National Street Improvements Study: Findings from Memphis

1. Introduction

Across the country, policymakers and planning departments are making cities more livable by better accommodating people who walk and bike. Improving streets and upgrading transportation infrastructure often require reducing on-street parking or traffic lanes. While studies have shown how such upgrades improve traffic safety and mobility for city residents, the question remains how such infrastructure improvements affect economic outcomes.

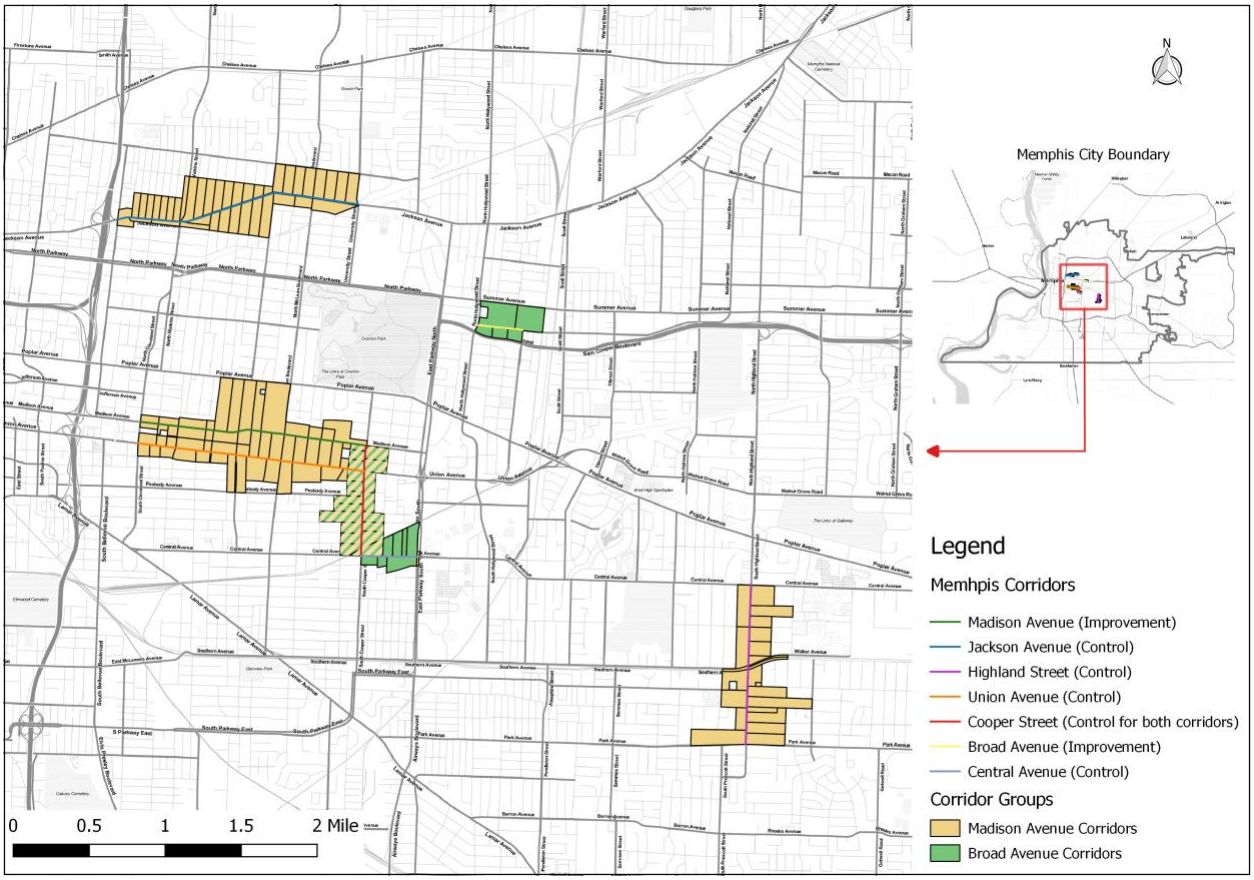

Figure 1-1. Memphis Corridors Map

Active transportation advocates often assert that the improvement of active transportation infrastructure will largely increase the number of customers that can arrived via alternative modes in addition to automobiles, and, ultimately, lead to greater revenue and employment growth. While there is some suggestive evidence of this, ranging from self-supported surveys of business owners (Flusche 2012; Jaffe 2015; Stantec Consulting 2011) to consumer behavior surveys (Clifton et al. 2012; Bent and Singa 2009) before and after the installation of active transportation projects. Recently, a few studies have approached this research question by comparing sales tax or employment trends over time for on the

improved blocks (NYCDOT 2013; Rowe 2013; Poirier 2017). However, while some researchers have started employing quasi-experimental methodologies (Dill et al. 2014; Yu et al. 2018), the majority have been descriptive or exploratory in nature, or have been limited to case studies within specific urban areas. The validity concerns and lack of consistent data backing many of the previous studies have given the pause and reason to call for additional research and evidence to address the data and methodological concerns.

This study will attempt to answer to what extent these types of corridor-level street improvements impact economic activity and business vitality in the immediate vicinity. Utilizing systematic data sources and methodologies across multiple cities and corridors, we examine, in particular, how do street improvements impact retail sales and employment?

Memphis has conducted many street improvement projects in past years, including new bike lanes and road diets. This report explores two recent street improvement corridors—Madison Avenue and Broad Avenue—to understand the economic and business impacts of these active transportation infrastructure investments.

2. Data Sources & Methodology

2.1 Data Sources

For this study, we used multiple data sources to estimate the effect of new bike lane infrastructure investment. Because this project makes use of a variety of different data sources, it required collaboration between the research team and representatives from multiple agencies/departments. Our principle contact was with the City of Memphis, sales tax data was provided and aggregated by State of Tennessee Department of Revenue; QCEW data was provided by the Tennessee State Department of Labor & Workforce Development; and LEHD data was publicly available at United State Census Bureau.

First, we used the Longitudinal Origin-Destination Employment Statistics (LODES) data set from the **Longitudinal Employer-Household Dynamics Dataset** (LEHD). LEHD provides geographically granular detail about jobs, workers and local economies, allowing us to examine employment by broad industry sector, wage and educational attainment. One major disadvantage of the LEHD data set is that in order to guarantee confidentiality, block level data is "fuzzed" so the numbers do not reflect the exact number of jobs at this geographical level. Additionally, though employment is disaggregated by industry, it is only provided at the most general level (the equivalent of two digit NAICS[1] codes) so we are unable to isolate restaurant workers from hotel service workers, for example. That being said, the LEHD data set is comprehensive, offers unprecedented geographic detail, and is longitudinal, allowing for consistent comparisons over time.

Sales tax data is collected as the primary data source to allow us to estimate a more sensitive measure of economic activity than employment (as the decision to hire or fire employees for a firm is often an expensive one, and thus we would expect employment to be a delayed response to changes in economic activities). Some drawbacks of sales tax data are that some states do not have a sales tax or, in states or cities that do have one, the sales tax data is not broken down by specific industry and it is difficult to accurately parse out accurate figures. But the benefits of sales tax data largely outweigh these issues and do offer a more sensitive metric than employment. Tennessee has a general 7% sales tax for merchandise, with exception on non-restaurant food which tax is 5.5%. In Shelby County, where Memphis is located, there is an additional sales tax of 2.25%, as well as an additional 5% accommodations tax. This gives a range of 7.75-14.25% sales tax rates in the city of Memphis. However, medical supplies, certain groceries and food items are exempted from tax collection, which may hamper the ability of sales tax data to accurately reflect all retail business vitality.

This report also takes advantage of establishment level **Quarterly Census of Employment and Wages (QCEW)** data. The QCEW gives us address level-data on individual establishments as well as detailed employment information, allowing for more accurate

[1] North American Industry Classification System (NAICS) - https://www.census.gov/eos/www/naics/

pinpointing of the geographic location of businesses and industrial classifications. In addition, the research team is able to use *employment* and *wages* as additional indicators of economic performance in the corridors. The aggregated employment numbers correspond closely to the LEHD data used in our analysis, but with the advantage that the numbers are not "fuzzed" for confidentiality concerns.

2.2 Methodology

We applied three methods in order to isolate the impact of street improvements on business vitality while controlling for other economic and regional factors. The methods include an aggregated trend analysis (following the NYCDOT study (2013)), a difference-in-difference approach, and an interrupted time series analysis. The time frame used in the analysis for LEHD data is 2004-2015, 2004-2016 for sales data, and 2000-2017 for QCEW data.

2.2.1 Corridor Selection & Comparison

In order to properly isolate the effect of the street improvements, we must identify treatment corridors (corridors where the street improvement occurred) and control corridors (corridors that are similar to the treatment corridors except they remain unimproved). Treatment corridors are corridors where new bike or pedestrian related improvements were installed, ideally made up of a minimum of 10 adjacent, or intersecting, census blocks with a minimal number of retail and food service jobs. Additionally, we chose street improvement corridors installed between 2008 and 2013 in order to guarantee we have sufficient data (at least 3 data points pre- and post-treatment) to track pre- and post-treatment economic trends.

Once corridors are selected based on these criteria, further testing is conducted to discern the level of similarity between treatment and control corridors. We compare similarity in two broad aspects: transportation/geography and business activity levels. In terms of transportation and geographic characteristics, the corridors should ideally be geographically close to each other, with similar street classifications, travel volumes and relative location/role within the city's road network.

The level of business activity in both retail and food services industries should be similar on treatment and control corridors, and the general patterns of growth prior to the street improvement should be similar as well. Furthermore, the ratio of business jobs (defined as the sum of retail and food service industry jobs) to overall number of jobs on the treatment and control corridors should be at similar levels. These similarity tests include quintile comparisons and statistical tests of the corridor employment to citywide employment ratios and average block level employment on the street improvement corridor and the proposed corresponding control corridors.

Specifically, t-tests are performed on three metrics at the census block level: (a) "business" employment, the sum of retail and food employment; (b) a census block level "business share" metric that is the number of business employment over the sum of other services industry employment such as professional/scientific services, public administration and

educational services; alternatively, another business share metric is calculated that includes a smaller share of services employment (including professional/scientific services, administrative/waste management services and arts/accommodation services). As long as one of the business metrics indicates similarity between treatment and control corridors, we consider similarity between the two corridors; and (c) a pre-construction annual employment growth rate.

Table 2-1. Corridor comparison indicators and methods

Comparison Category	**Indicators**	**Method**
Transportation/ Geography	Geography proximity	Researcher judgement
	Street classification (travel volume)	
	Role in road network	
Business activity	Job percentile brackets to regional average	Statistical test (t-test)
	Business jobs share compared to overall jobs	
	Pre-construction employment growth rate	

2.2.2 Aggregated Trend Comparison

This first method follows the previous NYCDOT study (NYCDOT 2013), aiming to examine whether the treatment corridors tend to have better business performance than comparison corridors after street improvements. The approach compares the trends of treatment and control corridors in addition to city-wide trends over the full time period for which we have data. If treatment corridors show greater growth rates in employment or sales tax receipts, or a jump in the level of employment or sales, then that would represent a positive impact of the street improvement on business activities. This method is easy to follow and represents the aggregated trend of business activities. However, it lacks the rigor of econometric estimates and statistical tests that explicitly test whether or not the street improvement caused the changes.

We present both absolute and indexed values for all variables. Indexed values are useful when you need to compare values on different scales. For some corridors the differences in employment or sales tax is large and it is not possible to accurately compare those to smaller corridors without indexing. This is especially important for something like sales tax where some corridors have large amounts of taxable sales due to being on a major travel corridor or having a large anchor retailer like a department store.

2.2.3 Difference-in-Difference (DID)

The second method aims to estimate the difference in business vitality of pre- and post-improvement periods between treatment and control corridors within the same time period. This is known as a difference-in-difference (DID) approach (Angrist and Pischke

2009). It is a designed to answer the "but for" question of what a corridor's economic trajectory would look like, had the streets not been improved. It requires data from pre/post intervention such as panel data (individual level data overtime) or cross-sectional data (individual or group level). The approach looks at the change in the variable of interest in the treatment corridor before and after it is treated. In this case this means looking at some time period before and after a street improvement, and comparing the economic indicators to the control corridor which has not received the street improvement. The difference in growth trajectories between the two periods will give an unbiased estimate of the effect of the treatment. DID is a useful quasi-experimental technique when true randomized experiments are not possible. This approach removes biases in the second period comparisons between the treatment and control corridors that could be the result of inherent differences between these corridors, as well as biases from comparisons over time in the treatment corridor that could be the result of prior trends. A key assumption of DID estimate is that the differences between control group and treatment group would have remained constant in the absence of treatment.

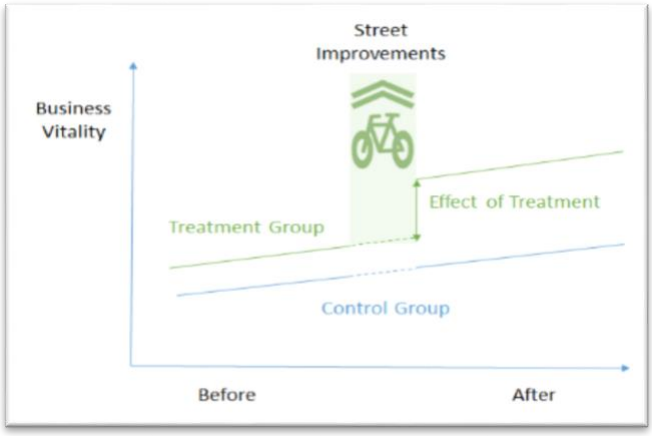

Figure 2-1. Illustration of DID method

DID is a linear modeling approach and its basic formula is expressed as:

$$Y_{it} = \beta_0 + \beta_1 T_{it} + \beta_2 A_{it} + \beta_3 T_{it} A_{it} + \varepsilon_{it}$$

Y_{it} is the observed outcome in corridors i and t (in this case change in employment or sales tax revenue); T_{it} is a dummy variable set to 1 if the observation is from the treatment corridor, or 0 if the observation is from the control corridor; A_{it} is a dummy variable set to 1 if the observation is from the post-treatment period; β_3 is the DID estimator of the treatment effect, specified as the ***prepost:corridor_name*** coefficient in our analysis. Typically, the DID estimator of interest is β_3, and if it is estimated to be statistically significant and positive, then this suggests a positive causal effect of the street improvement on the economic indicator in question. Conversely, if the estimate is significant and negative, then that indicates a negative effect of the improvement. Finally, a non-significant result indicates the improvement had no statistically discernible effect.

2.2.4 Interrupted Time Series (ITS)

Interrupted time series (ITS) is an econometric technique that estimates how street improvements impact corridor economic vitality from a longitudinal perspective. This approach tracks the treatment corridor over time and estimates the impact from the street improvement by identifying changes in its growth trend after the treatment (Lopez Bernal et al., 2016). If the treatment has a causal impact, the post-intervention economic indicators will have a different level or slope than the pre-intervention data points. In our research, interrupted-time series will be used to distinguish differences in economic level or growth before and after a specific time period when a street improvement is constructed, such as a new buffered or protected bike lane.

One advantage of ITS is that it allows for the statistical investigation of potential biases in the estimate of the effect of the intervention. Given the longitudinal nature of the test, ITS requires a significantly larger amount of data in order to accurately estimate a real effect on the growth trend.

The interrupted time-series analysis equation can be expressed as:

$$Y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 T_t X_t + \varepsilon_{it}$$

Y_t is the observed business outcome in time period t; T_t indicates the number of quarters from start to finish of the series; X_t is the treatment dummy variable taking on values of 0 in the pre-intervention period and 1 in the post-intervention period; β_0 is the model intercept or baseline level at t = 0; β_1 represents the estimated slope (or growth rate) during the pre-intervention period, which we specify as the ***ts_year*** coefficient; β_2 represents the level change following the intervention, specified as the ***prepost*** coefficient; and β_3 indicates the slope change following the intervention, which is the ***ts_year:prepost*** coefficient. A positive and statistically significant β_2 coefficient tends to suggest a positive causal effect on the level of business vitality immediately following the street improvement. A positive and statistically significant β_3 coefficient would suggest a positive causal effect on the growth in business vitality over time.

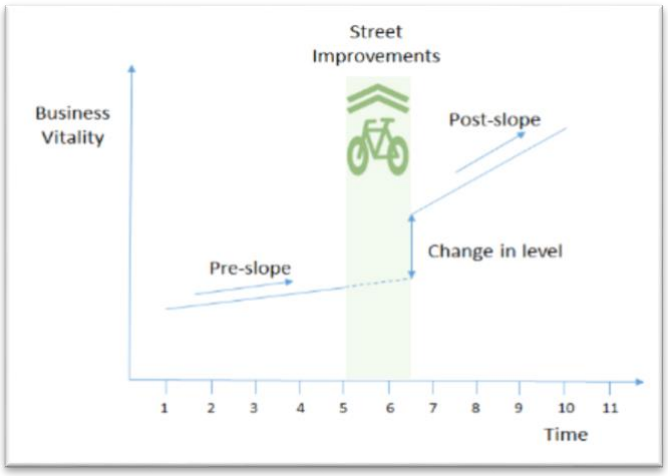

Figure 2-2. Illustration of ITS method

In conclusion, aggregated trend analysis and DID analysis both utilize control corridors to determine the impacts of the street improvement corridor, while the ITS analysis uses multiple time points on the street improvement corridor itself to pinpoint economic outcomes. In general, the ITS analysis provides more robust results than the other two methods, since it is less likely to be affected by the selection of control corridors. However, this method generally requires more data points post-intervention to achieve meaningful and valid impact estimations. The DID approach is heavily dependent on finding comparable control corridors (which may not always exist), so the analytical results may be weakened when appropriate corridors cannot be identified.

Additional data points after the completion of street improvements may help to provide further validity and rigor to the analysis of resulting economic outcomes. Moreover, further contextual information about the street improvement corridor, such as quality or level of the street improvement, number of parking spots eliminated, and subsequent bicycle ridership or pedestrian increases, would help to better understand the linkages between the improvements and potential impacts on business vitality. Extending this research to more closely examine the changes and shifts in industrial patterns will be valuable as well.

3. Corridor Comparisons

Our first test in corridor comparability is to compare the count of the total jobs, retail, and food service industry jobs on the corridors compared to block figures for the city of Memphis as a whole. This is allows us to have a broad understanding of the relative job density of the corridors. This serves two purposes: first, it gives us a quick estimate of the range of employment in each industry on the corridors; and second, it shows how similar the corridors are to each other in terms of economic activities. Finally, we perform a t-test (a statistical test designed to measure if the means of two different groups are statistically similar) on the number of economic indicators, which offers a more rigorous test of the comparability of the corridors. All of the following figures and tables use employment data from the LEHD in the year prior to the street improvement project as the base year for comparison.

3.1 Broad Avenue

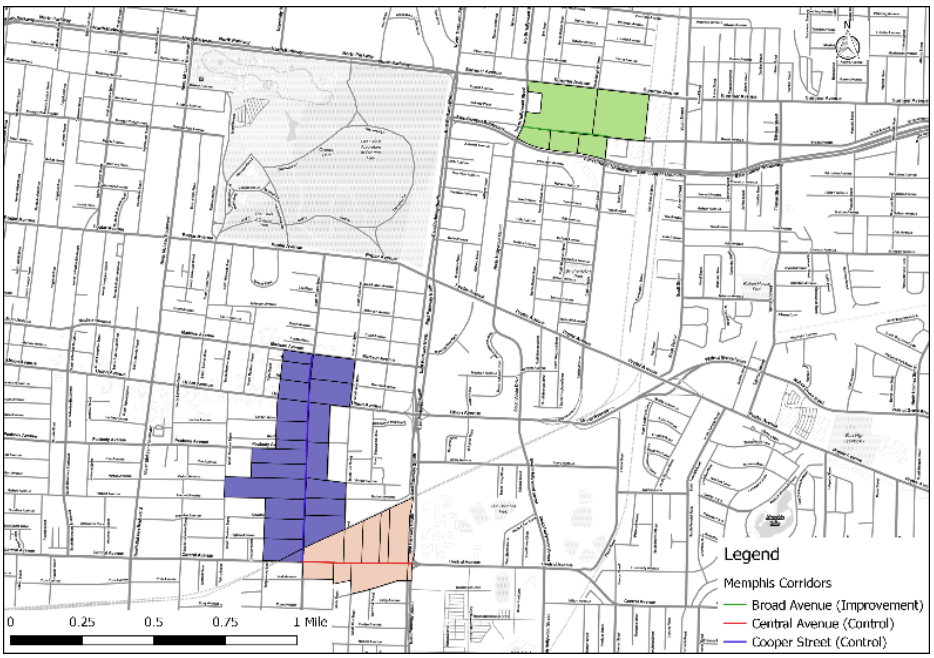

Figure 3-1. Broad Avenue Corridor

Our first treatment corridor is Broad Avenue, which installed buffered bike lane separated by parking in 2010. However, it is a relatively short improvement project, involving only five blocks along the corridor. The control corridors are Cooper Street and Central Avenue. The two control corridors locate not very close to the treatment corridor, and have higher traffic volume than those of the treatment corridor.

The following table shows total, retail, and food employment for Broad Avenue, Central Avenue, and Cooper Street as well as the city-based percentile ranks of employment on the corridors. Although Cooper Street corridor has much more total employment than others, they share similar amounts of street-level retail and food employment, which is also shown in the percentile ranks of employment per block.

Table 3-1. Broad Avenue, Central Avenue, and Cooper Street Employment

		Employment per block		Percentiles		
Corridor	Total	Retail	Food	Total	Retail	Food
Broad Ave.	40	13	4	50-60	75-80	65-70
Central Ave.	53	6	5	60-65	65-70	70-75
Cooper St.	124	6	12	75-80	65-70	75-80

We also performed a series of t-tests in order to determine whether the average employment levels per block between the treatment and control corridors are statistically significantly different. A statistically significant results here would suggest that the corridors are not necessarily comparable. In terms of absolute employment amount, both control corridors show non-significant t-test result indicating they have similar employment with treatment corridor. However, we performed a second set of t-tests on the business/service employment ratios between the corridors. Both corridors show significant results to some extend suggesting that they have different structure of 'business' versus service jobs from treatment corridor. Apparently, two control corridors have more other service related jobs other than 'business' employment.

3.2 Madison Avenue

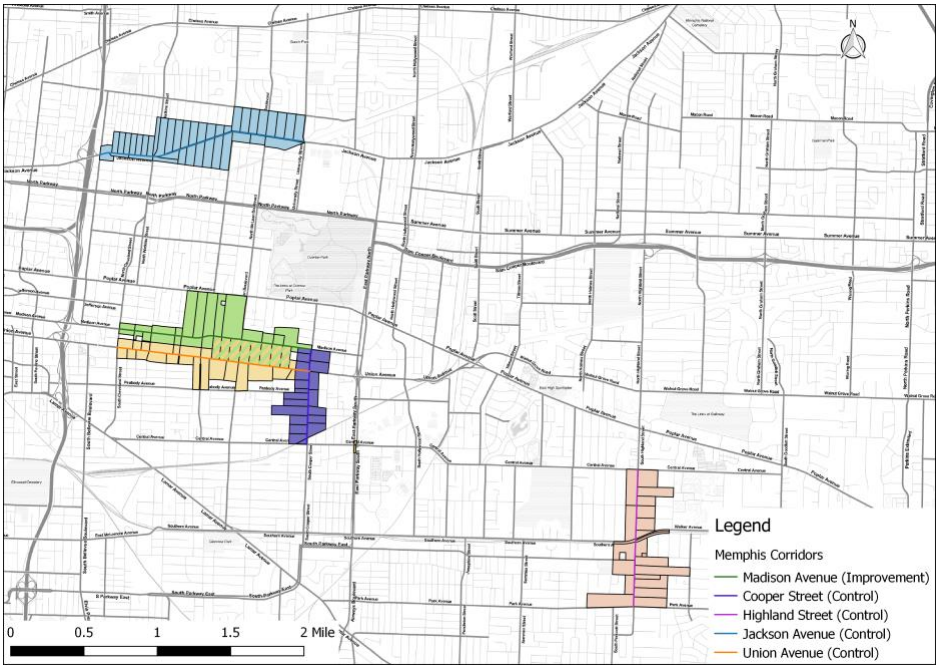

Figure 3-2. Madison Avenue Corridor

Our second treatment corridor is Madison Avenue in Midtown district, which installed buffered bike lane in 2011. The control corridors are Highland Street, Jackson Avenue, and Union Avenue. Union Avenue corridor is close to the treatment corridor in Midtown district, while Highland Street and Jackson Avenue are located in east and north boundary of the Midtown district. Union Avenue has more travel lanes and higher traffic volume than

treatment corridor, which the other two control corridors have slightly higher travel volume than treatment corridor.

The following table shows total, retail, and food employment for the Madison Avenue and control corridors, as well as the city-based percentile ranks of employment on the corridors. Comparing total employment among corridors, we find the Highland Street Corridor has very similar total employment with the Madison Ave corridor. While the Union Avenue has much more total employment than the Madison Avenue, it has similar retail and food employment with the treatment corridor. The Jackson Avenue is less comparable with treatment corridors, since it has much smaller amount of economic activities.

Table 3-2. Madison Avenue and Control Corridors Employment

	Employment per block			Percentiles		
Corridor	Total	Retail	Food	Total	Retail	Food
Madison Ave.	68	16	17	65-70	80-85	80-85
Highland St.	77	10	25	70-75	70-75	85-90
Jackson Ave.	8	2	1	25-30	50-55	45-50
Union Ave.	140	12	16	95-100	75-80	80-85

The Jackson Avenue corridor mean 'business' and food employment per block is significantly different from the Madison corridor blocks, according to our t-tests. Additionally, we performed a second set of t-tests on the business/service employment ratios between the two corridors. In this case, all of the comparison corridors t-tests came back non-significant indicating the corridors have a similar structure of 'business' versus service jobs.

3.3 Corridor Comparison Summary

The following table shows a summary of the corridor comparison analysis for all treatment and control corridor groups, with nine comparability indicators for each group. We determined that the corridor groups met a sufficient number of comparability checks, though a few corridors have very low retail or food employment at the block level. In terms of Madison Avenue improvement corridor, the Highland and Union control corridors are very similar and comparable in most aspects, except some of the street types. However, Jackson corridor is not a comparable corridor, since it has much smaller amount of business related employment and less geography proximity. Therefore, Jackson corridor is excluded in further analysis. With respect to Broad Avenue corridor, two control corridors are equally comparable to the treatment corridor, although there is different structure of business/service, and the control corridors are not close to the treatment corridor.

Table 3-3. Corridor Comparison Summary

Treatment Corridor	Indicator		**Madison Avenue**				**Broad Avenue**	
Control Corridor			Cooper	Highland	Jackson	Union	Cooper	Central
Transportation/ Geography	Geographic Proximity		✓	x	x	✓	x	x
	Street Classification		✓	✓	✓	x	✓	✓
	Role in Street Network		✓	✓	✓	x	✓	✓
Business Activity	Job Density Percentile	Retail	✓	✓	x	✓	✓	✓
		Food	✓	✓	x	✓	✓	✓
	Share of Business Jobs		✓	✓	✓	✓	x	x
	Employment Growth Rate	Retail	x	✓	✓	✓	✓	✓
		food	✓	✓	✓	✓	x	✓

4. Data Analysis

4.1 Broad Avenue

4.1.1 Trend Analysis

4.1.1.1 LEHD

On Broad Avenue, we can clearly observe negatively trending retail employment growth subsequent to the street improvement, comparing with control corridors and city-wide trends. Food service industry, however, shows opposite trend; the treatment corridor increases continuingly after street improvement. While it is similar to Cooper control corridor, it apparently performs better than Central control corridor and city-wide trend. In these respects, street improvement in Broad Avenue has a negative impact on retail employment, but a positive impact on food employment.

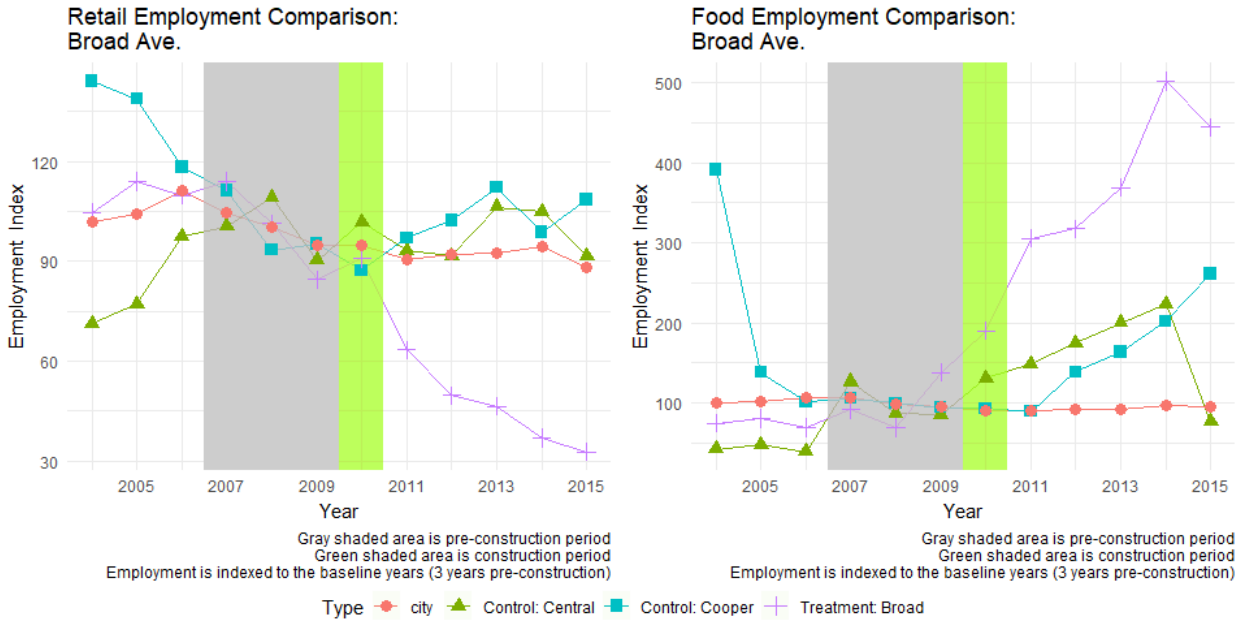

Figure 4-1. Broad Avenue Employment Comparison (LEHD)

4.1.1.1 Sales Tax

In order to better understand the impacts of the street improvement on the corridors, we utilized sales tax data in our analysis. As mentioned previously, sales taxes can be a more sensitive measure of economic activity than employment and the data is typically available on a more frequent basis. Despite this advantage, we only have retail sales data, so we cannot identify the economic activity of food industry.

Broad Avenue remains consistently lower than control corridors which are Central Avenue and Cooper Street in absolute terms over time. The rate of change in growth, however, in retail receipts for Broad Avenue accelerates post-construction. It significantly performs better than control corridors, although all sales indexes tend to increase after construction.

Thus, we can conclude that bike lane installation on Broad Avenue substantially results in an increase in retail gross sales.

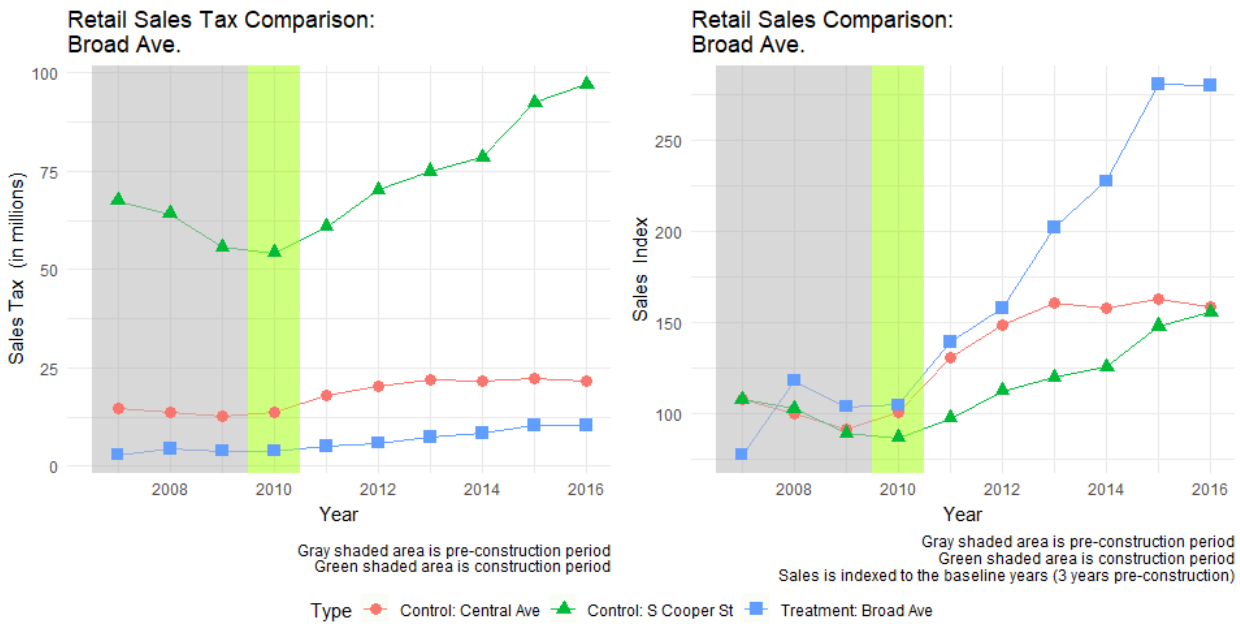

Figure 4-2. Broad Avenue Sales Revenue Comparison (Sales tax data)

4.1.1.1 QCEW

As mentioned earlier, the QCEW data provided by the state will give us more economic indicators as it includes establishment counts and total wage information for the retail industry on the corridors. While we do not have access to fully disaggregated data, the increased sample size and detail on establishments and wages is still valuable and expands our understanding of the economic and business dynamics of our corridors.

The Broad Avenue aggregated trend analysis shows that there were large jumps in both retail and food activity on the corridors subsequent to the construction. Despite a large decline, they represent a higher level of employment than before construction. The employment change trends of control corridors, however, are similar to those of Broad Avenue. In other words, we should conduct another analyses such as DID or ITS in order to identify the impact of street improvement on employment activity.

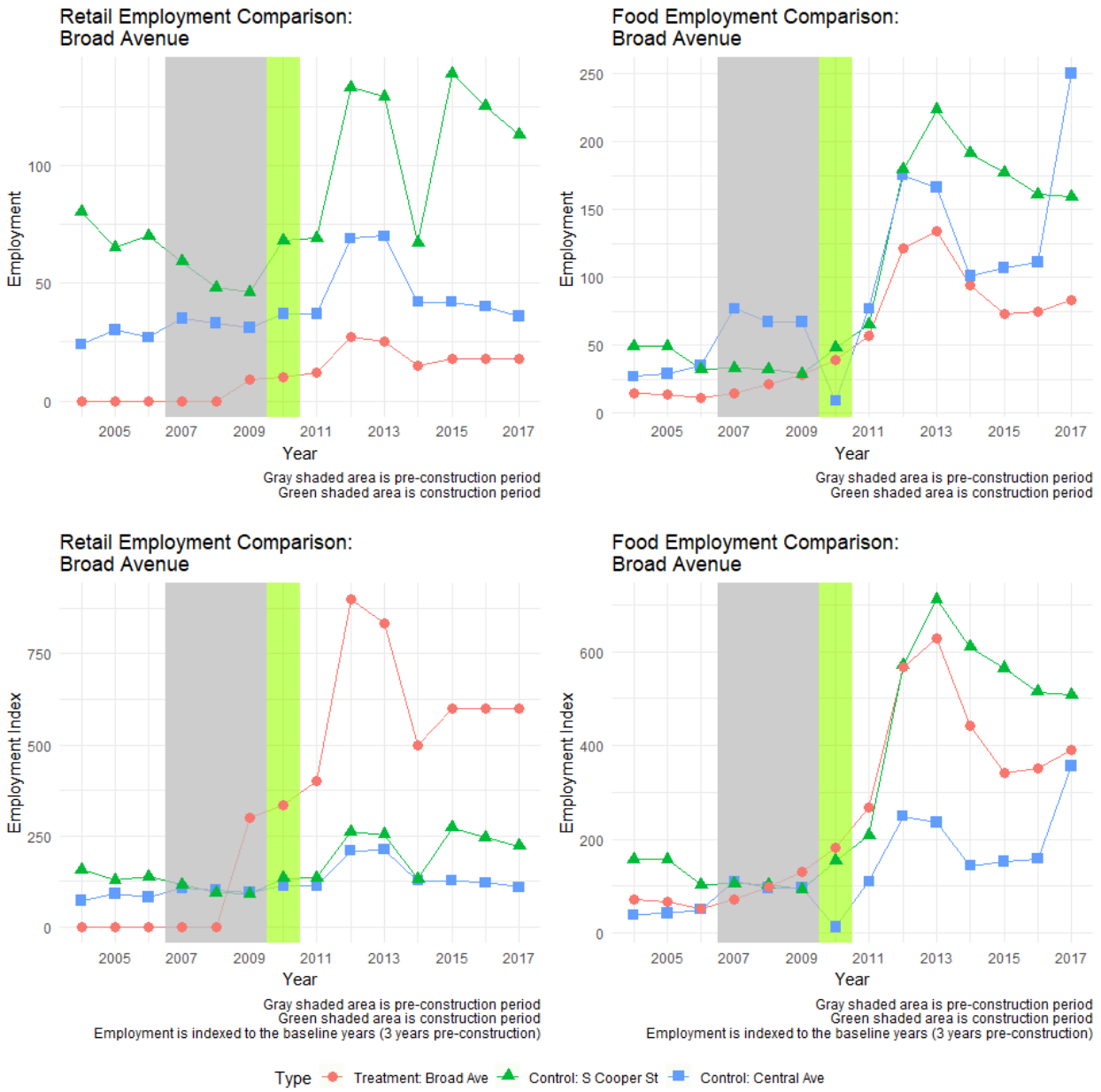

Figure 4-3. Broad Avenue Employment Comparison (QCEW)

In the case of wage comparison, the trend analysis indicates that the growth rates of wage in both retail and food of Broad Avenue increase after street improvement. In particular, there was a large increase in wage growth on Broad Avenue after construction. Nonetheless, comparing the wage change trends of Cooper Street and Central Avenue corridor, it is unclear that the street improvement had any discernable impact on retail and food wage growth. Therefore, we need additional analyses to figure out the impact of construction economic activity.

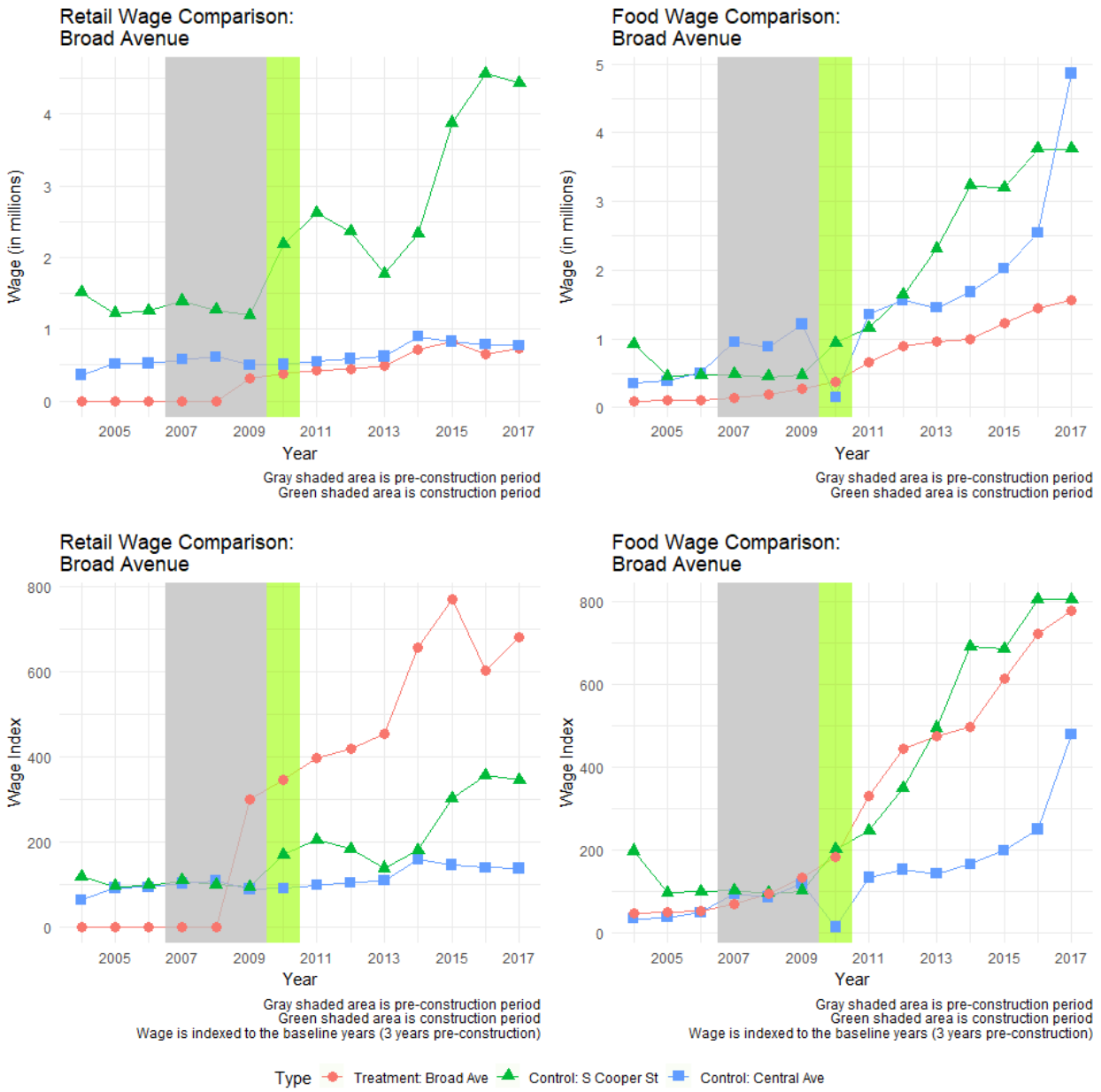

Figure 4-4. Broad Avenue Wage Comparison (QCEW)

Table 4-1. Broad Corridor Trend Analysis Summary Table

	Retail						Food					
	Baseline		Post-implementation				Baseline		Post-implementation			
Area	Base	Growth	1st Year	2nd Year	3rd Year	Avg.	Base	Growth	1st Year	2nd Year	3rd Year	Avg.
LEHD: [employment]												
Treatment	95	-13.89%	-36.84%	-21.67%	-6.38%	-21.63%	17	37.50%	211.76%	3.77%	16.36%	77.30%
Control: Cooper	112	-7.05%	-2.68%	5.50%	9.57%	4.13%	235	-5.58%	-10.21%	54.50%	18.10%	20.80%
Control: Central	69	-4.32%	-7.25%	-1.56%	15.87%	2.35%	64	-16.32%	48.44%	17.89%	14.29%	26.87%
Sales: [sales revenue, 1,000,000$]												
Treatment	3.7	20.19%	39.39%	13.39%	27.98%	26.92%	-	-	-	-	-	-
Control: Cooper	62.5	-8.94%	-2.52%	15.35%	6.83%	6.55%	-	-	-	-	-	-
Control: Central	13.7	-8.00%	30.51%	14.07%	8.06%	17.55%	-	-	-	-	-	-
QCEW: [employment]												
Treatment	3	-	300.00%	125.00%	-7.41%	139.20%	21	36.67%	171.43%	112.28%	10.74%	98.15%
Control: Cooper	51	-11.41%	35.29%	92.75%	-3.01%	41.68%	31	-6.20%	109.68%	175.38%	24.58%	103.21%
Control: Central	33	-5.89%	12.12%	86.49%	1.45%	33.35%	70	-6.49%	10.00%	127.27%	-5.14%	44.04%

1 Baseline is defined as the average of the three years prior to the construction year;
2 Pre-growth rate is defined as the average of the baseline annual growth rates;
3 Post-growth rate is defined as the average annual growth rate of three time points after the construction year.

The table above summarizes the detailed percentage changes in retail and food services economic indicators across the three data sources. Retail employment on Broad Avenue corridor shows some contradictory patterns where its retail LEHD employment is largely decreased but the sales tax receipts and QCEW retail employment largely grew after bike lane installation. In the case of the food service employment, LEHD data shows a larger positive impact of the street improvement on the economic activity than control corridors. QCEW data, however, indicates that Cooper Street, which is a control corridor, shows larger growth rates than Broad Avenue after the construction, despite an increase in growth rate.

4.1.2 DID Analysis

DID analysis of LEHD data indicates that the Broad Avenue treatment corridor exhibits a statistically significant and negative effect of infrastructure construction on the retail employment. The effect for other industry sectors, however, are not statistically significant, indicating no specific impact patter on food industry employment.

In terms of sales tax data, due to the absolute value difference between treatment corridor and control corridors, especially Cooper Street, the model indicates negative impact of bike lane on treatment retail sale is very likely affected by less absolute retail sales increase estimates. Thus, we need to interpret this result with extra cautious. In terms of number of establishment, Broad Avenue street improvement has a positive impact on establishment opening, compared to Central Avenue.

The QCEW DID result show that Broad Avenue treatment corridor indicates a statistically significant and negative effects of infrastructure construction on the number of employment and wage when using the Cooper Street as a control group. When we employ the Central Avenue as a control group, however, the difference terms are not statistically significant. These inconsistent results indicate that additional analyses like ITS analysis are necessary to identify the effects of treatment on employment and wage.

4.1.3 ITS Analysis

In the case of the ITS analysis of the Broad Avenue corridor using LEHD data, only food employment model shows statistically significant result. It indicates bike lane installation causes the food employment experience greater slope change, that is increase 5 more employment annually than pre-installation period, after the improvement. The effect on retail employment is not significant though.

In terms of using sales tax data, the results of the two models, employing retail gross sales and number of establishments as dependent variables, indicate negative level change and positive slope change after bike lane installed on Broad Avenue. Although we need extra time points to verify the retail sales impacts in future, in general, the bike lane installation on Broad Avenue has positive impact on retail sales based on ITS analysis.

The results of the QCEW DID of the retail employment show that Broad Avenue corridor exhibits a level change from the pre-treatment trend patterns which are an increasing pattern over time period. In terms of food and business employment, the result mirrors the visual trends analyses of employment that show a clear jump after construction.

With respect to wage, Broad Avenue corridor does not have a significant effect on total wage of retail. In the case of food industry, on the other hand, all coefficients are significant. Especially, *ts_year* and *ts_year:prepost* terms are positive and *prepost* term is negative. Considering the trend of total wage of food industry, however, it is inferred that the *prepost* term gets to have the negative value in the estimation process, although treatment does not make the level of wage of food industry reduce in reality. Finally, in terms of total wage of business, the treatment cannot lead to the change in the level of business wage, but it results in the increase in the slope of business wage change.

4.1.4 Key Results

- The analysis reveals consistent evidence of positive impacts of the protected bike lane street improvement on employment in the food services industry, using both trend analysis and ITS methods across both employment data sources.
- The Broad Avenue corridor shows some contradictory patterns where the sales tax receipts and QCEW retail employment grew after the protected bike lane installation but the LEHD retail employment decreased. The sales tax and QCEW data are likely much more reliable in this circumstance, as it is quite likely that the fuzzed LEHD data contributes to inaccuracies at the small geographic scale of the Broad Avenue corridor.

- The low number of retail establishments along Broad Avenue in the baseline period means that the large post-construction growth rates should be interpreted with caution, and with particular attention to the local context.
- In conclusion, the protected bike lane triggered a significant employment increase in the food services industry after installation, indicating an improvement in business vitality as a result.

4.2 Madison Avenue

4.2.1 Trend Analysis

4.2.1.1 LEHD

Madison corridor installed buffered bike lane in 2011. There is a slight increase of retail employment right after bike lane installation on Madison corridor, however, with continuing drop after that. This performance is better than one control corridor, Union Avenue, but worse than the other two control corridors, Highland Street and Cooper Street. In addition, city-wide retail employment performs better than the treatment corridor, indicating the street improvement on Madison might have negative impact on retail employment.

With respect to food sector, there is a significant drop after bike lane installation, however, it recovered dramatically after two year. The performance of control corridors are mixed, Cooper corridor experienced an unexpected dramatic increase after 2011, while the other two corridors either grew slowly or had significant drop after 2011, and the city-level trend more likely remains flat. Therefore, bike lane installation on Madison Avenue might have positive impact on food employment. Due to the variety of three control corridors, it is hard to draw conclusive results from visual check on the trend graphs. Additional econometric analysis would uncover the impact of Madison bike lane corridor more clearly.

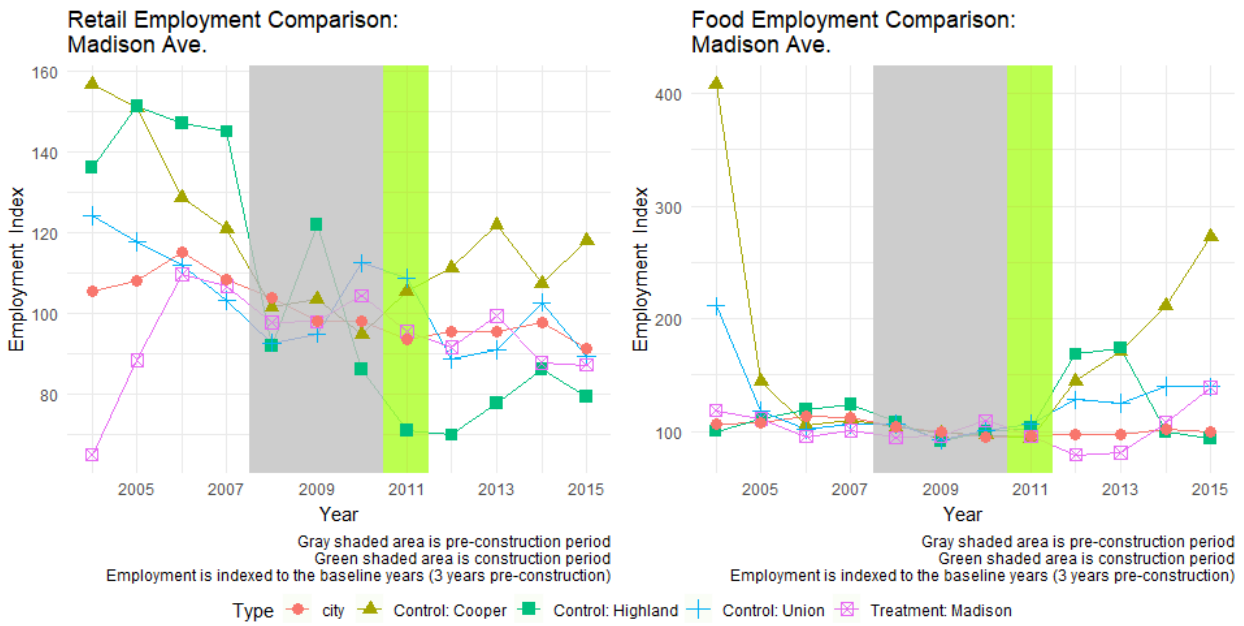

Figure 4-5. Madison Avenue Employment Comparison (LEHD)

4.2.1.1 Sales Tax

From the retail sales and establishment analysis, we can uncover more about the business performance after bike lane installation in 2011. Compared with control corridors, treatment corridor has more establishments opening after street improvement, with the

indexed retail gross sales increase faster than two control corridors except Cooper Street. However, in terms of gross sale per establishment, the treatment corridor tracks the control corridors closes. Therefore, the bike lane installation on Madison Avenue has a positive impact on gross retail sales, mostly due to more establishments opening along the corridor.

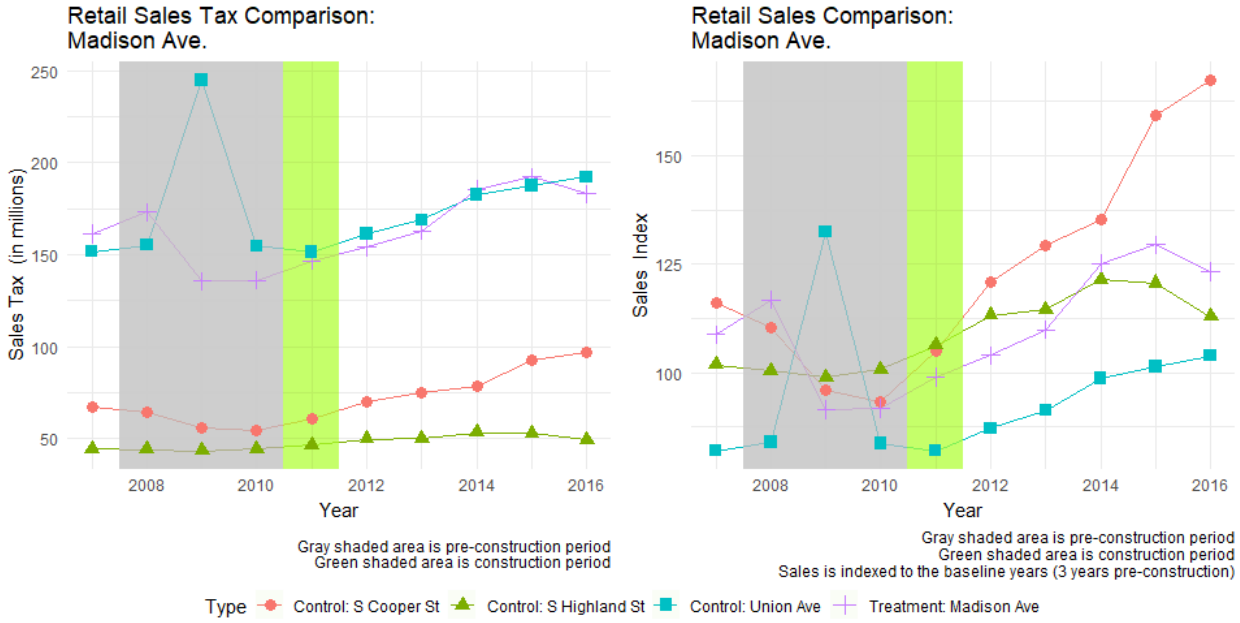

Figure 4-6. Madison Avenue Sales Revenue Comparison (Sales tax data)

4.2.1.1 QCEW

In the case of retail employment, Madison Avenue aggregated trend analysis shows that there were large jumps on the corridor after bike lane installation construction. The employment change trends of control corridors, however, are similar to that of Madison Avenue. It means that we have to conduct another analyses such as DID, ITS in order to identify the effects of construction on employment growth. In terms of food service industry employment, there were also large jumps on all corridor after construction. While the employments of the control corridors have slightly decreased after 2013, that of treatment corridors has been steadily maintained.

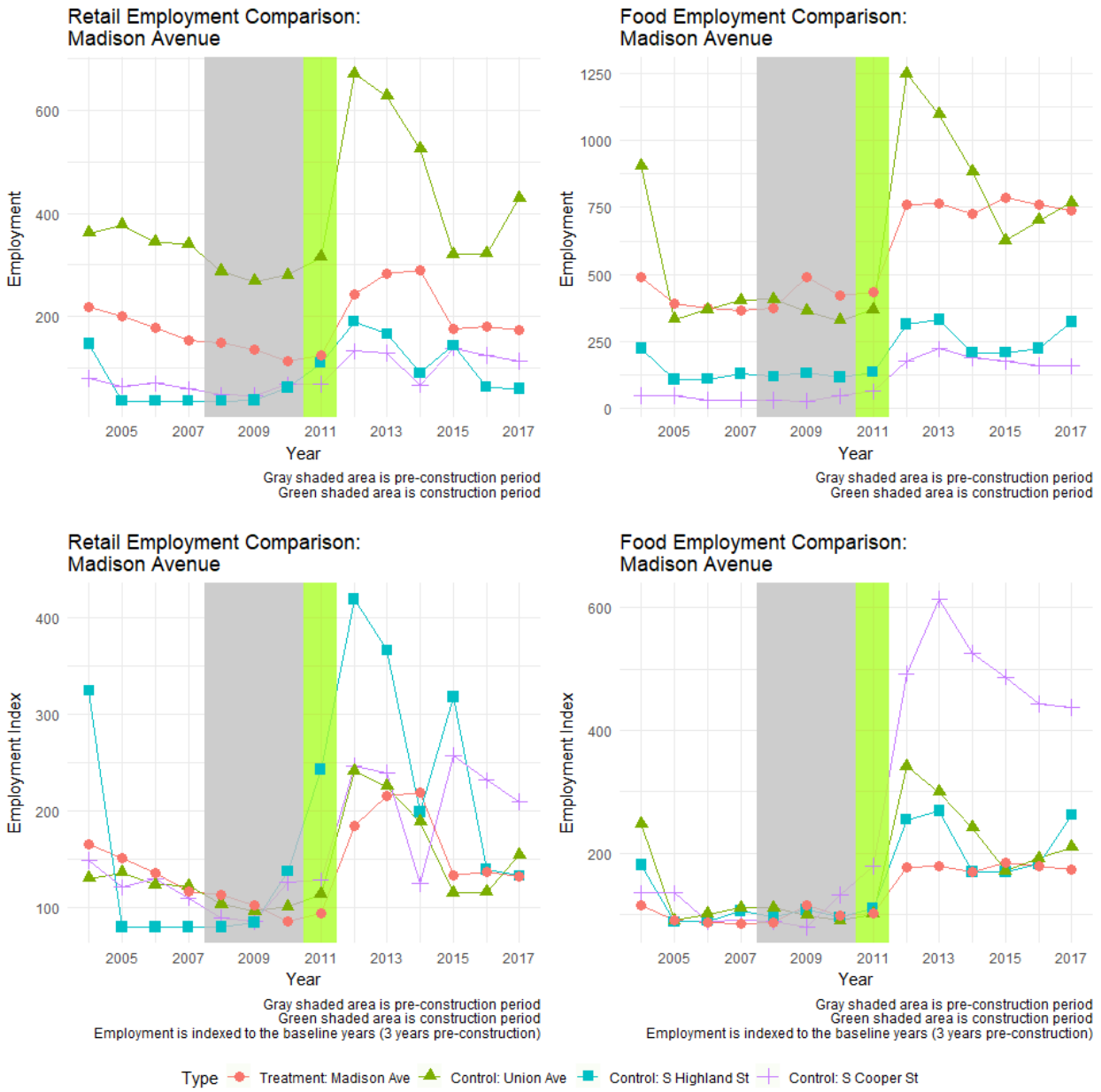

Figure 4-7. Madison Avenue Employment Comparison (QCEW)

With respect to retail wage, there is large jump on the treatment corridor's wage level after street improvement project; however, this trend was similar in control corridors. In terms of food industry, similarly, there were jumps of wage level on all corridors after construction period. Moreover, unlike other control corridors where wage levels were fluctuated after construction, the wage on Madison Avenue maintained a stable level.

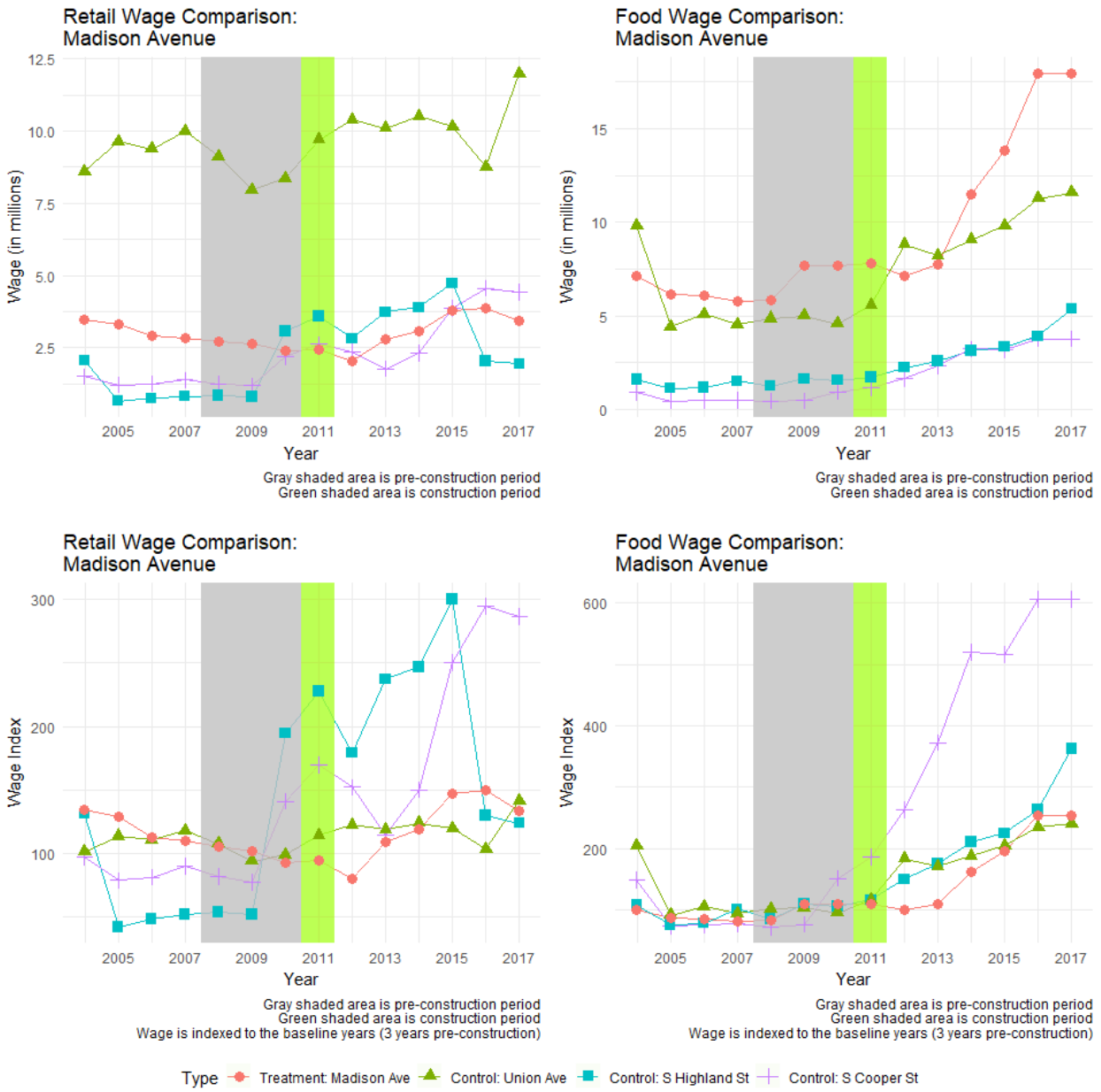

Figure 4-8. Madison Avenue Wage Comparison (QCEW)

Table 4-2. Madison Corridor Trend Analysis Summary Table

	Retail						Food					
	Baseline		Post-implementation				Baseline		Post-implementation			
Area	Base	Growth	1st Year	2nd Year	3rd Year	Avg.	Base	Growth	1st Year	2nd Year	3rd Year	Avg.
LEHD: [employment]												
Treatment	494	3.41%	-8.30%	8.39%	-11.61%	-3.84%	510	7.90%	-20.78%	2.48%	32.85%	4.85%
Control: Union	399	10.45%	-11.28%	2.54%	12.95%	1.40%	565	-2.20%	28.32%	-2.34%	12.01%	12.66%
Control: Highland	190	1.63%	-30.00%	11.28%	10.81%	-2.64%	421	-3.04%	68.65%	3.24%	-42.84%	9.68%

	Retail						Food					
	Baseline		Post-implementation				Baseline		Post-implementation			
Area	Base	Growth	1st Year	2nd Year	3rd Year	Avg.	Base	Growth	1st Year	2nd Year	3rd Year	Avg.
Control: Cooper	103	-3.25%	11.65%	9.57%	-11.90%	3.10%	225	-3.44%	44.89%	18.10%	23.64%	28.87%
Sales: [sales revenue, 1,000,000$]												
Treatment	148.3	-10.64%	3.92%	5.69%	13.95%	7.85%	-	-	-	-	-	-
Control: Union	185.0	10.47%	-12.86%	4.75%	8.08%	-0.01%	-	-	-	-	-	-
Control: Highland	43.8	0.22%	13.15%	1.16%	6.16%	6.82%	-	-	-	-	-	-
Control: Cooper	58.1	-7.94%	20.97%	6.83%	4.62%	10.81%	-	-	-	-	-	-
QCEW: [employment]												
Treatment	132	-12.85%	84.85%	16.39%	1.76%	34.33%	428	8.14%	77.34%	0.79%	-5.10%	24.34%
Control: Union	279	-1.05%	140.86%	-6.55%	-16.40%	39.30%	366	-10.09%	241.53%	-12.24%	-19.42%	69.96%
Control: Highland	45	34.36%	322.22%	-12.63%	-45.78%	87.94%	124	-0.22%	154.03%	5.40%	-37.05%	40.79%
Control: Cooper	54	21.83%	146.30%	-3.01%	-48.06%	31.74%	36	28.07%	397.22%	24.58%	-14.35%	135.82%

1 Baseline is defined as the average of the three years prior to the construction year;
2 Pre-growth rate is defined as the average of the baseline annual growth rates;
3 Post-growth rate is defined as the average annual growth rate of three time points after the construction year.

The table above summarizes the detailed percentage changes of retail and food service economic indicators across three different data sources. Madison Avenue corridor shows some contradictory patterns where its retail LEHD employment is largely decreased but the sales tax receipts and QCEW retail employment largely grew after bike lane installation. In addition, in terms of the food service industry, while the result of the LEHD shows the negative growth rate, that of the OCEW shows a large positive growth rate subsequent to the street improvement, although average growth rates of LEHD and QCEW are positive.

4.2.2 DID Analysis

The DID estimators using LEHD data are non-significant for all three models, indicating there is no impact particular pattern on business employment, although the trend analysis indicates some preliminary result.

Similarly, two models, using retail gross sales and number of establishments of the sales tax data as dependent variables, are estimated. The DID estimators are non-significant for both models, indicating there is no particular impact pattern on retail sales and business establishment numbers, although the trend analysis indicates some preliminary positive impact.

Using QCEW data, the results of the DID analysis of the employment indicate that the corridor shows some mixed results depending on control corridors. In the cases of the Cooper Street and Highland Street, the difference terms for food and business employment are negative and significant. It means that Madison Avenue treatment corridor has positive effects of infrastructure construction on the number of food and business employment. On the other hand, the difference terms for retail and business employment of the Union

Avenue exhibit a statistically significant and positive effect. These results indicate that Madison Avenue treatment corridor has negative impacts on the number of retail and business employment when we use the Union Avenue as a control group.

In the cases of wage, the difference terms for the Cooper Street and Highland Street are significant, while those for the Union Avenue do not show statistically significant effects. The results for the Cooper Street and Highland Street, however, are equivocal. On one hand, the difference terms for total wage of retail are significant and positive. On the other hand, those for total wage of food industry are significant and negative. These results indicate that Madison Avenue treatment corridor has positive effects on the wage of food industry, while it affects wage of retail negatively. The difference terms for business, however, are not significant.

To sum up, in the case of the DID analysis of QCEW data, there are different results when using the Cooper Street or Highland Street as control groups and when using the Union Avenue. Considering the trends analysis presented above, the reason why these results are derived is that the Union Avenue might be not appropriate as a control group. In short, the difference terms for the Union Avenue may not reflect well the effect of the treatment excluding the effects of extraneous factors.

4.2.3 ITS Analysis

According to the results of the ITS analysis of LEHD data on Madison Avenue, food employment model shows statistically significant result. It indicates bike lane installation causes the food employment significant level drop 1152 after the project, but with greater slope change, that is growing 115 more employment annually than pre-installation period. The reason why level change is negative is probably due to limited of data points after interruption, bike lane installation, which lead to smaller intercept after interruption than before given steeper slope. Longer time data points would help to smooth the fitting line, and generate more accurate estimation of both intercept and slope parameters.

In terms of using the sales data, the slope change parameter for gross sales model indicates after buffer bike lane installed in Madison Avenue, the gross sales increase $15,288,908 more every year than pre-installation. In terms of number of establishment model, the level change parameter is negative, while slope change parameter is positive. It indicates the bike lane installation bring about 57 establishments reduction, but 8 more in annual growth rate. Similar as LEHD employment models, the estimation will be more smooth and accurate with longer time data points collected in future. In general, the bike lane installation on Madison Avenue has positive impact on retail sales based on ITS analysis.

The ITS analysis of QCEW data on Madison Avenue represents that Madison Avenue corridor contributes to the increase in the level of employment for retail and food industry, although it cannot lead to significant effects on the slope changes. In terms of wage, both *prepost* and *ts_year:prepost* terms are significant for both retail and food. In particular, *prepost* coefficients are negative and *ts_year:prepost* terms are positive. These results should be interpreted with the trend analyses because it is possible to misrepresent the results of estimation. Considering both results, the treatment has a negative effect on

the level of total wage of retail, but, at the same, it converts the slope of wage change to be positive. In other words, the treatment can contribute to the increase in retail wage in the long term, even though it makes the level of wage decrease. In the cases of food and total business, it is inferred that the treatment does not negatively affect the level of wage, although the coefficient is significant and negative. In short, the treatment has a positive effect on the slope of food wage.

4.2.4 Key Results

- Our ITS analyses show positive and statistically significant impacts of the street improvement on both food employment and retail sales, suggesting a positive causal relationship.
- Analysis of sales tax receipts also shows that sales along Madison Avenue follows a parallel trend when compared with its control corridors, with no detrimental impacts to either retail or food services industry sales after the street improvement.
- The LEHD and QCEW employment data on Madison Avenue both show similar trends with its control corridors after street improvement. Cooper Street experienced a larger bump in employment in the post-construction period, but we suspect that this may be due to events unrelated to the construction of the buffered bike lane on Madison Avenue.
- DID analyses indicate non-significant or mixed impacts of the Madison Avenue street improvement on the employment and sales economic indicators.
- While some analyses indicate little impact of the street improvement on certain economic indicators, the positive causal results of our ITS analyses are significant enough for us to conclude that the buffered bike lane on Madison Avenue improved food services employment and retail sales in the corridor and had a positive effect on business vitality.

5. Conclusion

Based on our analysis of two street improvement corridors in Memphis, we found street improvement projects improve, or had insignificant impacts on, economic outcomes. In particular, we can conclude that:

- The protected bike lane on Broad Avenue triggered a significant employment increase in the food services industry after installation, indicating an improvement in business vitality as a result.
- On Madison Avenue, we found that while some analyses indicate little impact of the street improvement on certain economic indicators, the positive causal results of our ITS analyses are significant enough for us to conclude that the buffered bike lane on Madison Avenue improved food services employment and retail sales in the corridor and had a positive effect on business vitality.

In the other analyzed corridors and industry sectors, we found either mixed results or insignificant results. This is typically due to either insufficient number of data points after the completion of the street improvement (for ITS analysis), or control corridors that may not be fully comparable (for DID analysis). However, the insignificant results may be significant in this context, indicating that there does not appear to be a negative causal impact of right-of-way or parking lane removal on economic outcomes.

Three data sources were used for this analysis, each with its pros and cons. The analysis results using the three data sources should be viewed as complementary to each other. LEHD data is comprehensive, easy to access, and provides rough trends of employment change at small geographical scales. It allows for comparisons between the street improvement corridors with overall city economic trends, and for both treatment and control corridor selection without obtaining additional data. Once street improvement corridor selection is completed, sales tax data (sales revenue) and QCEW data (employment and wages) can provide finer grain economic activity details. Sales tax data for Memphis is limited to the retail sector (excluding food service industries).

We employed three different analytical approaches to investigate the economic impacts of street improvement corridors. Aggregated trend analysis and difference-in-difference (DID) analysis both utilize control corridors to determine the impacts of the street improvement corridor, while the interrupted time series (ITS) analysis uses multiple time points on the street improvement corridor itself to pinpoint economic outcomes. In general, the ITS analysis provides more robust results than the other two methods, since it is less likely to be affected by the selection of control corridors. However, this method generally requires more data points post-intervention to achieve meaningful and valid impact estimations. The DID approach is heavily dependent on finding comparable control corridors (which may not always exist), so the analytical results may be weakened when appropriate corridors cannot be identified.

Additional data points after the completion of street improvements may help to provide further validity and rigor to the analysis of resulting economic outcomes. Moreover, further contextual information about the street improvement corridor, such as quality or level of the improvement, number of parking spot reduction, and subsequent bicycle ridership or

pedestrian increases, would help to better understand the linkages between the improvements and potential economic impacts. Extending this research to more closely examine the changes and shifts in industrial patterns will be valuable as well.

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7. Technical Appendix

The following section presents the estimation tables of the difference-in-difference (DID) and interrupted time series (ITS) analysis for each corridor group. The sections are organized by the data source of the model: LEHD, sales tax and QCEW. Please refer to the appropriate sections earlier in the report for descriptions of the data, methodology and interpretation of the results.

7.1 LEHD

7.1.1 Broad Avenue

Broad Ave. Corridor Difference-in-Difference Estimates

	Dependent variable:	
	CNS07 Retail Emp.	CNS18 Food Emp.
TypeControl: Central	-33.714***	33.571
	(7.496)	(68.863)
TypeControl: Cooper	29.286***	326.286***
	(7.496)	(68.863)
prepost	-53.886***	49.486
	(8.211)	(75.435)
DID estimator: Central	57.314***	4.629
	(11.612)	(106.682)
DID estimator: Cooper	43.914***	8.914
	(11.612)	(106.682)
Constant	97.286***	17.714
	(5.3)	(48.693)
Observations	36	36
R^2	0.842	0.62
Adjusted R^2	0.816	0.557
Residual Std. Error (df = 30)	14.023	128.83
F Statistic (df = 5; 30)	31.960***	9.799***
Note:		*p<0.1; p<0.05;* p<0.01

Broad Ave. Corridor Interrupted Time Series Estimates

	Dependent variable:	
	CNS07 Retail Emp.	CNS18 Food Emp.
Yearly trend	-3.679**	2.857*
	(1.25)	(1.264)
Level change	1.4	-19.086
	(21.844)	(22.09)
Slope change	-3.321	5.143*
	(2.436)	(2.463)
Constant	112.000***	6.286
	(5.588)	(5.651)
Observations	12	12
R^2	0.964	0.957
Adjusted R^2	0.95	0.941
Residual Std. Error (df = 8)	6.612	6.686
F Statistic (df = 3; 8)	71.200***	59.730***
Note:		*p<0.1; **p<0.05;* ***p<0.01***

7.1.2 Madison Avenue

Madison Ave. Corridor Difference-in-Difference Estimates

	Dependent variable:	
	CNS07 Retail Emp.	CNS18 Food Emp.
TypeControl: Cooper	-348.500***	-196.250**
	(22.577)	(78.337)
TypeControl: Highland	-246.750***	-71.875
	(22.577)	(78.337)
TypeControl: Union	-40.750*	143.500*
	(22.577)	(78.337)
prepost	-20.625	-4.625
	(27.652)	(95.943)
DID estimator: Cooper	14.75	127.5
	(39.105)	(135.684)
DID estimator: Highland	-56.5	117.375
	(39.105)	(135.684)
DID estimator: Union	-40.5	91.5
	(39.105)	(135.684)
Constant	472.875***	523.625***
	(15.965)	(55.393)
Observations	48	48
R^2	0.925	0.434
Adjusted R^2	0.912	0.335
Residual Std. Error (df = 40)	45.155	156.674
F Statistic (df = 7; 40)	70.415***	4.387***
Note:		p<0.1; p<0.05; p<0.01

Madison Ave. Corridor Interrupted Time Series Estimates

	Dependent variable:	
	CNS07 Retail Emp.	CNS18 Food Emp.
Yearly trend	14.679	-10.464
	(8.921)	(7.065)
Level change	174.579	-1,152.114***
	(276.696)	(219.143)
Slope change	-26.979	115.264***
	(27.35)	(21.661)
Constant	406.821***	570.714***
	(45.047)	(35.677)
Observations	12	12
R^2	0.29	0.78
Adjusted R^2	0.024	0.698
Residual Std. Error (df = 8)	57.812	45.787
F Statistic (df = 3; 8)	1.091	9.472***
Note:		p<0.1; p<0.05; p<0.01

7.2 Sales Tax

7.2.1 Broad Avenue

Broad Ave. Corridor Difference-in Difference Estimates

	Dependent variable:	
	gross_sales	business
TypeControl: Central	10,012,101**	15.655***
	(4,785,404)	(2.214)
TypeControl: Cooper	56,674,377***	29.947***
	(4,785,404)	(2.214)
prepost	4,171,963	7.922***
	(4,368,456)	(2.022)
DID estimator: Central	3,094,667	-6.915**
	(6,177,930)	(2.859)
DID estimator: Cooper	14,484,859**	-2.415
	(6,177,930)	(2.859)
Constant	3,724,262	6.324***
	(3,383,792)	(1.566)
Observations	30	30
R^2	0.958	0.949
Adjusted R^2	0.95	0.938
Residual Std. Error (df = 24)	6,767,583	3.132
F Statistic (df = 5; 24)	110.284***	88.431***
Note:		*p<0.1; **p<0.05;* ***p<0.01

Broad Ave. Corridor Time Series Estimates

	Dependent variable:	
	gross_sales	business
Yearly trend	248,699.6	0.523
	(241,748.2)	(0.5)
Level change	-3,842,012**	-8.678**
	(1,194,265)	(2.468)
Slope change	902,730.3**	1.865**
	(274,116.7)	(0.566)
Constant	3,102,513***	5.016**
	(662,054.8)	(1.368)
Observations	10	10
R^2	0.974	0.971
Adjusted R^2	0.961	0.957
Residual Std. Error (df = 6)	540,565.5	1.117
F Statistic (df = 3; 6)	74.470***	67.249***
Note:		*p<0.1; **p<0.05;* ***p<0.01

7.2.2 Madison Avenue

Madison Ave. Corridor Difference-in-Difference Estimates

	Dependent variable:	
	gross_sales	business
TypeControl: Cooper	-90,151,456***	-58.577***
	(11,297,117)	(3.382)
TypeControl: Highland	-106,100,132***	-40.597***
	(11,297,117)	(3.382)
TypeControl: Union	20,952,570*	-5.194
	(11,297,117)	(3.382)
prepost	24,907,011.**	3.05
	(11,297,117)	(3.382)
DID estimator: Cooper	-2,714,756	3.567
	(15,976,536)	(4.783)
DID estimator: Highland	-18,361,986	-1.778
	(15,976,536)	(4.783)
DID estimator: Union	-18,079,759	0.9
	(15,976,536)	(4.783)
Constant	150,648,061.***	94.844***
	(7,988,268)	(2.392)
Observations	40	40
R^2	0.925	0.962
Adjusted R^2	0.909	0.954
Residual Std. Error (df = 32)	17,862,311	5.348
F Statistic (df = 7; 32)	56.468***	116.551***
Note:		*p<0.1; **p<0.05;* ***p<0.01

Madison Ave. Corridor Time Series Estimates

	Dependent variable:	
	gross_sales	business
Yearly trend	-6,620,538	-1.065
	(3,937,011)	(1.718)
Level change	-64,301,562	-57.938***
	(34,547,128)	(15.078)
Slope change	15,288,908**	8.289**
	(5,567,774)	(2.43)
Constant	170,509,676***	98.038***
	(13,057,587)	(5.699)
Observations	10	10
R^2	0.747	0.759
Adjusted R^2	0.62	0.638
Residual Std. Error (df = 6)	12,449,921	5.434
F Statistic (df = 3; 6)	5.894**	6.282**
Note:		*p<0.1; **p<0.05;* ***p<0.01

7.3 QCEW

7.3.1 Broad Avenue

Broad Ave. Corridor Difference-in-Difference Estimates (Employment)

	Dependent variable:		
	CNS07 Retail Emp.	CNS18 Food Emp.	business 'Business' Emp.
TypeControl: Central Ave	28.286***	24	52.286**
	(8.033)	(18.998)	(23.39)
TypeControl: S Cooper St	59.571***	18.429	78.000***
	(8.033)	(18.998)	(23.39)
prepost	16.286*	70.571***	86.857***
	(8.033)	(18.998)	(23.39)
TypeControl: Central Ave:prepost	0.714	26	26.714
	(11.36)	(26.867)	(33.078)
TypeControl: S Cooper St:prepost	32.143***	55.571**	87.714**
	(11.36)	(26.867)	(33.078)
Constant	2.714	20.429	23.143
	(5.68)	(13.434)	(16.539)
Observations	42	42	42
R^2	0.862	0.729	0.804
Adjusted R^2	0.843	0.692	0.777
Residual Std. Error (df = 36)	15.028	35.542	43.758
F Statistic (df = 5; 36)	45.154***	19.397***	29.494***
Note:			*p<0.1; p<0.05;* p<0.01

Broad Ave. Corridor Difference-in-Difference Estimates (Wage)

	Dependent variable:		
	CNS07 Retail Wage	CNS18 Food Wage	business 'Business' Wage
TypeControl: Central Ave	416,048.9	452,342.4	868,391.3
	-265,345.40	-372,838.50	-554,005.10
TypeControl: S Cooper St	1,331,515***	417,505.9	1,749,021***
	-265,345.40	-372,838.50	-554,005.10
prepost	513,212.4*	923,699**	1,436,911**
	-265,345.4	-372,838.50	-554,005.10
TypeControl: Central Ave:prepost	-308,656.1	654,395.1	345,739
	-375,255	-527,273.20	-783,481.60
TypeControl: S Cooper St:prepost	1,191,443***	1,200,210**	2,391,653***
	-375,255	-527,273.20	-783,481.60
Constant	99,559.43	181,588	281,147.4
	-187,627.50	-263,636.60	-391,740.80
Observations	42	42	42
R^2	0.825	0.669	0.774
Adjusted R^2	0.801	0.623	0.742
Residual Std. Error (df = 36)	496,415.7	697,516.9	1,036,449
F Statistic (df = 5; 36)	33.954***	14.562***	24.593***
Note:			*p<0.1; p<0.05;* p<0.01

Broad Ave. Corridor Interrupted Time Series Estimates (Employment)

	Dependent variable:		
	CNS07 Retail Emp.	CNS18 Food Emp.	business 'Business' Emp.
ts_year	1.714*	3.929	5.643
	(0.873)	(4.016)	(4.764)
prepost	25.893**	115.750**	141.643**
	(10.512)	(48.363)	(57.368)
ts_year:prepost	-1.964	-6.607	-8.571
	(1.235)	(5.68)	(6.737)
Constant	-4.143	4.714	0.571
	(3.904)	(17.962)	(21.306)
Observations	14	14	14
R^2	0.826	0.8	0.812
Adjusted R^2	0.774	0.74	0.756
Residual Std. Error (df = 10)	4.619	21.252	25.209
F Statistic (df = 3; 10)	15.813***	13.331***	14.443***
Note:			*p<0.1; p<0.05;* p<0.01

Broad Ave. Corridor Interrupted Time Series Estimates (Wage)

	Dependent variable:		
	CNS07 Retail Wage	CNS18 Food Wage	business 'Business' Wage
ts_year	63,133.96**	44,084.93***	107,218.9***
	(20,125.89)	(10,417.93)	(22,309.48)
prepost	113,153.2	-498,235.4***	-385,082.1
	(242,347.8)	(125,448.5)	(268,641.7)
ts_year:prepost	-3,807.143	101,212.7***	97,405.57**
	(28,462.3)	(14,733.18)	(31,550.37)
Constant	-152,976.4	5,248.286	-147,728.1
	(90,005.7)	(46,590.41)	(99,771.02)
Observations	14	14	14
R^2	0.909	0.992	0.984
Adjusted R^2	0.882	0.989	0.98
Residual Std. Error (df = 10)	106,496.2	55,126.52	118,050.7
F Statistic (df = 3; 10)	33.271***	398.364***	208.592***
Note:			*p<0.1; p<0.05;* p<0.01

7.3.2 Madison Avenue

Madison Ave. Corridor Difference-in-Difference Estimates (Employment)

	Dependent variable:		
	CNS07 Retail Emp.	CNS18 Food Emp.	business 'Business' Emp.
TypeControl: S Cooper St	-95.875***	-375.375***	-471.250***
	(30.778)	(56.037)	(79.335)
TypeControl: S Highland St	-96.375***	-282.250***	-378.625***
	(30.778)	(56.037)	(79.335)
TypeControl: Union Ave	163.125***	17.75	180.875**
	(30.778)	(56.037)	(79.335)
prepost	65.667*	339.000***	404.667***
	(33.244)	(60.527)	(85.692)
TypeControl: S Cooper St:prepost	-11.125	-199.458**	-210.583*
	(47.014)	(85.599)	(121.187)
TypeControl: S Highland St:prepost	-9.458	-205.250**	-214.708*
	(47.014)	(85.599)	(121.187)
TypeControl: Union Ave:prepost	95.208**	113.583	208.792*
	(47.014)	(85.599)	(121.187)
Constant	159.000***	417.500***	576.500***
	(21.763)	(39.624)	(56.099)
Observations	56	56	56
R^2	0.845	0.873	0.877
Adjusted R^2	0.822	0.854	0.859
Residual Std. Error (df = 48)	61.556	112.075	158.671
F Statistic (df = 7; 48)	37.315***	46.995***	48.866***
Note:			*p<0.1; p<0.05;* p<0.01

Madison Ave. Corridor Difference-in-Difference Estimates (Wage)

	Dependent variable:		
	CNS07 Retail Wage	CNS18 Food Wage	business 'Business' Wage
TypeControl: S Cooper St	-1,259,970***	-6,090,435***	-7,350,405***
	(441,902.2)	(918,457.4)	(1,089,526)
TypeControl: S Highland St	-1,261,179***	-5,316,280***	-6,577,459***
	(441,902.2)	(918,457.4)	(1,089,526)
TypeControl: Union Ave	6,252,991***	-1,276,678	4,976,313***
	(441,902.2)	(918,457.4)	(1,089,526)
prepost	332,869.5	5,920,253***	6,253,122***
	(477,309)	(992,047.4)	(1,176,823)
TypeControl: S Cooper St:prepost	1,307,796*	-3,604,991**	-2,297,195
	(675,016.8)	(1,402,967)	(1,664,279)
TypeControl: S Highland St:prepost	1,285,857*	-3,936,700***	-2,650,843
	(675,016.8)	(1,402,967)	(1,664,279)
TypeControl: Union Ave:prepost	885,488.6	-1,615,372	-729,883.6
	(675,016.8)	(1,402,967)	(1,664,279)
Constant	2,840,231***	6,759,229***	9,599,459***
	(312,472.1)	(649,447.5)	(770,411.4)
Observations	56	56	56
R^2	0.937	0.833	0.897
Adjusted R^2	0.928	0.809	0.882
Residual Std. Error (df = 48)	883,804.4	1,836,915	2,179,052
F Statistic (df = 7; 48)	102.048***	34.181***	59.967***
Note:			*p<0.1; p<0.05;* p<0.01

Madison Ave. Corridor Interrupted Time Series Estimates (Employment)

	Dependent variable:		
	CNS07 Retail Emp.	CNS18 Food Emp.	business 'Business' Emp.
ts_year	-14.643***	1.524	-13.119
	(4.071)	(6.841)	(7.553)
prepost	253.431***	358.671**	612.102***
	(76.146)	(127.967)	(141.29)
ts_year:prepost	-7.414	-2.638	-10.052
	(7.506)	(12.614)	(13.928)
Constant	224.893***	410.643***	635.536***
	(20.556)	(34.546)	(38.142)
Observations	14	14	14
R^2	0.823	0.952	0.96
Adjusted R^2	0.77	0.938	0.948
Residual Std. Error (df = 10)	26.382	44.335	48.951
F Statistic (df = 3; 10)	15.471***	66.838***	80.414***
Note:			*p<0.1; p<0.05;* p<0.01

Madison Ave. Corridor Interrupted Time Series Estimates (Wage)

	Dependent variable:		
	CNS07 Retail Wage	CNS18 Food Wage	business 'Business' Wage
ts_year	-151,107.7***	204,190.5	53,082.73
	(41,764.3)	(146,815.4)	(163,815.3)
prepost	-3,897,261***	-21,786,975***	-25,684,236***
	(781,226.8)	(2,746,272)	(3,064,265)
ts_year:prepost	459,816***	2,285,034***	2,744,850***
	(77,009.56)	(270,714.2)	(302,060.4)
Constant	3,520,215***	5,840,372***	9,360,587***
	(210,899.4)	(741,381.5)	(827,226.5)
Observations	14	14	14
R^2	0.804	0.962	0.96
Adjusted R^2	0.745	0.951	0.948
Residual Std. Error (df = 10)	270,663.6	951,472.6	1,061,644
F Statistic (df = 3; 10)	13.681***	84.817***	80.2***
Note:			*p<0.1; p<0.05;* p<0.01