reported Bicycle Parking Location (n=13)**

| Bicycle Parking Location | Count of Responses |
|---|---|
| Bike Rack | 8 |
| BlueBike Station | 4 |
| Other | 1 |
| Total | 13 |

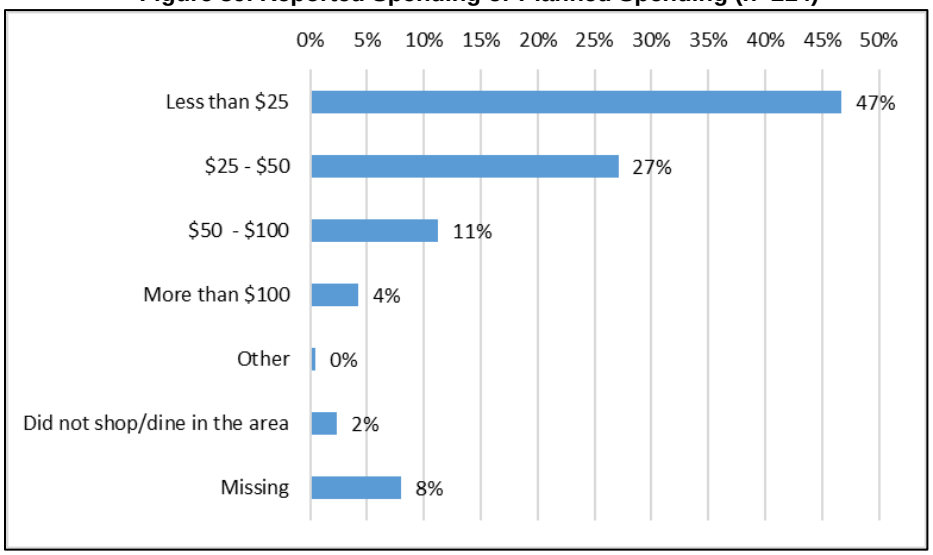
**Table 20. Reported Time to Find Parking (n=32)**

| Time to Find Parking | Count of Responses |
|---|---|
| 0 - 5 minutes | 15 |
| 5 - 10 minutes | 11 |
| 10 - 15 minutes | 6 |
| Total | 32 |

#### *6.3.5.4 Spending*

About half of respondents indicated spending or planning on spending less than 25 dollars on the day they were surveyed, and 27% reported spending between 25 and 50 dollars, as shown in Figure 39.

**Figure 39. Reported Spending or Planned Spending (n=214)**



# 7. Conclusions

This study has applied a mixed-methods approach to assessing the impacts of protected bicycle lane infrastructure projects in Cambridge on retail sales and overall neighborhood economic vitality. In the sections above, the study team reviewed existing published literature and prior studies on this topic; presented an overview of the specific project corridors studied and study methodology; and analyzed the available data across multiples sources and datasets, using both "before vs. after" and "treatment vs. control" approaches. Data sources include Census data on employment and income, commercial databases covering real estate and retail sales, and survey responses from local business owners and customers. In this section, the findings are distilled into a set of overall conclusions and suggestions for future studies.

## 7.1 Context

While several studies have previously examined the impacts of bicycle infrastructure projects on retail sales, there is still a relatively limited degree of coverage in the literature. Within the available studies, there is arguably no clear consensus on these impacts, as they can vary significantly according to the details of each project and neighborhood-specific factors such as demographics and retail mix. That said, as summarized in Section 2, there is a general finding across studies that impacts – whether positive or negative – are fairly modest in magnitude and can be difficult to discern against the backdrop of larger macroeconomic changes such as unemployment, the COVID-19 pandemic, inflation, and interest rates.

Individual project outcomes can also be affected by weather, seasonality, changes in transit service and fares, new property developments in the area, and other factors that are largely unrelated to the bicycle infrastructure. This can be mitigated to some extent by using a treatment vs. control methodology, which allows project areas to be compared against otherwise similar areas that would have experienced similar external factors.

The data available at each location can also vary significantly, since some cities have local sales taxes or agreements with data providers that can permit more in-depth analysis, while others have relied on publicly available Census data and similar datasets. The choice of data and the metrics used to define and measure impacts (e.g., tax receipts vs. property values) can also influence the conclusions from prior studies as to whether there were changes in the retail environment as a result of bicycle infrastructure projects.

Analysis of smaller, "quick build" bicycle projects, as is the case here, presents additional inherent challenges because of the very high level of granularity that is needed in both the spatial and temporal dimensions. That is, with projects that may extend for only a few blocks in each direction, regional and citywide data of the type used for other studies are often of limited use because they do not clearly distinguish between treatment and non-treatment areas. It is necessary instead to develop datasets that

can provide information at the level of individual city blocks or even specific locations. Likewise, data that are presented at the annual level do not have the specificity to distinguish impacts that took place during the portions of the year that were before, rather than after, the completion of the bicycle lane project. (Impacts that occur after the project is implemented cannot necessarily be assumed to be caused by the project, as other factors could be more influential, but it is reasonable to infer that impacts that occur prior to implementation were unlikely to have been caused by the project.) Ultimately, no single source of data can provide perfect insight into changes in retail sales, particularly when direct records such as register receipts and tax records are not available.

## 7.2 Findings from the Analysis

Despite these limitations, the study team was able to identify some important patterns in the data:

- LEHD data from the U.S. Census Bureau indicate that there was a slight downward trend in food and retail income and employment in Cambridge relative to the rest of the Boston metro area, and that this predates both the Cycling Safety Ordinance and the COVID-19 pandemic.
    - Understanding the causes of this trend is beyond the scope of the current study, though it may be related to an underlying shift in the city's commercial base, with an increase in professional services and related industries.
    - Due to this preexisting trend, it is possible that the counterfactual baseline in which no bicycle facilities were constructed would still feature a decline in overall retail sales in Cambridge, despite no changes to parking or other factors affecting access.
    - Direct comparisons of bike lane installation areas (also referred to in the report as treatment areas) against control areas and citywide averages show little to no consistent differences in retail employment levels in the period up to 2020.

- Commercial real estate data provides an indirect measure of retail sales and overall neighborhood vitality, but exhibits changes over time which could be due to many factors unrelated to bicycle infrastructure. The study team's analysis of commercial real estate availability data and rent estimates from the CoStar database found very few significant differences between treatment areas and control areas.
    - Availability increased after bicycle lane implementation in one treatment area, which is an indicator of a weaker rental market and retail environment, while in another treatment area, the opposite was true, i.e., there was a decrease in availability which would indicate a stronger market. Both effects were relatively small.

- SafeGraph data on estimated retail spending were analyzed to assess differences between treatment and control areas. This dataset provides monthly updates and a high level of geographic specificity, making it a logical choice for this type of analysis; however, it is important

to note that the data does not directly capture transaction records, but instead represents estimates using location-based services and a proprietary algorithm. The study team's review of the raw data showed that there were many unexplained inconsistencies, such as implausibly low estimated transaction volumes or sales estimates that varied by 100-fold over the course of a few months, in addition to large sales data gaps for many establishments. This made it unsuitable for any sort of difference-in-difference regression or other analysis, and no conclusions could be drawn from this dataset.

- Responses to a survey administered by the City of Cambridge yielded a wide range of views from business respondents in Cambridge, covering trends in business revenue, customer counts, parking availability, and the impacts of nearby bicycle infrastructure projects. When comparing businesses in treatment corridors against those in control corridors, the study team found that respondents in treatment areas were more likely to report a decrease in revenue, and that this difference was statistically significant.
    - The limited number of respondents in each treatment area limited the ability to examine any key differences by type of business (e.g., retail, dining, professional services, etc.) or by location within the city.
    - The time period covered by the survey had an unusually influential set of external factors (pandemic disruptions, followed by historically high inflation and interest rates) making it more difficult to infer that changes in revenue were caused by, rather than merely associated with, the changes to bicycle facilities and parking. Moreover, although a number of techniques including personal follow-up were applied to increase survey response rates, the voluntary nature of the survey means that it may not be fully representative of all affected businesses as a whole.

## 7.3 Overall Takeaways

Taken as a whole, the data sources described above present a mixed picture of the effects of bicycle infrastructure projects on retail/services sales**.** Looking strictly at quantitative data, **there are little to no discernable differences between "treatment" areas and otherwise similar "control" areas, and most of the differences that exist are either not statistically significant or point in opposite directions.** To some extent this reflects the underlying limitations of the data sources, which were generally not designed for analysis at this highly detailed geographic scale. Meanwhile, **survey data indicated that businesses in treatment areas were more likely than those in control areas to report a decrease in revenue**.

Unfortunately, it was not possible to compare these perceived changes in sales against quantitative sales data, as the relevant SafeGraph dataset suffered from data quality issues that made it unsuitable for analysis.

## 7.4 Considerations for Future Analysis

Due to the ambitious schedule associated with the Cycling Safety Ordinance, it is understandable that most of the effort to date has been associated with deployment and implementation rather than with assessment of impacts. In addition, the timing of the CSO meant that many of these projects took place during the COVID-19 pandemic, making it difficult to collect meaningful baseline data on traffic volumes and other variables. Going forward, the City may wish to take a more forward-looking approach in which more robust evaluation is built into each deployment from the outset. As this study has shown, it is possible to conduct a purely retrospective assessment of the changes in retail sales and neighborhood economic vitality, but most of the available data sources do not provide detail at the temporal (i.e., monthly) and geographical scales required.

Based on this experience, the study team identified a number of suggestions for future analysis. The overall goal would be to create a systematic evaluation approach for future infrastructure projects that defines a baseline and employs multiple streams of data to draw inferences about project impacts.

- First, it is important to **define treatment and control areas** with geographic precision in advance of infrastructure projects so that data can be systematically gathered to support analysis of transportation and local business impacts. Because the business impacts of infrastructure projects are typically small relative to changes in the business cycle and other contextual factors, it is necessary to define these areas precisely and gather data to serve as a pre-treatment baseline. Without a careful definition of treatment and control areas, any analysis would need to rely on a before-vs.-after comparison, in which it is much more difficult to detect meaningful differences, make causal inferences, or control for the influence of external factors.
- **Improved parking data** could add an important dimension to the analysis. Several stakeholders and survey respondents noted that changes to on-street parking – rather than the bicycle facilities themselves – are the primary mechanism by which retail sales may be affected. The City has developed a database of on-street parking spaces and is able to track changes in parking inventory associated with bicycle projects. In-depth studies have also been conducted in the area of some corridors. However, there is currently no means by which parking occupancy and duration can be monitored in real time or at a detailed geographic level.[75] This makes it difficult to analyze parking impacts over time or to compare treatment areas, which may be as small as a few blocks, to control areas.
    - Ideally, such studies would obtain a pre-treatment baseline on parking inventory, utilization/occupancy levels by day and time, meter revenue, and violation rates. However, some of the more granular data on parking utilization would require investments in new data collection procedures. With this information, changes to the baseline on these metrics could then be tracked, allowing for more definitive

[75] The SF*park* program in San Francisco is an example of a program to collect real-time parking utilization data. https://www.sfmta.com/projects/sfpark-pilot-program

assessment of whether parking changes may have affected the accessibility of the area and the retail environment.
    - Systematic tracking of parking impacts, including occupancy, turnover, and violations would also help establish a clear empirical basis for discussions with neighborhood stakeholders. For example, survey data indicated that businesses sometimes had differing responses about whether there had been changes to parking, even within the same treatment area, suggesting that there is some subjectivity in these assessments.
    - Detailed analysis of parking utilization could help identify policy changes that could mitigate any negative impacts of parking loss, for example by better matching of time limits to usage patterns, or programs to increase turnover and availability.
- **Vehicle, pedestrian, and bicyclist counts** from the treatment and control areas are another potential data source to provide a fuller picture of project impacts. While these do not provide direct measures of retail/personal services sales and can be influenced by external factors such as seasonality, they provide proxy measures of the change in accessibility of treatment areas and can help the evaluation team to interpret other trends in the data. A number of public and private data providers also offer estimates of traffic volumes and congestion, which can be used as another metric of project outcomes.
- City staff can continue to monitor offerings by **private sector data providers** to assess whether new or revised offerings can be used for analysis of bicycle infrastructure corridors.
    - In the case of CoStar data on commercial real estate, the study team suggests working with the data provider to develop a method to produce more robust time-series data on rents and vacancies, with fewer missing data points and clearer definitions of rental values and other variables.
    - For SafeGraph and similar data providers that could provide more direct measures of retail sales, periodic checks of sample data could be conducted to assess whether data quality has improved to the point where these datasets could support analysis. However, presently the dataset is not suitable for statistical analysis at the geographic level required for this type of study.
    - Future studies may also consider the NETS database, which was noted as a potential source of retail sales and employment data in previous studies. The study team lacked time and resources to do a comprehensive review of the data, and significant questions remain on the data viability in terms of data coverage, retail sale imputation by establishment and time dimension (annualized data).
- Coordination with **public sector agencies** can also potentially yield new data options that could be used to analyze project impacts. These include the release of updated LEHD data from the U.S. Census Bureau as well as access to the more geographically detailed LEHD dataset.
    - Data from tax records have also been used in other studies and are typically of high quality due to consistent reporting requirements and definitions. While the City was unable to reach agreement with the Massachusetts Department of Revenue on a data-sharing arrangement due to taxpayer privacy concerns, it is possible that a future

agreement could be reached that uses fully anonymized data and/or a secure data commons that limits output to aggregate statistics.[76]

- **Business surveys** proved to be a useful means for obtaining direct feedback on bicycle project impacts, but like all surveys, there are issues with self-selection and other potential sources of bias, as well as differences in interpretation of some questions. In particular, future surveys may wish to provide more detailed definitions (and possibly pictures) of different types of bicycle infrastructure, as the terminology may not be consistently understood.
    - More frequent survey administration would also allow for more reliable and consistent baseline data, and would permit analysis of changes over a shorter time period with fewer confounding factors.
    - Continued periodic business surveys of non-treatment areas are also important to serve as controls. These survey responses may also be useful to other departments within the City as indicators of overall retail health.

[76] The Transportation Secure Data Center is an example of a secure data commons where detailed personal travel survey information can be analyzed for research purposes without disclosing personal identifying information. https://www.nrel.gov/transportation/secure-transportation-data/

# Appendix A: Survey Questionnaires

# Cycling Safety Ordinance (CSO) Economic Impact Study Business Survey

## Introduction

Hello! The City of Cambridge Community Development Department Economic Opportunity and Development Division is conducting a local business survey as part of the Cycling Safety Ordinance Economic Impact Study. You can find more information about the study, including the final report and summary survey data here.

Click here for further information on the Cycling Safety Ordinance and its projects.

The survey will take about 5 minutes.  We appreciate your feedback.

For online surveys, add a link to the City's Privacy Statement: https://www.cambridgema.gov/privacystatement

**This survey should be completed by the business owner, manager, or person with knowledge of the operations and finances of the business**. If you own multiple businesses in Cambridge, each ground floor location will receive a separate email.

# Cycling Safety Ordinance (CSO) Economic Impact Study Business Survey

1. Enter your survey ID code from the letter you received

# Cycling Safety Ordinance (CSO) Economic Impact Study Business Survey

## 2. Information about your business

Name of business

Address of this location

Phone

Website

Email

Year business opened

Title of person completing this survey

Name of person completing this survey

Your contact information and individual responses will only be used if we need to follow-up or clarify your survey responses. It will not be reported in the study.

# Cycling Safety Ordinance (CSO) Economic Impact Study Business Survey

## About your business

3. Which category best describes the nature of your business at this location?

- ◯ Retail Sales
- ◯ Dining/Takeout
- ◯ Personal Services (examples: hair salon, childcare)
- ◯ Professional Services (example: medical office)
- ◯ Other (please specify)

* 4. How long has your business been at this location?

- ◯ Since 2015 or earlier
- ◯ Since 2015 to 2019
- ◯ Since 2020 or later
- ◯ Don’t know

5. On average, about how many customers do you serve per weekday?

- ◯ Less than 25
- ◯ 25-49
- ◯ 50-99
- ◯ 100 or more

6. On average, about how many customers do you serve per weekend day?

- ◯ Less than 25
- ◯ 25-49
- ◯ 50-99
- ◯ 100 or more

## Cycling Safety Ordinance (CSO) Economic Impact Study Business Survey

* 7. Thinking about the year 2019 as a “pre-COVID” baseline for comparison, how does your current overall revenue at this location compare to 2019?

- ◯ Decreased significantly
- ◯ Decreased somewhat
- ◯ About the same
- ◯ Increased somewhat
- ◯ Increased significantly
- ◯ Don’t know
- ◯ Not open at this location in 2019 or otherwise not applicable.

## Cycling Safety Ordinance (CSO) Economic Impact Study Business Survey

8. Thinking about the last question, please provide us with the percentage decrease in business revenue from 2019 to this year.

0% decrease 100% decrease

## Cycling Safety Ordinance (CSO) Economic Impact Study Business Survey

9. Thinking about the last question, please provide us with the percentage increase in business revenue from 2019 to this year.

0% increase 100% increase

## Cycling Safety Ordinance (CSO) Economic Impact Study Business Survey

### Bicycle Facilities

* 10. Have bicycle facilities, such as protected bike lanes, been installed or expanded on your block or in the immediate area of your business in the past few years? *The immediate area is considered to be two blocks in any direction of your business' location*.

- ◯ Yes
- ◯ No
- ◯ Don't know

11. In your opinion, how, if at all, have the changes to bicycle facilities affected the overall level of revenue at your business at this location?

- ◯ Decreased significantly
- ◯ Decreased somewhat
- ◯ About the same
- ◯ Increased somewhat
- ◯ Increased significantly
- ◯ Don’t know
- ◯ Not applicable

## Cycling Safety Ordinance (CSO) Economic Impact Study Business Survey

### Parking

12. Does your business have any off-street parking for staff and/or customers?

- ◯ Yes, at least one off-street parking space for staff
- ◯ Yes, at least one off-street parking space for customers
- ◯ Yes, at least one off-street parking space for either staff or customers
- ◯ No off-street parking

* 13. Have on-street public metered parking or loading zones been changed on your block or in the immediate area of your business in the past few years? *The immediate area is considered to be two blocks in any direction of your business' location*.

- ◯ Yes – public metered parking
- ◯ Yes – loading zones
- ◯ Yes – both
- ◯ No
- ◯ Don't know

14. How has on-street public metered parking been changed on your block or in the immediate area of your business in the past few years? *The immediate area is considered to be two blocks in any direction of your business' location*.

- ◯ Number of on-street public spaces has increased
- ◯ Number of on-street public spaces has decreased
- ◯ On-street public spaces have been relocated (e.g., moved to side street or opposite side of the street)
- ◯ Changes to parking time limits or meter fees
- ◯ Other changes or multiple changes (please specify)

15. In your opinion, how, if at all, have the changes to on-street public metered parking affected the overall level of revenue at your business at this location?

- ◯ Decreased significantly
- ◯ Decreased somewhat
- ◯ About the same
- ◯ Increased somewhat
- ◯ Increased significantly
- ◯ Don't know
- ◯ Not applicable

16. How have loading zones been changed on your block or in the immediate area of your business in the past few years? *The immediate area is considered to be two blocks in any direction of your business' location.*

- ◯ Increased number/size of loading zones
- ◯ Reduced number/size of loading zones
- ◯ Relocation of loading zones
- ◯ Changes to loading times/limits (please provide details in the comment box below)

Other changes or multiple changes (please specify)

17. Has your business incurred any additional expenses due to the changes to parking and/or loading zones on your block or in the immediate area of your business in the past few years? *The immediate area is considered to be two blocks in any direction of your business' location*. Select all that apply.

- [ ] Yes, incurred additional costs to provide off-street parking spaces for customers/employees
- [ ] Yes, incurred additional costs on incoming shipments/deliveries
- [ ] Yes, incurred additional costs to provide customers with free or discounted delivery or pick-up services
- [ ] None of these
- [ ] Yes, incurred other costs related to parking and loading zone changes. Please describe:

# Cycling Safety Ordinance (CSO) Economic Impact Study Business Survey

## Additional Comments

18. Please use this space for additional comments on the impact of recent traffic or transportation changes near your business.

# Cycling Safety Ordinance (CSO) Economic Impact Study Business Survey

## Optional Sales Data

To evaluate the economic impacts of bike lane installation/parking changes, we need as much objective data on sales before and after the changes were implemented. If you would like to provide your business' financial data for this study, you can do so in two ways listed below. **This is OPTIONAL. If you choose to share your data, your information will be treated confidentially. Your business will NOT be identified by name or address in any studies**.

To share more information about the financials of your business pre and post separated bike lane installation, you may upload any of your 2019, 2020, 2021, 2022 business tax returns, profit and loss statements, or similar documents.

Please note: For districts/streets that received bike lanes prior to 2019, such as parts of Brattle St. and Cambridge St., you are encouraged to upload pre-2019 data, such as 2016, 2017, 2018 taxes, profit and loss statements, or similar documents.

19. Select a file to upload

Choose File | Choose File | No file chosen

20. Select a file to upload

Choose File | Choose File | No file chosen

21. Select a file to upload

Choose File | Choose File | No file chosen

22. If you are not ready to provide any financial data at this moment, please check this box and we will email you to submit the data later.

- [ ] Please email me

# Cambridge Local Business Customer Intercept Survey 2023

**Surveyor Name: _____**

| **Location:** | **Alewife/ Fresh Pond** | **Central Square** | **East Cambridge/ Cambridge Street** | **Harvard Square** | **Huron Village** | **Inman Square** | **Kendall Square** | **Porter Square** |
|---|---|---|---|---|---|---|---|---|

**Time: __ Morning __ Mid-Day/Afternoon __ Weekend** **Date: ____ / ____ / ____**

1. What is your reason for you being in this area today? (You can choose more than one answer)?
    - o I live here
    - o I work nearby
    - o For school
    - o Dining
    - o Event / Meeting
    - o Shopping/Services
    - o Visiting Friends / Family
    - o Bringing child/family member to do activities
    - o On my way somewhere else (commuting)
    - o Other

2. In a typical week, how many days do you visit this area of Cambridge? ____ days

3. When do you usually go shopping in this area or in Cambridge?
    a. Weekdays
    b. Weekday nights (after 6PM)
    c. Weekend days
    d. Weekend nights (after 6PM)
    e. No set time

4. How did you get to here today?
    - o Walk
    - o Bicycle (my own)
    - o Bicycle (BlueBike)
    - o Public Transit – Bus
    - o Public Transit - Train
    - o Rideshare Service / Taxi

- Car (personal)
- Commercial Vehicle (Delivery Vehicle)
- Other

5. If by car, where did you park?
   a. Metered parking b. City permit parking c. Parking garage d. other

6. If by car, when you drove a car and parked, how long did it take you to find parking today?
   - 0 – 5 minutes
   - 5 – 10 minutes
   - 10 – 15 minutes
   - 15 + minutes

7. If by biked, where did you park your bike?
   - Bike rack
   - parking sign
   - Bluebike station
   - d. other

8. Approximately how much money did you spend, or do you plan to spend shopping today?
   - Less than $25
   - $25 - $50
   - $50 - $100
   - More than $100
   - Did not shop/dine in the area

9. What is your age?
   - 0-17
   - 18-24
   - 25-34
   - 35-44
   - 45-54
   - 55-64
   - 65-74
   - 75+
   - Prefer not to answer